CONTRACT 950137

RANGER TV SUBSYSTEM (BLOCK III) FINAL REPORT

VOLUME 4b: APPENDICES

Prepared For:

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Appendix A

Tabulations for Preliminary Reliability Analysis

TABLE A-1
PRELIMINARY PARTS-COUNT RELIABILITY ANALYSIS FOR RANGER
BREAKDOWN OF SUBSYSTEMS BY COMPONENTS

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Communications												
Transmitter 1	Parts	9	18	75	49	38	15	3	2	8		
	F. Rate @ 25°C	0.360	0.635	1.007	1.177	0.445	0.710	1.000	6.000	0.706	217	12.040
	F. Rate @ 70°C	0.378	0.705	3.337	1.976	0.980	0.710	1.175	7.000	1.036		17.297
Transmitter 2	Parts	9	18	75	49	38	15	3	2	8	217	
	F. Rate @ 25°C	0.360	0.635	1.007	1.177	0.445	0.710	1.000	6.000	0.706		12.040
	F. Rate @ 70°C	0.378	0.705	3.337	1.976	0.980	0.710	1.175	7.000	1.036		17.297
R.F. Output	Parts		2			2	25			7	36	
	F. Rate @ 25°C		0.090			0.050	1.000			12.050		13.190
	F. Rate @ 70°C		0.100			0.150	1.000			13.138		14.388
Transmitter Telemetry Components	Parts	12	14	24	60	6	8	1		2	127	
	F. Rate @ 25°C	0.480	0.440	0.444	1.140	0.060	0.740	16.200		0.119		19.623
	F. Rate @ 70°C	0.504	0.486	1.184	1.800	0.120	0.740	16.200		0.290		21.324
Cruise Mode Telemetry	Parts	3	5	19	27	5	7	1		4	76	
	F. Rate @ 25°C	0.320	0.190	0.319	0.513	0.090	0.295	0.300		3.139		5.166
	F. Rate @ 70°C	0.336	0.211	0.968	0.810	0.300	0.295	0.300		3.310		6.580
Total for Communications												
	Parts	38	57	193	185	89	70	8	4	27	671	
	F. Rate @ 25°C	1.520	1.990	2.777	4.007	1.090	3.455	18.500	12.000	16.720		62.059
	F. Rate @ 70°C	1.596	2.207	8.826	6.562	2.530	3.455	18.900	14.000	18.810		76.886
TV Cameras and Circuitry												
F-Scan Cameras	Part	220	342	256	620	10	14	8	2	14	1486	
	F.Rate @ 25°C	8.800	11.010	2.268	12.534	0.210	1.800	3.200	8.000	2.737		50.659
	F.Rate @ 70°C	9.240	12.136	5.910	20.712	0.950	1.900	3.800	9.000	3.155		66.803
P-Scan Cameras	Parts	463	694	558	1309	43	29	16	4	24	3140	
	F.Rate @ 25°C	18.520	22.320	4.904	26.379	0.650	3.920	6.400	16.000	4.736		103.829
	F.Rate @ 70°C	19.446	24.602	12.694	43.494	2.360	3.920	7.600	18.000	5.400		137.516
Video Mixing Amplifiers	Parts	30	114	27	102		15	1			289	
	F. Rate @ 25°C	1.200	4.140	0.072	1.983		1.260	0.300				8.955
	F. Rate @ 70°C	1.260	4.578	0.138	3.366		1.260	0.350				10.952

TABLE A-1
PRELIMINARY PARTS-COUNT RELIABILITY ANALYSIS FOR RANGER BREAKDOWN OF SUBSYSTEMS BY COMPONENTS (Continued)

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
TV Cameras and Circuitry (Cont'd)												
Tone Code Generators	Parts	18	18	35	56		7				134	
	F. Rate @ 25°C	0.720	0.810	0.488	1.100		0.525					3.649
	F. Rate @ 70°C	0.756	0.885	1.150	1.791		0.525					5.107
Totals for T.V.	Parts	731	1168	876	2087	53	65	25	6	38	5049	
	F. Rate @ 25°C	29.240	38.280	7.732	42.002	0.860	7.605	9.900	24.000	7.473		167.092
	F. Rate @ 70°C	30.702	42.201	19.892	69.363	3.310	7.605	11.750	27.000	8.555		220.378
Control Programmer and Camera Sequencer												
"Selective" Or Gate and 2-18 KC Oscillators	Parts	10	14	6	30		3				63	
	F. Rate @ 25°C	0.400	0.400	0.015	0.548		0.315					1.678
	F. Rate @ 70°C	0.420	0.436	0.036	0.900		0.315					2.107
Cameras A, B, Sequencer (18 ctrs, 50 gts)*	Parts	50	358	136	380		68				992	
	F. Rate @ 25°C	3.440	10.740	0.544	8.712		7.140					30.576
	F. Rate @ 70°C	3.612	11.814	1.088	15.050		7.140					38.704
Cameras 1,2,3,4 Sequencer (16 ctrs, 60 gts)	Parts	92	396	152	400		76				1116	
	F. Rate @ 25°C	3.680	11.880	0.608	9.144		7.980					33.292
	F. Rate @ 70°C	3.864	13.068	1.216	15.820		7.980					41.948
Counter Circuitry (22 ctrs, 15 gts)	Parts	59	207	148	280		37				731	
	F. Rate @ 25°C	2.360	6.210	0.592	6.498		3.855					19.515
	F. Rate @ 70°C	2.748	6.831	1.184	11.155		3.855					25.503
A, B, Sequencer Power Supply	Parts	10	12	6	16	1	2	1			48	
	F. Rate @ 25°C	0.400	0.540	0.173	0.390	0.040	0.210	0.300				2.053
	F. Rate @ 70°C	0.420	0.600	0.481	0.660	0.200	0.210	0.350				2.921
1,2,3,4 Sequencer Power Supply	Parts	10	12	6	16	1	2	1			48	
	F. Rate @ 25°C	0.400	0.540	0.173	0.390	0.040	0.210	0.300				2.053
	F. Rate @ 70°C	0.420	0.600	0.481	0.660	0.200	0.210	0.350				2.921

*ctrs. = counters
gts. = gates

TABLE A-1
PRELIMINARY PARTS-COUNT RELIABILITY ANALYSIS FOR RANGER
BREAKDOWN OF SUBSYSTEMS BY COMPONENTS (Continued)

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Totals for Programmer-Sequencer												
	Parts	231	999	454	1122	2	188	2			2998	
	F. Rate @ 25°C	10.680	30.310	2.105	25.682	0.080	19.710	0.600				89.167
	F. Rate @ 70°C	11.214	33.349	4.486	44.245	0.400	19.710	0.700				114.104
Test and Control Function												
Test Mode Switch	Parts		1				1	1			3	
	F. Rate @ 25°C		0.045				0.120	3.000				3.165
	F. Rate @ 70°C		0.050				0.120	3.200				3.370
Operational Switch	Parts						1	1			2	
	F. Rate @ 25°C						0.120	3.000				3.120
	F. Rate @ 70°C						0.120	3.200				3.320
Operational Switch Driving Amp.	Parts	2	1		4		1				8	
	F. Rate @ 25°C	0.080	0.045		0.164		0.075					9.364
	F. Rate @ 70°C	0.084	0.050		0.296		0.075					0.505
Totals for Test and Control												
	Parts	2	2		4		3	2			13	
	F. Rate @ 25°C	0.080	0.090		0.164		0.315	6.000				6.649
	F. Rate @ 70°C	0.084	0.100		0.296		0.315	6.400				7.195
Power Source and Regulator												
(2) Prime Power Sources	Parts		2				1	2		2	7	
	F. Rate @ 25°C		0.090				0.145	0.300		1.000		1.535
	F. Rate @ 70°C		0.100				0.145	0.350		1.500		2.095
Series Regulating Control Elements and Driver	Parts	3		1				2			6	
	F. Rate @ 25°C	0.120		0.043				0.300				0.463
	F. Rate @ 70°C	0.126		0.120				0.350				0.596
Error Detector and Reference	Parts	2	1		6		1			1	11	
	F. Rate @ 25°C	0.080	0.045		0.114		0.120			0.069		0.428
	F. Rate @ 70°C	0.084	0.050		0.180		0.120			0.080		0.514
Error Amplifier	Parts	2		1	2		1				6	
	F. Rate @ 25°C	0.080		0.002	0.038		0.120					0.240
	F. Rate @ 70°C	0.084		0.006	0.060		0.120					0.270

TABLE A-1
PRELIMINARY PARTS-COUNT RELIABILITY ANALYSIS FOR RANGER
BREAKDOWN OF SUBSYSTEMS BY COMPONENTS (Continued)

Subsystems by Components	Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Totals Power Supply and Regulator											
Parts	7	3	2	8		3	4		3	30	
F. Rate @ 25°C	0.280	0.135	0.045	0.152		0.385	0.600		1.069		2.666
F. Rate @ 70°C	0.294	0.150	0.126	0.240		0.385	0.700		1.580		3.475

TABLE A-2
BREAKDOWN OF TRANSMITTER 1 OR 2 FOR RANGER PARTS-COUNT RELIABILITY ANALYSIS

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Transmitter No. 1 or 2												
FM Modulator	Parts	4	8	27	25	8	4	1		5	82	
	F. Rate @ 25°C	0.160	0.250	0.271	0.721	0.090	0.160	0.400		0.617		2,669
	F. Rate @ 70°C	0.168	0.276	1.282	1.256	0.170	0.160	0.475		0.936		4.723
X12 Multiplier	Parts	3	6	27	18	21	3				78	
	F. Rate @ 25°C	0.120	0.210	0.402	0.342	0.215	0.155					1.444
	F. Rate @ 70°C	0.126	0.234	1.069	0.540	0.430	0.155					2.554
X4 Multiplier	Parts		1	2			2				5	
	F. Rate @ 25°C		0.040	0.004			0.080					0.124
	F. Rate @ 70°C		0.045	0.005			0.080					0.130
Intermediate Power Amplifier	Parts			8		4	2		1	1	16	
	F. Rate @ 25°C			0.077		0.040	0.100		3.000	0.010		3.227
	F. Rate @ 70°C			0.186		0.030	0.100		3.500	0.010		3.876
Power Amp. (60w)	Parts			7	1	4	3		1	2	18	
	F. Rate @ 25°C			0.139	0.019	0.060	0.140		3.000	0.079		3.437
	F. Rate @ 70°C			0.356	0.030	0.100	0.140		3.500	0.090		4.216
Power Supply	Parts	2	3	4	5	1	1	2			18	
	F. Rate @ 25°C	0.080	0.135	0.114	0.095	0.040	0.075	0.600				1.139
	F. Rate@ 70°C	0.084	0.150	0.439	0.150	0.200	0.075	0.700				1.798
Totals for Transmitter 1 or 2												
	Parts	9	18	75	49	38	15	3	2	8	217	
	F. Rate @ 25°C	0.360	0.635	1.007	1.177	0.445	0.710	1.000	6.000	0.706		12.040
	F. Rate @ 70°C	0.378	0.705	3.337	1.976	0.980	0.710	1.175	7.000	1.036		17.297

TABLE A-3
BREAKDOWN OF CRUISE-MODE TELEMETRY FOR RANGER PARTS-COUNT RELIABILITY ANALYSIS

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Cruise Mode Telemetry	Parts									4	4	
	F. Rate @ 25°C									3.139		3.139
	F. Rate @ 70°C									3.310		3.310
Channel-8 VCO	Parts	5	3	15	20	3	3				49	
	F. Rate @ 25°C	0.200	0.100	0.204	0.380	0.030	0.090					1.004
	F. Rate @ 70°C	0.210	0.111	0.528	0.600	0.060	0.090					1.599
AC Amplifier	Parts	1		1	4	1	3				12	
	F. Rate @ 25°C	0.040		0.087	0.076	0.020	0.130					0.353
	F. Rate @ 70°C	0.042		0.241	0.120	0.040	0.130					0.573
Power Supply	Parts	2	2	1	3	1	1	1			11	
	F. Rate @ 25°C	0.080	0.090	0.028	0.057	0.040	0.075	0.300				0.670
	F. Rate @ 70°C	0.084	0.100	0.199	0.090	0.200	0.075	0.350				1.098
Totals	Parts	8	5	19	27	5	7	1		4	76	
	F. Rate @ 25°C	0.320	0.190	0.319	0.513	0.090	0.295	0.300		3.139		5.166
	F. Rate @ 70°C	0.336	0.211	0.968	0.810	0.300	0.295	0.350		3.310		6.580

TABLE A-4
BREAKDOWN OF TV CAMERA A FOR RANGER PARTS-COUNT RELIABILITY ANALYSIS

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Camera A (w/color wheel)	Parts						1	4	1	5	11	
	F. Rate @ 25°C						0.230	1.600	4.000	0.444		6.274
	F. Rate @ 70°C						0.230	1.900	4.500	0.680		7.310
6.3 Regulator, DC Converter and Hi Voltage Regulator	Parts	25	48	21	50	4	1				149	
	F. Rate @ 25°C	1.000	1.800	0.606	0.950	0.080	0.120					4.556
	F. Rate @ 70°C	1.050	1.992	1.684	1.500	0.400	0.120					6.746
Deflection Amps.	Parts	22	58	24	78		1				183	
	F. Rate @ 25°C	0.880	1.740	0.024	1.692		0.120					4.456
	F. Rate @ 70°C	0.924	1.914	0.024	2.900		0.120					5.882
Video Amps. and Pre Amps.	Parts	15	3	22	45		1			1	87	
	F. Rate @ 25°C	0.600	0.090	0.154	0.855		0.120			0.040		1.859
	F. Rate @ 70°C	0.630	0.099	0.363	1.350		0.120			0.045		2.607
Grid 1 Regulator and Telemetry Link Monitor	Parts	16	11	16	31		1			1	76	
	F. Rate @ 25°C	0.640	0.330	0.073	0.570		0.120			0.069		1.802
	F. Rate @ 70°C	0.672	0.363	0.226	0.930		0.120			0.080		2.391
Programmer	Parts	20	50	22	70		1				163	
	F. Rate @ 25°C	0.800	1.500	0.022	1.516		0.120					3.958
	F. Rate @ 70°C	0.840	1.650	0.022	2.596		0.120					5.228
Shutter and Drive Amp.	Parts	12	1	23	36	1	1			1	75	
	F. Rate @ 25°C	0.480	0.045	0.255	0.684	0.025	0.120			1.000		2.609
	F. Rate @ 70°C	0.504	0.050	0.636	1.080	0.075	0.120			1.000		3.465
Totals for Camera A	Parts	110	171	128	310	5	7	4	1	8	744	
	F. Rate @ 25°C	4.400	5.505	1.134	6.267	0.105	0.950	1.600	4.000	1.553		25.514
	F. Rate @ 70°C	4.620	6.068	2.955	10.356	0.475	0.950	1.900	4.500	1.805		33.629

TABLE A-5
BREAKDOWN USED FOR CAMERAS B, 2, 3 OR 4 IN RANGER PARTS-COUNT RELIABILITY ANALYSIS

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Camera Type Used for B, 2, 3, and 4	Parts						1	4	1	3	9	
	F. Rate @ 25°C						0.230	1.600	4.000	0.075		5.905
	F. Rate @ 70°C						0.230	1.900	4.500	0.225		6.855
6.3v Reg., DC Conv. HV Regulator	Parts	25	48	21	50	4	1				149	
	F. Rate @ 25°C	1.000	1.800	0.606	0.950	0.080	0.120					4.556
	F. Rate @ 70°C	1.050	1.992	1.684	1.500	0.400	0.120					6.746
Deflection Amps.	Parts	22	58	24	78		1				183	
	F. Rate @ 25°C	0.880	1.740	0.024	1.692		0.120					4.456
	F. Rate @ 70°C	0.924	1.914	0.024	2.900		0.120					5.882
Video Amps and Pre-Amps	Parts	15	3	22	45		1			1	87	
	F. Rate @25°C	0.600	0.090	0.154	0.855		0.120			0.040		1.859
	F. Rate @70°C	0.630	0.099	0.363	1.350		0.120			0.045		2.607
Grid 1 Reg. and Telemetry Link Monitor	Parts	16	11	16	31		1			1	76	
	F. Rate @ 25°C	0.640	0.330	0.073	0.570		0.120			0.069		1.802
	F. Rate @ 70°C	0.672	0.363	0.226	0.930		0.120			0.080		2.391
Programmer	Parts	20	50	22	70		1				163	
	F. Rate @ 25°C	0.800	1.500	0.022	1.516		0.120					3.958
	F. Rate @ 70°C	0.840	1.650	0.022	2.596		0.120					5.228
Shutter and Drive Amp.	Parts	12	1	23	36	1	1			1	75	
	F. Rate @ 25°C	0.480	0.045	0.255	0.684	0.025	0.120			1.000		2.609
	F. Rate @ 70°C	0.504	0.050	0.636	1.080	0.075	0.120			1.000		3.465
Totals for One Camera	Parts	110	171	128	310	5	7	4	1	6	742	
	F. Rate @ 25°C	4.400	5.505	1.134	6.267	0.105	0.950	1.600	4.000	1.184		25.145
	F. Rate @ 70°C	4.620	6.068	2.955	10.356	0.475	0.950	1.900	4.500	1.350		33.174

TABLE A-6
BREAKDOWN OF CAMERA 1 FOR RANGER PARTS-COUNT RELIABILITY ANALYSIS

Subsystems by Components		Transistor	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Misc.	Total Parts	Total Failure Rates
Camera 1 (with Internal Sync)	Parts						1	4	1	3	3	
	F. Rate @ 25°C						0.230	1.600	4.000	0.075		5.905
	F. Rate @ 70°C						0.230	1.900	4.500	0.225		6.855
6.3v Reg., DC Conv. and HV Regulator	Parts	25	48	21	50	4	1				149	
	F. Rate @ 25°C	1.000	1.800	0.606	0.950	0.080	0.120					4.556
	F. Rate @70°C	1.050	1.992	1.684	1.500	0.400	0.120					6.746
Synchronizer	Parts	23	10	46	69	23	1				172	
	F. Rate @ 25°C	0.920	0.300	0.368	1.311	0.230	0.120					3.249
	F. Rate @ 70°C	0.966	0.330	0.874	2.070	0.460	0.120					4.820
Deflection Amps.	Parts	22	58	24	78		1				183	
	F. Rate @ 25°C	0.880	1.740	0.024	1.692		0.120					4.456
	F. Rate @ 70°C	0.924	1.914	0.024	2.900		0.120					5.882
Video Amps and Pre-Amps.	Parts	15	3	22	45		1			1	87	
	F. Rate @ 25°C	0.600	0.090	0.154	0.855		0.120			0.040		1.859
	F. Rate @ 70°C	0.630	0.099	0.363	1.350		0.120			0.045		2.607
Grid 1 Reg and Telemetry Link Monitor	Parts	16	11	16	31		1			1	76	
	F. Rate @ 25°C	0.640	0.330	0.073	0.570		0.120			0.069		1.802
	F. Rate @ 70°C	0.672	0.363	0.226	0.930		0.120					2.391
Programmer	Parts	20	50	22	70		1				163	
	F. Rate @25°C	0.800	1.500	0.022	1.516		0.120					3.958
	F. Rate @70°C	0.840	1.650	0.022	2.596							5.228
Shutter and Drive Amp.	Parts	12	1	23	36	1	1			1	75	
	F. Rate @ 25°C	0.480	0.045	0.255	0.684	0.025	0.120			1.000		2.609
	F. Rate @ 70°C	0.504	0.050	0.636	1.080	0.075	0.120			1.000		3.465
Totals for Camera 1	Parts	133	181	174	379	28	8	4	1	6	914	
	F. Rate @ 25°C	5.320	5.805	1.502	7.578	0.335	1.070	1.600	4.000	1.184		28.394
	F. Rate @70°C	5.586	6.398	3.829	12.426	0.935	1.070	1.900	4.500	1.350		37.994

Appendix B

Tabulations for Detailed Reliability Analysis

TABLE B-2
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE SEQUENCER-A9 EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Counter P Channel										
Parts	55	64	36	275	-	2	-	-	-	432
FR	1.760	0.704	0.324	11.801	-	0.270	-	-	-	14.859
Controller P Channel										
Parts	82	119	12	276	-	2	-	-	-	491
FR	2.624	2.499	0.012	12.620	-	0.550	-	-	-	18.305
Controller and Modulator										
Parts	36	72	27	178	-	2	1	-	-	316
FR	1.152	1.512	0.302	7.117	-	0.415	0.232	-	-	10.730
Controller and Timer "F" Channel										
Parts	70	118	17	267	-	2	-	-	-	474
FR	2.240	2.478	0.017	10.348	-	0.620	-	-	-	15.703
Counter F Channel										
Parts	52	58	36	268	-	2	-	-	-	416
FR	1.664	1.218	0.324	11.532	-	0.315	-	-	-	15.053
Dual Oscillator										
Parts	11	6	7	43	2	2	-	-	2	73
FR	0.352	0.126	0.021	1.451	0.054	0.280	-	-	0.040	2.324
Dual Sequencer Power Supply										
Parts	24	18	19	58	2	2	-	-	-	123
FR	0.798	0.426	0.314	3.612	0.400	0.445	-	-	-	5.995

TABLE B-1
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE COMMUNICATIONS EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Transmitter (2)										
Parts	20	66	162	172	70	28	10	6	4	536
FR	1.026	21.622	4.932	8.394	0.912	1.348	5.470	57.000	0.040	100
RF Combiner										
Parts	-	2	-	-	-	6	-	-	2	10
FR	-	2000	-	-	-	0.240	-	-	0.240	2.480
Telemetry										
Parts	8	10	14	82	4	10	2	-	4	134
FR	0.336	0.322	0.112	6.212	0.336	1.030	1.084	-	16.950	26.382
Cruise-Mode Telemetry										
Parts	9	10	10	33	5	3	-	-	4	74
FR	0.328	0.246	1.078	2.207	0.090	0.260	-	-	3.310	7.519
Total										
Parts	37	88	186	287	79	47	12	6	14	754
FR	1.690	24.190	6.132	16.813	1.338	2.878	6.554	57.000	20.540	137.125

TABLE B-2
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE SEQUENCER-A9 EQUIPMENT (Continued)

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Video Combiner										
Parts	15	6	7	74	-	-	-	-	-	102
FR	0.320	0.150	0.027	1.353	-	-	-	-	-	1.850
Analog-to-Digital Converter and Tone Oscillator										
Parts	8	-	21	28	-	-	-	-	3	60
FR	160	-	0.054	0.142	-	-	-	-	0.060	0.416
Analog-to-Digital Converter										
Parts	9	6	3	27	-	-	-	-	-	45
FR	0.180	0.06	0.022	0.835	-	-	-	-	-	1.097
Total										
Parts	362	467	185	1494	4	14	1	-	5	2532
FR	11.250	9.173	1.417	60.811	0.454	2.895	0.232	-	0.100	86.332

TABLE B-3
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE TV-CAMERA EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
F-Scan Cameras										
Parts	230	250	186	752	14	16	8	4	8	1468
FR	7.824	6.704	10.370	33.880	0.480	2.960	3.800	10.480	0.905	77.403
P-Scan Cameras										
Parts	513	529	423	1641	28	38	16	8	12	3208
FR	17.191	13.945	26.968	74.759	0.960	6.910	7.600	20.960	0.900	170.193
Total										
Parts	743	779	609	2393	42	54	24	12	20	4676
FR	25.015	20.649	37.338	108.639	1.440	9.870	11.400	31.440	1.805	247.596

TABLE B-4
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE TEST AND CONTROL EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Temp. Sensor										
Parts	-	4	-	27	-	-	-	-	-	31
FR	-	0.084	-	2.202	-	-	-	-	-	2.286
Command Switch										
Parts	4	7	2	28	-	-	2	-	-	43
FR	0.270	0.287	0.06	1.061	-	-	0.07	-	-	1.748
Total										
Parts	4	11	2	55	-	-	2	-	-	74
FR	0.270	0.371	0.060	3.263	-	-	0.07	-	-	4.034

TABLE B-5
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE POWER SOURCE AND REGULATOR EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Prime Power Sources (2)										
Parts	-	-	-	-	-	-	-	-	2	2
FR	-	-	-	-	-	-	-	-	0.750	0.750
High-Current Regulator										
Parts	7	6	2	25	-	-	-	-	-	40
FR	0.168	0.111	0.027	0.305	-	-	-	-	-	0.611
Low-Current Regulator										
Parts	3	3	1	12	-	-	-	-	-	19
FR	0.070	0.033	0.006	0.126	-	-	-	-	-	0.235
Total										
Parts	10	9	3	37	-	-	-	-	2	61
FR	0.238	0.144	0.033	0.431	-	-	-	-	0.750	1.596

TABLE B-6

COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE TRANSMITTER 1 OR 2 EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
FM Modulator										
Parts	4	11	30	34	8	5	1	-	2	95
FR	0.280	0.415	1.521	1.874	0.080	0.160	0.329	-	0.020	4.679
X12 Multiplier										
Parts	4	9	35	32	20	2	-	-	-	102
FR	0.169	6.108	0.235	0.838	0.220	0.080	-	-	-	7.650
Intermediate Power Amplifier										
Parts	-	-	4	-	4	1	-	2	-	10
FR	-	-	0.070	-	0.040	0.040	-	21.00	-	21.150
Power Amplifier										
Parts	-	-	3	3	1	3	-	1	-	11
FR	-	-	0.024	0.374	0.016	0.014	-	7.50	-	7.928
Power Supply										
Parts	2	10	7	9	2	2	4	-	-	36
FR	0.064	2.239	0.560	0.573	0.100	0.250	2.406	-	-	6.192
X4 Multiplier										
Parts	-	2	2	1	-	-	-	-	-	5
FR	-	2.000	0.056	0.030	-	-	-	-	-	2.086
Transmitter										
Parts	-	1	-	7	-	1	-	-	-	9
FR	-	0.049	-	0.508	-	0.130	-	-	-	0.687

TABLE B-6
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE TRANSMITTER 1 OR 2 EQUIPMENT (Continued)

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Total										
Parts	10	33	81	86	35	14	5	2	2	268
FR	0.513	10.811	2.466	4.197	0.456	0.674	2.735	3.000	0.020	50.372

TABLE B-7
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE RF-COMBINER EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Four-Part Hybrid										
Parts	-	-	-	-	-	-	-	-	1	1
FR	-	-	-	-	-	-	-	-	0.160	0.160
Dummy Load										
Parts	-	-	-	-	-	-	-	-	1	1
FR	-	-	-	-	-	-	-	-	0.080	0.080
Signal Sampler (2)										
Parts	-	2	-	-	-	6	-	-	-	8
FR	-	2.000	-	-	-	0.240	-	-	-	2.240
Total										
Parts	-	2	-	-	-	6	-	-	2	10
FR	-	2.000	-	-	-	0.240	-	-	0.240	2.48

TABLE B-8
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE TRANSMITTER TELEMETRY EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
90-Contact Commutator										
Parts	-	-	-	-	-	-	-	-	4	4
FR	-	-	-	-	-	-	-	-	16.950	16.950
225KC VCO (2)										
Parts	8	4	14	52	4	2	-	-	-	84
FR	0.336	0.196	0.112	4.964	0.336	0.130	-	-	-	6.074
Telemetry Processor (2)										
Parts	-	4	-	26	-	2	-	-	-	32
FR	-	0.084	-	1.134	-	0.260	-	-	-	1.478
Telemetry Unit										
Parts	-	2	-	4	-	6	2	-	-	14
FR	-	0.042	-	0.114	-	0.640	1.084	-	-	1.880
Total										
Parts	8	10	14	82	4	10	2	-	4	134
FR	0.336	0.322	0.122	6.212	0.336	1.030	1.084	-	16.950	26.382

TABLE B-9
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CRUISE-MODE TELEMETRY EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
15-Contact Commutator										
Parts	-	-	-	-	-	-	-	-	4	4
FR	-	-	-	-	-	-	-	-	3.310	3.310
Channel-8 VCO										
Parts	4	3	3	26	-	1	-	-	-	37
FR	0.168	0.099	0.010	2.046	-	0.100	-	-	-	2.423
AC Amplifier										
Parts	1	-	2	4	1	1	-	-	-	9
FR	0.032	-	0.184	0.092	0.020	0.075	-	-	-	0.403
Cruise-Mode Telemetry Power Supply										
Parts	4	7	5	3	4	1	-	-	-	24
FR	0.128	0.147	0.884	0.069	0.070	0.085	-	-	-	1.383
Total										
Parts	9	10	19	33	5	3	-	-	4	74
FR	0.328	0.246	1.078	2.207	0.090	0.260	-	-	3.310	7.519

TABLE B-10
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA A EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Vertical and Horizontal Deflector Programmer										
Parts	19	21	10	64	-	1	-	-	-	115
FR	0.608	0.441	0.073	4.024	-	0.195	-	-	-	5.341
Deflection Amplifiers A and B										
Parts	22	14	11	56	-	-	-	-	-	103
FR	0.904	0.294	0.120	1.988	-	-	-	-	-	3.106
Shutter and Lamp Drive Circuit										
Parts	15	19	2	44	-	1	-	-	-	81
FR	0.584	0.459	0.016	2.413	-	0.140	-	-	-	3.612
High-Voltage Regulator										
Parts	21	7	9	46	1	1	-	-	-	85
FR	0.702	0.189	1.219	2.697	0.010	120	-	-	-	4.937
Converter										
Parts	5	2	3	10	2	1	-	-	-	23
FR	0.248	0.084	0.774	0.290	0.190	0.195	-	-	-	1.781
Low-Voltage Regulator										
Parts	6	33	14	33	4	1	-	-	-	91
FR	0.192	1.252	1.953	1.315	0.040	0.230	-	-	-	4.982
Video Amplifier										
Parts	17	16	25	65	-	-	-	-	-	123
FR	0.544	0.336	0.342	1.739	-	-	-	-	-	2.961

TABLE B-10
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA A EQUIPMENT (Continued)

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
G1 Regulator										
Parts	10	13	14	52	-	1	-	-	-	90
FR	0.330	0.297	0.330	2.336	-	0.285	-	-	-	3.578
Preamplifier										
Parts	-	-	5	6	-	1	-	1	-	13
FR	-	-	0.358	0.138	-	0.085	-	0.740	-	1.321
Camera A										
Parts	-	-	-	-	-	1	4	1	5	11
FR	-	-	-	-	-	0.230	1.900	4.500	0.680	7.310
Total										
Parts	115	125	93	376	7	8	4	2	5	735
FR	3.912	3.352	5.185	16.940	0.240	1.480	1.900	5.240	0.680	38.929

TABLE B-11
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA B EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Vertical and Horizontal Deflection Programmer										
Parts	19	21	10	64	-	1	-	-	-	115
FR	0.608	0.441	0.073	4.024	-	0.195	-	-	-	5.341
Deflection Amplifier A and B										
Parts	22	14	11	56	-	-	-	-	-	103
FR	0.704	0.294	0.120	1.988	-	-	-	-	-	3.106
Shutter and Lamp Drive Circuit										
Parts	15	19	2	44	-	1	-	-	-	81
FR	0.584	0.459	0.016	2.413	-	0.140	-	-	-	3.612
High-Voltage Regulator										
Parts	21	7	9	46	1	1	-	-	-	85
FR	0.702	0.189	1.219	2.697	0.010	0.120	-	-	-	4.937
Converter Power Supply										
Parts	5	2	3	10	2	1	-	-	-	23
FR	0.248	0.084	0.774	0.290	0.190	0.195	-	-	-	1.781
Low-Voltage Regulator										
Parts	6	33	14	33	4	1	-	-	-	91
FR	0.192	1.252	1.953	1.315	0.040	0.230	-	-	-	4.982
Video Amplifier										
Parts	17	16	25	65	-	-	-	-	-	123
FR	0.544	0.336	0.342	1.739	-	-	-	-	-	2.961

TABLE B-11
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA B EQUIPMENT (Continued)

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
G1 Regulator										
Parts	10	13	14	52	-	1	-	-	-	90
FR	0.330	0.297	0.330	2.336	-	0.285	-	-	-	3.578
Preamplifier										
Parts	-	-	5	6	-	1	-	1	-	13
FR	-	-	0.358	0.138	-	0.085	-	0.740	-	1.321
Camera										
Parts	-	-	-	-	-	1	4	1	3	9
FR	-	-	-	-	-	0.230	1.900	4.500	0.225	6.855
Total										
Parts	115	125	93	376	7	8	4	2	3	733
FR	3.912	3.352	5.185	16.940	0.240	1.480	1.900	5.240	0.225	38.474

TABLE B-12
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA NO. 1 EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Horizontal Sync Generator										
Parts	4	11	4	20	-	1	-	-	-	40
FR	0.128	0.255	0.228	1.114	-	0.065	-	-	-	1.790
Vertical Sync Generator										
Parts	21	14	23	77	-	1	-	-	-	136
FR	0.687	0.294	2.176	3.305	-	0.145	-	-	-	6.607
Vertical and Horizontal Deflection Programmer										
Parts	19	21	10	64	-	1	-	-	-	115
FR	0.608	0.441	0.073	4.024	-	0.195	-	-	-	5.341
Deflection Amplifier Camera Nos. 1, 2, 3, or 4										
Parts	22	14	10	56	-	1	-	-	-	103
FR	0.704	0.294	0.114	1.988	-	0.195	-	-	-	3.295
Shutter and Lamp Drive Circuit										
Parts	15	19	2	44	-	1	-	-	-	81
FR	0.584	0.459	0.016	2.413	-	0.140	-	-	-	3.612
High-Voltage Regulator										
Parts	21	7	9	46	1	1	-	-	-	85
FR	0.702	0.189	1.219	2.697	0.010	0.120	-	-	-	4.937
Converter Power Supply										
Parts	5	2	3	10	2	1	-	-	-	23
FR	0.248	0.084	0.774	0.290	0.190	0.195	-	-	-	1.781

TABLE B-12
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA NO. 1 EQUIPMENT (Continued)

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Low-Voltage Regulator										
Parts	6	33	14	33	4	1	-	-	-	91
FR	0.192	1.252	1.953	1.315	0.040	0.230	-	-	-	4.982
Video Amplifier										
Parts	17	16	25	65	-	-	-	-	-	123
FR	0.544	0.336	0.342	1.739	-	-	-	-	-	2.961
G1 Regulator										
Parts	17	14	21	62	-	1	-	-	-	115
FR	0.512	0.294	1.292	2.981	-	0.285	-	-	-	5.364
Preamplifier										
Parts	-	-	5	6	-	1	-	1	-	13
FR	-	-	0.358	0.138	-	0.085	-	0.740	-	1.321
Camera No. 1 (with internal sync)										
Parts	-	-	-	-	-	1	4	1	3	9
FR	-	-	-	-	-	0.230	1.90	4.500	0.225	6.855
Total										
Parts	147	151	126	483	7	11	4	2	3	934
FR	4.909	3.898	8.545	22.004	0.240	1.885	1.900	5.240	0.225	48.846

TABLE B-13
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA NOS. 2, 3, OR 4 EQUIPMENT

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
Vertical and Horizontal Deflection Programmer										
Parts	19	21	10	64	-	1	-	-	-	115
FR	0.608	0.441	0.073	4.024	-	0.195	-	-	-	5.341
Deflection Amplifier										
Parts	22	14	10	56	-	1	-	-	-	103
FR	0.704	0.294	0.114	1.988	-	0.195	-	-	-	3.295
Shutter and Lamp Drive										
Parts	15	19	2	44	-	1	-	-	-	81
FR	0.584	0.459	0.016	2.413	-	0.140	-	-	-	3.612
High-Voltage Regulator										
Parts	21	7	9	46	1	1	-	-	-	85
FR	0.702	0.189	1.219	2.697	0.010	0.120	-	-	-	4.937
Converter Power Supply										
Parts	5	2	3	10	2	1	-	-	-	23
FR	0.248	0.084	0.774	0.290	0.190	0.195	-	-	-	1.781
Low-Voltage Regulator										
Parts	6	33	14	33	4	1	-	-	-	91
FR	0.192	1.252	1.953	1.315	0.040	0.230	-	-	-	4.982
Video Amplifier										
Parts	17	16	25	65	-	-	-	-	-	123
FR	0.544	0.336	0.342	1.739	-	-	-	-	-	2.961

TABLE B-13
COMPONENT-PART FAILURE RATES AT 70°C: SUMMATIONS FOR THE CAMERA NOS. 2, 3, OR 4 EQUIPMENT (Continued)

Equipment	Transistors	Diodes	Capacitors	Resistors	Inductive Components	Connector	Relays and Switches	Vacuum Tubes	Miscellaneous	Totals
G1 Regulator										
Parts	17	14	21	62	-	1	-	-	-	115
FR	0.512	0.294	1.292	2.981	-	2.85	-	-	-	5.364
Preamplifier										
Parts	-	-	5	6	-	1	-	1	-	13
FR	-	-	0.358	0.138	-	0.085	-	0.740	-	1.321
Camera										
Parts	-	-	-	-	-	1	4	1	3	9
FR	-	-	-	-	-	0.230	1.900	4.500	0.225	6.855
Total										
Parts	122	126	99	386	7	9	4	2	3	758
FR	4.094	3.349	6.141	17.585	0.240	1.675	1.900	5.240	0.225	40.449

Appendix C

Failure Effects Analysis of Initial System Configuration Compared to Split-System Configuration

TABLE C-1
FAILURE EFFECTS ANALYSIS OF INITIAL SYSTEM CONFIGURATION (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Camera Head (A1) (Continued)	c) Loss of camera #3 (A1A3)	Same as above	Loss of partial-scan video #3	Same as above	Same as above	D_p E_o	2	-
	d) Loss of camera #4	Same as above	Loss of partial-scan video #4	Same as above	Same as above	D_p E_o	2	-
	e) Loss of camera A (A1A5)	Same as above	Loss of full-scan video A	Same as above	Loss of 1/2 of full-scan pictures	C_F E_o	2	-
	f) Loss of camera B (A1A6)	Same as above	Loss of full-scan video B	Same as above	Same as above	C_F E_o	2	-
Camera #1 Electronics (A_2)	a) Loss of camera #1 video	1) Faulty internal circuitry 2) Faulty vidicon and shutter 3) Faulty cable or connectors 4) Loss of bias voltage 5) Shorted video combiner	Loss of partial-scan video #1	Partially redundant partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	2	Has self-contained free-running horizontal and vertical sync generators.
	b) Loss of ±6.3 volts power	Same as above	Same as above	None	None or loss of all P video, depending on status of camera #3 power	D_p E_o	2	-
Camera #2 Electronics (A3)	Loss of camera #2 video (assumes camera head is functioning properly)	Same as above, except, 6) Faulty sequencer	Loss of partial-scan video #2	Partially redundant partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	2	-
Camera #3 Electronics (A4)	Loss of camera #3 video (same assumption)	Same as above	Loss of partial-scan video #3	Same as above	Same as above	D_p E_o	2	-
Camera #4 Electronics (A5)	Loss of camera #4 video (same assumption)	Same as above	Loss of partial-scan video #4	Same as above	Same as above	D_p E_o	2	-
Camera A Electronics (A6)	Loss of camera A video (same assumption)	Same as above	Loss of full-scan video A	Partially redundant full-scan pictures	Loss of 1/2 full-scan pictures	C_F E_o	2	-
Camera B Electronics (A7)	a) Loss of camera B video (same assumption)	Same as above	Loss of full-scan video B	Same as above	Same as above	C_F E_o	2	-
	b) Loss of camera B ±6.3 volts	Same as above	Loss of A and B video	None	No full-scan pictures	A_f C_o	4	Combine ±6.3 outputs from cameras A and B
Video Combiner (A8) (Assumes good camera electronics)	a) No "P" video modulator B (assumes good camera electronics)	1) Faulty internal circuitry 2) Faulty cable or connectors 3) Loss of bias voltages 4) Shorted Load 5) Faulty sequencer	No transmitter #2 modulation signals (video)	Partial redundancy of partial-scan pictures	No partial-scan pictures until the last two minutes of mission	D_p D_o	5	Combine input power from camera electronics

TABLE C-1
FAILURE EFFECTS ANALYSIS OF INITIAL SYSTEM CONFIGURATION

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Batteries (A10, A11)	Dead or weak	1) Excessively high drain 2) Faulty heaters 3) Defective battery 4) Faulty connecting diodes	1) Loss of voltage from high-voltage regulator 2) Loss of voltage from low-voltage regulator 3) Weak or lost unregulated voltage	Redundant battery	1) None - if one battery is working 2) Complete abortion of RCA mission - if both batteries fail	A_f, A_p, A_{T90}, A_{T15} } A_o	5	-
High-Current Regulator (A12)	Loss of voltage	1) Faulty SCR switch 2) Faulty regulator 3) Shorted load 4) Low battery voltage 5) Faulty cable or connectors	1) No regulated -27.5 volts (high current) 2) no unregulated -30.5 volts	1) None 2) None	1) No partial-scan pictures 2) No full-scan pictures 3) No 90-point telemetry	A_f, A_p, A_{T90} } A_o	5	-
Low-Current Regulator (A17)	Loss of voltage	1) Faulty regulator 2) Shorted load 3) Low battery voltage 4) Faulty cable or connector	No regulated -27.5 volts (low current)	None	1) No 90-point telemetry 2) No 15-point telemetry	A_{T90}, A_{T15} } D_o	5	-
Command Switch (A13)	a) Loss of CRUISE ON command	1) No command from JPL 2) Faulty internal circuitry 3) Faulty cable or connector	No power to telemetry during cruise	None	Loss of 15-point telemetry	A_{T15} E_o	5	No back-up
	b) No WARM UP command	Same as above	No warm-up period	None	Transmitter turn-on without warm-up	-	5	Tests have been conducted where operation has been successful without warm-up.
	c) No EMERGENCY T/M command	Same as above	No emergency T/M	None	No emergency T/M	A_{T90} D_o	5	Occurs only during emergency mode operation.
	d) No EMERGENCY OFF command	Same as above	No video in transmitter	None	1) No partial-scan pictures 2) No full-scan pictures	A_p, A_f } A_o	5	Occurs only after emergency mode operation.
Camera Head (A1)	a) Loss of camera #1 (A1A1)	1) Faulty sequencer 2) Faulty connector and cables 3) Faulty internal circuitry 4) Loss of -27.5 volts regulated 5) Loss of -30.5 volts unregulated 6) Shorted camera electronics 7) Faulty vidicon 8) Faulty shutter	Loss of partial-scan video #1	Partially redundant partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	2	-
	b) Loss of camera #2 (A1A2)	Same as above	Loss of partial-scan video #2	Same as above	Same as above	D_p E_o	2	-

TABLE C-1
FAILURE EFFECTS ANALYSIS OF INITIAL SYSTEM CONFIGURATION (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Video Combiner (A8) (Continued) (Assumes good camera electronics)	b) No P video modulator A	Same as a) and 6) faulty switch over	No transmitter #1 partial-scan modulation signals	Partial redundancy of partial-scan pictures	No partial-scan pictures from transmitter #1	E_p F_o	5	Same as above
	c) No F video modulator A	Same as a)	No full-scan video	None	No full-scan video	A_f C_o	5	Same as above
Sequencer (A9) Sequencer Power Supply (A28)	a) No DC return	1) Faulty internal circuitry 2) Faulty cable or connectors 3) Loss of -27.5 volts regulated	No power amplifier (transmitter) turn-on	Redundant JPL command	None	-	4	-
	b) No 2X horizontal sync 3000 cps and 900 cps	Same as a) and 4) Shorted load	Slight reduction in video levels and sensitivity	None	Slight loss in camera sensitivity	F_p, F_F } E_o	4	-
	c) No sync pulses: 1) Horizontal 1500 cps and 450 cps 2) Vertical read 3) Shutter 4) Erase	Same as a)	1) No full-scan video 2) Partial partial-scan video	1) None 2) Self-generating sync signals in camera #1	1) No full-scan pictures 2) Loss of 3/4 of partial-scan pictures	A_F, B_p } B_o	4	-
	d) No vertical blanking sync	Same as a)	1) Continuous video 2) Loss of blanking	Partial blanking in video combiner	Blanking retrace in pictures	F_p, F_F } E_o	4	-
	e) No flash sync	Same as a)	1) Poor erase 2) Improved sensitivity	Partially redundant cameras	Multiple exposure pictures	E_P, E_F } D_o	4	-
	f) No tone burst sync	Same as a)	No tone signals	None	No camera lights at GSE	- F_o	4	-
Transmitter #1 (A14) PA #1 (A15) Sig. Samp. (A18) Power Supply (A16) IPA (A31)	No output	1) Faulty internal circuitry 2) Faulty cables and connectors 3) No DC RETURN 4) Faulty command signals 5) Loss of power	No RF	Completely redundant 90-point telemetry	No full-scan pictures	A_f C_o	1	Fuse input power leads to isolate battery in case of short. Double check all RF cables.
Transmitter #2 (A19) PA #2 (A20) Sig. Samp. (A23) Power Supply (A21) IPA (A32)	No output	Same as transmitter #1	No RF	Completely redundant 90-point telemetry	No partial-can pictures until last two minutes of mission	D_p D_o	1	Same as transmitter #1

TABLE C-1
FAILURE EFFECTS ANALYSIS OF INITIAL SYSTEM CONFIGURATION (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
4-Port Hybrid (A24) and Dummy Load (A25) RF Cabling	Low RF or loss of output	1) Cabling and/or connectors 2) Air leak	Loss of RF	None	1) Decreased signal-to-noise ratio in both channels 2) No video	E_f to A_f, E_p to A_p, E_{T90} to A_{T90} } E_o to A_o	3	Redesign dummy load in a double hermetic seal. Double check all RF cables.
Telemetry (A36) Temp Sensor (A27) T/M Processor #1 (A29) T/M Processor #2 (A30)	a) No 90-point telemetry	1) Faulty commutator 2) Faulty internal circuitry 3) Faulty processors 4) Faulty temp sensors 5) Faulty cables and connectors	Loss of telemetry points	None	Loss of telemetry up to 88 points	F_{T90} to A_{T90} } E_o	3	Most of telemetry failures occur at the take-off points and not at the telemetry complex.
	b) No 15-point telemetry	Same as above	Same as above	Same as above	Loss of telemetry up to 13 points	F_{T15} to A_{T15} } E_o	3	-

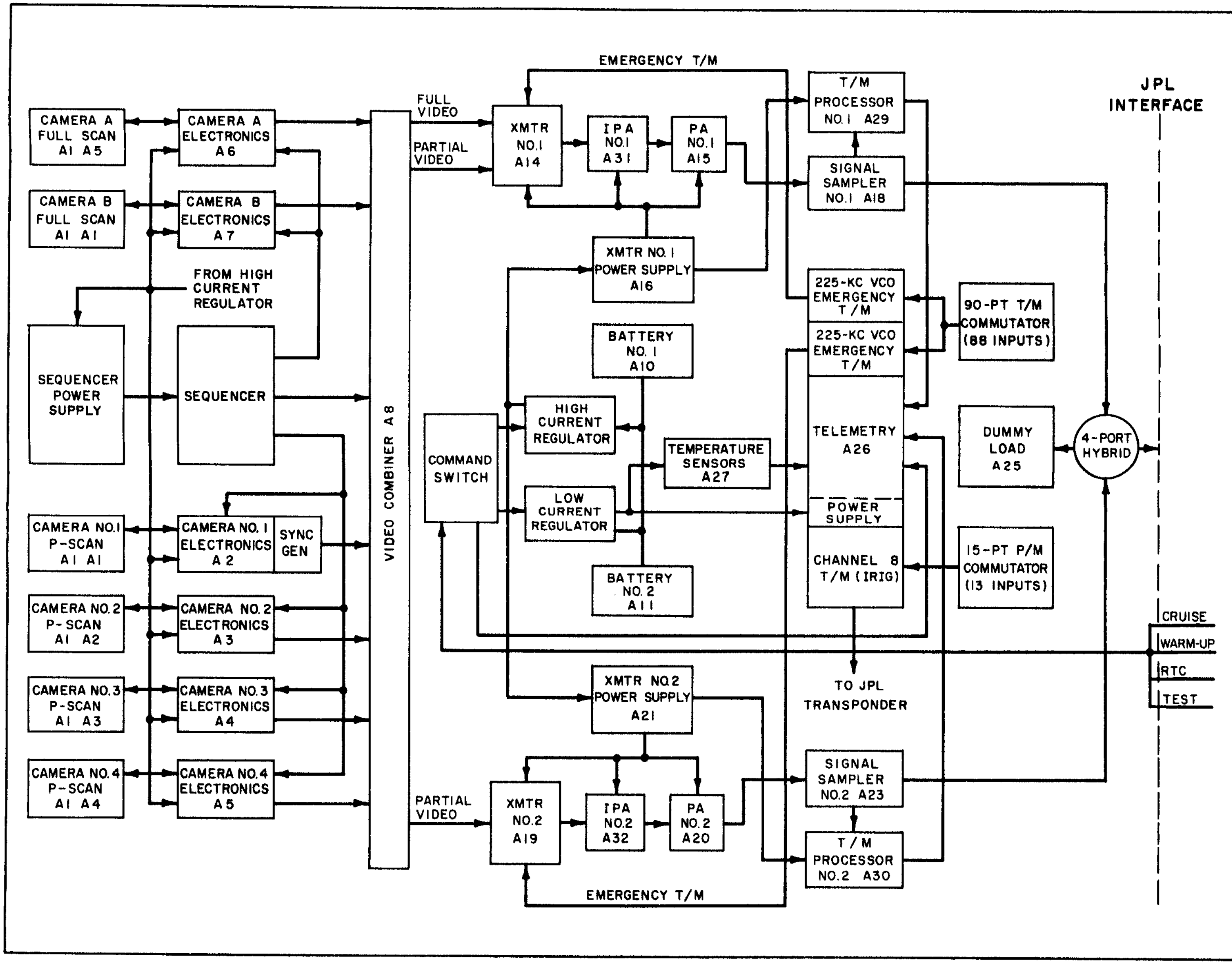


Figure C-1. Block Diagram of the Initial TV Subsystem Configuration

TABLE C-2
FAILURE EFFECTS ANALYSIS OF SPLIT-SYSTEM CONFIGURATION

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Battery (A10)	Dead or weak	1) Excessively high drain 2) Faulty heaters 3) Defective battery 4) Faulty connecting diode	1) Loss of high-current reg., A12, and low-current reg. A17 2) Loss of all T/M 3) Weak or lost unregulated F channel only	None	No F scan or T/M	A_f, A_{T90}, A_{T15} } B_o	2	It should be noted that independent channels, including the batteries are employed for the F and P scans.
Battery (A11)	Dead or weak	Same as above	1) Loss of high-current reg., A22 2) No loss of T/M 3) Weak or lost unregulated P channel only	None	No P scan	A_p C_o	2	Same as above
Batteries (A10 & A11)	Dead or weak	Same as above	Same as above for A10 and A11 combined	None	Aborted	A_f, A_p, A_{T90}, A_{T15} } A_o	5	-
High-Current Regulator (A12)	a) Open circuit	1) Faulty regulator circuit (open series element) 2) Faulty SCR's	1) Loss of voltage to F channel during all modes 2) Loss of voltage to T/M during terminal mode	None	1) No F scan 2) No T/M during terminal mode	A_f, A_{T90} } C_o	5	-
	b) Shorted circuit across regulator	Faulty regulator circuit (shorted series element)	Over voltage on -27.5 volts line (=30.5 -35 volts) F-scan and T/M terminal mode only	None	Degradation or possible loss of F-scan and 90-point T/M during terminal mode	F_{t} to A_f, F_{T90} to A_{T90} } F_o to C_o		
	c) Loss of voltage	1) Shorted load 2) Faulty SCR switch 3) Low battery voltage 4) Faulty regulator 5) Faulty cable connector	1) No reg. -27.5 volts 2) No unreg. 30.5 volts	None	1) No F-scan, ever 2) No P-scan	A_f, A_{T90} } C_o A_p C_o	5 5	- -
High-Current Reg. (A22)	a) Open circuit	1) Faulty reg. circuit (open series element) 2) Faulty SCR's	Loss of voltage to P-channel all modes	None	No P-scan	A_p C_o	5	-
	b) Short circuit across reg.	Faulty regulator circuit (shorted series element)	Over voltage on -27.5 volts line (=30.5 -25 volts) during P-scan	None	Degradation or possible loss of P-scan	F_p to A_p } F_o to C_o	3	-
A17, Low Current Reg.	a) Open circuit	1) Faulty reg. circuit (open series element) 2) Faulty series diode 3) Faulty relay (command switch)	T/M supplied by high-current reg. A12, during terminal mode; no 15-point T/M during cruise mode	Redundant with high-current reg. A12, during terminal mode	Loss of 15-point T/M during cruise mode	A_{T15}, 65, Hy } F_o	5	

TABLE C-2
FAILURE EFFECTS ANALYSIS OF SPLIT-SYSTEM CONFIGURATION (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
A17, Low Current Reg. (Continued)	b) Shorted circuit across reg.	Faulty reg. circuit	Over voltage on -27.5 volts line during cruise to T/M	None	Degradation or possible loss of 15-point T/M during cruise mode	F_{T15} to A_{T15}] 65 H_y; F_o	3	-
	c) Loss of voltage	1) Shorted load 2) Low battery voltage 3) Faulty regulator 4) Faulty cable connector	Same as a) above. Possible oscillation of CRUISE ON relay in command switch	Redundant with high-current reg. A12 during terminal mode only	Possible loss of F-scan and T/M	A_{T15} to A_f } F_o to B_o; A_{T90}	5	The indicated effect on the mission could result from discharge of the battery due to CRUISE-ON relay oscillation due to short-circuit load
Command Switch (A13)	a) No CRUISE-ON command	1) No input from JPL 2) Faulty cable or connector 3) Faulty latching relay	No T/M during cruise	None	Loss of 15-point T/M during cruise mode	A_{T15}] 65 H_y } F_o	5	-
	b) No WARM-UP command	1) No input from JPL 2) Faulty cable or connector 3) Faulty SCR ampl. 4) Faulty diodes to SCR's	No high-current regulator output; no F- or P-scan; no 90-point T/M during terminal mode	1) RTC signal as 1st back-up 2) Clock signal as 2nd back-up	None, provided back-up works	-	5	-
	c) No EMERGENCY command	1) Faulty relay in transmitter #1 or #2 2) Selection connection open 3) Faulty wiring of return to stepper switch 4) Inoperative stepper	None for expected (normal) operating conditions; however no emergency T/M is possible. When stepper switch is inoperative, system is locked in cruise mode if warm-up signal from JPL has failed.	None, since this is a back-up command	Loss of back-up for minimal T/M data return. No effect if warm-up signal from JPL works. Otherwise, subsystem is locked in cruise mode	A_{T90} E_o	5	Only during emergency mode operation
	d) No EMERGENCY OFF command	Frozen stepper switch	Continued operation in emergency mode assuming failures require going to the emergency operation	None, since this is a back-up command	Inability to effect desired T/M return, inability to repeat trials for desired operation upon encountering initial difficulties, i.e., no warm-up signal	A_f A_p } A_o	5	Failure class and probability figures apply only after emergency operation and clearing of difficulties precipitating emergency operation
	e) No RTC input response	1) Faulty RCA-JPL interface conn. 2) Faulty relay driver 3) Faulty RTC relay 4) Faulty RTC signal source	Loss of back-up command capability for turn-on and loss of emergency telemetry	None	1) None if back-up not required 2) Locked in cruise if back-up is required	A_f A_p A_{T90} } A_o	5	Failure class and probability figures apply only after initial failure of warm-up signal from JPL and clock
Camera Head (F-Scan)	a) Loss of camera A (A1A6)	1) Faulty sequencer to F-channel 2) Faulty connector or cable 3) Faulty internal circuit 4) Loss of 27.5 volts reg.	Loss of F-scan video A	-	Loss of 1/2 of F-scan pictures	C_i D_o	2	-

TABLE C-2
FAILURE EFFECTS ANALYSIS OF SPLIT-SYSTEM CONFIGURATION (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Camera Head (F-scan) (Continued)		5) Loss of 30.5 volts reg. 6) Shorted camera electronics 7) Faulty vidicon and shutter						
	b) Loss of camera B (A1A5)	Same as above	Loss of F-scan video B	-	Same as a)	C_f D_o	2	-
	c) Loss of both camera A and B	Same as above	Loss of all F-scan	P-scan returns, no F-scan	Loss of all F-scan pictures	A_f C_o	5	-
Camera Head (P-scan)	a) Loss of camera #1	1) Faulty sequencer 2) Faulty cable or connector 3) Faulty internal circuit 4) Loss of -27.5 volts reg. 5) Loss of -30.5 volts unreg. 6) Shorted camera electronics 7) Faulty vidicon 8) Faulty shutter	Loss of P-scan video #1	Partially redundant partial-scan pictures	Loss of 1/4 of P-scan pictures	D_p E_o	2	-
	b) Loss of camera #2	Same as above	Loss of P-scan video #2	Same as above	Same as above	D_p E_o	2	-
	c) Loss of camera #3	Same as above	Loss of P-scan video #3	Same as above	Same as above	D_p E_o	2	-
	d) Loss of camera #4	Same as above	Loss of P-scan video #4	Same as above	Same as above	D_p E_o	2	-
Camera Electronics (A2) P-scan Cameras	a) Loss of any one of the four P-scan camera videos (assume camera head is O.K.)	1) Faulty internal circuitry 2) Faulty vidicon and shutter 3) Loss of bias voltage 4) Shorted video combiner 5) Faulty cable or connector	Loss of one P-scan video	Partially redundant P-scan pictures	Loss of 1/4 P-scan pictures	D_p E_o	2	-
	b) Loss of ±6.3 volts from either camera #1 or #2	1) Faulty internal circuit 2) Faulty cable 3) Faulty diode	None	±6.3 volts is redundant	None	F_p F_o	5	Simultaneous loss of ±6.3 volts from cameras #1 and #2 is required to disable the video combiner causing loss of all P-scan video
	c) Loss of ±6.3 volts from both cameras	Same as above	Loss of all P-scan video	None	Loss of all P-scan pictures	A_p C_o	-	-

TABLE C-2
FAILURE EFFECTS ANALYSIS OF SPLIT-SYSTEM CONFIGURATION (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Camera Electronics Camera A or Camera B	a) Loss of camera A or B video (assumes camera head is working properly)	1) Faulty internal circuit 2) Loss of bias voltages 3) Shorted video combiner 4) Faulty cable or connector 5) Faulty vidicon and shutter 6) Faulty sequencer	Loss of F-scan video, A or B		Loss of 1/2 F-scan pictures, A or B	D_f D_o	2	-
	b) Loss of ±6.3 volts	1) Faulty internal circuit 2) Faulty cable 3) Faulty diode	None	±6.3 volts is redundant	None	F_f F_o	5	Simultaneous loss of ±6.3 volts from cameras A and B is required to disable the video combiner and cause loss of all F-scan video
	c) Loss of camera A and B video (assumes camera head is O.K.)	Same as a) above	Loss of all F-video	None	No F-video returned	A_f C_o	5	T/M return possible
	d) Loss of ±6.3 volts both cameras	Same as b) above	Loss of all F-video	None	No F-video return	A_f C_o	5	-
Video Combiner (A8)	a) No P-video modulator B (assumes good camera electronics)	1) Faulty internal circuit 2) Faulty cable or connector 3) Loss of bias voltage 4) Shorted load 5) Faulty sequencer	No XMTR #2 modulation signals (video)	None	Complete loss of P-scan pictures	A_p C_o	5	-
	b) No F-video modulator A (assumes good camera electronics)	Same as a) above	No XMTR #1 modulation signals (video)	None	Complete loss of F-scan pictures	A_f C_o	5	-
Sequencer (A9) Sequencer Pwr. Supply (A28) Channel F or Channel P	a) No DC return (transmitter return)	1) Faulty relay 2) Faulty cable or connector 3) Faulty relay driver 4) Faulty timer	No XMTR operation	Redundant JPL command	None	-	4	-
	b) Loss of gating signals (to combiner)	1) Faulty cable or connector 2) Faulty timer 3) Faulty internal circuit	Deficient video or no video combining	Redundant channels employed, "P" and "F"	No video (i.e., loss of 1 to 2 video returns one channel, 1 to 6 other channels)	A_f or A_p } C_o	4	-
	c) Loss of camera sync functional signals (to camera electronics)	Same as b) above	Deficient video or no video	Redundant channels employed, "P" and "F". Camera P1 and free-running sync. provisions.	No video or degraded video (i.e., same as above)	A_f or A_p } C_o	4	-

TABLE C-2
FAILURE EFFECTS ANALYSIS OF SPLIT-SYSTEM CONFIGURATION (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
XMTR #1 PA #1 (A15) 2nd IPA (A31) Pwr. Supply (A16)	No output	1) Faulty internal circuit 2) Faulty cable and connector 3) No DC return 4) Faulty command signal 5) Loss of power	No RF	Redundant 90-point T/M	No "F" scan pictures	A_f C_o	1	-
XMTR #2 PA #2 (A20) 2nd IPA (A32) Pwr. Supply (A21)	No output	Same as above	No RF	Same as above	No "P" scan pictures	A_p C_o	1	-
4-Port Hybrid (A24) and Dummy Load (A25)	Low or lost output	1) Faulty cabling or connector 2) Arcing 3) Air leakage	No RF	None	Decreased signal-to-noise ratio both channels. Possible loss of all video and 90-point T/M	E_f to A_f, E_p to A_p, E_{T90} to A_{T90} } E_o to A_o		
T/M (A26) Temp Sensor (A27) T/M Processor #1 T/M Processor #2	a) No 90-point T/M	1) Faulty commutator 2) Faulty internal circuit 3) Faulty processors 4) Faulty temperature sensors 5) Faulty cables and connectors	Loss of T/M points	None	Loss of T/M up to 88 points	F_{T90} to A_{T90} } E_o	3	-
	b) No 15-point T/M	Same as above	Same as above	None	Loss of T/M up to 13 points	F_{T15} to A_{T15} } E_o	3	-

TABLE C-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NO. 1 AND ASSOCIATED ELECTRONICS

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Interface Power	a) Loss of regulated -27.5 volts	Open cable and/or connector(s)	1) No video from camera #1 2) No loss of bias voltage to video combiner resulting in no video modulation of B	1) P video modulates A during last 8 minutes of terminal mode 2) 3 other partial-scan cameras	1) No P-video during first 8 minutes of terminal mode	D_p, D_p } D_o	5	Combine input power from camera electronics
	b) Loss of unregulated voltage	Open cable and/or connectors	No video in faulty camera due to no shutter power	3 other partial-scan cameras	Loss of 1/4 of partial-scan pictures	D_p E_o	5	-
Interface Signals	a) Loss of: 2X horizontal sync, flash sync, black clamp sync, and vertical blanking	Open cable and/or connectors	None	None needed	None	- F_o	5	-
	b) Loss of: horizontal sync	Open cable and/or connectors	Slightly wider picture	3 other partial-scan cameras	Slightly wider P-scan on camera #3	F_p F_o	5	-
	c) Loss of: vertical read sync	Open cable and/or connectors	Slightly longer picture	3 other partial-scan cameras	Slightly longer P-scan on camera #3	F_p F_o	5	-
	d) Loss of: erase sync	Open cable and/or connectors	Picture every other frame	3 other partial-scan cameras	Half as many pictures from camera #3	E_p E_o	5	-
	e) Loss of: shutter sync	Open cable and/or connectors	Slightly vertical center shift	3 other partial-scan cameras	Slight vertical shift on P-scan from camera #3	F_p F_o	5	-
±6.3 Regulator and Converter	a) ±6.3 regulator and converter	1) Faulty internal circuitry 2) Shorted load	1) No video from camera #3 2) Loss of bias voltage(s) to video combiner resulting in no video modulation of B	1) 3 other partial-scan pictures 2) P video modulates A during last two minutes of terminal mode	1) No P video during first 8 minutes of terminal mode 2) Loss of 1/4 of partial-scan pictures	D_p, D_p } D_o	4	-
	b) Same as above	Shorted chopper	Short on -27 volt bus	None	No TV presentation	A_p, A_f } A_o	4	Design with input fuses in each camera circuit
Interface Power	a) Loss of regulated -27.5 volts	Open cable and/or connector(s)	1) No video from camera #1 2) No loss of bias voltage to video combiner resulting in no video modulation of B	1) P video modulates A during last two minutes of terminal mode 2) 3 other partial-scan cameras	1) No P video during first 6 minutes of terminal mode	D_p, D_p } D_o	5	Combine input power from camera electronics
	b) Loss of unregulated voltage	Open cable and/or connectors	No video in faulty camera due to no shutter power	3 other partial-scan pictures	Loss of 1/4 partial-scan pictures	D_p E_o	5	-

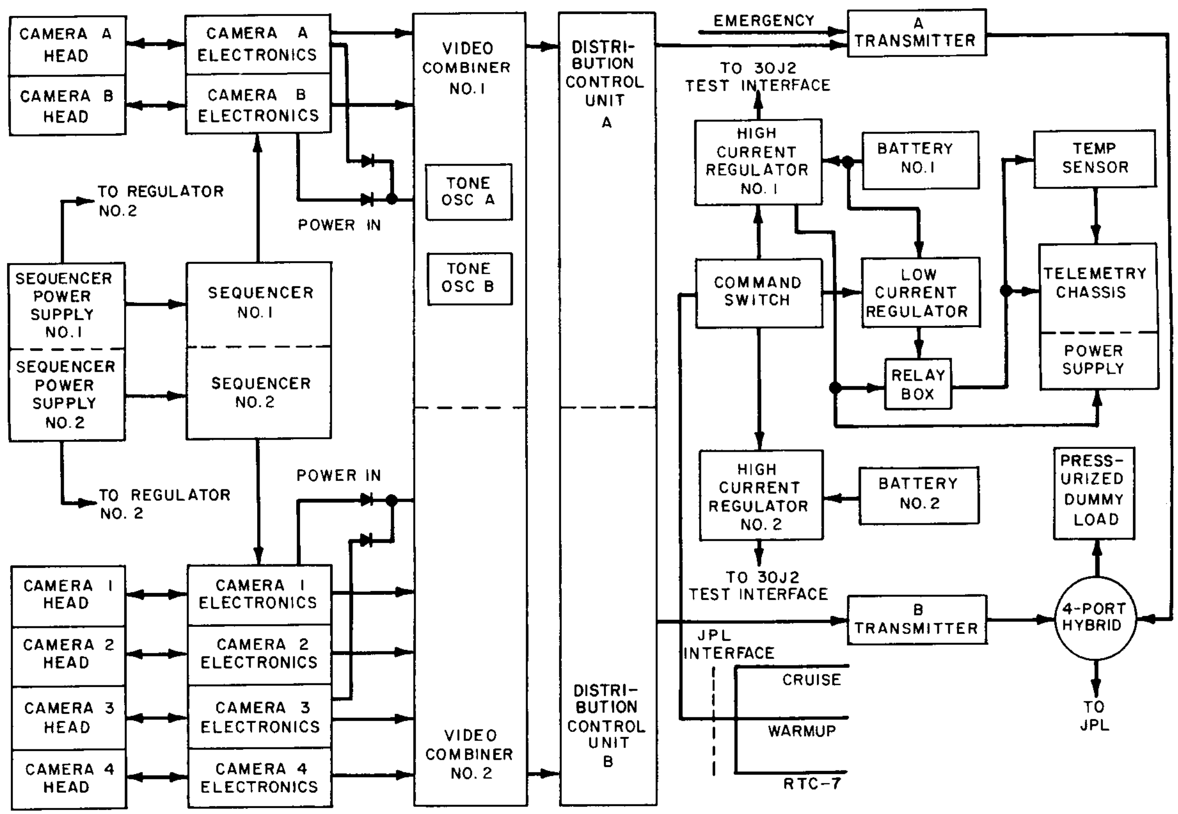


Figure C-2. Block Diagram of the Split-System Configuration

TABLE C-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NO. 1 AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Interface Signals	a) Loss of: 2X horizontal sync, flash sync, black clamp sync, and vertical blanking	Open cable and/or connectors	None	None needed	None	- F_o	5	-
	b) Loss of: horizontal sync:	Open cable and/or connectors	Slightly wider picture	3 other partial-scan cameras	Slightly wider P-scan on camera #3	F_p F_o	5	-
	c) Loss of: vertical read sync	Open cable and/or connectors	Slightly longer picture	3 other partial-scan cameras	Slightly longer P-scan on camera #3	F_p F_o	5	-
	d) Loss of: erase sync	Open cable and/or connectors	Picture every other frame	3 other partial-scan cameras	Half as many pictures from camera #3	E_p E_o	5	-
	e) Loss of: shutter sync	Open cable and/or connectors	Slight vertical center shift	3 other partial-scan cameras	Slight vertical shift on P-scan from camera #3	F_p F_o	5	-
±6.3 Regulator and Converter	a) ±6.3 regulator and converter	1) Faulty internal circuitry 2) Shorted load	1) No video from camera #3 2) Loss of bias voltage(s) to video combiner resulting in no "video modulator B"	1) 3 other partial-scan pictures 2) P video modulates A during last two minutes of terminal mode	1) No P-video during first 8 minutes of terminal mode 2) Loss of 1/4 of partial-scan pictures	D_p } D_p } D_o	4	-
	b) Same as above	Shorted chopper	Short on -27 volt bus	None	No TV presentation	A_p } A_f } A_o	4	Design with input fuses in each camera circuit
Lamp Circuit	Lamp driver and lamp	1) Faulty internal circuitry 2) Loss of sync signal(s) 3) Loss of bias voltage(s) 4) Open cable or connector(s) 5) Open lamp	1) Improved sensitivity 2) Poor erase	3 other partial-scan pictures	One partial-scan picture will have multiple exposure picture	E_p E_o	3 to 4	-
Shutter and Shutter Control	Shutter and shutter drive circuit	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Locked shutter 4) Open cable or connectors 5) Shutter and lamp telemetry circuit	1) No video from camera #3 2) No shutter motion 3) Possible erratic shutter action 4) Transient injection into video	3 other partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	2	Redesign telemetry pick-up point
Beam Current and Regulator Switch	Beam current and regulator switch	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Faulty vidicon	No video from camera #3 or severe degradation of video by: defocusing and beam oscillation	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	3	Protect transistors from excessive collector voltages

TABLE C-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NO. 1 AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Beam Current and Regulator Switch (Continued)		4) Faulty read signal (due to cable or connectors)						
Vertical Deflection Amplifier	Vertical deflection amplifier	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Shorted yoke coil 4) Loss of sync signals 5) Failure in deflection programming	No video or partial (non linear) vertical sweep from camera #3	3 other partial-scan pictures	Loss or degradation of 1/4 of partial scan pictures	D_p E_o	5	-
Horizontal Deflection Amplifier	Horizontal deflection amplifier	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Shorted yoke coil 4) Loss of sync signals 5) Failure in deflection programming	No video or partial (non linear) horizontal sweep from camera #3	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	5	-
Mixed Cathode Blanking	Mixed cathode blanking	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Loss of sync signals 4) Faulty vidicon	No video or possibly unblanked horizontal and/or vertical lines on video from camera #3	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	5	-
Deflection Programmer	Deflection programmer	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Loss of sync signals 4) Faulty cable or connector(s)	No video or possibly degraded video from camera #3 (center shifts and/or size shifts)	3 other partial-scan pictures	Loss or degradation of 1/4 of partial scan pictures	D_p E_o	5	—
Focus Current Regulator	Focus current regulator	1) Faulty internal circuitry 2) Loss of power input	No video or possibly defocused video from camera #3	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	3	-
Vidicon	Vidicon	1) Faulty tube 2) Connectors 3) Loss of bias voltage(s) 4) Faulty focus or deflection coils 5) Poor focus current regulation 6) Faulty optical alignment	No video or degraded video from camera #3	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	2	-

TABLE C-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NO. 1 AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Telemetry	a) Shutter telemetry	Shorted transistor	Erratic shutter operation	3 other partial-scan pictures	Loss or degradation of 1/4 partial-scan pictures	D_p, E_{T90} } E_o	3	Redesign telemetry take-off point
	b) Other telemetry	Faulty internal circuitry	Erratic video or loss of telemetry points	None	Partial loss of engineering data	D_p, E_o } E_o	3	-
Vertical Sync Generator	a) Loss of read sync	1) Faulty internal circuitry 2) Loss of bias voltage(s)	No video from camera #3	3 other partial-scan pictures	Possible loss of 1/4 of partial-scan	D_p E_o	4	-
	b) Loss of flash pulse	1) Faulty internal circuitry 2) Loss of bias voltage(s)	1) Increase of sensitivity 2) Multiple exposure	3 other partial-scan pictures	Possible loss of 1/4 of partial-scan	D_p E_o	4	-
	c) Loss of erase pulse	Same as above	No video from camera #3	Same as above	Same as above	D_p E_o	4	-
	d) Loss of dark current sample	Same as above	None	Same as above	Same as above	D_p E_o	4	-
	e) Loss of shutter pulse	Same as above	No video from camera #3	Same as above	Same as above	D_p E_o	4	-
Horizontal Sync Generator	a) Loss of horizontal sync	1) Faulty internal circuitry 2) Loss of bias voltage(s)	No video from camera #3	3 other partial-scan pictures	Possible loss of 1/4 of partial-scan	D_p E_o	4	-
	b) Loss of 2X horizontal sync	Same as above	Very little effect	Same as above	Same as above	D_p E_o	4	-

TABLE C-4
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NOS. 2, 3, AND 4 AND ASSOCIATED ELECTRONICS

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Interface Power	a) Loss of regulated -27.5 volts	Open cable and/or connectors	1) No video from faulty camera(s) 2) If camera #3 is at fault, no partial-scan video to modulator A 3) Clipper to modulator B is not properly biased	1) Partial-scans from other cameras (if camera #3 is bad, partial-scan to modulator B only) 2) Redundant P-scan video during last two minutes of terminal mode	1) Loss of 1/4 of partial-scan pictures 2) Over deviation of both transmitters if camera #3 is at fault. Last two minutes of terminal mode only B modulator will operate	D_p, D_p } D_o	5	Combine input power from camera electronics
	b) Loss of unregulated voltage	Open cable and/or connectors	No video in faulty camera due to shutter power	3 other partial-scan cameras	Loss of 1/4 of partial-scan pictures	D_p E_o	5	-
Interface Signal	a) Loss of 2X horizontal sync (3000 cps)	Open cable and/or connectors	Slight loss in video levels, slight loss in sensitivity	3 other partial-scan cameras	Very little effect on overall partial-scan pictures	F_p F_o	5	-
	b) Loss of horizontal sync (1500 cps), vertical read, shutter, and erase	Open cable and/or connectors	No video	3 other partial-scan cameras	Loss of 1/4 of partial-scan pictures	D_o E_o	5	-
	c) Loss of flash	Open cable and/or connectors	a) Improved sensitivity b) Poor erase (not as critical as in full-scan pictures)	3 other partial-scan cameras	One partial-scan picture is slightly degraded	E_p F_o	5	-
	d) Loss of vertical blanking	Open cable and/or connectors	Continuous video loss of blanking	Partial blanking effect is accomplished in video combiner	Blanking retrace in picture	E_p F_o	5	-
	e) Loss of black clamp	Open cable and/or connectors	No effect	None needed	None	- F_o	5	May be used at later time for other purposes
±6.3 Regulator and Converter, Camera #2 or Camera #4	a) ±6.3 regulator and converter, camera #2 or camera #4	1) Faulty internal components 2) Shorted load	No video from camera #2 or from camera #4	3 other partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	4	-
	b) Same as a) above	Shorted chopper	Short on -27 volt bus	None	No TV presentation	A_f, A_p } A_o	4	Design with input fuses in each camera circuit
±6.3 Regulator and Converter, Camera #3	a) ±6.3 regulator and converter, camera #3	1) Faulty internal components 2) Shorted load	1) No video from camera #3 2) No partial-scan video to modulator A 3) Clipper to modulator B is not properly biased	Partial-scan to modulator B only	1) Loss of 1/4 of partial-scan pictures 2) Over deviation of both transmitters before switchover — after switchover only B modulator will be operative	D_p, C_p } C_o	4	Combine input power from camera electronics
	b) Same as a) above	Shorted chopper	Short on -27 volt bus	None	No TV presentation	A_f, A_p } A_o	-	Design with input fuse in each camera circuit

TABLE C-4
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NOS. 2, 3, AND 4 AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-Voltage DC-to-DC Converter	a) High voltage DC-to-DC converter	1) Faulty internal components 2) Shorted load 3) Faulty high-current regulator (due to over voltage transient)	No video from faulty camera	3 other partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	4	Design over-voltage protection in high-current regulator
	b) Same as a) above	Shorted chopper	Short on -27 volt bus	None	No TV presentation	A_f, A_p } A_o	4	Design with input fuses in each camera circuit
High-Voltage Regulator	High-voltage regulator (failure of any output voltage) ±30 +300 ±27 +1000 40 -150	1) Faulty internal components 2) Shorted load	Poorly focused video or no video	3 other partial-scan pictures	Complete loss of camera #3 picture or picture is defocused	A_p E_o	2	Check into transistor Q32 failure modes
Preamplifier	Preamplifier	1) Faulty internal components 2) No vidicon picture 3) Loss of bias voltage(s) 4) Cable or connector(s)	No video from faulty camera (telemetry point)	3 other partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	4	Check into nuvistor failure modes. Design with transistor preamplifier
Video Amplifier	Video amplifier	1) Faulty internal components 2) No video from preamp 3) Loss of bias voltage(s)	No video from faulty camera (possibly degraded video) from faulty camera	3 other partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	5	-
Video Clamp and Sync Injection	Video clamp and sync injection	1) Faulty internal components 2) Loss of horizontal or vertical sync 3) No video from video amplifier 4) Loss of bias voltage(s)	No video from faulty camera (possibly degraded video) from faulty camera	3 other partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	5	-
Lamp Circuit	Lamp driver and lamp	1) Faulty internal components 2) Loss of sync signal(s) 3) Loss of bias voltage(s) 4) Open cable or connectors 5) Open lamp	1) Improved sensitivity 2) Poor erase	3 other partial-scan pictures	One partial-scan picture will have multiple exposure pictures	D_p E_o	3 to 4	-
Shutter and Shutter Control	Shutter and shutter drive circuit	1) Faulty internal components 2) Loss of bias voltage	1) No video from faulty camera 2) No shutter motion	3 other partial-scan pictures	Loss of 1/4 of partial-scan pictures	D_p E_o	2	Redesign telemetry take-off point

TABLE C-4
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NOS. 2, 3, AND 4 AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Shutter and Shutter Control (Continued)		3) Locked shutter 4) Open cable or connectors 5) Shutter and lamp telemetry circuit	3) Possible erratic shutter action					
Beam Current Regulator and Switch	Beam current regulator and switch	1) Faulty internal components 2) Loss of bias voltages 3) Faulty vidicon 4) Faulty read signal (due to cables or connectors)	No video from faulty camera or severe degradation of video by defocusing and beam oscillation	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	3	Protect transistors from excessive collector voltages.
Vertical Deflection Amplifier	Vertical deflection amplifier	1) Faulty internal components 2) Loss of bias voltages 3) Shorted yoke coil 4) Loss of sync signals 5) Failure in deflection programming	No video or partial (non-linear) vertical sweep from faulty camera	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	5	-
Horizontal Deflection Amplifier	Horizontal deflection amplifier	1) Faulty internal components 2) Loss of bias voltages 3) Shorted yoke coil 4) Loss of sync signal(s) 5) Failure in deflection programming	No video or partial (non-linear) horizontal sweep from faulty camera	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	5	-
Mixed Cathode Blanking	Mixed cathode blanking	1) Faulty internal components 2) Loss of bias voltage(s) 3) Loss of sync signals 4) Faulty vidicon	No video or possibly unblanked horizontal and/or vertical lines on video	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	5	-
Deflection Programmer	Deflection Programmer	1) Faulty internal components 2) Loss of bias voltages 3) Loss of sync signals 4) Faulty connector(s) or cable	No video or possibly degraded video (center shifts and size shifts)	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	5	-
Focus Current Regulator	Focus current regulator	1) Faulty internal components 2) Loss of power input	No video or possibly defocused video from faulty camera	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	3	-
Vidicon	Vidicon	1) Faulty tube 2) Connectors 3) Loss of bias voltages 4) Faulty focus or deflection coils	No video or degraded video from faulty camera	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	2	-

TABLE C-4
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA NOS. 2, 3, AND 4 AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Vidicon (Continued)		5) Poor focus current regulator 6) Faulty optical alignment						
Telemetry	a) Shutter telemetry	Shorted transistor	Erratic shutter operation and erratic video	3 other partial-scan pictures	Loss or degradation of 1/4 of partial-scan pictures	D_p E_o	3	Redesign telemetry takeoff point.
	b) Other telemetry	Faulty components	Loss of telemetry points	None	Partial loss of engineering data	E_{T90} E_o	3	-

TABLE C-5
FAILURE EFFECTS ANALYSIS OF FULL-SCAN CAMERAS F_a AND F_b AND ASSOCIATED ELECTRONICS

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Interface Power	a) Loss of regulated -27.5 volts	Open cable or connector(s)	1) No video 2) Partial bias voltages in video combiner	None	1) If camera A is at fault — no tone signals and only one full-scan set of pictures	C_F E_o	5	Combine video combiner input power from two camera electronics. Use a diode "OR" gate
					2) If camera B is at fault, no full-scan pictures	A_F C_o	5	Same as above
	b) Loss of unregulated voltage	Open cable or connector(s)	Inoperative shutter	Partially redundant full-scan video	Loss of 1/2 of full-scan video	C_F E_o	5	-
Interface Signals	a) Loss of 2X horizontal sync (450 cps)	Open cable or connector(s)	Loss in video levels, loss in sensitivity	Partially redundant full-scan video	Small loss of 1/2 of full-scan video	D_F F_o	5	-
	b) Loss of: horizontal sync (450 cps), vertical read sync, shutter sync, and erase sync	Open cable or connector(s)	Loss in video	Partially redundant full-scan video	Loss of 1/2 of full-scan video	C_F E_o	5	-
	c) Loss of flash sync	Open cable or connector(s)	1) improved sensitivity 2) poor erase	Partially redundant full-scan video	A set of multiple exposure pictures	D_F, C_F } E_o	5	-
	d) Loss of vertical blanking	Open cable or connector(s)	Continuous video loss of blanking	Partial blanking is accomplished in video combiner	Blanking retrace in full-scan picture	F_F F_o	5	-
±6.3 Converter Regulator Camera A	a) Loss of ±6.3 volts	1) Faulty internal circuitry 2) Shorted load(s)	1) No video from camera A 2) No power to tone gates in video combiner	Partially redundant full-scan video B	1) No tone signals at GSE 2) Loss of 1/2 of full-scan pictures	C_F E_o	4	Combine video combiner input power from two camera electronics. Use a diode "OR" gate.
	b) Loss of ±6.3 volts	Shorted chopper (shorted input)	Short on -27 volt bus (regulated)	None	1) Loss of full-scan pictures 2) Loss of partial-scan pictures	A_F, A_F } A_o	4	Design with input fuses in each camera circuit.
±6.3 volts Converter Regulator Camera B	a) Loss of ±6.3 volts	1) Faulty internal circuitry 2) Shorted loads	1) No video from camera B 2) No power to F video gates on F video combiner gates	None	Loss of full-scan pictures	A_f C_o	4	Combine video combiner input power from two camera electronics. Use a diode "OR" gate.
	b) Loss of ±6.3 volts	Shorted chopper (shorted input)	Short on -27 volts bus (regulated)	None	a) Loss of full-scan pictures b) Loss of partial-scan	A_f, A_p } A_o	4	Design with input fuses in each camera circuit
High-Voltage, DC-to-DC Converter	a) Inoperative Converter	1) Faulty internal circuitry 2) Shorted load(s) 3) Faulty high-current regulator	Loss of full-scan video A or B	Partially redundant full-scan video	Loss of 1/2 of full-scan pictures	C_f E_o	4	

TABLE C-5
FAILURE EFFECTS ANALYSIS OF FULL-SCAN CAMERAS F_a AND F_b AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-Voltage DC-to-DC Converter (Continued)	b) Same as above	Shorted chopper (shorted input)	short on -27 volts bus (regulated)	None	1) Loss of full-scan pictures 2) Loss of partial-scan pictures	A_f } A_o A_p }	4	Design with input fuses in each camera.
High Voltage Regulator	Loss of any output voltage ±20 + 300 +27 +1000 +40 - 150	1) Faulty internal circuitry 2) Shorted load(s)	Degraded video or no full-scan video A or B	Partially redundant full-scan video	Loss of 1/2 of full-scan video	L_F E_o	2	Check into transistor Q32 failure modes
Preamplifier	a) Loss of preamplifier output	1) Faulty internal circuitry 2) Faulty vidicon (head) 3) Loss of bias voltage(s) 4) Cable or connector(s)	No video (full-scan) A or B telemetry point	Partially redundant full-scan video	Loss of 1/2 of full-scan video	C_F E_o	4	Check into nuvistor failure modes; check into transistor design.
	b) microphonic preamplifier output	microphonic nuvistor	Noisy video (full-scan) A or B	Partially redundant full-scan video pictures	Noisy full-scan pictures	F_F-C_F E_o	4	Select nuvistor for minimum microphones
Video Amplifier	Loss of amplifier output	1) Faulty internal circuitry 2) Faulty Preamplifier 3) Loss of bias voltage	1) No full-scan video A or B 2) Degradation of video output (full-scan)	Partially redundant full-scan video	Loss of 1/2 of full-scan video	C_F E_o	5	
Video Clamp and Sync Injection	Loss of output	1) Faulty internal circuitry 2) Loss of horizontal and vertical sync 3) Faulty video amp 4) Loss of bias voltage(s)	1) No full-scan video A or B 2) Degraded full-scan video	Partially redundant full-scan video	Loss of 1/2 of full-scan video	C_F E_o	5	
Lamp Driver and Lamp	Loss of excitation	1) Faulty internal circuitry 2) Loss of flash sync 3) Loss of bias voltage(s) 4) Faulty cable or connectors 5) Open lamp	1) improved sensitivity 2) poor erase	Partially redundant full-scan video	One full-scan picture will have multiple exposure pictures	E_F F_o	3 to 4	
Shutter and Shutter Control	Loss of shutter action	1) Faulty internal circuitry 2) Faulty connector(s) or cable 3) Loss of bias voltage(s) 4) Locked shutter 5) Faulty shutter and lamp telemetry circuitry	1) No full-scan video A or B 2) No shutter motion 3) Possible erratic shutter action	Partially redundant full-scan video	Loss of 1/2 of full-scan pictures	C_F E_o	2	Redesign telemetry take-off point.

TABLE C-5
FAILURE EFFECTS ANALYSIS OF FULL-SCAN CAMERAS F_a AND F_b AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Beam Current Regulator and Switch	Loss of regulation	1) Faulty internal circuitry 2) Faulty connector(s) or cable 3) Faulty vidicon tube 4) Faulty read sync 5) Loss of bias voltage(s)	1) No full-scan video A or B 2) Degraded full-scan video (defocusing and beam oscillation)	Partially redundant full-scan video	1) Loss of 1/2 of full-scan pictures 2) Possible degradation of same video channel	C_F E_o	3	Protect transistors from excessive collector-to-emitter voltages.
Vertical Deflection Amplifier	Loss of output	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Shorted yoke coil 4) Loss of sync signals 5) Failure in deflection programming	1) No full-scan video A or B 2) Partial (non-linear) video sweep	Partially redundant full-scan video	Loss or degradation of 1/2 of full-scan pictures	C_F E_o	5	-
Horizontal Deflection Amplifier	Loss of output	1) Faulty internal circuitry 2) Loss of bias voltages 3) Shorted yoke coil 4) Loss of sync signals 5) Failure in deflection programming	1) No full-scan video A or B 2) Partial (nonlinear) video sweep	Partially redundant full-scan video	Loss or degradation of 1/2 of full-scan pictures	C_F E_o	5	-
Mixed Cathode Blanking	Loss of output	1) Faulty internal circuitry 2) Loss of bias voltages 3) Loss of sync signals 4) Faulty cable or connector(s)	1) No full-scan video A or B 2) Possibly unblanked horizontal and/or vertical lines on video	Partially redundant full-scan video	Loss or degradation of 1/2 of full-scan video	C_F E_o	5	-
Deflection Programmer	Loss of output(s)	1) Faulty internal circuitry 2) Loss of bias voltage(s) 3) Loss of sync signals 4) Faulty cable or connector(s)	1) No full-scan video A or B 2) Possibly degraded video (1) center shifts (2) size shifts	Partially redundant full-scan video	Loss or degradation of 1/2 of full-scan video	C_F E_o	5	-
Focus Current Regulator	Loss of regulation	1) Faulty internal circuitry 2) Loss of power inputs	1) No full-scan video A or B 2) Possibly degraded video (defocused)	Partially redundant full-scan video	Loss or degradation of 1/2 of full-scan video	C_F E_o	3	-
Vidicon	Faulty picture	1) Faulty optical alignment 2) Faulty tube 3) Faulty connectors 4) Loss of bias voltages 5) Faulty focus or deflection coils 6) Poor focus current regulation	1) No full-scan video A or B 2) Degraded video	Partially redundant full-scan video	Loss or degradation of 1/2 of full-scan video	C_F E_o	2	-

TABLE C-5
FAILURE EFFECTS ANALYSIS OF FULL-SCAN CAMERAS F_a AND F_b AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Telemetry	a) Faulty outputs	Shorted transistor	1) Erratic shutter operation 2) Erratic video	Partially redundant full-scan video	Loss or degradation of 1/2 of full-scan video	C_F E_o	3	Redesign telemetry take-off point.
	b) Other telemetry	Faulty internal circuitry	Loss of telemetry points	None	Partial loss of engineering data	E_{T90} F_o	4	

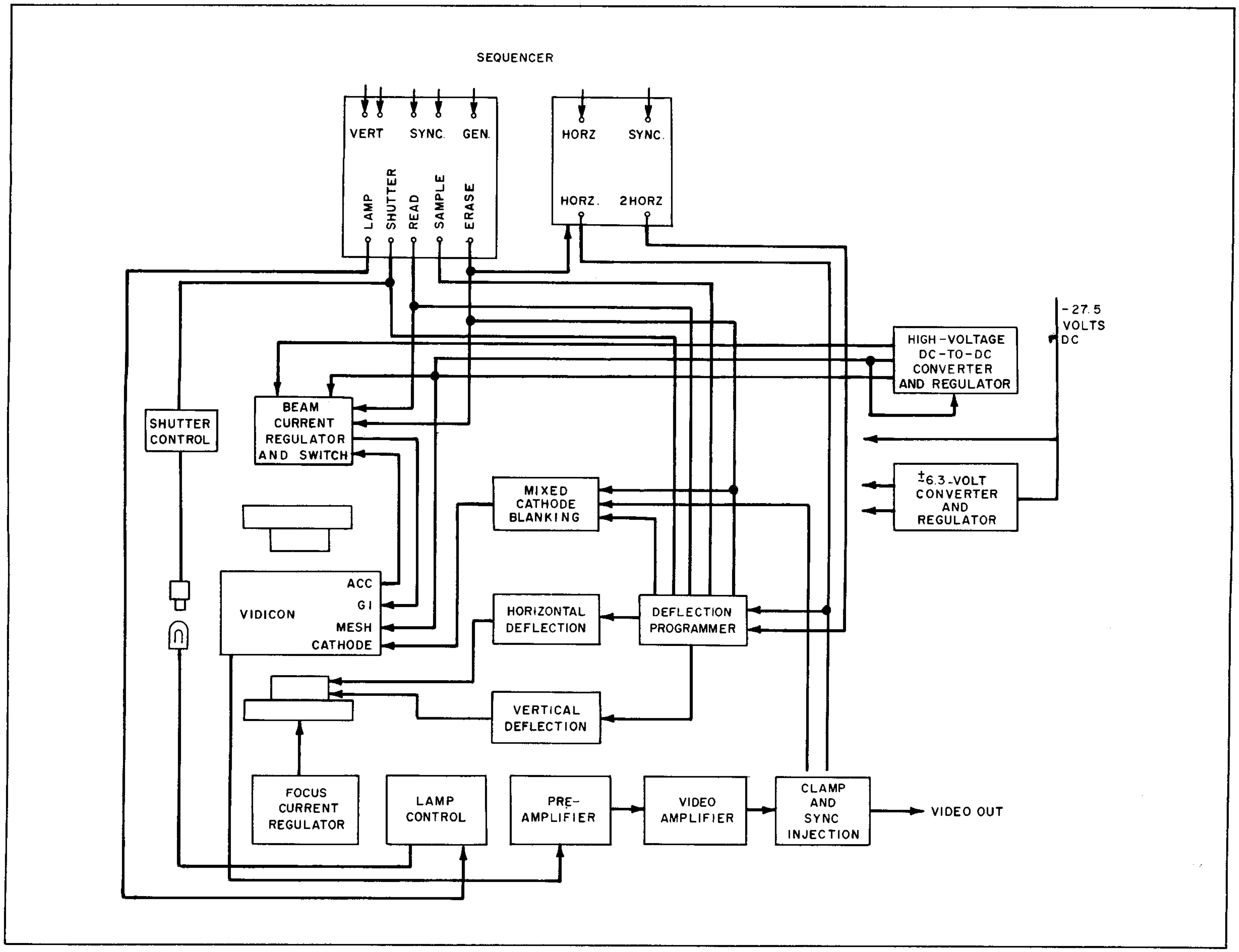


Figure C-3. Block Diagram of the Full-Scan and Partial-Scan Camera and Camera Electronics Assemblies

TABLE C-6
FAILURE EFFECTS ANALYSIS OF THE VIDEO COMBINER

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Interface Power	a) Loss of ±6.3 volts to oscillator board	1) Faulty cable or connectors 2) Faulty camera A electronics	No oscillator tones	None	Full-scan camera A and B pictures are not discernible at OSE	D_F E_o	5	Apply ±6.3 volts from two camera electronics via diode "OR" gates.
	b) Loss of ±6.3 volts to "F" summing board	1) Faulty cable or connectors 2) Faulty camera B electronics	1) No full-scan video 2) Over modulation on channel A after switch-over	None	1) No full-scan video 2) Adjacent channel interference after switch-over	A_f C_o	5	1) Power clippers from amplifier which drives clipper. 2) Apply ±6.3 volt from two camera electronics via diode "OR" gates.
	c) Loss of ±6.3 volts to "P" summing board	1) Faulty cable or connectors 2) Faulty camera #1 electronics	No partial-scan video	None	No partial-scan video	A_p B_o	5	1) Power clippers from amplifier which drives clipper. 2) Apply ±6.3 volts from two camera electronics via diode "OR" gates. 3) Redundant channel for partial-scan video in combiner.
	d) Loss of ±6.3 volts to isolation amplifier board	1) Faulty cable or connectors 2) Faulty camera #3 electronics	1) Over modulation due to lack of clipping action 2) Badly distorted "P" scan video and "F" scan video	None	1) Distorted full-scan video 2) Distorted partial-scan video 3) Adjacent channel interference	C_f } C_p } C_o	5	Apply ±6.3 volts from two camera electronics via diode "OR" gates.
Interface Signals	Loss of gate inputs	1) Faulty cable or connectors 2) Faulty sequencer power supply	1) Tones permanently superimposed on video 2) Clipping of partial-scan video 3) Clipping of full-scan video (not serious) 4) High noise content	Dual power supply in sequencer	1) Interference of tones on video 2) Lower signal-to-noise ratio 3) Loss of partial-scan contrast 4) Increasing distortion of video with highlights	C_p D_o	5	
Partial Scan Video Gates	Gates fail closed (signals transmitted)	1) Open cable or connectors 2) Sequencer signal(s) not present 3) Internal gate circuitry failure	1) Continuous conduction of signals to transmitters 2) Increase of DC offset	None	1) Decreased signal-to-noise ratio in partial-scan video 2) Decreased contrast and highlight detail	D_p E_o	5	1) Effects become more serious with increasing number of gate failures. 2) Open cable or connector failure modes can be compensated with minor design changes.
Full-Scan Video Gates	Gates fail closed (signals transmitted)	1) Open cable or connectors 2) Sequencer signals not present 3) Internal gate circuitry failure	1) Continuous conduction of signals to transmitters 2) Increase DC offset	None	1) Decreased signal-to-noise ratio in full-scan video 2) Decreased contrast and highlight detail in full-scan video	D_F E_o	5	Same as partial-scan video gates.

TABLE C-6
FAILURE EFFECTS ANALYSIS OF THE VIDEO COMBINER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Tone Gate	Gate fails closed (signals transmitted)	1) Open cable or connectors 2) Sequencer signals not present 3) Internal gate circuitry failure	Constant tones superimposed on video	Tones can be separated from video at OSE	Interference between tones and video	E_f, E_p } E_o	5	Same as partial-scan video gates
Switch-Over Gate	Gate fails closed (signals transmitted)	1) Open cable or connectors 2) Sequencer signals not present 3) Internal gate circuitry failure	Partial-scan and full-scan fideo are interfering in channel A	Possible separation of video at OSE	Severe interference on full-scan video	D_F E_o	5	—
Clipper	a) Clipper (fully actuated)	1) Internal clipper circuitry failure 2) Loss of bias voltages	No clipper action leading to overmodulation in transmitter	None	Slight adjacent channel interference if highlights are present	F_F, F_p } F_o	5	Apply power from two camera electronics via diode "OR" gates.
	b) Clipper (shorted)	1) Internal clipper circuit failures 2) Shorted loads	Low video signals	Possible compensation at OSE	1) Loss of video contrast 2) Decreased signal-to-noise ratio	E_F, E_p } E_o	5	—
P Scan Power Amplifier	Power amplifier	1) Internal amplifier circuitry failure 2) Loss of ±6.3 volts	No partial-scan video	None	No partial-scan video	A_p B_o	5	Apply power from two camera electronics via diode "OR" gates.
F Scan Power Amplifier	F scan power amplifier	1) Loss of ±6.3 volts 2) Faulty internal circuitry	No full-scan video	None	No full-scan video	A_F C_o	5	Apply ±6.3 volts from two camera electronics via diode "OR" gates.
Isolation Amplifier	Isolation amplifier	1) Loss of ±6.3 volts 2) Faulty internal circuitry	No partial-scan video modulator A	Partial-scan video modulator B	No partial-scan video in modulator A after switch-over	F_p F_o	5	Apply ±6.3 volts from two camera electronics via diode "OR" gates.
Tone-A Oscillator	Tone-A oscillator	1) Loss of ±6.3 volts 2) Faulty internal circuitry	No 144-kc tone	Tone B signal	No tone light for camera B at OSE	- F_o	5	Apply ±6.3 volts from two camera electronics via diode "OR" gates.
Tone-B Oscillator	Tone-B Oscillator	1) Loss of ±6.3 volts 2) Faulty internal circuitry	No 162-kc tone	Tone-A signal	No tone light for camera A at OSE	- F_o	5	Apply ±6.3 volts from two camera electronics via diode "OR" gates.

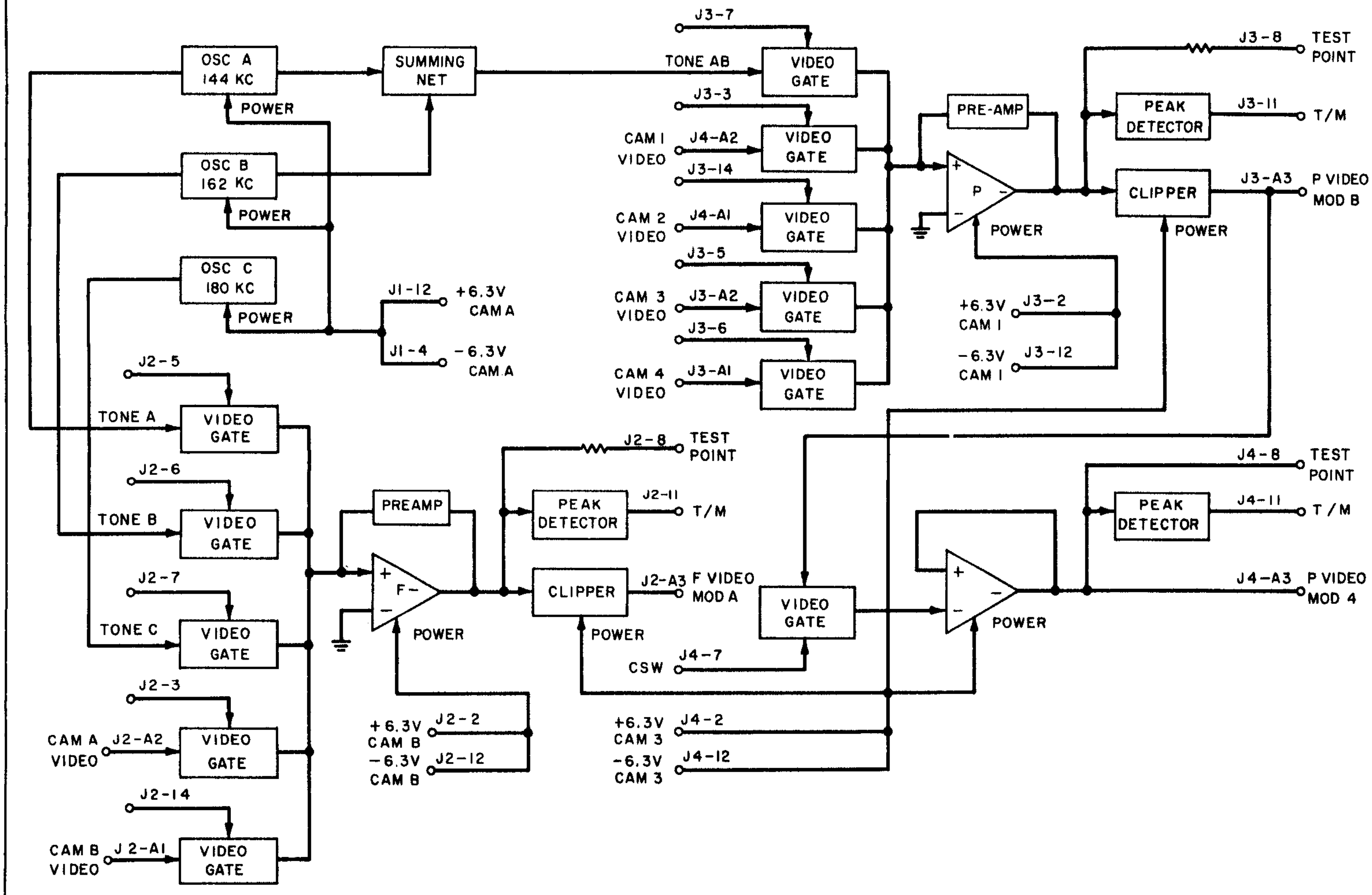


Figure C-4. Block Diagram of the Video-Combiner Assembly

TABLE C-7
FAILURE EFFECTS ANALYSIS OF THE SEQUENCER

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Power Interface	a) Loss of -27.5 volts regulator	Open cable or connectors	No sequencer signals	Diode matrix to allow partial-scan #1 video to be transmitted	3/4 of partial-scan video missing — all full-scan video missing	B_p, A_f } B_o	5	-
	b) Shorted input	1) Shorted DC-to-DC converter transistors 2) Shorted sequencer input	1) High battery current drain 2) No sequencer signals 3) No video	None	No partial-scan video - no full-scan video	A_p, A_f } A_o	5	Separate and fused input lines for each DC-to-DC converter
DC Return (for transmitters)	Open DC return	Open cable or connector	No signals transmitted	Back-up command in JPL (CC and S)	Possible loss of some video pictures of early stages of transmission	D_p, D_f } D_o	5	-
Input Signal Interface (P Disable)	P disable input shorted	1) Shorted cable or connector (test connector) 2) Stuck or shorted switch in OSE	No partial-scan sequencer signals	1) Partial-scan #1 will still operate 2) Fast repair in ground station	3/4 of partial-scan video missing	B_p B_o	5	-
Input Signal Interface (Manual Reset)	Manual reset input shorted	1) Shorted cable or connector (test connector 2) Stuck or shorted switch in OSE	1) No switch-over logic signals 2) No transmitter turn-on	1) Back-up command in JPL (CC and S) 2) Fast repair in ground station	1) No switch-over logic signals 2) No transmission 3) Possible loss of some video pictures at early stages of transmission if fault occurs at OSE	B_2 B_o	5	-
Input Signal Interface (Camera Manual Switch-over override)	Camera manual switch-over override	1) Shorted cables or connection (test connector) 2) Stuck or shorted switch in OSE	1) No switch-over logic signals 2) No full-scan video output from video combiner	Fast repair in Ground Station if failure occurs there	No full-scan pictures unless short could be repaired in OSE	A_f C_o	5	-
Power Supply Converter and Regulator (Full-Scan)	a) Loss of -12 volts	1) Faulty internal circuitry 2) Loss of -27.5 volts 3) Faulty cable or connectors 4) Shorted load(s)	1) Erratic or complete loss of gating signals 2) Erratic or complete loss of "F" scan video	None	No full-scan pictures	A_f C_o	4	Design for power switch-over in case of power supply failure.
	b) Loss of +12 volts	1) Faulty internal circuitry 2) Loss of -27.5 volts 3) Faulty cable or connectors 4) Shorted load(s)	1) No full-scan frequency division 2) No full-scan sequencer signals 3) No full-scan video	None	No full-scan pictures	A_f C_o	4	Design for power switch-over in case of power supply failure.
Power Supply Converter and Regulator (Partial-Scan)	a) Loss of -12 volts	1) Faulty internal circuitry 2) Loss of -27.5 volts 3) Faulty cable or connectors	1) Erratic or complete loss of gating signals 2) Erratic or complete loss of partial-scan #2, #3, and #4 pictures	None	1) Loss of 3/4 of partial-scan pictures 2) Slight loss of resolution on partial-scan #1	B_p, F_p-E_p } C_o-B_o	4	Design for power switch-over in case of power supply failure.

TABLE C-7
FAILURE EFFECTS ANALYSIS OF THE SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Power Supply Converter and Regulator (Partial-Scan) (Continued)		4) Shorted load(s)	3) Low possibility of erratic partial-scan #1					
	b) Loss of +12 volts	1) Faulty internal circuitry 2) Loss of -27.5 volts 3) Faulty cable or connectors 4) Shorted loads	1) No partial-scan frequency division 2) No partial-scan sequencer signals 3) No partial-scan video from cameras #2, #3 and #4	None	1) Loss of 3/4 of partial-scan pictures 2) Slight loss of resolution on partial-scan #1 picture	B_p, F_p-E_p → C_o-B_o	4	Design for power switch-over in case of power supply failure.
Dual Clock and Driver	Loss of clock output	1) Faulty internal circuitry 2) Faulty cable or connectors 3) Shorted test points (both of them) 4) Shorted "P" or "F" divider chain inputs	No sequencer signals	Redundant clock oscillators	1) Loss of 3/4 of partial-scan pictures 2) Loss of full-scan pictures 3) Slight loss of resolution on partial-scan #1 pictures	B_p, A_f, F_p → A_o	5	1) Design with redundant clock drivers. 2) Remove test points or install isolation resistors in series with test points.
F Division Chain	a) Loss of any Divider outputs	1) Faulty internal circuitry 2) Faulty cable or connectors 3) Loss of bias voltages 4) Shorted loads	Loss of F sequencer outputs	None	No full-scan video	A_f C_o	4	
	b) Loss of any gate outputs (feedback gate)	1) Faulty circuitry 2) Loss of bias voltages 3) Shorted loads	1) Loss of sequencer outputs 2) Erroneous repetition rates 3) Erroneous pulse widths	None	Worst-case situation would be loss of full-scan pictures	A_f C_o	4	Analysis of various gate failures is too complex to be discussed here.
F Logic Decoder	Loss of any of the following outputs: a) 2x horizontal sync	1) Faulty circuitry 2) Shorted loads 3) Open connectors or cables	Loss of sensitivity in low video levels	None	Poor quality full-scan pictures	B_f D_o	5	-
	b) horizontal sync	1) Faulty circuitry 2) Shorted loads 3) Open connectors or cables	No camera horizontal sync	None	No full-scan pictures	A_f C_o	5	-
	c) Vertical read A	Same as above	No camera A vertical read sync	Partially redundant camera B	Only one full-scan set of pictures	C_F E_o	5	-
	d) Vertical read B	Same as above	No camera B vertical read sync	Partially redundant camera A	Only one full-scan set of pictures	C_F E_o	5	-
	e) Shutter A	Same as above	No camera A shutter sync	Partially redundant camera B	Only one full-scan set of pictures	C_F E_o	5	-
	f) Shutter B	Same as above	No camera B shutter sync	Partially redundant camera A	Only one full-scan set of pictures	C_F E_o	5	-

TABLE C-7
FAILURE EFFECTS ANALYSIS OF THE SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
F Logic Decoder (Cont.)	g) Erase A	Same as above	No Camera A erase sync	Partially redundant camera B	Only one full-scan set of pictures	C_F E_o	5	-
	h) Erase B	Same as above	No camera B erase sync	Partially redundant camera A	Only one full-scan set of pictures	C_F E_o	5	-
	i) Flash A	Same as above	No camera A flash sync	Partially redundant camera B	Set of multiple exposure pictures in camera A (full-scan)	E_F, D_F } E_o	5	-
	j) Flash B	Same as above	No camera B flash sync	Partially redundant camera A	Set of multiple exposure pictures in camera B	E_f, D_f } E_o	5	-
	k) Vertical blanking	Same as above	No vertical blanking sync pulses	None	Non-synchronized pictures at ground station	E_F F_o	5	If pictures are on tape they may be restored during playback.
F Video Combiner Logic	a) Video A ON gate (at +12 volts only)	1) Faulty circuitry 2) Shorted loads 3) Open connectors or cable 4) Loss of signal from logic decoder	1) No sync tone 2) No video A gate sync	None Partially redundant camera B	No sync tone light at OSE only one full-scan set of pictures	C_F E_o	5	-
	b) Video A ON gate (at 0 volt only)	Same as above	1) Continuous video A gate on 2) Shifting of black clamp level for video A	None	Poor contrast in both full-scan pictures	C_F E_o	5	-
	c) Video B ON gate (at 0 volt only)	Same as above	No video B gate sync	Partially redundant camera A	Only one full-scan set of pictures	C_F E_o	5	-
	d) Video B ON gate at +12 volt only	1) Faulty circuitry 2) Shorted loads 3) Open cable or connectors 4) Loss of signal from logic decoder	1) Continuous video B gate 2) Shifting of black clamp level for video B	None	Poor contrast in both full-scan pictures	P_F E_o	5	-
F timer	a) No 5-minute sync	1) Faulty circuitry 2) Shorted loads 3) Open cable or connector 4) Faulty input signal(s)	No 5-minute sync output from F Timer	Redundant 5-minute sync output from P timer	None	- F_o	4 to 5	-
	b) Early 5-minute sync	1) Faulty circuitry Faulty input signals	Early 5-minute sync output	None	Early power amplifier (transmitter) turn-on	-	5	Possible transmitter damage.
Camera Switch-Over	No switch-over signal state "1"	1) Faulty internal circuitry 2) Shorted cable or connector 3) Loss of bias voltages	No switch-over signal	None	No full-scan pictures	A_f C_o	4 to 5	Localize circuitry in controller modulator board in order to eliminate possible interface problems.

TABLE C-7
FAILURE EFFECTS ANALYSIS OF THE SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Transmitter Power Turn-on Logic	a) No DC return to transmitters	1) Faulty relay 2) Faulty internal circuits 3) Loss of set input signals due to cables or connectors 4) Loss of bias voltage	No full power-on to transmitter A and B	Back-up command from JPL bus	1) With back-up signal — none 2) With no back-up signals no partial-scan pictures, no full-scan pictures, and no 90-point telemetry	E_o	5	-
	b) Immediate DC return to transmitter	1) Faulty relay 2) Faulty internal circuits 3) Continuous high set input 4) Continuous low reset input	Continuous DC return, high battery drain	None	No warm-up period — possible damage to transmitters	A_f A_p	5	-
Automatic Reset	a) No reset (at +12 volt level)	1) Faulty internal circuitry 2) Loss of bias voltages	1) Immediate camera switch-over 2) Faulty indication to P and/or F timer	None	1) Effect on telemetry 2) No full-scan pictures 3) No transmitter warm-up period	B_{90} A_f A_p	5	Redesign automatic reset outputs into two parts
	b) (at O volt level)	Same as above	No camera switch-over	Back-up command from JPL bus	No partial-scan pictures in transmitter A during last two minutes of terminal mode	E_p F_o	5	Same as above
P Division Chain	a) Loss of any divider outputs	1) Faulty internal circuitry 2) Faulty cable or connectors 3) Loss of bias voltages 4) Shorted loads	Loss of P sequencer outputs	None	1) Loss of 3/4 of partial-scan pictures 2) Partial loss of resolution of partial-scan #1 pictures	B_p, F_p, E_p } C_o-B_o		
	b) Loss of any gate outputs (feedback gates)	1) Faulty circuitry 2) Loss of bias voltages 3) Shorted loads	1) Loss of sequencer outputs 2) Erroneous repetition rates 3) Erroneous pulse widths	None	1) Worst-case condition would be loss of 3/4 of partial-scan pictures 2) Partial loss of resolution of partial-scan #1 pictures	B_p, F_p, E_p } C_o-B_o	4	Analysis of various gate failures is too complex to be discussed here.
P Logic Decoder	Loss of any of the following outputs a) 3.0 kc power supply and black clamp syncs	1) Faulty internal circuitry 2) Shorted loads 3) Open cable or connector(s)	Not being used	Not used	None	F_o	5	Eventual removal from system.
	b) 2X horizontal sync 3000 cps	Same as above	Loss of sensitivity, low video levels on partial-scan cameras #2, #3, and #4	Partial-scan camera #1 has own sync generators	Poor quality partial-scan pictures #2, #3, & #4	D_p-B_p C_o	5	Separate line to each camera instead of a single line.

TABLE C-7
FAILURE EFFECTS ANALYSIS OF THE SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
P Logic Decoder (Continued)	c) Horizontal sync 1500 cps	Same as above	1) No camera horizontal sync from sequencer 2) No video from cameras 2, 3, 4	1) Partial-scan camera #1 & 2 2) Two separate sync lines	No partial-scan pictures from camera #2, #3, #4	B_p C_o	5	-
	d) Vertical read #1	Same as above	No camera #1 vertical read pulse	Camera #1 has own generator	None	F_o	5	-
	e) Vertical read or #2, or #3, or #4	Same as above	No camera vertical read pulse to camera #2, or #3 or #4	3 partially redundant partial-scan videos	Loss of 1/4 of partial-scan pictures	D_p E_o	5	-
	f) Shutter #1	Same as above	No camera #1 shutter pulse	Camera #1 has own generator	None	F_o	5	-
	g) Shutter sync for cameras #2, #3, #4	Same as above	No camera shutter sync to cameras #2, or #4	3 partially redundant partial-scan videos	Loss of 1/4 of partial-scan pictures	D_p E_o	5	-
	h) Erase sync for cameras #1	1) Faulty internal circuitry 2) Shorted loads 3) Open cable or connector(s)	No erase sync to camera #1	Camera #1 has own generator	None	F_o	5	-
	i) Erase sync for camera #2 or #3 or #4	Same as above	No erase sync to cameras #2 or #3 or #4	3 partially redundant partial-scan videos	Loss of 1/4 of partial-scan pictures	D_p E_o	5	-
	j) Flash sync for camera #1	Same as above	No camera #1 flash sync	Camera #1 has own generator	None	F_o	5	-
	k) Flash sync for cameras #2 or #3 or #4	Same as as above	No camera #2 or #3 or #4 effects erase	3 partially redundant partial-scan videos	Set of multiple exposure partial-scan pictures	D_p E_o	5	-
	l) P vertical blanking	Same as above	No vertical blanking sync pulses	1) Camera #1 has own generator 2) 3 partially redundant cameras	Continuous pictures at OSE (no blanking)	E_p-D_p E_o	5	-
P Video Combiner Logic	a) Loss of P burst sync	1) Faulty circuitry 2) Shorted loads 3) Open cable or connectors 4) Loss of sync from logic decoder	No sync tone	None	OSE cannot recognize which partial-scan camera is supplying the video	E_p E_o	5	-
	b) Video #1 on gate (at +12 volts only)	Same as above	No video #1 on gate	Designed for fail-safe	None	F_o	5	-
	c) Video #1 on gate (at 0 volt only)	Same as above	Continuous transmission of video from camera #1	None	Residual video (partial-scan) in pictures from all cameras (poor contrast)	D_p-C_p D_o	5	-
	d) Video #2 or #3 or #4 on gate (at +12 volts only)	Same as above	No video #2, #3, or #4	3 partially redundant partial-scan cameras	Loss of 1/4 of partial-scan pictures	D_p E_o	5	New circuit design.

TABLE C-7
FAILURE EFFECTS ANALYSIS OF THE SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
P Logic Decoder (Continued)	e) Video #2 or #3 or #4 on gate (at O volts only)	Same as above	Continuous transmission of video from cameras #2, #3 or #4	None	Residual video (partial-scan) in pictures from all cameras (poor contrast)	D_p-C_p-D_o	5	New circuit design.
P Timer	a) No 5-minute sync out	1) Faulty circuitry 2) Shorted loads 3) Open cable or connectors 4) Faulty input signals	No 5-minute sync from P timer	Redundant 5-minute sync output from F timer	None	F_o	4	-
	b) Early 5-minute sync out	Same as above	Premature 5-minute sync out	None	Early power amplifier(s) (transmitter) turn-on	A_p A_f	5	Possible transmitter
	c) No 13-minute sync out	Same as above	No 13-minute sync from "P" timer	None	No switch-over	E_p F_o	4	-
	d) Early 13-minute sync out	Same as above	Premature 13-minute sync from "P" timer	None	Lack of full-scan pictures (depending on time of switch-over)	F_F-A_F C_o	5	-

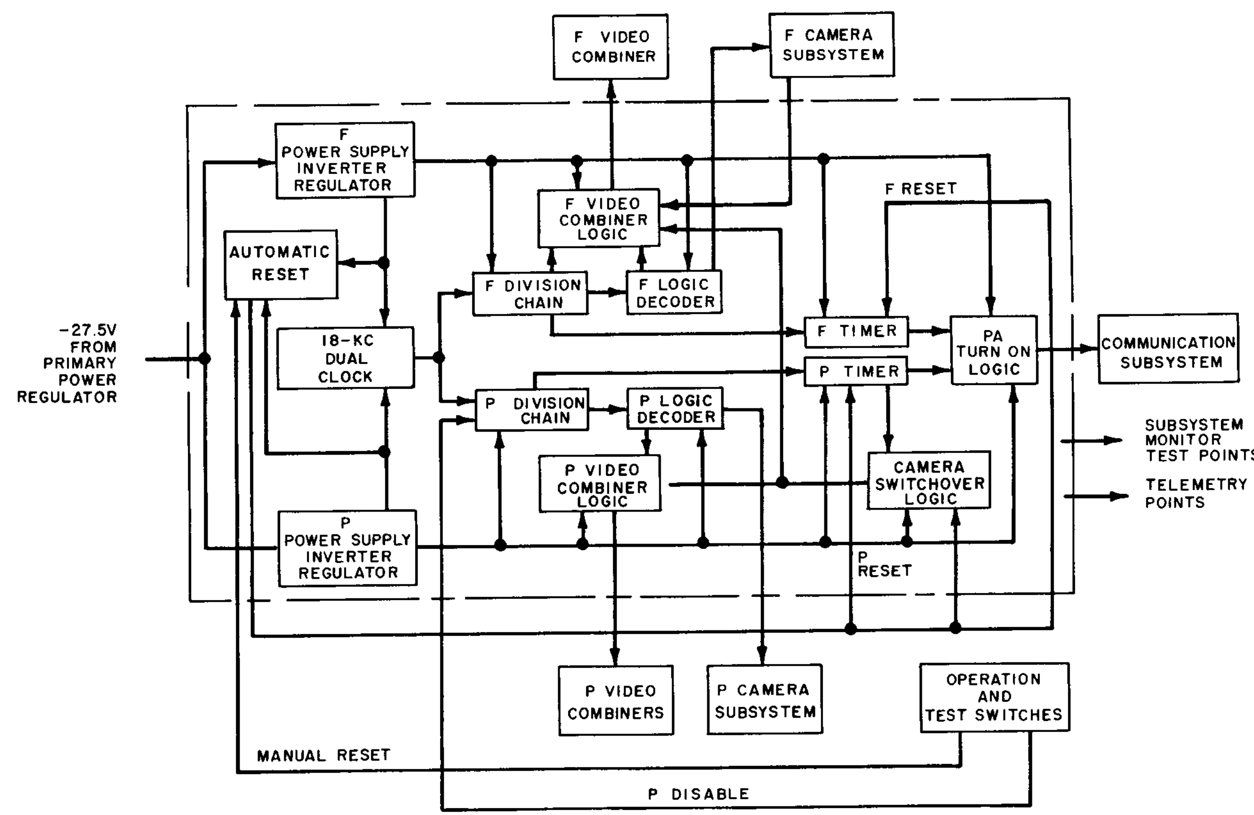


Figure C-5. Block Diagram of the Control Programmer and Camera Sequencer Assembly

TABLE C-8
FAILURE EFFECTS ANALYSIS OF TRANSMITTER NOS. 1 AND 2

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Power Supply	a) No output voltages	1) Shorted load circuits 2) Facility cable or connectors 3) Open transformer winding 4) Defective control-circuit relays	1) Loss of one or more voltages: 100 volts 1000 volts -500 volts -750 volts 6.3 volts 2) High-battery drain 3) DC-to-DC converter might fail to oscillate	Partially redundant transmitter and power supply	1) If channel A fails - no full-scan pictures 2) If channel B fails - no partial-scan pictures until last two minutes of mission	A_f C_o D_p D_o	3 to 2	Current limiting or fuses in each load circuit to reduce battery drain.
	b) Loss of output voltages	Excessive switching transients causing input circuit short	1) Very high battery drain 2) Reduction of power supply output voltage	1) Fuse to isolate power supplies 2) Partially redundant transmitter	1) If channel A fails, no full-scan pictures 2) If channel B fails, no partial-scan pictures until last two minutes of mission	A_f C_o D_p D_o	3 to 2	Determine the extent of transients by multiple turn-on — turn-off switching.
	c) Reduction of output voltages	Shorted turns of converter transformer	a) Low RF power output b) Possible modulation distortion	None in any one transmitter channel	Poor picture quality in one channel a) Loss in picture detail b) High noise in picture	C_f to A_f C_o (Channel A) D_p D_o (Channel B)	4	Effective transformer pretesting.
	d) Open DC return	1) Cabling or connectors fault 2) Fault in transmitter power turn-on in sequencer	No 1000 volts for power amplifier No 1000 volts for power amplifier	Partial redundancy in channel B 1) Complete loss in channel A 2) Redundant telemetry (90-point) 3) Back-up command from JPL bus	Partial-scan in the last two minutes only None	C_p E_o F_o	5 5	
		3) Cabling or connectors fault	No 1000 volts for both power amplifiers	None	No partial-scan video No full-scan video No 90-point telemetry	A_f, A_p, A_{T90} } A_o	5	
		4) Faulty relay control (faulty signal)	No 1000 volts } for both No -750 volts } transmitters	None	Same as above	Same as above		
FM Modulator Oscillator	a) Weak modulation	1) Faulty internal circuitry 2) Loss of bias voltages 3) Fault in cable or connectors	None	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) Low signal-to-noise ratio 2) Poor picture resolution	C_f to A_f D_o to C_o (channel A) D_p D_o (channel B)	5 5	Check regulation of bias voltages
	b) No modulation	1) Faulty internal circuitry 2) Loss of bias voltages 3) Fault in cable or connectors 4) Loss of bias voltages	None	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) If fault is in channel A, no full-scan pictures 2) If fault is in channel B, no partial-scan pictures until last two minutes	A_F C_o D_p D_o	5 5	

TABLE C-8
FAILURE EFFECTS ANALYSIS OF TRANSMITTER NOS. 1 AND 2 (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
FM Modulator Oscillator (Continued)	c) No 20 megacycles	1) Shorted zener regulator 2) Faulty internal circuitry 3) Fault in cable or connectors 4) Loss of bias voltages	No RF	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) If fault is in channel A, no full-scan pictures 2) If fault is in channel B, no partial-scan pictures until last two minutes	A_f C_o D_p D_o	5 5	Check regulation of bias voltage.
	d) Off-center frequency	1) bad crystal 2) Bandpass amplifier partially shorted	Possible interchannel interference	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) If fault in channel A, loss in full-scan picture resolution 2) If fault is in channel B, loss in partial-scan picture resolution	D_f to B_f } D_o D_p D_o	5 5	-
	e) No video	1) Faulty K_1 relay 2) Faulty internal circuitry 3) Open cable on connector 4) Loss of bias voltages	None	1) Partially redundant transmitter 2) Telemetry is completely redundant	1) If fault is in channel A, no partial-scan picture 2) If fault is in channel B no partial-scan pictures until last two minutes	A_f C_o D_p D_o	4 5	-
X12 Multiplier	a) Low power	Slight detuning	None	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) Low signal-to-noise ratio in channel A 2) Low signal-to-noise ratio in channel B	E_f-B_f Q_o D_p D_o	2 2	Check regulation of bias voltages.
	b) No power	1) Faulty X2 multiplier 2) Faulty X3 multiplier 3) Loss of bias voltages	No RF	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) If fault is in channel A, no full-scan pictures 2) If fault is in channel B, no partial-scan pictures until last two minutes of mission	A_f C_o D_p D_o	5 5	-
1st Intermediate Power Amp	a) Low RF power	1) Slight detuning 2) Weak amplifier 3) Instability due to warm-up	None	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) Low signal-to-noise ratio in channel A 2) Low signal-to-noise ratio in channel B	E_F-B_f D_o E_p-D_p D_o	3 to 2 3 to 2	-
	b) No RF power	1) Faulty internal circuitry 2) Faulty cable or connectors 3) Loss of supply voltages	No RF	1) Partially redundant transmitter 2) Telemetry is completely redundant (90-point)	1) If fault is in channel A, no full-scan pictures 2) If fault is in channel B, no partial-scan pictures until last two minutes of mission	A_f C_o D_p D_o	3 to 2 3 to 2	-

TABLE C-8
FAILURE EFFECTS ANALYSIS OF TRANSMITTER NOS. 1 AND 2 (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
2nd Intermediate Power Amp	Same as 1st IPA	Same as 1st IPA	Same as 1st IPA	Same as 1st IPA	Same as 1st IPA	Same as 1st IPA	3 to 2	-
Power Amplifier	a) Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	2	-
	b) Same as above	1) faulty internal circuitry 2) faulty cable or connectors 3) loss of supply voltages 4) faulty current regulator in telemetry processor	Same as above	Same as above	Same as above	Same as above	2	-
Signal Sampler	Partial or complete short	1) Arc leak 2) Arc over 3) High VSWR due to faulty terminations 4) Cables or connector faulty	Loss (partial loss) of RF power	1) Partially redundant transmitter 2) Telemetry is completely redundant	Same as above	Same as above	3	Redesign with solid teflon spacers.
4-Port Hybrid	Partial or complete short	1) Cabling or connector faults 2) Partial pressure	Partial loss of RF power	None	1) Decreased signal-to-noise ratio in both channels 2) Loss of picture resolution	E_f-A_f A_p-A_p E_{T90}- A_{T90} } E_o to A_o	5	-
Dummy Load	Partial short	1) Fault cable or connector 2) Loss of hermetic seal resulting in internal breakdown	Reduction of power from 3 to 6 db mismatch	None	1) Decreased signal-to-noise-ratio in both channels (A & B) 2) Loss of picture resolution	E_f-B_f E_p-B_p E_{T90}- B_{T90} } E_o-B_o	3	Redesign with redundant hermetic seal.
RF Cables and Connectors	Cables and connectors	1) Partial or complete short 2) Open 3) Poor workmanship	1) High VSWR 2) Loss of power	1) Partially redundant transmitters 2) Telemetry is completely redundant (90-point)	Decreased signal-to-noise-ratio: if in channel A, poor full-scan resolution; if in channel B, poor partial-scan resolution	E_f-A_f E_p-A_f E_{T90}- A_{T90} } E_o-A_o	1 to 2	1) Pack all cables in silicon grease. 2) Pretest all high-power cables at 90 watts (4 cables). 3) Controlled assembly techniques.
T/M Processor Current Regulator (Located in processor)	a) Open	1) Fault in connectors and cables 2) Faulty internal circuitry	No RF output (telemetered point)	1) Partially redundant transmitters	1) If fault is in channel A, no full-scan pictures	A_f C_o	4	-

TABLE C-8
FAILURE EFFECTS ANALYSIS OF TRANSMITTER NOS. 1 AND 2 (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
T/M Processor Current Regulator (Located in processor) (Continued)				2) Telemetry is completely redundant (90-point)	2) If fault is in channel B, no partial-scan pictures until last two minutes	D_p D_o	4	-
	b) Short	1) Fault in connectors and cables 2) Faulty internal circuitry	1) High direct current drain in 1000 volts 2) Possible PA tube burn-out	Same as above	Same as above	Same as above	4	-
15 T/M Processor	a) Loss of RF power out	Same as above	Lack of telemetry data	Same as above except 15 point	Lack of telemetry data	E_{T90} F_o	5	-
	b) PA EK	Same as above	Same as above	Same as above	Same as above	Same as above	5	-
	c) PA HV	Same as above	Same as above	Same as above	Same as above	Same as above	5	-
	d) IPA HV	Same as above	Same as above	Same as above	Same as above	Same as above	5	-

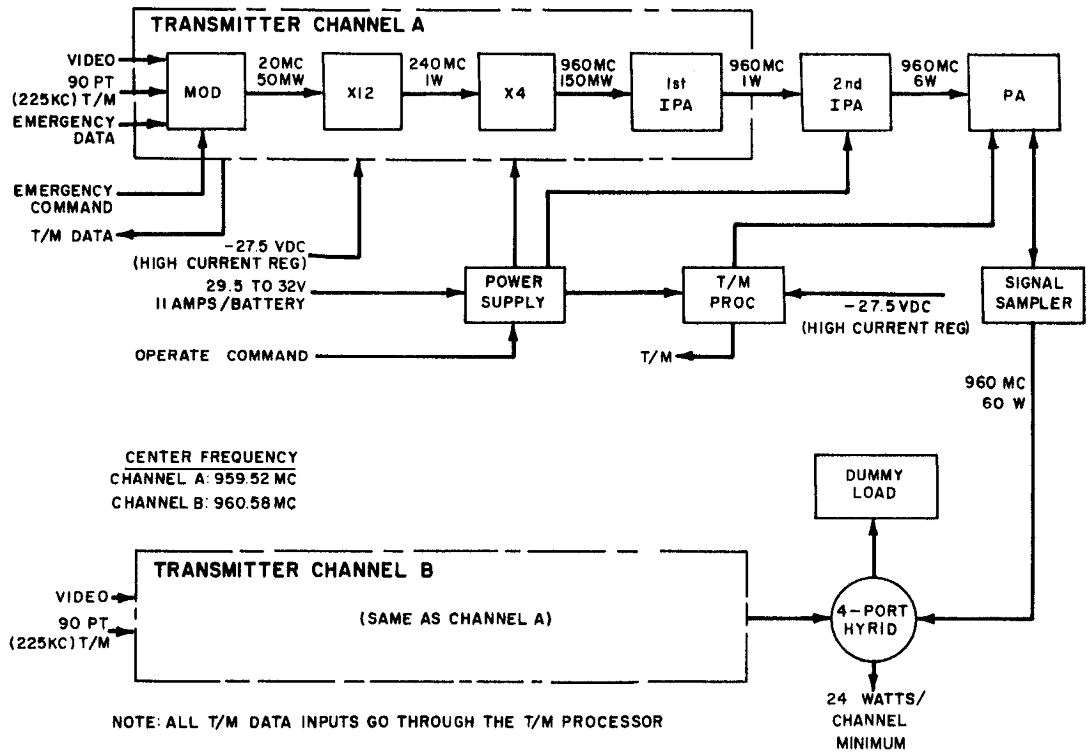


Figure C-6. Block Diagram of the TV Subsystem Communications Equipment

TABLE C-9
FAILURE EFFECTS ANALYSIS OF THE TELEMETRY EQUIPMENT

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Interface Power	a) Loss of -27.5 volts from low-power regulator	1) Faulty cables or connector(s) 2) Faulty warm-up relays (two in parallel)	No 15-point commutation	Redundant warm-up relays	1) No 15-point telemetry 2) No 90-point telemetry	A_{T15}, A_{T90} } D_o	5	-
	b) Loss of -27.5 volts from high-power regulator	Faulty cable or connector(s)	No 90-point commutation	None	No 90-point telemetry	A_{T90} E_o	5	-
15-Point Commutator	a) Partial loss of T/M data and/or inaccuracy of T/M data	1) Faulty cable or connectors 2) Faulty switching	Loss and/or erroneous data	Playback video tape from OSE	Loss in confidence of 15-point T/M data	A_{T15} E_o	3	
	b) Stalled motor	Motor binding due to brush deterioration	No 15-point commutation	None	Loss of 15-point telemetry	A_{T15} E_o	4 to 5	Seal motor bearings.
Channel 8 VCO	Partial or full loss of T/M data	1) Loss of +28.0 volts 2) Faulty cables or connectors 3) Faulty internal circuitry 4) Shorted load	Loss of telemetry data	None	Partial or complete loss of 15-point telemetry	A_{T15} E_o	5	-
AC Amplifier	Partial or complete loss of telemetry data	1) Loss of +28.0 volts 2) Faulty cable or connectors 3) Faulty internal circuitry 4) Shorted load	Loss of telemetry data	None	Partial or complete loss of 15-point telemetry	A_{T15} E_o	5	-
Telemetry Power Supply	a) Change in output voltage	1) Shorted poor transistor 2) Faulty regulator	Shift in V_{CO} center frequency	None	Partial or complete loss of: 15-point telemetry and 90-point telemetry	D_{T15}, D_{T90} } E_o	3	-
	b) Shorted input	1) High load 2) Shorted capacitors 3) Shorted transistors	Short on -27.5 volts low-current regulated	None	No telemetry	A_{T90}, A_{T15} } D_o	4	Fuse input line use better capacitors.
	c) Shorted rectifier diodes	Faulty components	Ripple on telemetry	None	No serious effect on telemetry at OSE	F_o	4	-
90-Point Commutator	a) Partial loss of telemetry data b) Inaccuracy from stalled motor	1) Faulty cable or connector(s) 2) Faulty switching in commutator 3) Motor binding due to brush deterioration	1) Erroneous data 2) No commutation	Playback video tape from OSE	1) Loss in confidences in 90-point telemetry 2) No 90-point telemetry	A_{T90} D_o	3	-
225 KC VCO	Partial or full loss of telemetry	a) Loss of bias voltage b) Faulty cable or connectors c) Faulty internal circuitry d) Shorted load	Loss of telemetry data	Redundant 225 KC V_{CO} on other transmitter channel	None	F_o	5	-

TABLE C-9
FAILURE EFFECTS ANALYSIS OF THE TELEMETRY EQUIPMENT (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Temperature Sensor	Partial or full loss of telemetry data	1) Faulty cable or connectors 2) Faulty internal circuitry 3) Loss of bias voltages	Loss of telemetry data	None	Loss in telemetry data from temperature sensor	$\left.\begin{matrix} B_{T15} \\ D_{T90} \end{matrix}\right\} E_o$	4 to 5	-

TABLE C-10

FAILURE EFFECTS ANALYSIS OF THE COMMAND SWITCH

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Command Switch	a) No SCR turn-on	1) Open R8 or R5 or open R6 or R11	No 15-point T/M	None required RTC-7 command performs redun-ant function	Loss of T/M if RTC-7 performs; if RTC-7 does not, no T/M and no video	A_{T10}, A_{T15} } D_o	5	-
						A_{T90}, A_{T15} } A_o	5	
		2) Open Q1 and/or Q2	Same as above	Same as above	Same as above	A_{T90}, A_{T15} } D_o	5	-
						A_{T90}, A_{T15} } A_o		
		3) Any other A2 board failure not producing SCR output turn-on signal	Same as above	Same as above	Same as above	A_{T90}, A_{T15} } D_o	5	-
						A_{T90}, A_{T15} } A_o		
		4) No CC&S signal	Same as above	Same as above	Same as above	A_{T90}, A_{T15} } D_o	5	-
						A_{T90}, A_{T15} } A_o		
	b) Relay, K-1	1) Open coil	No 15-point T/M	Same as above	Loss of 15-point T/M	A_{T15} F_o	5	-
		2) Shorted coil	Same as above	Same as above	Same as above	A_{15} F_o	5	-
	c) S-1	Failure on A-1 board	No RTC-7 step switching in event of CC&S failure	None	Redundant device itself; used only in event of CC&S command failure	-	5	-
	d) No CC&S signal	External to TV Sub-system	No 15-point T/M; also no other output if follow-on RTC-7 signal is not received	Already in ex-istence in the form of RTC-7	-	-	5	-
	e) No RTC-7 signal	External to Ranger TV Subsystem	Assuming loss of CC&S com-mand, no T/M and no video	Redundant - automatic turn-on provision	Loss of all return in absence of CC&S	-	5	-
	f) No warm-up	Failure of Relay, K-1	No 15-point T/M	None required RTC-7 command performs redun-dant function	Loss of 15-point T/M	A_{T15} F_o	5	-
	g) No emergency-on	1) No RTC-7 signal	Assuming loss of CC&S command, no T/M and no video	Redundant - automatic turn-on provision	Loss of all return in absence of CC&S	-	5	-
		2) Failure on board A1	No 90-point T/M	Redundant boards	No 90-point T/M	A_{T90} E_o	5	-

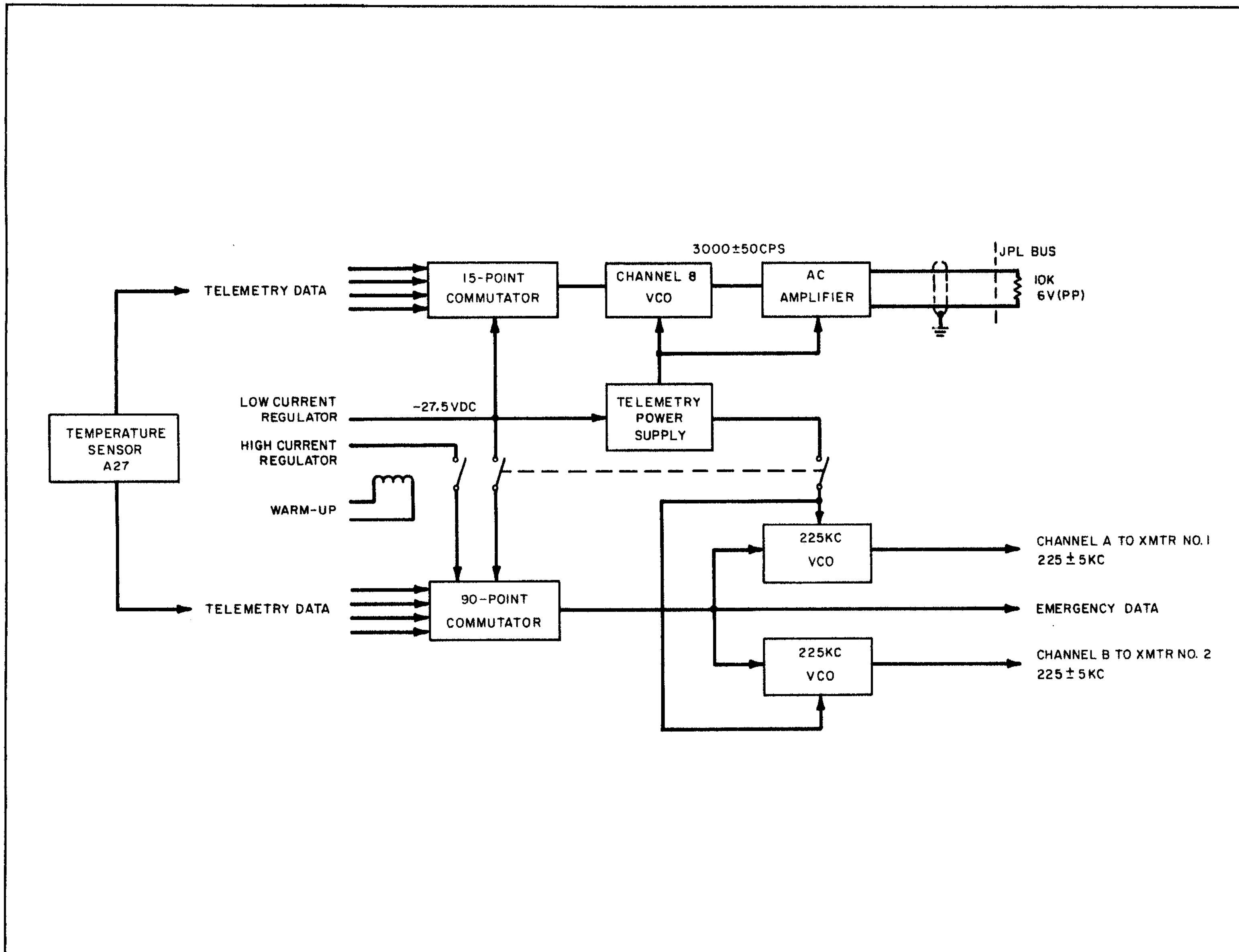


Figure C-7. Block Diagram of the TV Subsystem Telemetry Equipment

TABLE C-9
FAILURE EFFECTS ANALYSIS OF THE TELEMETRY EQUIPMENT (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Command Switch (Continued)	b) No emergency-off	Same as e), f), and g) above	No last minute video	Redundant beards	No last minute video	$\left.\begin{matrix} A_{T90} \\ A_{T15} \end{matrix}\right\} A_0$	5	-

TABLE C-10
FAILURE EFFECTS ANALYSIS OF THE COMMAND SWITCH

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-Current Voltage Regulator	a) No output	1) No battery input	Subsystem completely inoperative	Increase redundancy in batteries	Complete Subsystem failure; no RF; no TM; etc.	A_f, A_p, A_{T90}, A_{T15} } A_o	5	-
		2) Combined shorted battery and SCR	Same as above	Increase isolation in reverse direction between batteries	Same as above	A_f, A_p, A_{T90}, A_{T15} } A_o	5	-
		3) Open series regulator transistors, Q6 and Q7	No F or P camera video and no programming from sequencers	Redundant regulator	No video from either camera group and no timing from loss of sequencing	A_f, A_p } A_o	5	-
		4) Open series regulator equalizing resistors, R10 and R11	Same as above	Same as above	Same as above	A_f, A_p } A_o	5	-
		5) Open emitter on driver, Q5	Same as above	Same as above	Same as above	A_f, A_p } A_o	5	-
		6) Failure to receive SCR turn-on command	Same as above	Redundant command signaling	Same as above	A_f, A_p } A_o	5	Used to ensure starting
		7) Opens on terminal board	Same as above	Redundant regulator	Same as above	A_f, A_p } A_o	5	-
		8) Open connector, input or output	Same as above	Redundant connectors	Same as above	A_f, A_p } A_o	5	-
		9) Regulator failed to start, open in circuit comprising R13, R14, and CR2	Same as above	Not required, this is a redundant configuration to assure regulator starting	Same as above	A_f, A_o } A_o	5	The failure probability here is the product of this probability and that of the regulator not starting without this circuit.
		10) Short on output	No F or P camera video and no programming from sequencers	Fuse various parts of load	No video from either camera group and no timing for lack of sequencer operation	A_f, A_p } A_o	5	-
	b) No regulation (above nominal output)	1) Shorted Q6 or Q7	Load voltage equals battery voltage	None	Shift in VCO center frequency in T/M; video output of cameras distorted or out	B_f, B_p } B_o	0.7 x F.R. 5	-

TABLE C-11
FAILURE EFFECTS ANALYSIS OF THE POWER SUPPLY (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-Current Voltage Regulator (Continued)		2) Short in driver, emitter-to-collector of Q5	Same as above	None	-	D_f-A_f D_o- D_p-A_p A_o	5	-
		3) Failure in Q1, 2, 3, or 4	Same as above	None	-	D_f-A_f D_o- D_p-A_p A_o	1x4xF.R.	-
		4) Open Zener, CR1	Same as above	None	-	D_f-A_f D_o- D_p-A_p A_o	0.3xF.R.	-
	(c) No regulation (below nominal output)	1) Shorted CR2 in starting circuit	-	-	-	-	-	-
		2) Excess leakage in output cap., C-1	-	-	-	-	-	-
		3) Overload (ext. to regulator)	-	-	-	-	-	-
		4) Low battery input	-	-	-	-	-	-
Low-Current Voltage Regulator	a) No output	1) No battery input	No telemetry	Redundancy in batteries	Loss of both 15-point and 90-point telemetry	A_{T15}, A_{T90} } D_o	5	-
		2) Open series regulator, Q-1	Same as above	Redundant regulator	Same as above	A_{T15}, A_{T90} } D_o	5	-
		3) Failure to receive turn-on command from command switch	Same as above	Redundant command signaling	Same as above	A_{T15}, A_{T90} } D_o	5	-
		4) Open isolation diodes, CR2 and 3	Same as above	Redundant diodes	Same as above	A_{T15}, A_{T90} } D_o	5	-
		5) Connector opens	Same as above	Redundant connections	Same as above	A_{T15}, A_{T90} } D_o	5	-
		6) Opens on terminal board	Same as above	Redundant regulator	Same as above	A_{T15}, A_{T90} } D_o	5	-
		7) Shorted output(*)	Same as above	None	Same as above	A_{T15}, A_{T90} } D_o	5	-

(*) With shorted output on low-current voltage regulator, the circuit becomes a current supply at a maximum level of approximately 50 ma.

TABLE C-11
FAILURE EFFECTS ANALYSIS OF THE POWER SUPPLY (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Low-Current Voltage Regulator (Continued)	b) No regulation	1) Shorted series regulator, Q1	Output follows battery voltage	None	From complete loss of telemetry data to some minor loss depending on battery EMF, also frequency change in VCO	D_{T15} $-A_{T15}$ D_{T90} $-A_{T90}$ } E_o- D_o	5	-
		2) Open voltage regulator diode, CR1	Same as above	None	Same as above	D_{T15} $-A_{T15}$ D_{T90} $-A_{T90}$ } E_o- D_o	5	-
		3) Shorted voltage regulator diode, CR1	Same as above	None	Same as above	D_{T15} $-A_{T15}$ D_{T90} $-A_{T90}$ } E_o- D_o	5	-
		4) Failure of Q1 or Q2 in any mode	Same as above	None	Same as above	D_{T15} $-A_{T15}$ D_{T90} $-A_{T90}$ } E_o- D_o	5	-
		5) Low battery input	Same as above	Redundant or higher watt-HR batteries	Same as above	D_{T15} $-A_{T15}$ D_{T90} $-A_{T90}$ } E_o- D_o	5	-

Appendix D

Failure Effects Analysis of Split-System Configuration

TABLE D-1
FAILURE EFFECTS ANALYSIS OF TV SUBSYSTEM

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Channel F Battery (A10, Figure D-1)	Dead or weak	1) Excessively high drain 2) Faulty heaters 3) Defective battery 4) Faulty connecting diode	1) Loss of High-Current Regulator, A12, and Low-Current Regulator, A17 2) Loss of all telemetry, unregulated F Channel only	None	No F-scan RF (Channel F) output	A_f D_o	3	Connect Battery A11 to terminal mode commutator when Battery A10 fails (telemetry only). This should be an exclusive "or-ing" arrangement.
Channel P Battery (A11, Figure D-1)	Dead or weak	Same as above	1) Loss of High-Current Regulator, A22 2) Loss of telemetry during cruise mode 3) Weak or lost unregulated P Channel only	Telemetry operates from A10 during terminal and warming mode	No P-scan RF (Channel P) Output	A_p C_o A_{T15}	3	Connect Battery A10 to terminal mode commutator when A11 fails (telemetry only) in exclusive "or-ing" arrangement.
(Channel F) High-Current Regulator (A12, Figure D-1)	a) Open circuit	1) Faulty regulator circuit (open series element) 2) Faulty Silicon Control Rectifiers (SCR)	1) Loss of voltage to F Channel during all modes 2) Loss of redundant voltage to telemetry processor during terminal mode	None	No F-scan video	A_f D_o	5	
	b) Short circuit across regulator	Faulty regulator circuit (shorted series element)	Over voltage on -27.5 volts line (-30.5 to -35 volts) F-scan and telemetry, terminal mode only	None		F_f to F_o A_f to C_o F_{T90} to A_{T90}	4	
	c) Loss of voltage	1) Shorted load 2) Faulty SCR switch 3) Low Battery voltage 4) Faulty regulator 5) Faulty cable connector	1) No regulated -27.5 volts	None	No F-scan video, and no RF if SCR fails	A_f C_o A_{T90} A_p C_o	5 5	
(Channel P) High-Current Regulator (A37, Figure D-1)	a) Open circuit	1) Faulty regulator circuit (open series element) 2) Faulty SCR's	Loss of voltage to P Channel in all modes	None	No P-scan video	A_p C_o	5	
	b) Short circuit across regulator	Faulty regulator circuit (shorted series element)	Overvoltage on -27.5 volts line (=30.5 -35 volts) during P-scan	None	Degradation or possible loss of P-scan	F_p to F_o A_p to C_o	4	
Low-Current Regulator (A17, Figure D-1)	a) Open circuit	1) Faulty regulator circuit (open series element) 2) Faulty series diode 3) Faulty relay (Command Switch)	Telemetry supplied by High-Current Regulator A12 during terminal mode; no telemetry during cruise mode	Redundant with High-Current Regulator A12 during terminal mode	Loss of telemetry during cruise mode	A_{T15} F_o	5	
	b) Shorted circuit across regulator	Faulty regulator circuit	Over voltage on -27.5 volts line during cruise mode	None	Degradation or possible loss of telemetry during cruise mode	F_{T15} F_o A_{T15}	4	

TABLE D-1
FAILURE EFFECTS ANALYSIS OF TV SUBSYSTEM (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Low-Current Regulator (A17, Figure D-1) (Continued)	c) Loss of voltage	1) Shorted load 2) Faulty regulator 3) Faulty cable connector	Same as (a) above; possible oscillation of cruise-on relay in Command Switch	1) Redundant with High-Current Regulator A12 during terminal mode only 2) Fuse input	Possible loss of F-scan and telemetry if battery A10 is pulled down because of overload	A_{T15} F_o	4	
Command Switch (A13, Figure D-1)	a) No "Cruise-On" command	1) Faulty cable or connector 2) Faulty latching relay	No telemetry during cruise	None	Loss of telemetry during cruise mode	A_{T15} F_o	4	
	b) No "Warm-Up" command response	1) Faulty cable or connector 2) Faulty SCR amplifier 3) Faulty diodes to SCR's	No high-current regulator output; no F- or P-scan; no telemetry during terminal mode	1) RTC signal as 1st back-up 2) Clock signal as 2nd back-up (effects channel F only)	None, provided back-up works		4	The failure class factor can not be considered separately, since there are redundant considerations. For channel F there are three turn-on possibilities: the CC&S command, the RTC-7, and the clock signal.
	c) No "Emergency" command	1) Selection connection open 2) Faulty wiring of return to stepper switch 3) Inoperative stepper	None for expected (normal) operating conditions; however, emergency telemetry is not possible. When stepper switch is inoperative, system is locked in cruise mode if warm-up signal from JPL has failed.	None, since this is a back-up provision	Loss of back-up for minimal telemetry data return. No effect if warm-up signal from JPL works. Otherwise, system is locked in cruise mode.	A_{T90} E_o	4	This failure can occur only during emergency-mode operation.
	d) No "Emergency Off" command	Stepper switch locked in "Emergency-On"	Continued operation in emergency mode, assuming failures have necessitated emergency operation	None, since this is a back-up provision	Inability to effect desired telemetry return; inability to repeat trials for desired operation upon encountering initial difficulties, i.e., no warm-up signal	A_f A_o A_p	4	Failure class factor would apply only should return to normal operating conditions be attempted, after conditions initiating emergency mode have been cleared. Figure is reduced in criticality, therefore, by probability of "Emergency-Off" command being required.
	e) No RTC input response	1) Faulty RCA-JPL interface connection 2) Faulty relay driver 3) Faulty RTC relay 4) Faulty RTC signal source	1) Loss of emergency mode (if needed) 2) Loss of a back-up command for P-scan video	1) None for P-scan 2) Clock for F-scan and terminal-mode telemetry	1) None if back-up not required 2) Loss of P-scan video if back-up is required	A_p C_o	5	
Camera Head F-scan (A1, Figure D-1)	a) Loss of camera F_a (A1A6)	1) Faulty sequencer to F channel 2) Faulty connector or cable 3) Faulty internal circuit	Loss of F-scan video from F_a camera		Loss of 1/2 of F-scan pictures	D_f E_o	3	

TABLE D-1
FAILURE EFFECTS ANALYSIS OF TV SUBSYSTEM (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Camera Head F-scan (A1, Figure D-1) (Continued)		4) Internal loss of -27.5 volts reg. 5) Internal loss of -30.5 volts unreg. 6) Shorted camera electronics 7) Faulty vidicon and shutter						
	b) Loss of camera F_b (A1A5)	Same as above	Loss of F-scan video from F_b camera		Same as above	D_f E_o	3	
	c) Loss of both cameras F_a and F_b	Same as above	Loss of all F-scan video	P-scan returns, no F-scan	Loss of all F-scan pictures	A_f D_o	5	
Camera Head P-Scan (A1, Figure D-1)	a) Loss of camera P1	1) Faulty sequencer 2) Faulty cable or connector 3) Faulty internal circuit 4) Internal loss of -27.5 volts reg. 5) Internal loss of -30.5 volts unreg. 6) Shorted camera electronics 7) Faulty vidicon 8) Faulty shutter	Loss of P-scan video P1	Partially redundant pictures from P-scan cameras	Loss of 1/4 of P-scan video	E_p E_o	3	
	b) Loss of camera P2	Same as above	Loss of P-scan video P2	Same as above	Same as above	E_p E_o	3	
	c) Loss of camera P3	Same as above	Loss of P-scan video P3	Same as above	Same as above	E_p E_o	3	
	d) Loss of camera P4	Same as above	Loss of P-scan video P4	Same as above	Same as above	E_p E_o	3	
Camera Electronics P-scan (A2, A3, A4, A5, Figure D-1)	a) Loss of any one of the four P-scan camera videos (Camera head is assumed to be operating properly.)	1) Faulty internal circuitry 2) Faulty vidicon and shutter 3) Loss of bias voltage 4) Shorted video combiner 5) Faulty cable or connector	Loss of one P-scan video	Partially redundant P-scan pictures	Loss of 1/4 of P-scan video	E_p E_o	2	
	b) Loss of ±6.3 volts from either camera P1 or P2	1) Faulty internal circuit 2) Faulty cable 3) Faulty diode	None	±6.3 volts is redundant	None	F_p F_o	5	Simultaneous loss of ±6.3 volts from cameras P1 and P2 is required to disable the Video Combiner causing loss of all P-scan video.

TABLE D-1
FAILURE EFFECTS ANALYSIS OF TV SUBSYSTEM (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Camera Electronics P-scan (Continued)	c) Loss of ±6.3 volts from both cameras	Same as above	Loss of all P-scan video	None	Loss of all P-scan video	A_p C_o	5	
Camera Electronics F-Scan (A6, A7 Figure D-1)	a) Loss of cameras F_a or F_b video (camera 2) head is assumed to be operating properly.)	1) Faulty internal circuit 2) Loss of bias voltages 3) Shorted video combiner 4) Faulty cable or connector 5) Faulty vidicon and shutter 6) Faulty sequencer	Loss of F-scan video, F_a or F_b	None	Loss of 1/2 of F-scan video	D_f E_o	2	
	b) Loss of ±6.3 volts	1) Faulty internal circuit 2) Faulty cable 3) Faulty diode	None	±6.3 volts is redundant	None	F_f F_o	5	Both F-scan cameras would have to lose ±6.3 volts simultaneously to disable the video combiner and cause disable the video loss of all F-scan video.
	c) Loss of camera F_a and F_b video (assumes camera head is O.K.)	Same as failure (a) above	Loss of all F-scan video	None	No F-scan video	A_f D_o	5	
	d) Loss of ±6.3 volts both cameras	Same as failure (b) above	Loss of all F-scan video	None	No F-scan video	A_f D_o	5	
Video Combiner (A8, Figure D-1)	a) No Channel P video	1) Faulty internal circuit 2) Faulty cable or connector 3) Loss of bias voltage internally 4) Shorted load 5) Faulty sequencer	No transmitter No. 2 modulation signals (video)	None	Complete loss of P-scan video	A_p C_o	5	
	b) No Channel F video	Same as (a) above	No transmitter No. 1 modulation signals (video)	None	Complete loss of F-scan video	A_f D_o	5	
Sequencer Power Supply, Channel F (A28, Figure D-1)	a) No d-c return (transmitter return	1) Faulty relay 2) Faulty cable or connector 3) Faulty relay driver 4) Faulty timer	No transmitter No. 1 operation by sequencer	Redundant turn-on command in electronic clock	None		4	

TABLE D-1
FAILURE EFFECTS ANALYSIS OF TV SUBSYSTEM (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Sequencer Power Supply, Channel F (Continued)	b) Loss of gating signals (to combiner and sequencer power supply	1) Faulty cable or connector 2) Faulty timer 3) Faulty internal circuit	Loss of synchronizing and gating signals; loss of video, deficient video, or no video combining	None	No video	A_f D_o	4	
	c) Loss of camera-sync functional signals (to camera electronics)	Same as above	Deficient Video or no video	None	Deficient video or no video.	A_f C_o		
Sequencer Power Supply (Channel P) (A28, Figure D-1)	a) Same as failure (a) above	Same as failure (a) above	No transmitter No. 2 operation	None	No P-scan RF output	A_p C_o	4	
	b) Same as failure (b) above	Same as failure (b) above	Loss of sync, and gating signals, some loss of video, deficient video, or no video combining	None	No video A	A_p C_o	4	Power "fail-safe" gate from camera P1 electronics.
	c) Same as failure (c) above	Same as failure (c) above	Deficient or no video from cameras P2, P3, or P4	Free-running sync. generator in camera P1	Deficient or no video from cameras P2, P3, or P4		4	
P-Channel Transmitter (A14), Power Amplifier (A15), Power Supply (A16, Figure D-1)	No output	1) Faulty internal circuit 2) Faulty cable and connector 3) No DC return 4) Faulty command signal 5) Loss of power 6) Modulator and multiplier failure	No RF output	Redundant terminal mode telemetry	No F-scan RF output	A_f D_o	1	
F-channel Transmitter (A19), Power Amplifier (A20), Power Supply (A21, Figure D-1)	No output	Same as above	No RF output	Same as above	No P-scan RF output	A_p C_o	1	
Four Port Hybrid (A24) and Dummy Load (A25, Figure D-1)	Low or lost output	1) Faulty cabling or connector 2) Arcing 3) Air leakage	No RF output	None	Decreased signal-to-noise ratio both channels; possible loss of all video and terminal mode telemetry	E_f to E_o, A_f to A_o, E_p, A_p, E_{T90}, A_{T90}	5	

TABLE D-1
FAILURE EFFECTS ANALYSIS OF TV SUBSYSTEM (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Telemetry Assembly (A26), Temperature Sensor (A27), Telemetry Processor No. 1, Telemetry Processor No. 2 (Figure D-1)	a) No terminal mode telemetry	1) Faulty commutator 2) Faulty internal circuit 3) Faulty processors 4) Faulty temperature sensors 5) Faulty cables and connectors	Loss of telemetry points	None	Loss of telemetry up to -88 points	F_{T90} to E_o A_{T90}	3	
	b) No cruise mode telemetry	Same as above	Same as above	None	Loss of telemetry up to 13 points	F_{T15} to E_o A_{T15}	3	
Electronic Clock (A35, Figure D-1)	a) No turn-on output	1) Faulty internal circuit 2) Faulty cable or connector 3) Faulty DCU	1) No clock turn-on signal 2) No system A turn-on if all other turn-ons fail	RTC-7 command from JPL bus	1) None if either CC&S commands operate or RTC-7 commands operate	F_p F_o	5	
					2) Lack of F-scan video and terminal telemetry if clock is needed	A_f C_o A_{T90}	5	
	b) Accidental turn-on	Same as above	Constant transmission of F-scan video	None	3) Excessive power drain on channel F may cause failure of channel during terminal mode	A_f D_o	5	Design for power turn-off is needed, in case of accidental clock turn-on.
Power Control Unit (A36, Figure D-1)	No turn-off signal	1) Faulty internal circuit 2) Faulty cable or connectors 3) Faulty command switch	No DC disconnect in the event of accidental power turn-on	None	1) Possible loss of F-scan video if battery is low	A_f D_o	5	Turn-off provision is strictly a compensating provision.
					2) Possible loss of P-scan video if battery is low	A_p C_o	5	
					3) Possible loss of F-scan and P-scan video and terminal telemetry	A_p A_f A_o A_{T90}	5	
Distribution Control Unit (A34, Figure D-1)	a) Loss of regulated power to 2 sequencer power supplies	1) Faulty internal circuit 2) Faulty cable or connectors	No regulated DC input (-27.5) to either unit	None	1) Loss of power to F-sequencer power supply; no F-scan video	A_f D_o	5	Separate power cables are needed.
					2) Loss of power to P-sequencer power supply; no P-scan video	A_p C_o	5	Power "fail-safe" gate from camera P1 electronics
	b) Loss of regulated power to 2 F-scan cameras	1) Faulty internal circuit 2) Faulty cable or connectors	No regulated d-c input (-27.5) to either unit	Redundant F-scan camera	Loss of power to both F cameras; loss of 1/2 of F-scan pictures	D_f E_o	5	Separate power cables are needed.

TABLE D-1
FAILURE EFFECTS ANALYSIS OF TV SUBSYSTEM (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Distribution Control Unit (Continued)	c) Loss of regulated power to 4 P-scan cameras	1) Faulty internal circuit 2) Faulty cable or connectors	No regulated DC input (-27.5) to any one or all of the units	Three other redundant partial scan cameras	Loss of power to all four P cameras; loss of 1/4 of P-scan video	E_p E_o	5	Separate power cables are needed.
	d) Loss of regulated power to 2 telemetry processors	1) Faulty internal circuit 2) Faulty cable or connectors	No regulated DC input (-27.5) to either unit	None	1) Loss of power to transmitter No. 1 telemetry processor; loss of Channel F 2) Loss of power to transmitter No. 2 telemetry processor; loss of Channel P	A_f D_o	5	Separate power cables are needed.
	e) Loss of unregulated power to 2 F-scan camera electronics	1) Faulty internal circuit 2) Faulty cable or connectors 3) Faulty battery	No unregulated DC input to either unit	Redundant F-scan camera	Loss of 1/2 F-scan video	D_f E_o	5	
	f) Loss of unregulated power to 4 P-scan camera electronics	1) Faulty internal circuit 2) Faulty cable or connectors 3) Faulty battery	No unregulated DC input to any one or more of the four units	3 redundant P-scan cameras	Loss of 1/4 P-scan video	E_p E_o	5	
	g) Loss of unregulated power to 2 transmitters (No. 1 and No. 2, P-scan)	1) Faulty internal circuit 2) Faulty cable or connectors 3) Faulty battery	No unregulated DC input to either unit	None	Complete loss of F-scan video	A_8 D_o	5	
	h) Loss of unregulated power to electronic clock	1) Faulty internal circuit 2) Faulty cable or connectors 3) Faulty battery	No unregulated DC input to unit	None	Complete loss of P-scan video	A_{T15} F_o	5	
	i) Loss of unregulated power to command switch	1) Faulty internal circuit 2) Faulty cable or connectors 3) Faulty battery	1) No unregulated DC input to command switch, 2 battery heaters via command switch, low-current regulator via command switch 2) No power to low-current regulator	1) CC&S and RTC-7 signals 2) None	1) No turn-on clock signal 2) Loss of cruise telemetry	A_{T15} F_o	5	Redundant turn-on command
	j) Loss of emergency-mode signals	1) Faulty internal circuit 2) Faulty cable or connectors 3) Faulty command switch	No emergency mode signals to either transmitter No. 1 or transmitter No. 2	Both channels carry terminal mode telemetry	None	F_{T90} F_o	5	
	k) Loss of clock signals	1) Faulty internal circuit 2) Faulty cable or connectors	Partial operation of clock, or none	CC&S and RTC-7 signals	No turn-on signal			Redundant turn-on command

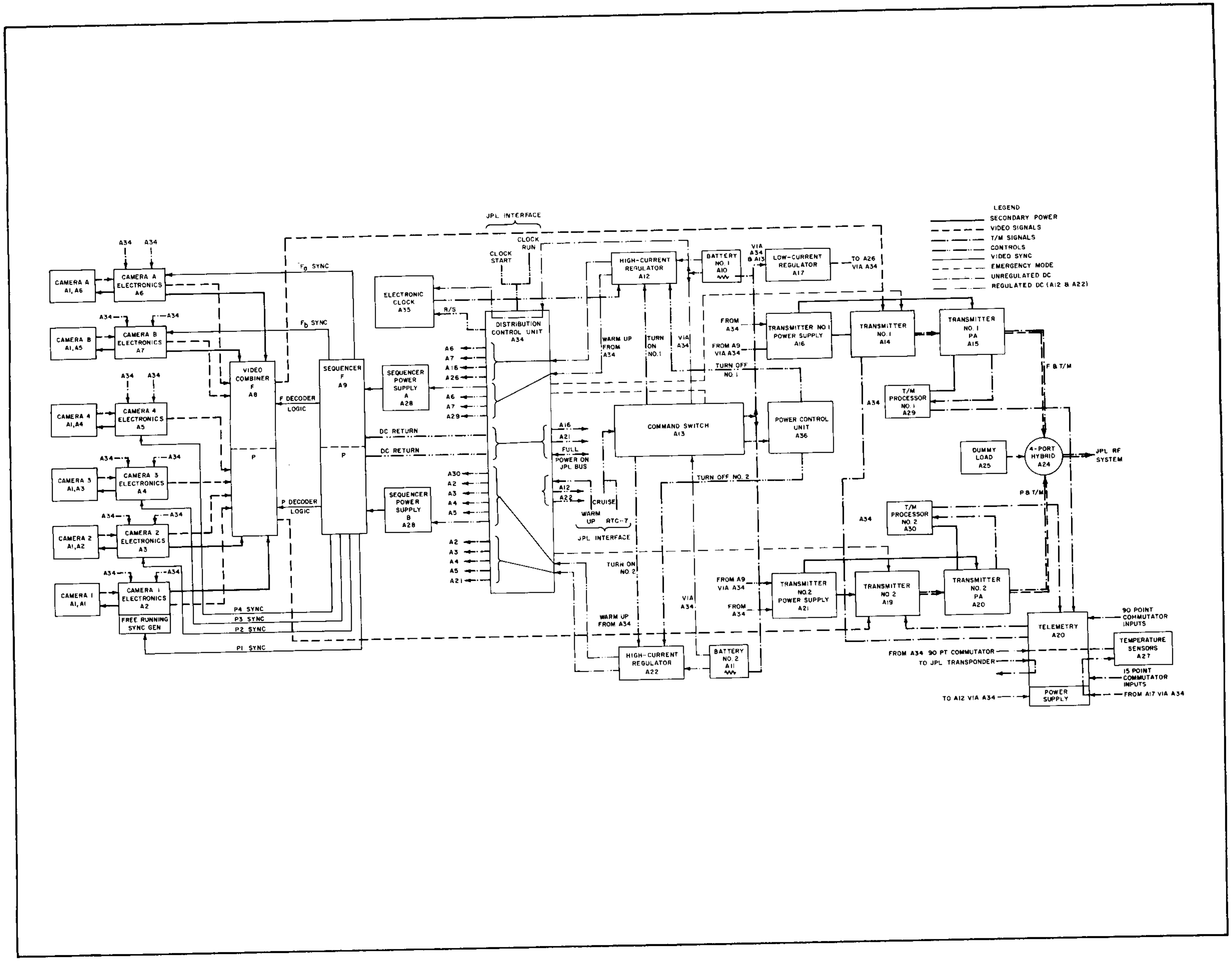


Figure D-1. Split-System Configuration of the TV Subsystem

TABLE D-2
FAILURE EFFECTS ANALYSIS OF FULL-SCAN CAMERA F_a AND ASSOCIATED ELECTRONICS

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Video Pre-amplifier (Figure D-2)	a) No video output from pre-amp.	Nuvistor failure short in either C3 or C4	No video contribution from the F_a chain	F-scan video is also being provided by the F_b camera	Loss of 1/2 of the F-scan video	C_f D_o	5	The CK06 ceramic capacitor now being used has been the source of noise and microphonic problems on at least two DEP equipments. A molded Mylar capacitor of the same electrical ratings and approximately the same physical size is available from J. E. Fast Co. and is recommended as a substitute (J. E. Fast Type F310C103M).
	b) Noisy video output from pre-amp.	Noisy coupling capacitors C1 or C5	Noisy video from F_a camera chain	Same as above	1/2 of the F-scan video will be noisy	D_f E_o		
Video Amplifier (Figure D-2)	No video to combiner	Failures in Q_1 through Q_6 and associated components	No video contribution from the F_a camera chain	Same as above	Loss of 1/2 of the F-scan video	C_f D_o	5	It was indicated by the design group that the function provided by stages Q_1 through Q_6 could be achieved with only four stages. This would eliminate the transistors and their associated components and result in an improvement in reliability. It was recommended that this redesign be seriously considered.
Mixed Cathode Blanking (Figure D-2)	No blanking to vidicon cathode	Failure in Q_{17}	No video contribution from the F_a camera chain	Same as above	Same as above	C_f D_o	5	
Clamp and Sync Injection (Figure D-2)	a) No video to combiner	Failure in Q_{12}, Q_{13}, Q_{16}, or Q_{18} (Q_{13} shorted)	No video contribution from the F_a camera chain	Same as above	Same as above	C_f D_o		
	b) No horizontal sync. pulses on video	Q_{13} fails open	Video from F_a camera chain will not contain any horizontal sync pulses					
Deflection Amplifier (Figures D-3, D-4)	a) No vertical scan	1) Failure or slump in Q_1	No video from F_a camera chain	F-scan video also supplied by F_b	1/2 of the F-scan video will be lost	C_f D_o	5	
		2) Failure of Q_3 through Q_{11} or associated components	Same as above	Same as above	Same as above	C_f D_o		
	b) No horizontal scan	1) Failure or slump in Q_{12} or Q_{13}	Same as above	Same as above	Same as above	C_f D_o		
		2) Failure of Q Q_{14} through Q_{22}	Same as above	Same as above	Same as above	C_f D_o		

TABLE D-2
FAILURE EFFECTS ANALYSIS OF FULL-SCAN CAMERA F_a AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Deflection Programmer (Figure D-5)	a) No erase	Failure of Q_2, Q_5, Q_6, Q_7, Q_9, Q_{10}, Q_{12}, Q_{13}, Q_{14}, and associated components	No video from F_a camera	Same as above	Same as above	C_f D_o	5	
	b) No deflection	Failure of Q_1, Q_3, Q_4, Q_8, and associated components	Same as above	Same as above	Same as above	C_f D_o		It was indicated that the purpose of diode CR6 is to protect transistor Q_8 in the event that pot R29 is set to one end of its range. It is recommended that the alternate solution of placing a fixed resistor in series with the pot and removing diode CR6 be considered.
High-Voltage DC-to-DC Converter and Regulator (Figure D-2)	a) No 1000 volts, 300 volts, -150 volts, 50 volts, 40, +27.5 volts, +20 volts simultaneously	1) Shorted reference Zener CR25 (1N1530A) 2) C-E short in either Q_3 or Q_4 (1754122)	No video contribution from F_a camera chain	F-scan video also being provided by camera F_b	Loss of 1/2 of F-scan information	C_f D_o	4	
	b) 1000 volts, 300 volts, -150 volts, 50 volts, 40 volts, +27.5 volts lines approx. 10% above nominal with no regulation	C-E short in either Q_{33} (1753007) or Q_5 (1754122)	Degraded video from F_a camera chain	Same as above	1/2 of the only F-scan video will be degraded	C_f D_o		
±6.3 volts DC to DC Converter and Regulator (Figure D-2)	a) Loss of both + and -6.3 volts DC	C-E short in Q_1 or Q_2 (1754122)	No video contribution from F_a camera chain	Same as above	Loss of 1/2 of F-scan information	C_f D_o	4	Both 6.3 volts supplies use an IN827 reference Zener diode. This is a selected type costing approximately $30, and it has an indefinite delivery cycle. It is recommended that the IN821 be considered for this application, as it is much less expensive and more readily available. The two parts are mechanically identical: both are 6.2 volts Zeners, with the IN827 specified as having a temp. coefficient of .001%/°C vs .1%/°C for the IN821.
	b) +6.3 volts output rises to approx. 7.3 volts with no regulation	C-E short in Q_2 (1754123)	1) Because of the "or-ing" arrangement, the increased 6.3 volts will back-bias the "or" diode and take over the loads in the video combiner 2) Nuvistor heater will see approx. 7.5 volts	None	All of the F-scan video will be slightly degraded	B_f D_o		
	c) -6.3 volts output rises to approx. -7.3 volts with no regulation	Collector-emitter short in Q_4 (1754123)	Same as above, except that the vidicon heater instead of the nuvistor heater will see approx. 7.3 volts	None	Same as above	B_f D_o		

TABLE D-2
FAILURE EFFECTS ANALYSIS OF FULL-SCAN CAMERA F_a AND ASSOCIATED ELECTRONICS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Shutter and Lamp Drive Circuits (Figure D-2)	a) Shutter will not operate	Catastrophic failure of any transistor from Q_1 through Q_{10} or Q_{12} through Q_{14}	No video from F_a camera	F-scan video also being provided by camera F_b	Loss of 1/2 of F-scan information	C_f D_o	4	
	b) Lamp remains on	C-E short in Q_{18}	Same as above	Same as above	Same as above	C_f D_o		
	c) Lamp will not turn on	Lamp burned out	Slightly degraded video from F_a camera due to slower erasure of previous picture	Same as above	1/2 of F-scan video will present some double-exposure appearance	D_f E_o		
G1 Regulator (Figure D-2)	No control of vidicon	Failure of Q_3, Q_4, Q_5, Q_7, and associated components	No video from F_a camera due either to inability to erase previous picture or to vidicon blanking off	Same as above	Loss of 1/2 of F-scan video	C_f D_o	4	

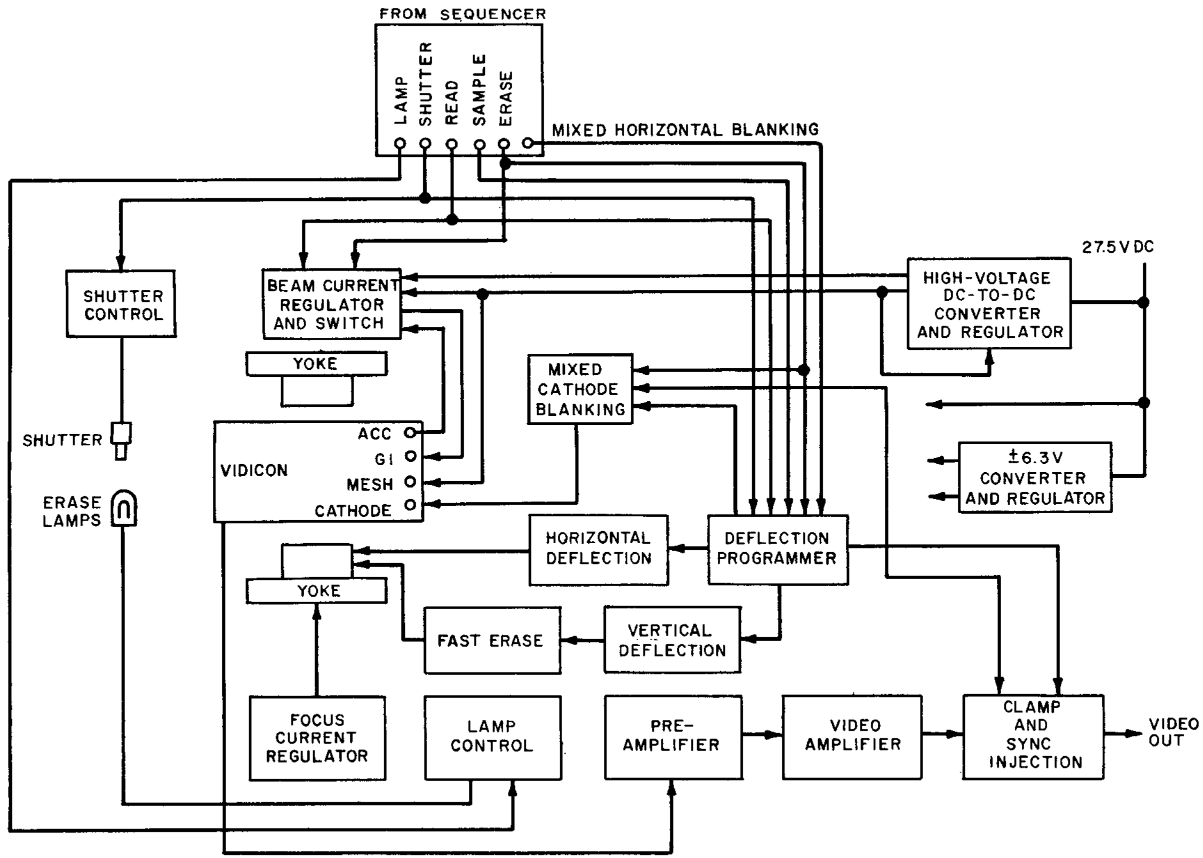


Figure D-2. Full-Scan Camera Electronics Assembly

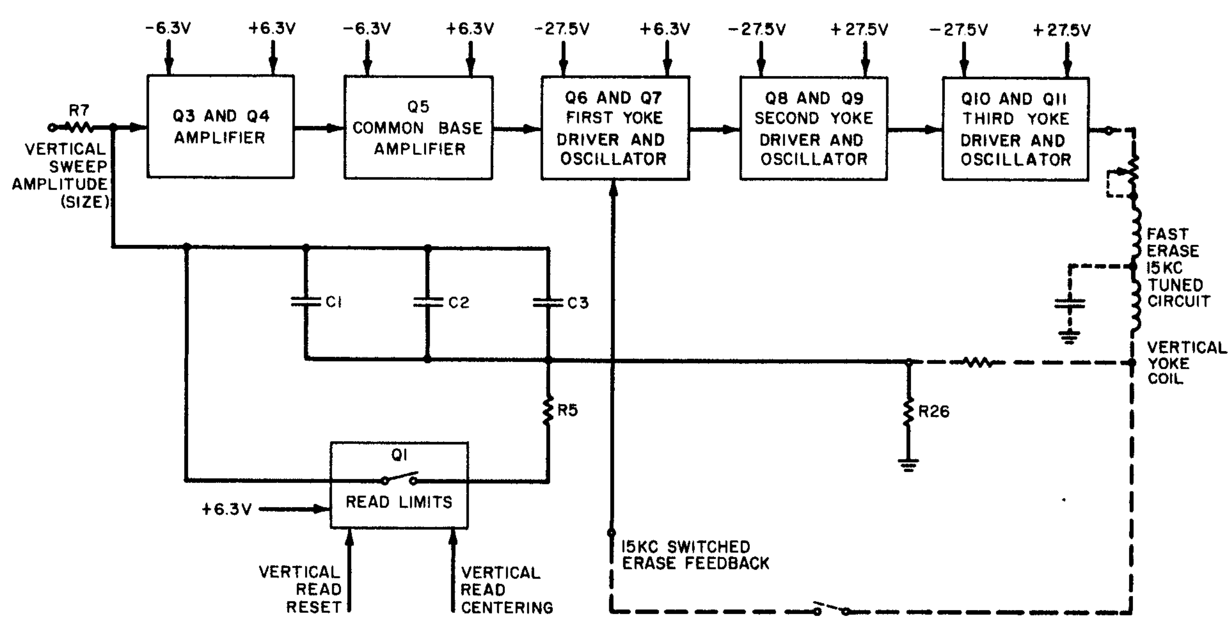


Figure D-3. Vertical Deflection Amplifier of the F_o-Camera Assembly

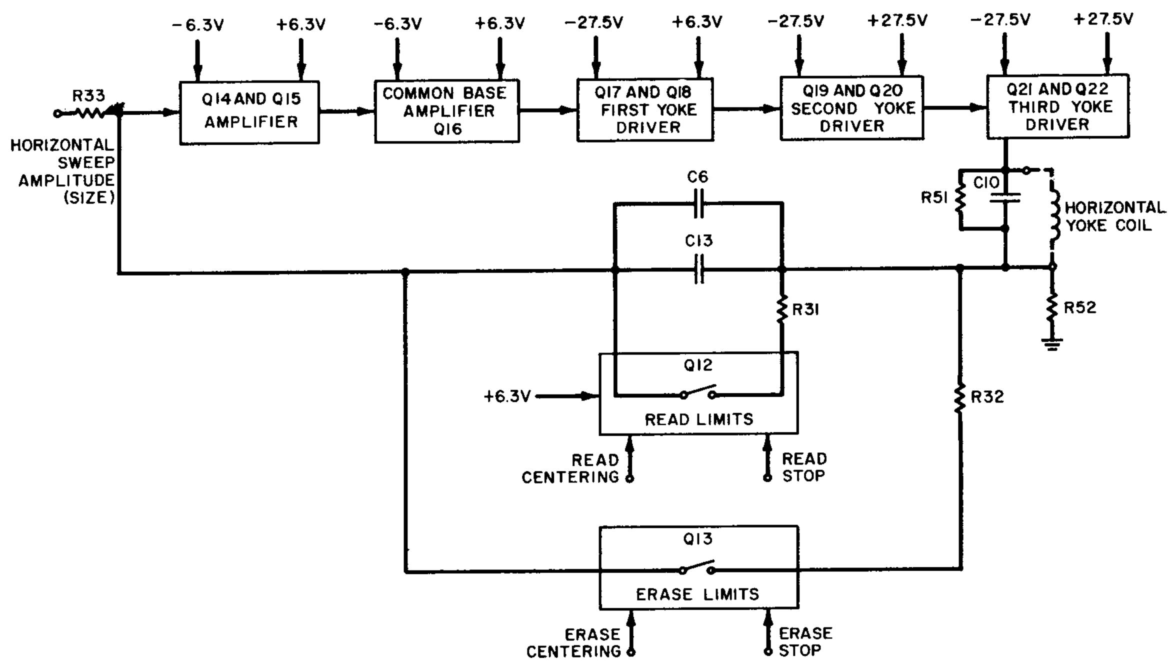


Figure D-4. Horizontal Deflection Amplifier of the F_a-Camera Assembly

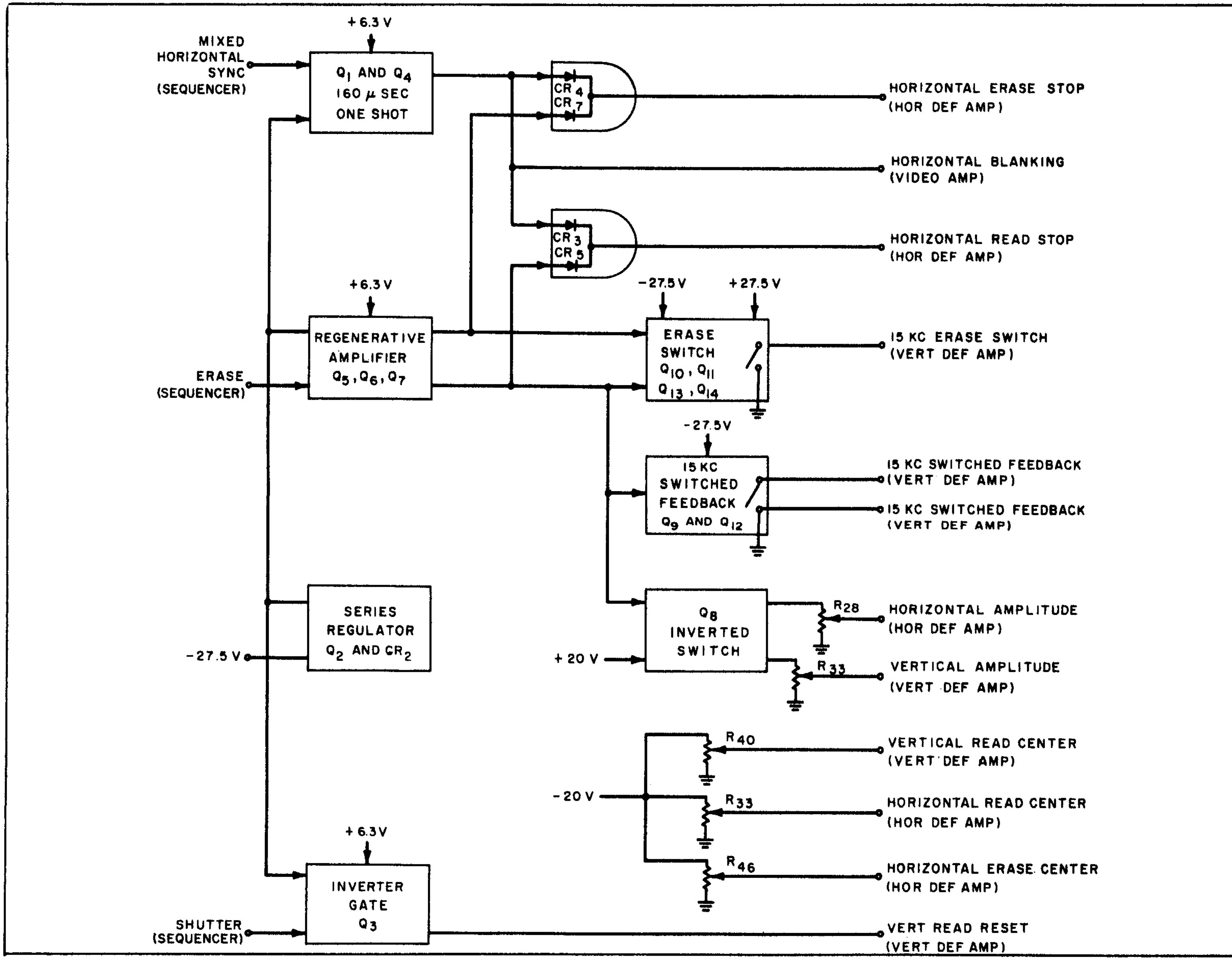


Figure D-5. Deflection Programmer of the F_a-Camera Assembly

TABLE D-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA P1 AND ELECTRONICS (A1A1 AND A2)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-voltage DC-to-DC Converter and Regulator (Figure D-6)	a) No 1000 volts 300 volts, -150 volts, 50 volts, 40 volts, +27.5 volts, +20 volts simultaneously	1) Short-circuited reference Zener CR25 (1N1530A) 2) C-E Short-circuited in either Q3 or Q4 (1754122)	No video contribution from P1 camera chain	P video also being provided by camera P2, P3, and P4.	Loss of 1/4 of P-scan information; loss of free-run mode in the event of a sequencer failure	D_p D_o If sequencer fails these factors become A_p C_o	4	
	b) 1000 volts, 300 volts, -150 volts 50 volts, 40 volts, +27.5 volts lines approx. 10% above nominal with no regulation	C-E short-circuited in emitter Q33, Q4 (1753007), Q5 (1754122)	Degraded video from P1 camera chain	Same as above	In the event of a sequencer failure, the only available P-scan video will be degraded	E_p E_o If sequencer fails, these factors become B_p C_o		
±6.3 volts DC to DC Converter and Regulator (Figure D-6)	a) Loss of both + and -6.3 volts DC	C-E short in Q_1 or Q_2 (1754122)	No video contribution from P1 camera chain	Same as above	Loss of 1/4 of P-scan information; loss of free-run mode in the event of a sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o	4	
	b) +6.3 volts output rises to approx. 7.3 volts with no regulation	C-E short in Q_2 (1754123)	Because of the "OR-ing" arrangement, the increased 6.3 volts will back-bias the "OR diode and take over the loads in the video combiner. Nuvistor heater will see approx. 7.3 volts	None	All of the P-scan video will be slightly degraded	C_p D_o If sequencer fails, these factors become B_p C_o		
	c) -6.3 volts output rises to approx. -7.3 volts with no regulation	C-E short in Q-4 (1754123)	Same as above, except that the vidicon heater instead of the nuvistor heater will see approx. 7.3 volts	None	Same as above	C_p D_o If sequencer fails, these factors become B_p C_o		
Horizontal-Sync Generator (Figure D-6)	a) No horizontal-rate output	Failure of Q3, Q4, Q5, and associated components	No video from P1 camera, due to absence of horizontal scan	Same as above	Same as above			
	b) No control of horizontal-sync. generator	Failure of Q1	Double-exposure appearance of picture, or vertical bar washing out approximately 20% of picture (type of malfunction depends on whether Q1 fails to open or shorts)	Same as above	Degraded picture from P1 camera	E_p E_o If sequencer fails, these factors become B_p C_o	5	
Vertical-Sync Generator (Figure D-6)	a) Multivibrator or associated buffer amplifier inoperative	Failure of Q1, Q2, Q3, and associated components	No video from P1 camera, because of lack of vertical-read output	Same as above	1/4 of P-scan video will be lost; free-run mode in the event of sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o		

TABLE D-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA P1 AND ELECTRONICS (A1A1 AND A2) (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Vertical-Sync Generator (Continued)	b) Shutter drive one-shot or associated buffer amplifier inoperative	Failure of Q19, Q20, Q21, and associated components	No video from P1 camera, due to loss of control of shutter	Same as above	Same as above			
	c) Vertical-sync. generator inoperative	Failure of any transistor from Q1 through Q21 and associated components except Q6, Q12, or Q18	Loss of free-run mode	P-scan video also being supplied by three other P-scan cameras	1/4 of the P-scan video will be lost; free-run mode in the event of sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o	5	
Deflection Amplifier (Figure D-6)	a) No vertical scan	1) Failure or slump in either Q1 or Q5	No video from P1 camera	P-scan video supplied by three other P cameras	1/4 of the P-scan video will be lost; free-run mode in the event of sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o	5	
		2) Catastrophic failure of Q3 through Q11 and associated components	Same as above	Same as above	Same as above	D_p D_o If sequencer fails, these factors become A_p C_o		
	b) No horizontal scan	1) Failure or slump in either Q12 or Q13	No video from P1 camera	Same as above	Same as above	D_p D_o If sequencer fails, these factors become A_p C_o		
		2) Catastrophic failure of Q14 through Q22 and associated components	Same as above	Same as above	Same as above	D_p D_o If sequencer fails, these factors become A_p C_o		
Deflection Programmer (Figure D-6)	a) Vertical-size output does not change level	Failure of Q11, Q12, Q13, and associated components	Solid white stripes across picture, washing out approximately 20% of picture	P-scan video supplied by three other P-scan cameras	Approximately 20% of P1 video will be lost	E_p E_o If sequencer fails, these factors become B_p C_o	5	
	b) Vertical erase-stop and erase-sync outputs do not change level	Failure of Q18	No video from P1 camera, due to absence of vertical scan	Same as above	Loss of 25% of P-scan video and loss of free-run mode in the event of a sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o		

TABLE D-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA P1 AND ELECTRONICS (A1A1 AND A2) (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Deflection Programmer (Figure D-6) (Continued	c) Horizontal size output does not change level	Failure of Q2, Q3, Q4 and associated components	Solid white stripes across picture washing out approximately 20% of picture	Same as above	Approximately 20% of P1 video will be lost	E_p E_o If sequencer fails, these factors become B_p C_o		
	d) Horizontal erase stop and erase blanking outputs do not change level	Failure of Q10	No video from P1 camera chain due to lack of horizontal sweep	Same as above	1/4 of the P-scan video will be lost; loss of free-run mode in the event of a sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o		
Video Pre-Amp. (Figure D-6)	a) No video output from the pre-amp.	1) Nuvistor failure 2) Short in either C3 or C4	No video contribution from P1 camera chain	P-video is also being provided by cameras P2, P3, and P4	Loss of 1/4 of P-scan information; loss of Free-Run Mode in the event of a sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o	5	
	b) Noisy video output from pre-amp.	Noisy coupling cap. (C1 or C5)	Noisy video from P1 camera chain	Same as above	Poor video from P1 camera; in the event of a sequencer failure only available P-scan video will be poor	E_p E_o If sequencer fails, these factors become B_p C_o		
Video Amplifier (Figure D-6)	No video to combiner	Failures in Q1 through Q6 and associated components	No video contribution from P1 camera chain	Same as above	Loss of 1/4 of P-scan information; loss of free-run mode in the event of a sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o	5	

TABLE D-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA P1 AND ELECTRONICS (A1A1 AND A2) (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Mixed Cathode Blanking (Figure D-6)	No blanking to vidicon cathode	Failure in Q17	Same as above	Same as above	Same as above	D_p D_o If sequencer fails, these factors become A_p C_o	5	
Clamp and Sync Injection (Figure D-6)	a) No video to combiner	Collector to emitter short in either Q12, Q13, Q16 or Q18 (Q13 shorted)	Same as above	Same as above	Same as above	D_p D_o If sequencer fails, these factors become A_p C_o	5	
	b) No horizontal sync pulses on video	Q13 fails to open	Video from P1 camera chain will not have any horizontal sync	Same as above				
Shutter and Lamp Drive Circuits (Figure D-6)	a) Shutter will not operate	Catastrophic failure of any transistor from Q1 through Q10 or Q12 through Q14	No video from P1 camera	P-video also being provided by cameras P2, P3, P4	Loss of 1/4 of P-scan information; loss of free-run mode in the event of a sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o	4	
	b) Lamp remains on	C-E short in Q18	Same as above	Same as above	Same as above	D_p D_o If sequencer fails, these factors become A_p C_o		
	c) Lamp will not turn on	Lamp burned out	Slightly degraded video from P1 camera due to slower erasure of previous picture	Same as above	1/4 of P-scan video will present some double exposure appearance	E_p E_o If sequencer fails, these factors become B_p C_o		
G1 Regulator (Figure D-6)	No control of vidicon	1) C-E short-circuited in Q11 2) Short-circuit in C11	No video information from P1 Camera	Same as above	Loss of 1/4 of P-scan information; loss of free-run mode in the event of a sequencer failure	D_p D_o If sequencer fails, these factors become A_p C_o	4	

TABLE D-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA P1 AND ELECTRONICS (A1A1 AND A2) (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Video Pre-Amplifier (Figure D-6)	a) No video output from preamp.	1) Nuvistor failure 2) Short circuit in either C3 or C4	No video contribution from the associated P-scan camera	P-scan video is supplied by three other P-scan cameras	Loss of 1/4 of P-scan video information	D_p D_o	5	
	b) Noisy video output from preamp.	Noisy coupling capacitors (C1 or C5)	Noisy video from the associated P-scan camera chain	Same as above	Poor video from one of the four P-scan cameras	E_p E_o		
Video Amplifier (Figure D-6)	No video to combiner	Failures in Q1 through Q6 and associated components	No video from the associated P-scan camera chain	Same as above	Loss of 1/4 of P-scan video information	D D	5	
Mixed Cathode Blanking (Figure D-6)	No blanking to vidicon cathode	Failure in Q17	Same as above	Same as above	Same as above	D_p D_o	5	
Clamp and Sync Injection (Figure D-6)	a) No video to combiner	Failure in either Q12, Q13, Q16 or Q18, (Q13 shorted)	Same as above	Same as above	Same as above	D_p D_o	5	
	b) No horizontal sync pulses on video	Q13 fails open	Video from associated P-scan camera chain will not contain horizontal sync pulses	Same as above	Same as above	D_p D_o		
Shutter and Lamp Drive Circuits (Figure D-6)	a) Shutter will not operate	Catastrophic failure of any transistor from Q1 through Q10 or Q12 through Q14	No video from the associated P-scan camera	P video being provided by the three other P-scan cameras still operating	Loss of 1/4 of the P-scan video information	D_p D_o	4	
	b) Lamp remains on	C-E short-circuited in Q18	Same as above	Same as above	Same as above	D_p D_o		
	c) Lamp will not turn on	Lamp burned out	Slightly degraded video from the associated P-scan camera due to slower erasure of previous picture	Same as above	1/4 of the P-scan video will present some double-exposure	E_p E_o		
G1 Regulator (Figure D-6)	No control of vidicon	1) C-E short-circuited in Q11 2) C11 short-circuited	No video information from associated P-scan camera	Same as above	Loss of 1/4 of P-scan information	D_p D_o	4	

TABLE D-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA P1 AND ELECTRONICS (A1A1 AND A2) (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-Voltage D-C to D-C Converter and Regulator (Figure D-6)	No 1000 volts, 300 volts, -150 volts, 50 volts, 40 volts, +27.5 volts, and +20 volts simultaneously 1000 volts, 300 volts, -150 volts, 50 volts, 40 volts, +27.5 volts lines approx. 10% above nominal with no regulation	1) Shorted reference Zener CR1530A 2) C-E short-circuit in either Q_3 or Q_4	No video contribution from the associated P-scan camera	P video is being provided by the three other P-scan cameras still operating	Loss of 1/4 of the P-scan information	D_p D_o	4	
±6.3 volts D-C Converter and Regulator (Figure D-6)	Loss of both + and -6.3 volts d-c	C-E short-circuit in Q_1 or Q_2	No video contribution from the associated P-scan camera	Same as above	Loss of 1/4 of the P-scan information	D_p D_o	4	
	+6.3 volts output rises to approx. 7.3 with no regulation	C-E short-circuit in Q_2	Because of the "OR-ing" arrangement, the increased 6.3 volts will back-bias the "OR" diode and take over the loads in the video combiner. Nuvistor heater will see approx. 7.3 volts	None	All of the P-scan video will be slightly degraded	C_p D_o		
	-6.3 volts output rises to approx. 7.3 volts with no regulation	C-E short-circuit in Q_4	Same as above, except that the vidicon heater instead of the nuvistor heater will see approx. 7.3 volts	None	Same as above	C_p D_o		
Deflection Amplifier (Figure D-6)	No vertical scan	1) Failure or slump in either Q_1 or Q_5	No video from associated P-scan camera	P-scan video supplied by three other P cameras	Loss of 1/4 of the P-scan video	D_p D_o	5	
		2) Catastrophic failure of Q_3 through Q_{11} and associated components	Same as above	Same as above	Same as above	D_p D_o		
	No horizontal scan	1) Failure or slump in either Q_{12}, Q_{13}	No video from associated P-scan camera	Same as above	Same as above	D_p D_o		

TABLE D-3
FAILURE EFFECTS ANALYSIS OF PARTIAL-SCAN CAMERA P1 AND ELECTRONICS (A1A1 AND A2) (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Deflection Amplifier (Continued)		2) Catastrophic failure of Q_{14} through Q_{22} and associated components	Same as above	Same as above	Same as above	D_p D_o		
Deflection Programmer (Figure D-6)	a) Horizontal size output does not change level	Failure of Q_2, Q_3, Q_4, and associated components	Solid white stripes across picture, eashing out approximately 20% of picture	Same as above	Approximately 20% of P1 video will be lost	E_p E_o	5	
	b) Horizontal erase stop and erase blanking outputs do not change level	Failure of Q_{10}	No video from associated P-scan camera chain due to lack of horizontal sweep	Same as above	1/4 of the P-scan video will be lost	D_p D_o		
	c) Vertical size output does not change level	Failure of Q_{11}, Q_{12}, Q_{13}, and associated components	Solid white stripes across picture, washing out approximately 20% of picture	P-scan video supplied by three other P cameras	Approximately 20% of P-scan video will be lost from associated camera.	E_p E_o	5	
	d) Vertical erase stop and erase sync outputs do not change level	Failure of Q_{18}	No video from associated P-scan camera due to lack of vertical scan	Same as above	1/4 of P-scan video will be lost	D_p D_o		

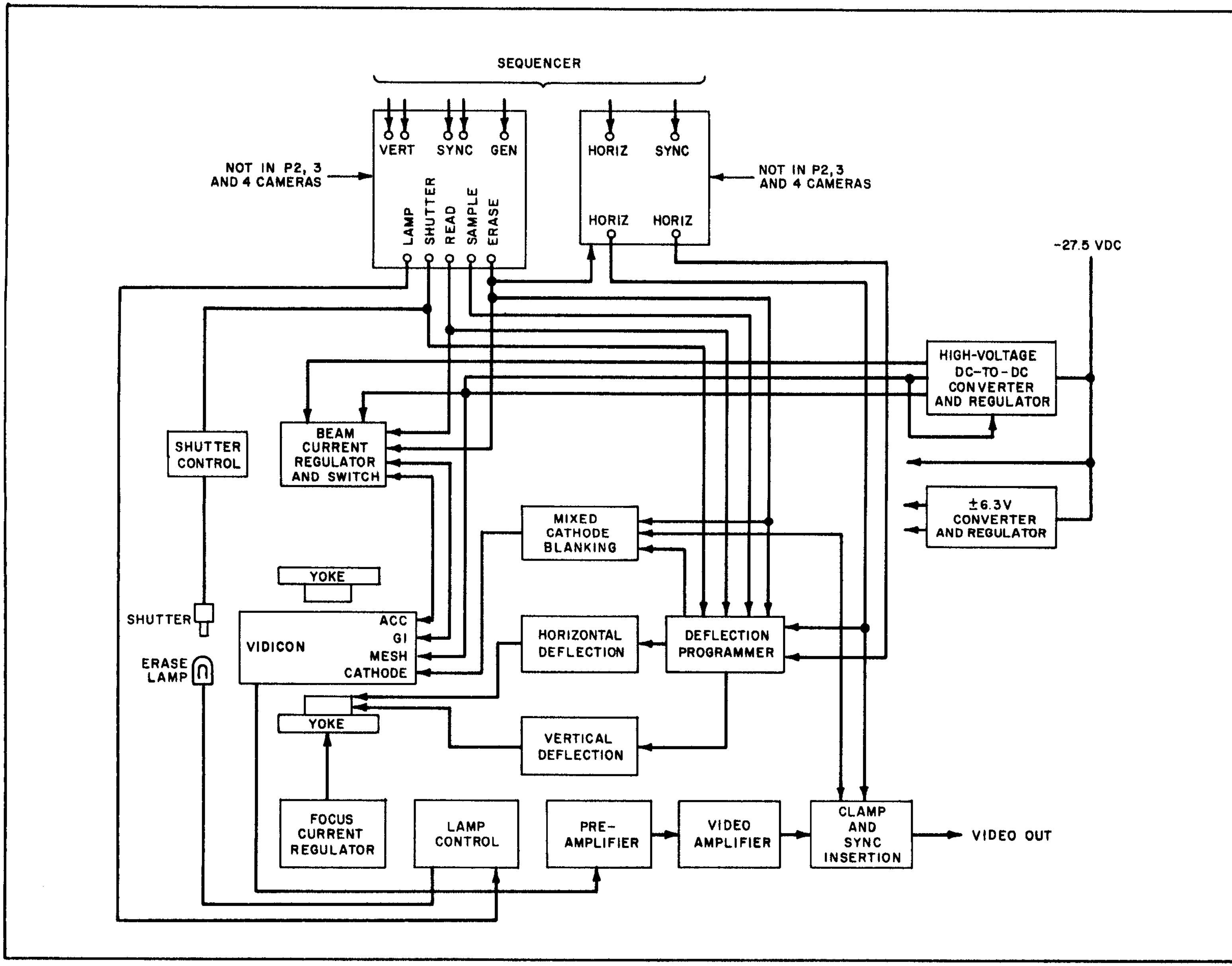


Figure D-6. Partial-Scan Camera and Camera Electronics Assembly

TABLE D-4
FAILURE EFFECTS ANALYSIS OF THE VIDEO COMBINER

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Gate Amplifier & Peak Detector (Figure D-8)	a) Shorted decoupling capacitor (8 or 9)	Shorted decoupling capacitor	No F-scan video or No P-scan video	None	No F-scan or no P-scan video	A_f D_o or A_p B_o	5	
	b) Loss of sequencer drive	Grounded or open line from sequencer	Continuous transmission through affected gate.	None	1) Increased noise on video channel 2) Loss of snyc. signals in affected channel	C_f E_o E_p E_o	5	Assumes failure in a single channel
	c) Constant transmitting gate	1) Shorted Q_8, Q_{10}, Q_{12}, Q_{14} 2) Open Q_9, Q_{11}, Q_{13} Q_{15} 3) Shorted diode bridge-CR_3, CR_4, CR_5, & CR_6 4) Open R_{35}, R_{47}, R_{63}, & R_{76}	Same as above	None	Same as above	C_f E_o E_p E_o	5	Same as above
	d) Constant inhibiting gate	1) Open Q_8, Q_{10}, Q_{12}, Q_{14} 2) Shorted Q_9, Q_{11}, Q_{13}, Q_{15} 3) Open R_{33}, R_{45}, R_{84}, R_{69}	Loss of video in affected gate	Fail-safe gate for camera P-1 video	1) Loss of 1/2 F-scan video, or 2) Loss 1/4P-scan video, all but camera P1	D_f E_o E_p F_o	5	
	e) D-C shift caused by faulty gate	1) Open R_{36} thru R_{41} (typical in a single gate) 2) Faulty diode in any bridge network	Loss of video in that particular channel	Same as above	1) Loss of F-scan video, or 2) Loss of P-scan video	A_f D_o A_p B_o	5	Redesign gate in order to eliminate a portion of video channel in advent of a single failure
	f) Amplifier failure	1) Any open resistor 2) Any short or open transistor 3) Shorted capacitor C_7 4) Open capacitor C_7	1) Loss of video in that particular channel 2) Loss of high-frequency preemphasis	Same as above	1) Loss of F-scan video, or 2) Loss of P-scan video 3) Partial loss of high-frequency resolution	A_f D_o A_p B_o D_f E_o D_p D_o	5 5	
	g) Peak detector failure	Any open or shorted part	Loss of telemetry point	Same as above	Loss of monitoring point	F_{t90} F_o	5	
Interface Power (Figure D-8)	a) Loss of ± 6.3v to oscillator board	1) Faulty cable or connectors 2) Faulty camera F_a electronics	No oscillator tones	None	F-scan camera F_a and F_b pictures are not discernible at OSE	F_f F_o	5	
	b) Loss of ± 6.3v to F summing board	1) Faulty cable or connectors 2) Faulty camera F_b electronics	1) No F-scan video 2) Over-modulation on channel F after switch-over	None	1) No F-scan video 2) Adjacent channel interference after switch-over	A_f D_o	5	

TABLE D-4
FAILURE EFFECTS ANALYSIS OF THE VIDEO COMBINER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Interface Power (Continued)	c) Loss of ±6.3 volts to P summing board	1) Faulty Cable or connectors 2) Faulty camera P1 electronics	No P-scan video	None	No P-scan video	A_p C_o	5	
144kc GSC Gate (Figure D-8)	Loss of gate inputs	1) Faulty cable or connectors 2) Faulty sequencer power supply	Tones permanently superimposed on video	None	Interference of tone on F-scan video	E_f F_o	5	
Partial-Scan Video Gates (Figure D-8)	Gates fail closed (signals transmitted)	1) Open cable or connectors 2) Sequencer signal(s) not present 3) Internal gate circuit failure	1) Continuous conduction of signals to transmitter 2) Small shift of DC level	None	Temporary loss of sync. at OSE	F_p F_o	5	
Full-Scan Video Gates (Figure D-8)	Gates fail closed (signals transmitted)	1) Open cable or connectors 2) Sequencer signals not present 3) Internal gate circuit failure	Continuous conduction of signals to transmitters	None	Decreased signal-to-noise ratio in F-scan video	E_f F_o	5	
Clipper (Figure D-7)	a) Clipper (fully actuated	1) Internal clipper clipper circuit failure 2) Loss of bias voltages	No clipper action leading to overmodulation in transmitter	None	Slight adjacent channel interference if highlights are present	E_f F_p F_o	5	
	b) Clipper (short-circuited)	1) Internal clipper circuit failures 2) Shorted loads	Low video signals	Possible compensation at OSE	1) Loss of video contrast 2) Decreased signal-to-noise ratio	E_f E_p E_o	5	
P-Scan Power Amplifier (Figure D-8)	Power amplifier failed	Internal amplifier circuit failure	No P-scan video	None	No P-scan video	A_p C_o	5	
F-Scan Power Amplifier (Figure D-8)	F-scan power amplifier failed	Faulty internal circuit	No F-scan video	None	No F-scan video	A_f D_o	5	
144kc-Tone Oscillator (Figure D-8)	Tone oscillator	Faulty internal circuit	No 144kc tone	Camera F_b tone signal	No tone light for camera F_b at OSE	- F_o	5	
Converter F_a Tone Oscillator (Figure D-8)	a) No 144kc tone	Shorted power decoupling capacitors C22 and/or C23	No 144kc tone, and no camera F_a video	None	Only 1/2 of F-scan video	C_f E_o	5	
	b) Output level increase	Open resistor, R_{22}, R_{23}, R_{13}, or R_{14} in tone circuit	Increase in amplitude	None	Loss of F_a video	F_f F_o	5	

TABLE D-4
FAILURE EFFECTS ANALYSIS OF THE VIDEO COMBINER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Converter F_a Tone Oscillator (Continued)	c) No 144kc tone	Bad crystal, electrical or mechanical	No 144kc tone	None	No tone signals	E_f F_o	5	
	d) Change in frequency	Other faulty components	Change in tone frequency	None	No tone signal at OSE	E_f F_o	5	
Clipper in Peak Detector	a) No video output	1) Open R_{55}, faulty connector or cable	No F-scan video	None	No F-scan video	A_f D_o	5	
		2) Open R_{34}, faulty connector or cable	No P-scan video	None	No P-scan video	A_p B_o	5	
	b) Loss of clipping	1) Open Q_{10} or Q_{11}, R_{48} or R_{51}, R_{47} or R_{52}, R_{45} or R_{53}	No clipping of F video	None	Over-modulation of channel F video, and some probable adjacent channel interference and loss of beacon by swamping action	D_f E_o	5	
		2) Q_8 or Q_9, R_{38} pr R_{41}, R_{37} or R_{42}, R_{35} or R_{43}	No clipping of P video	None	Over-modulation of channel P video, and slight adjacent channel interference	D_p E_o	5	
	c) Distorted video	1) Open R_{46}, short-circuited Q_{10} or Q_{11}	Distorted F-scan video (severe clipping)	None	Loss of F-video contrast	E_f F_o	5	
		2) Open R_{36}, short-circuited Q_8 or Q_9	Distorted P-scan video (severe clipping)	None	Loss of P-video contrast	E_p F_o	5	

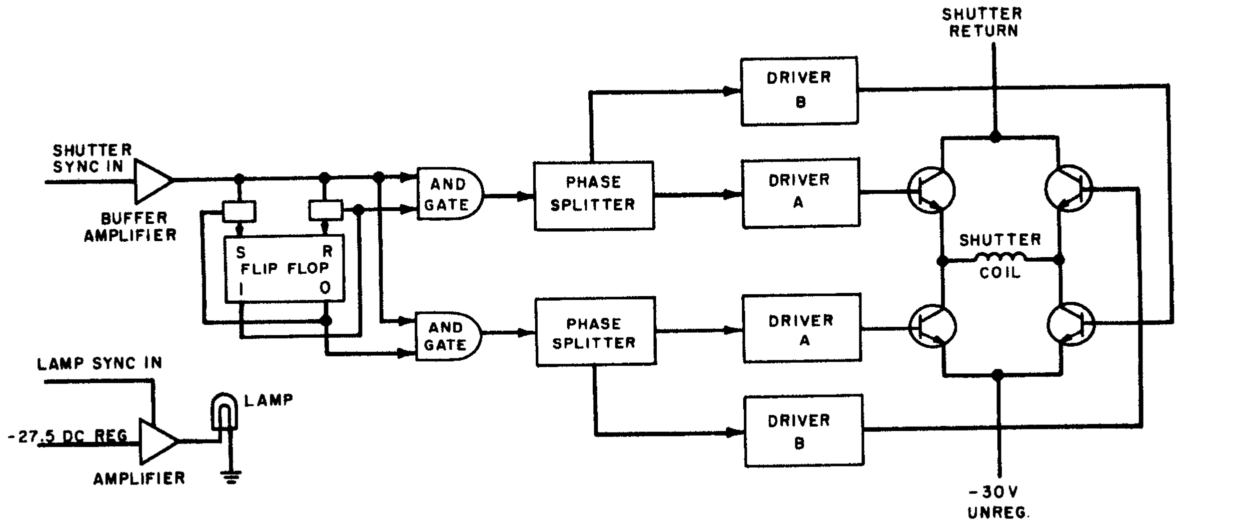


Figure D-7. Partial-Scan Camera Shutter and Lamp-Drive Circuitry

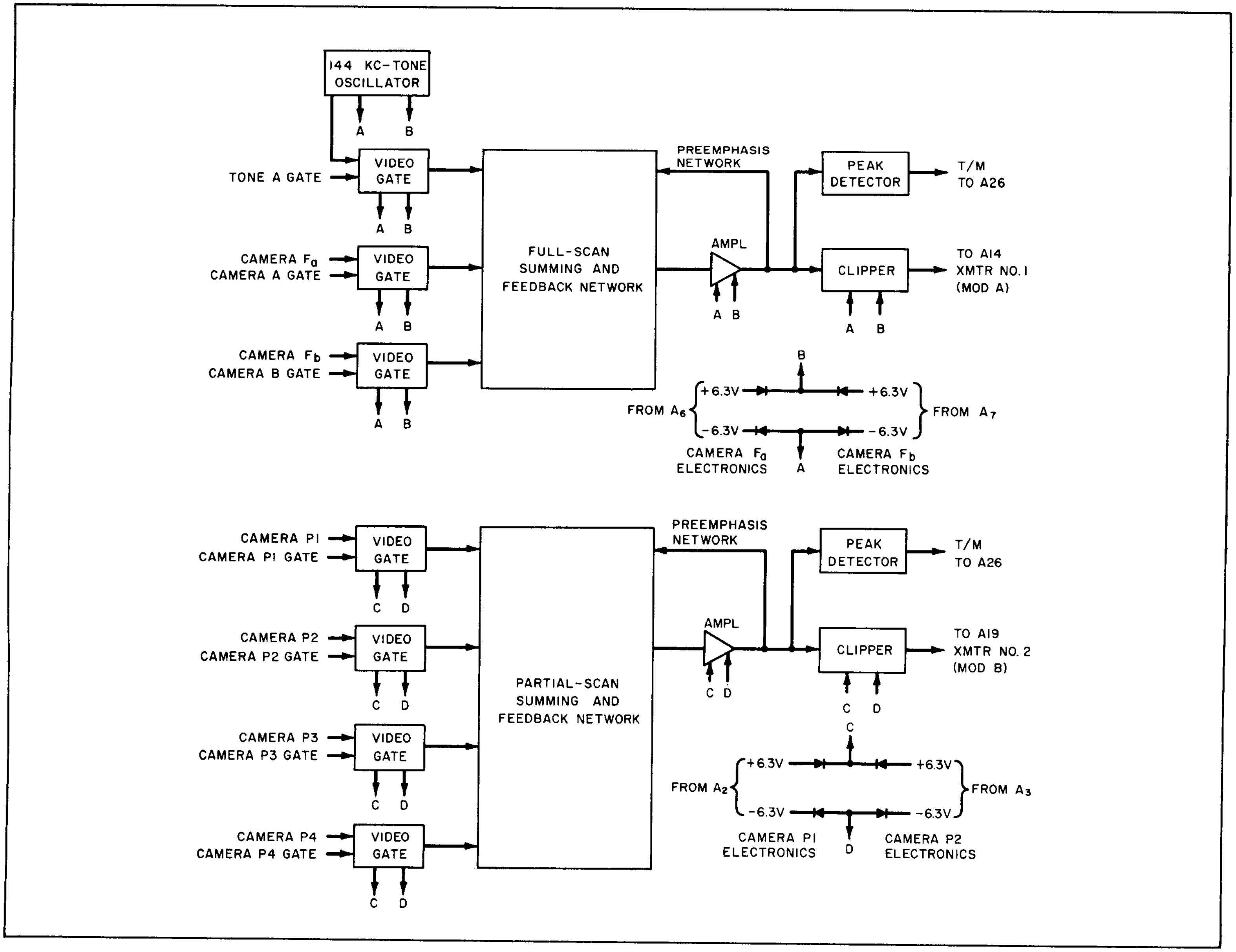


Figure D-8. Video-Combiner Assembly

TABLE D-5
FAILURE EFFECTS ANALYSIS OF THE PARTIAL-SCAN CAMERA SEQUENCER

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Channel P Power Supply Converter & Regulator (Figure D-9)	a) Loss of -12 volts	1) Faulty cable or connectors 2) Faulty -12 volts regulator	1) Erratic or complete loss of gating signals 2) No automatic turn-on	One free-running P-scan camera	Only 25% of P-scan pictures	B_p D_o	4	
	b) Loss of +12 volts	1) Faulty cable or connectors 2) Faulty DC to DC converter 3) Faulty +12 volts regulator	1) Loss of gating signals 2) No automatic turn-on	One free-running P-scan camera	Only 25% of P-scan pictures	B_p D_o	4	
18 kc Clock & Driver (Figure D-9)	Loss of clock output	1) Faulty cable or connectors 2) Faulty clock circuit 3) Faulty driver circuit 4) Faulty P division chain input 5) Faulty gate (5)	No sequencer signals	One free-running P-scan camera	Only 25% of P-scan pictures	B_p D_o	5	
Telemetry of 18 kc Clock (Figure D-9)	Loss of 18 kc telemetry (P-Scan)	1) Faulty cable or connectors 2) Faulty rectifier 3) Reference circuit failure 4) Faulty gate (11)	No 18 kc telemetry	None	No 18 kc telemetry from P-scan channel	$F_{t90}F_o$	5	
P-Division Chain (Figure D-9)	Loss of counting of 1 of 3 Binary counters 1-3: 1 divider or 1-5: 1 divider or 1-6: 1 divider or 1-25: 1 divider Total of 16 complimentary flip-flops	1) Faulty flip-flops 2) Faulty connector 3) Shorted loags (gate)	Loss of all: 1) P-logic decoder outputs 2) P video combiner inputs 3) P automatic turn-on	One free-running P-scan camera	Only 25% of P-scan pictures	B_p D_o	5	
P-Divider Telemetry Monitor (Figure D-9)	Open or shorted voltage divider resistor	Faulty connector	No P-divider telemetry output	None	No P-divider telemetry output	$F_{t90}F_o$	5	
P-Logic Decoder (Figure D-9)	a) Loss of 2X horizontal sync (3 kc)	Failure of: 1) P clock 2) Gate (5) 3) Flip-flop A, B, or C 4) Gates (R35) (R36) 5) Cables or connectors	Loss of sensitivity of low video signals from cameras P2, P3, and P4	One free-running P-scan camera	Poor quality pictures from cameras P2, P3, and P4	(A_p-B_p) D_o	5	Recommend separate line to each camera instead of a single line to all cameras.
	b) Loss of horizontal sync 1.5 kc (2 outputs: 1-gate 33, 1-gate 30,	Failure of: 1) P clock 2) Gate (5) 3) Flip-flops A, B, C, or D 4) Gates (R32),(33),(30)	Loss of video from cameras P2, P3, and P4	One free-running P-scan camera	Only 25% of P-scan pictures	B_p D_o	5	

TABLE D-5
FAILURE EFFECTS ANALYSIS OF THE PARTIAL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
P-Logic Decoder (Continued)	c) Loss of vertical-read pulses	Failure of: 1) P clock 2) Gate (5) 3) Single flip-flop in P division chain					5	
	Loss of 1) Vertical-read #1	Failure of gates (80), (82)	No camera P1 read pulse	Free-running camera	None	F_p F_o	5	
	2) vertical-read #2	Failure of gates (77), (R79)	No camera P2 read pulse	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	3) vertical-read #3	Failure of gates (71), (R73)	No camera P3 read pulse	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	4) vertical-read #4	Failure of gates (R70), (69), (65), (D75), (74)	No camera P4 read pulse	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	d) Loss of shutter pulse:	Failure of: 1) P clock 2) Gate (5) 3) Single flip-flop in P division chain	Loss of cameras P2, P3, and P4	Free-running camera P1	Only 25% of P-scan pictures	B_p D_o	5	
	Loss of 1) shutter #1	Failure of gates (R60), (58), (50), (54)	No camera P1 shutter pulse	Free-running camera P1	None	F_p F_o	5	
	2) shutter #2	Failure of gates (R52), (56), (D81), (80), (50)	No camera P2 shutter pulse; no camera P2 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	3) shutter #3	Failure of gates (R55), (54), (D78), (77), (50)	No camera P3 shutter pulse; no camera P3 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	4) shutter #4	Failure of gates (R53), (51), (72), (71), (50)	No camera P4 shutter pulse; no camera P4 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	e) Loss of erase pulse:	Failure of: 1) P clock 2) Gate (5) 3) Single flip-flop in P division chain	No return from cameras P2, P3, and P4	Free-running camera P1	Only 25% of P-scan pictures	B_p D_o	5	
	Loss of 1) erase #1	Failure of gates (8), (9), (10), (1), (R79), (77), (71), (17), (74), (D74)	No camera P1 erase pulse	Free-running camera P1	None	F_p F_o	5	
	2) erase #2	Failure of gates (5), (6), (R7), (1), (17), (80), (R82), (RD73), (71)	No camera P2 erase pulse No camera P2 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	3) erase #3	Failure of gates (2), (3), (4), (1), (17), (74), (D75)	No camera P3 erase pulse No camera P3 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	4) erase #4	Failure of gates (1), (17), (RD73), (71), (17), (D81), (80)	No camera P4 erase pulse No camera P4 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	

TABLE D-5
FAILURE EFFECTS ANALYSIS OF THE PARTIAL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
P-Logic Decoder (Continued)	f) Loss of flash pulse	Failure of: 1) P clock 2) Gate (5) 3) Single flip-flop in P division chain	No usable return from cameras P2, P3, and P4	Free-running camera P1	Only 25% of P-scan pictures	B_p D_o	5	
	Loss of 1 1) flash #1	Failure of gates (R23), (21), (D78), (77), (14), (17)	No camera P1 flash pulse	Free-running camera P1	None	F_p F_o	5	
	2) flash #2	Failure of gates (R19), (16), (14), (17), (D72), (71)	No camera P2 flash pulse No camera P2 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	3) flash #3	Failure of gates (R18), (15), (14), (17), (D76), (74)	No camera P3 flash pulse No camera P3 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	4) flash #4	Failure of gates (66), (68), (65), (R37), (5), (1), (17), (RD82), (80), (74), (D75)	No camera P4 flash pulse No camera P4 video	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	g) Loss of black-clamp pulse:	Failure of 1) P clock 2) Gate (5) 3) Single flip-flop in P division chain	No black-clamp pulse in cameras P2, P3, and P4	Free-running camera P1	Camera P2, P3, and P4 pictures may still be reclaimable	F_p F_o	5	
	Loss of 1) black clamp #1	Failure of gates (R34), (31), (D76), (74)	No sync pulse to free-running generator	Free-running camera P1	None	F_p F_o	5	Possible elimination not active
	2) black clamp #2	Failure of gates (R29), (27), (20), (25), (D87), (80)	No clamp pulse	Not required	None	F_p F_o	5	Purpose questioned not active
	3) black clamp #3	Failure of gates (R28), (26), (D78), (77), (20), (25)	No clamp pulse	Not required	None	F_p F_o	5	Purpose questioned not active
	4) black clamp #4	Failure of gates (R24), (22), (D27), (71), (20), (25)	No clamp pulse	Not required	None	F_p F_o	5	Purpose questioned not active
	h) Loss of vertical-blanking pulse	Failure of: 1) P clock 2) Gate (5) 3) Single flip-flop in P division chain 4) Gates (38), (66), (D75), (68), (65), (74)	No vertical-blanking sync pulse	Camera P1 is free-running	Continuous pictures at OSE	E_p E_o	5	
P-Video Combiner Logic (Figure D-9)	a) Loss of video P1 analog-gate pulse	Failure of: 1) P clock 2) Gate (5) 3) Single flip-flop in P division chain	Loss of video #1 analog-gate pulse	Fail-safe gate for video P1	None	F_p F_o	5	

TABLE D-5
FAILURE EFFECTS ANALYSIS OF THE PARTIAL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
P-Video Combiner Logic (Figure D-9) (Continued)		4) Gates (R49), (D81), (80), (44), (62), (63), (40), (33), (39), (14), (17)						
	b) Loss of video P2 analog-gate pulse	Failure of gates (R47), (D78), (44), (77), (62), (63), (39), (33), (40), (14), (71)	Loss of video P2 analog-gate pulse	3 other P-scan cameras	Only 75% of P-scan pictures	D_f E_o	5	
	c) Loss of video P3 analog-gate pulse	Failure of gates (44), (R45), (62), (63), (39), (33), (40), (14), (17), (72), (71)	Loss of video P3 analog-gate pulse	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
	d) Loss of video P4 analog-gate pulse	Failure of gates (R42), (41), (38), (66), (68), (D75), (74), (65), (D76), (63), (40), (33)	Loss of video P4 analog-gate pulse	3 other P-scan cameras	Only 75% of P-scan pictures	D_p E_o	5	
P Timer (Figure D-9)	a) Loss of P-timer signals	Failure of 1) P clock 2) Gate (5) 3) Single binary in P division chain 4) Single binary in timer division chain 5) Encoder gate (R)	Failure of five-minute automatic turn-on signal for P channel	Full power on turn-on from CC&S	Possible transmission loss from some early P-scan pictures	F_p F_o	5	
	b) Continuous or premature P-timer signals	1) Faulty reset signal 2) Single divider in P-timer chain 3) Encoder gate (R)	Premature P-scan transmitter turn-on	None	Premature transmission of P-scan pictures	A_p C_o	5	Possible transmitter damage due to the lack of warm-up time. A_p assumes worst-case.
P Automatic or Reset Logic (Figure D-9)	a) Failure to reset	1) Failure of "AND" gate (Q27 & Q28) 2) Faulty control flip-flop	Late transmitter turn-on	Full power turn-on from CC&S	Possible transmission loss of some early P-scan pictures	F_p F_o	5	
	b) Premature turn-on	Same as above	Premature transmitter turn-on	None	Premature transmission of P-scan pictures	A_p C_o	5	Possible transmitter damage due to the lack of warm-up time. A_p assumes worst-case.
P-Timer Telemetry (Figure D-9)	a) Loss of telemetry signal	1) Failure of "AND" gate (Q23 & Q24) 2) Failure of telemetry SCR	Loss of telemetry point	None	No P-timer telemetry	$F_{t90}F_o$	5	
	b) Misleading telemetry information	3) Failure of clock after 40 seconds of operation	False telemetry data after telemetry SCR has been fired	None	No timer telemetry	$F_{t90}F_o$	5	
Fail-Safe Circuit (Figure D-9)	Failure of fail-safe	Failure of: 1) P clock 2) Gate (5) 3) Single binary in P division chain	Continuous transmission of camera P1 video	None	Some noise in P-scan picture	F_p F_o	5	

TABLE D-5
FAILURE EFFECTS ANALYSIS OF THE PARTIAL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Fail-Safe Circuit (Figure D-9) (Continued)		4) Gates (12), (44), (62), (33), (39), (14), (17), (63), (40)						
	Same as above	Gate (R49) held at 0 volt permanently	Loss of P-scan P1 video	3 other P-scan cameras	75% of P-scan video	D_p E_o	5	
	Same as above	Failure of P-scan sequencer power supply	Loss of all P-scan video	None	Loss of all P-scan pictures	A_p C_o	4	Diode "OR" the power for gate (12) from camera electronics P1 or from both sequencer power supplies
Sequencer Power Supply (Figure D-9)	a) +12 volts output drops to approx. +9 volts	Open circuit in transistor Q7	9 volts will be supplied to sequencer; sequencer output will not be sufficient to sync P1 free-run generator or operate P2, P3, and P4 cameras	P1 camera is designed to free-run in the event of a sequencer failure; combiner will pass P1 video	75% of the P-scan video will be lost	B_p C_o	3	Redesign chopper transformer to eliminate need for R16 and lower voltage into regulator. The decrease in secondary turns will lessen the possibility of Q1 or Q2 failure in the event of a momentary over-load on the +12 volts supply
	b) +12 volts output drops to zero	Short or open circuit in transistor Q1 or Q2	P-scan channel sequencer will be inoperative	Same as above	Same as above	B_p C_o	3	
	c) +12 volts output rises to approx. +24 volts	Short circuit in transistor Q7	+12 volts to P-scan sequencer and fail-safe gate in combiner	Same as above	Good possibility of P-scan sequencer malfunctioning, resulting in loss of P2, P3, and P4 video	B_p C_o	3	
	d) -12 volts output drops to less than -1 volt	Short circuit in transistor Q12	-1 volt will be supplied to sequencer and fail-safe gate in video combiner; P-scan channel sequencer will be inoperative	Same as above	Same as above	B_p C_o	3	
	e) -12 volts output rises to -21 volts	Open circuit in transistor Q12	-21 volts will be supplied to sequencer and fail-safe gate in video combiner; P-scan channel sequencer will operate, and fail-safe gate will operate	None required	None	F_p F_o	3	
Power Interface P Channel (Figure D-9)	Loss of -27.5 volts for P sequencer power supply (A28 B)	1) Open cable or connectors 2) Faulty sequencer power supply	No P-scan sequencer signals	One free-running P-scan camera	Only 25% of P-scan pictures	B_p D_o	4	
P Channel Power Amplifier Turn-On Logic (Figure D-9)	a) Open DC return	1) Open DC return cable	No five-minute automatic turn-on for P transmitter	Back-up command in JPL CC&S	Possible transmission loss of some early P-scan pictures	F_p F_o	5	

TABLE D-5
FAILURE EFFECTS ANALYSIS OF THE PARTIAL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
P Channel Power Amplifier Turn-On Logic (Continued)	b) Faulty P controller modulator	1) P clock failure 2) Division chain failure 3) P timer failure 4) Auto-reset logic (Q27 & Q28) failure 5) Reset flip-flop failure 6) Relay driver failure 7) Relay failure 8) P Sequencer power supply failure						
Input Signal Interface (Manual Reset) (Figure D-9)	Manual reset input short-circuited	1) Short-circuited cable or connector (test connector) 2) Stuck or shorted switch in OSE	None, if sequencer P automatic reset circuits are operating satisfactorily during flight	P Automatic reset circuitry	None	F_p F_o	5	
Input Signal Interface (P Disable) (Figure D-9)	P disable input short-circuited	1) Short-circuited cable or connector (test connector) 2) Stuck or shorted switch in OSE	No P-scan sequencer signals	One free-running P-scan camera	Only 25% of P-scan pictures	B_p D_o	5	

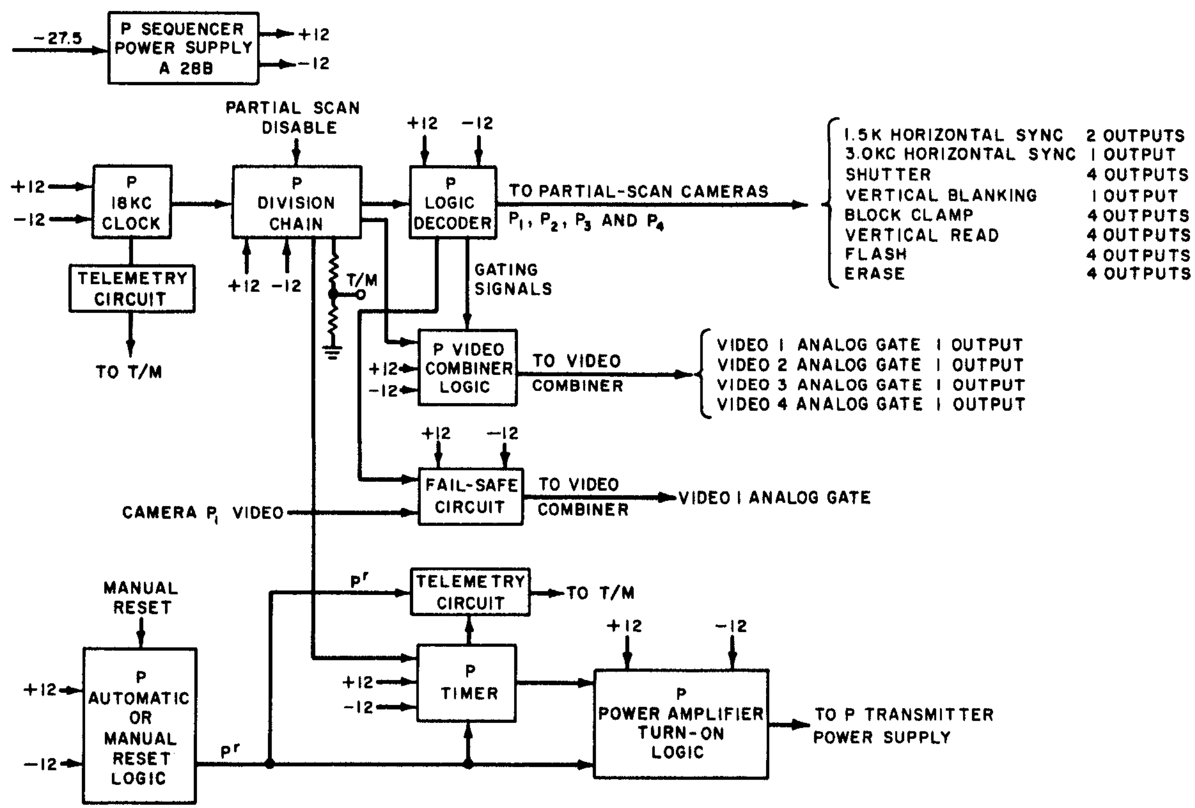


Figure D-9. Partial-Scan Camera Sequencer Assembly

TABLE D-6
FAILURE EFFECTS ANALYSIS OF THE FULL-SCAN CAMERA SEQUENCER

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Power Interlace, Channel F (Figure D-10)	Loss of -27.5 volts for channel F sequencer power supply (A28A)	1) Open cable or connectors 2) Faulty sequencer power supply	No F-scan sequencer signals	None	No F-scan video	A_f D_o	5	Design free-running generator for F-scan electronics.
Power Amplifier Turn-on Logic (Controller Modulator), Channel F (Figure D-10)	a) Open d-c return b) Faulty channel F controller modulator	1) Open DC return cable 2) Channel F clock failure 3) Division chain failure 4) Channel F timer failure 5) Failure of auto-reset logic (Q_{25}, Q_{26}) 6) Reset flip-flop failure 7) Relay driver failure 8) Relay failure 9) Channel F sequencer power supply failure	No five-minute automatic turn-on for channel F transmitter	1) Back-up command in JPL CC&S 2) Electronic Clock	Possible transmission loss of some early F-scan pictures	F_f F_o	5	
Input Signal Interface (Manual Reset), Channel F (Figure D-10)	Manual-reset input shorted	1) Shorted cable or connector (test connector) 2) Stuck or shorted switch in OSE	None, if channel F sequencer auto-reset circuits are operating properly during flight	Channel F auto-reset circuitry	None	F_f F_o	5	
Power Supply Converter and Regulator, Channel F (Figure D-10)	a) Loss of -12 volts	1) Faulty cable or connectors 2) Faulty -12 volts regulator	1) Erratic or complete loss of gating signals 2) No automatic turn-on	None	No F-scan pictures	A_f D_o	4	Design free-running generator for F-scan electronics (only one camera is necessary).
	b) Loss of +12 volts	1) Faulty cable or connectors 2) Faulty DC-to-DC converter 3) Faulty +12 volts regulator	1) Loss of gating signals 2) No automatic turn-on	None	No F-scan pictures	A_f D_o	4	
18 kc Clock and Driver (Figure D-10)	Loss of clock output	1) Faulty cable or connectors 2) Faulty clock circuit 3) Faulty driver circuit 4) Shorted F division chain input 5) Faulty gate	No sequencer signals	None	No F-scan pictures	A_f D_o	5	Design free-running generator for F-scan electronics (Camera F_a).
Telemetry of 18 kc Clock (Figure D-10)	Loss of 18 kc telemetry F-scan chain	1) Faulty cable or connectors	No 18 kc telemetry	None	No 18 kc telemetry from Channel F	F_{t90} F_o	5	

TABLE D-6
FAILURE EFFECTS ANALYSIS OF THE FULL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Telemetry of 18 kc Clock (Figure D-10) (Continued)		2) Faulty rectifier and reference circuit 3) Faulty gate						
Division Chain, Channel F (Figure D-10)	a) Loss of counting of 1 of 11 binary counters b) 5:1 counter c) 3:1 counter (total of 18 complementary flip-flops and 8 "nor" gates)	1) Faulty flip-flops 2) Faulty connector 3) Shorted loads (gates)	Loss of all: Channel F logic decoder outputs Channel F video combiner inputs Channel F automatic turn-on	None	No F-scan pictures	A_f D_o	5	Design free-running generator for F-scan camera electronics.
Logic Decoder, Channel F (Figure D-10)	a) Loss of Channel F vertical-blanking	Failure of: 1) Channel F clock 2) Gate (6) 3) Channel F division chain up to binary N 4) Gates (48), (50), (52), (53), (56), (59), & (R60)	Lack of vertical-blanking sync pulses	None	Non-synchronized pictures at ground station	E_f F_o	5	Pictures can be restored after playback at OSE.
	b) Loss of vertical-read F_a	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in Channel F division chain 4) Gate (RD49)	No camera F_a vertical read sync	Partially redundant camera F_b	Only one set of F-scan pictures	C_f E_o	5	
	c) Loss of vertical-read F_b	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in Channel F division chain 4) Gate (RD62)	No camera F_b vertical read sync	Partially redundant camera F_a	Only one set of F-scan pictures	C_f E_o	5	
	d) Loss of F_a erase	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (RD 49), (51), (48), (34), (70), (43), & (R37)	No camera F_a erase sync	Partially redundant camera F_b	Only one set of F-scan pictures	C_f E_o	5	
	e) Loss of F_b erase	Failure of: 1) Channel F clock 2) Gate (6)	No camera F_b erase sync	Partially redundant camera F_a	Only one set of F-scan pictures	C_f E_o	5	

TABLE D-6
FAILURE EFFECTS ANALYSIS OF THE FULL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Logic Decoder, Channel F (Continued)		3) Single binary in channel F division chain 4) Gates (RD62) (70), (43), (48), (63), (32), & (R35)						
	f) Camera mixed blanking F_a	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (49), (R50), (51), (RD49), (70), (51), (48), (42), (34), (R37), (21), (15), (18), (R25)	No camera mixed-blanking F_b sync	Partially redund-ant camera F_b	Only one set of F-scan pictures	R_f F_o	5	
	g) Camera mixed blanking F_b	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (48), (70), (43), (R35), (32), (30), (R28), (27), (RD62) & (63)	No camera mixed-blanking F_b sync.	Partially redund-ant camera F_a	Only one set of F-scan pictures	C_f F_o	5	
	h) Loss of F_a flash	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (RD49), (51), (39), (R42), (33), (47), (48), (50)	No camera F_a flash sync	Partially redund-ant camera F_b	Set of multiple-exposure pictures in camera F_a (F-scan)	(E_f D_f) E_o	5	
	i) Loss of F_b flash	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (R40), (R36), (R36), (63), (RD62), (33), (47), (50), (48)	No camera F_b flash sync	Partially redund-ant F_a camera	Set of multiple ex-posure pictures in camera F_b (full-scan)	(E_f D_f) E_o	5	
	j) Loss of shutter F_a	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain	No camera F_a shutter sync	Partially redund-ant F_b camera	Only one set of F-scan pictures	C_f E_o	5	

TABLE D-6
FAILURE EFFECTS ANALYSIS OF THE FULL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Logic Decoder, Channel F (Continued)		4) Gates (R46), (44), (51), (38), (43), (70), (RD49)						
	k) Loss of shutter F_b	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (70), (43), (38), (RD62), (63), (41), & (45)	No camera F_b shutter sync	Partially redundant F_a camera	Only one set of F-scan pictures	C_f E_o	5	
Video Combiner Logic, Channel F (Figure D-10)	a) Faulty video F_a gate signal	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (49), (R50), (51), (R65), (61), (R58), (63), (RD62)	No video F_a gate sync at +12.0 volts level	Partially redundant camera F_b	Only one set of F-scan pictures	C_f E_o	5	
	b) Faulty video F_b gate signal	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (R64), (61), (49), (R50), (51), (58), (RD49)	No video F_b gate sync at +12.0 volts level	Partially redundant camera F_a	Only one set of F-scan pictures	C_f E_o	5	
	c) Faulty tone F_a gate signal	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Gates (R57), (33), (47), (50), (48), (52), (54), (58)	No F_a tone signal at +12.0 volts level, continuous at 0 volt level	None None	Either lack of tone signal at OSE (at +12.0 volts level), or continuous tone signal (at 0 volt level)	F_f F_o F_f F_o	5 5	
Timer, Channel F (Figure D-10)	a) Loss of channel F timer signal	Failure of: 1) Channel F clock 2) Gate (6) 3) Single binary in channel F division chain 4) Single binary in channel F timer chain 5) Encoder gate	Failure of five-minute automatic turn-on of channel F	Full power turn-on from CC&S	Possible transmission loss of some early F-scan pictures	F_f F_o	5	

TABLE D-6
FAILURE EFFECTS ANALYSIS OF THE FULL-SCAN CAMERA SEQUENCER (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Timer, Channel F (Continued)	b) Continuous or premature channel F timer signal	1) Faulty reset signal 2) Single division in channel F timer chain 3) Encoder gate	Premature F-scan transmitter turn-on	None	Premature transmission of TV pictures	F_f F_o	5	Possible transmitter damage due to the lack of warm-up time
Automatic or Reset Logic, Channel F (Figure D-10)	a) Failure to reset	Failure of: 1) "AND" gate (Q_{25} & Q_{26}) 2) Faulty control flip-flop	Late transmitter turn-on	Full power turn-on from CC&S	Possible transmission loss of some early F-scan pictures	F_f F_o	5	
	b) Premature turn-on	1) Same	Premature F-scan transmitter turn-on	None	Premature transmission of TV pictures	F_f F_o	5	Possible transmitter damage due to the lack of warm-up time
Timer Telemetry, Channel F (Figure D-10)	a) Loss of telemetry signal	Failure of: 1) "AND" gates (Q_{21} & Q_{22}) 2) Telemetry SCR	Loss of telemetry point	None	No F-timer telemetry	F_{t90} F_o	5	
	b) Misleading telemetry information	Failure of clock after 40 seconds of operation	False telemetry data after SCR has been fired	None	False F-timer telemetry	F_{t90} F_o	5	
Sequencer Power Supply (Figure D-10)	a) +12 volts output rises to approx. +24 volts	Transistor Q_{19} short-circuits	+24 volts supplied to sequencer (F-scan)	None	Good possibility of F-scan sequencer malfunctioning and consequent loss of all F-scan video	A_f D_o	3	
	b) +12 volts output falls to zero	Short or open circuit in either Q_{13} or Q_{14}	F-scan sequencer inoperative	None	No F-scan video will be transmitted	A_f D_o		
	c) +12 volts output falls to +4 volts	Q_{19} open circuit	+4 volts applied to F-scan sequencer, causing it to malfunction	None	Same as above	A_f D_o		
	d) -12 volts output falls to less than -1 volt	Q_{24} short circuit	-1 volt applied to F-scan sequencer, causing it to malfunction		Same as above	A_f D_o		
	e) -12 volts output rises to -18 volts	Q_{24} open circuit	-18 volts applied to F-scan sequencer, which should still operate at this condition	None required	None	E_f E_o		
	f) +12 volts output drops to approx. +4 volts	Q_{19} open circuit	+4 volts supplied to F-scan sequencer, with result that this sequencer will be inoperative	None	All F-scan video will be lost	A_f D_o		

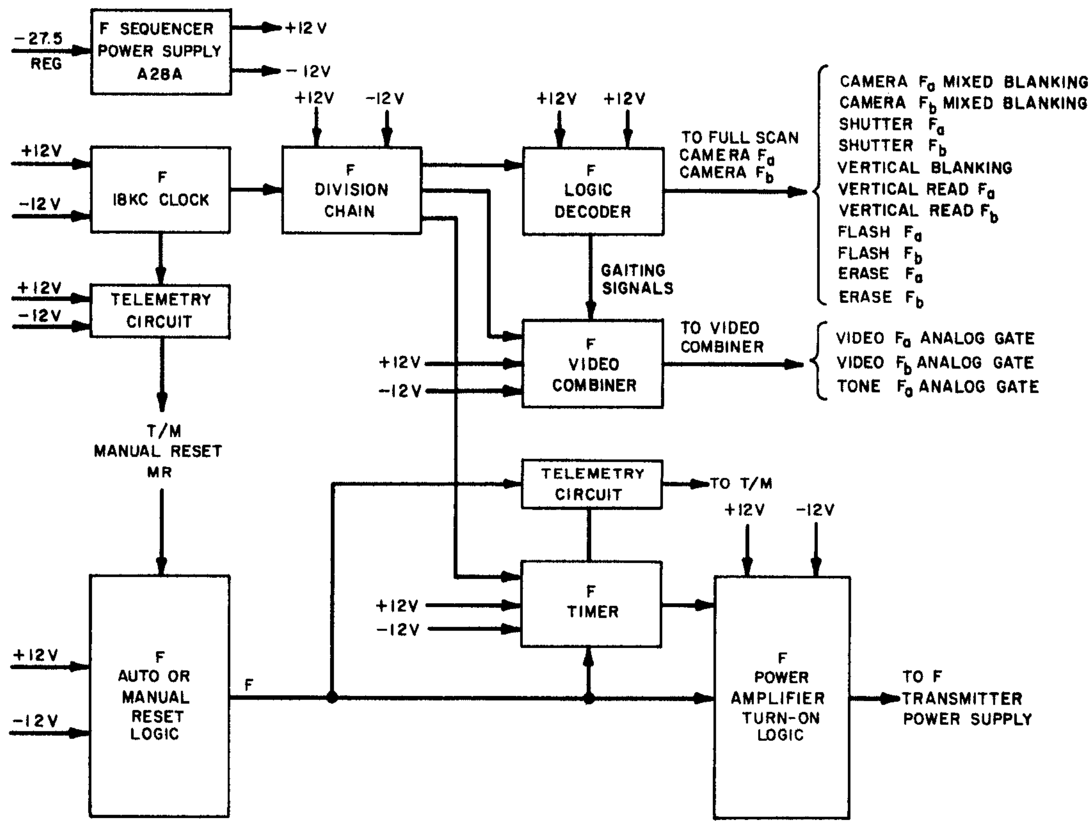


Figure D-10. Full-Scan Camera Sequencer Assembly

TABLE D-7
FAILURE EFFECTS ANALYSIS OF THE SPACECRAFT COMMUNICATIONS

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
FM Modulator Channel F (Figure D-11)	a) No radio frequency output	1) Open circuits in Q4 buffer stage	No RF output from modulator, no RF drive supplied to multiplier stages, IPA, and PA; thus, no RF output from this channel	None	Loss of Channel-F RF	A_f D_2	5	Against random failures, redundant combined outputs would be a corrective measure; the drive to succeeding multiplier stages would be reduced, however.
		2) Open circuit in Q3 oscillator stage	Substantially the same as above	None	Same as above	A_f D_2	5	This failure can only be offset by the dual modulation capability (multiplexing) of a single carrier, and the capability of data recovery under this operational mode.
		3) Shorts in Q4 (C-E, C-B) and shorts in Q3 (C-E, C-B)	Same as above	None	Same as above	A_f D_2	5	Same as note 1 above, except omit Q3.
	b) RF output unmodulated	1) Failure in FM modulator input circuit, including Q1	Q3 oscillator operates at crystal-controlled frequency with no frequency-modulation	None	Loss of Channel-F video	A_f D_2	5	
		2) Failed varactor (short) diode, CR10	Same as above	None	Same as above	A_f D_2	5	
		3) Failure in input such as CR1, open Q1 and K1	Same as above	None	Same as above	A_f D_2	4	Parallel unused relay contact sets in K1 to increase reliability.
	c) Change in modulation index	Input circuit failures or part parameter changes including Q1	Output signal characteristics from transmitter changed	None	Same as above	A_f to F_f	5	Reconstitution of video may be possible; loss of data occurs if deviation goes far enough outside of band, however.
	d) Center frequency off design point	CR10, Y1, or other frequency control elements change value	Modulator detuned in respect to portions of RF system following; transmission off frequency and down in magnitude	None	Possible loss of complete RF from this channel if shift is toward remaining operative channel or if transmitted signal level is too low	A_f D_2	5	
X12 Multiplier (Figure D-11)	a) No RF output	1) Any failed transistor (Q1-Q4) or varactor failure (CR1, CR3, CR6-9)	No output from this multiplier to drive following stages	None	No RF output from this channel	A_f D_2	3	Dissipation levels in all parts should be kept within safe margins. Operation in the presence of failures can be achieved in the present design only through dual redundancy and output-combining and/or switching.

TABLE D-7
FAILURE EFFECTS ANALYSIS OF THE SPACECRAFT COMMUNICATIONS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
X12 Multiplier (Continued)		2) Faulty RF cabling, including connectors	Same as above	None	Same as above	A_f D_2	5	
	b) Low output	Slight detuning (shift) in varactor diode characteristics; defective components in matching networks and amplifier stages	Output from this multiplier below nominal level; drive to X4 multiplier and IPA and PA low	None	Low output from this channel	A_f to F_f	4	Limit varactor diode bias current to some safe maximum and suppress transients due to switching, etc.
	c) Garbled output (excessive noise, low power, etc.)	Faulty varactors and/or detuning noise in amplifier (buffer stages)	Same as above	None	Same as above	A_f to F_f	4	Same as above
X4 Multiplier (Figure D-11)	a) No output	1) Failed varactors and/or inductors	No drive to IPA	None	No video from this channel	A_f D_o	5	
		2) Faulty RF cabling, including connectors	Same as above	None	Same as above	A_f D_o	5	
	b) Low output	1) Detuned cavity (shift in CR1 and/or CR2 parameters)	Insufficient power available to drive IPA (low output)	None	Low RF output from this channel	A_f to F_f	5	
		2) Incorrect bias, or none, applied to varactors	Same as above	None	Same as above	A_f to F_f	5	
Channel F IPA Cavity (Figure D-11)	a) No output	1) V1 tube failures	No drive supplied to power amplifier stage	None	No video from this channel	A_f D_o	2	Suggest power burn-in of all tubes, and gain and stability checks at selected intervals to ensure use of most stable tubes.
		2) Feed-through failures, cavity component failures	Same as above	None	Same as above	A_f D_o	5	
	b) Low output	1) Cavity detuned by mechanical repositioning of V1 or other cavity elements	Low drive power to PA; power fluctuates widely with frequency changes	None	Low output at nominal frequency with power a function of output frequency	A_f to F_f	5	
		2) V1 low G_m, etc.	Same as above	None	Low output during transmitter operation	A_f to F_f	3	Same as no output; V1 tube failures
		3) Mismatch between IPA and PA (due to cables, connectors, etc.); loss Y cable	Same as above	None	Same as above	A_f to F_f	5	
Channel F Power Amplifier (Figure D-11)	a) No output	1) Failures in V1	No RF drive to antenna system from channel	None	No video from this channel	A_f D_o	2	Same as no output; V1 tube failures occur in intermediate power amplifier.
		2) Failures in filament transformer, feed-through, contacting surfaces between	Same as above	None	Same as above	A_f D_o	5	

TABLE D-7
FAILURE EFFECTS ANALYSIS OF THE SPACECRAFT COMMUNICATIONS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Channel F Power Amplifier (Continued)		tube and cavity structures 3) Faulty cabling, connectors, cavity elements, etc.	Same as above	None	Same as above	A_f D_o	5	
	b) Low output	1) Low G_m in V1, etc.	Low RF to antenna subsystem	None	Low output during transmitter operation	A_f to F_f	3	Same as no output; V1 tube failures occur.
		2) Cavity detuned by V1, or other parts in cavity	Same as above	None	Same as above	A_f to F_f	5	
		3) Faulty RF cabling and connectors	Same as above	None	Same as above	A_f to F_f	5	
4-Port Hybrid (Figure D-11)	High input VSWR on either or both channels	1) Mismatched antenna or dummy load	Reduced power output; both channels affected	None	Received power may be too low for proper detection	A_o	5	
		2) Fault within hybrid	Same as above	None	Same as above	A_o	5	
Dummy Load (Figure D-11)	Open or short	1) Connector failure 2) Dielectric failure 3) Center conductor failure 4) Pressure seal failure	High VSWR presented to hybrid, and resulting mismatch reflected into both channels	Same as above	Same as above	A_o	5	
Channel F Transmitter No. 1 Power Supply (Power Supply Osc. & Transformer, T1) (Figure D-11)	No output	1) Open C-E of either or both of the inverter switching transistors, or open bases of the same two transistors	No current delivered to this power supply; no B+ available to either the IPA or PA	None	No RF transmission	A_f D_2	3	Adequate temperature control and/or derating of semiconductors and other parts will keep failure probability low.
		2) Failed transformer, T1, or failed filter choke	Same as above	None	Same as above	A_f D_2	5	
Channel F Transmitter No. 1 Power Supply (Diode Bridges) (Figure D-11)	a) No +1000 volts output	1) Failed diodes 2) Failed 1000 volts winding of T1	No high voltage applied to power amplifier; no output	None	Same as above	A_f D_2	5	1) Redundant diodes in bridge rectifiers can offset failure effects. 2) Redundancy in contact sets, conservative current levels & voltage breakdown applied to relay contact sets. Redundancy in bridge rectifiers
		3) Failures in K1, K2 and/or K4	Same as above	None	Same as above	A_f D_2	3	
	b) No -750 volts output	1) Failed diodes in -750 volts bridge rectifier	No cathode bias applied to IPA; substantially the same as loss of IPA B+; no RF output	None	Same as above	A_f D_o	3	
		2) Failures in K1, K2, or K4	Same as above	None				

TABLE D-7
FAILURE EFFECTS ANALYSIS OF THE SPACECRAFT COMMUNICATIONS (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Channel F Transmitter No. 1 Power Supply (Diode Bridges) (Continued)		3) Failures in -750 volts winding of T1	Same as above	None				
	c) No -500 volts output	1) Failed diodes in -500 volts bridge rectifier	No screen grid voltage applied to IPA; probable loss of IPA through excess screen current	None	Same as above	A_f D_o	5	
		2) Failures in -500 volts winding of T1	Same as above	None				
	d) No +100 volts output	1) Failed diodes in +100 volts bridge rectifier	No bias applied to varactor diode multipliers and +100 volts to FM modulator; no video data amplification and FM oscillator frequency offset	None	No RF output this channel because of loss of +100 volts and +70 volts to modulator and multiplier	A_f D_o	5	
		2) Failures in +100 volts winding of T1	Same as above	None				
Channel F Telemetry Processor (P.A. Cathode Current Regulator, (Figure D-11)	a) Cathode current through regulator is zero	1) Open C-E	Loss of RF output; cathode current reduced substantially by single 5k resistance to ground in cathode circuit	None	Loss of RF from this channel	A_f D_o	5	EMF developed across Q1, and the 5k resistance becomes high and punch-through may occur.
		2) Open base in Q1	Same as above	None				
	b) High cathode current	1) Q1 in saturation	V1 in PA overheating and possible destruction	None	Possible loss of RF from this channel	A_f D_o	5	
		2) C-E short	Same as above	None				
P-Channel RF		Details	same as F-Channel RF given	above		A_p C_o	1	Notes under channel F apply equally to channel P.

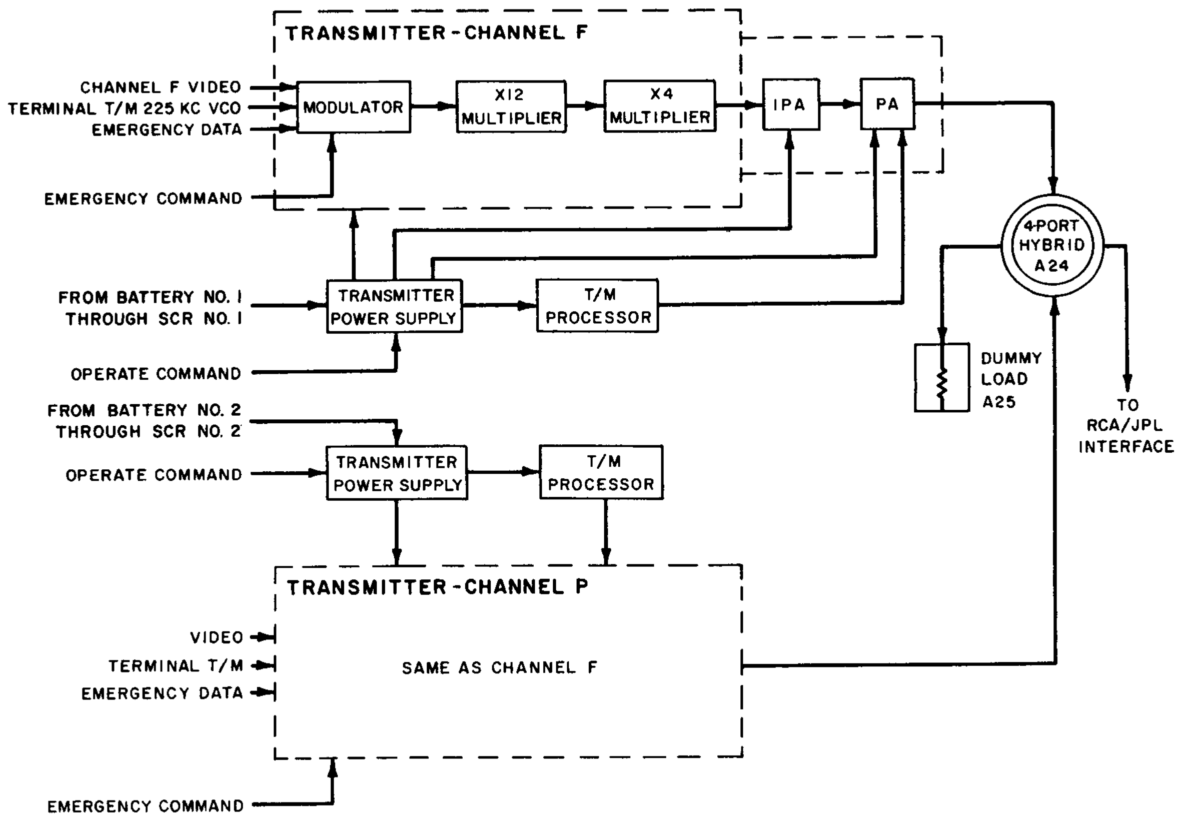


Figure D-11. TV Subsystem Communications Equipment

TABLE D-8
FAILURE EFFECTS ANALYSIS OF TELEMETRY EQUIPMENT

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Telemetry Processor #1, A-29 (Figure D-12)	a) No 1000 volts telemetry	Open resistor in divider	No power amplifier B+ telemetry	None	No power amplifier B+ telemetry data	F_{90} F_o	5	
	b) No RF level telemetry	Open R14	No RF level telemetry	None	No RF level telemetry data	F_{90} F_o	5	
	c) No cathode current telemetry	Open R7, CR2	No cathode current telemetry	None	No cathode current telemetry data	F_{90} F_o	5	
Telemetry Processor #2, A-30 (Figure D-12)			Same as Telemetry Processor #1, A-29, given above					
Telemetry Processor, A-26 Channel 8-AC Amplifier (Figure D-12)	No output	Open T1, C1, and C-E in Q1, R4	No cruise telemetry data output	None	No cruise telemetry data	A_{15} D_o	5	
TV Mission Telemetry Converter (Figure D-12)	No output	Open C-E on Q1, Q2, Q3 and/or Q4; open base on any or all of the above	No +27 volts DC regulated output and/or no +30 volts unregulated output; no B+ supplied to 225 kc VCO's of channels F and P	None	No cruise telemetry data	A_{15} D_o	5	
225 kc Voltage-Controlled Oscillator (Figure D-12)	a) No output	Internal part failure (purchased item)	Loss of terminal telemetry data to one RF channel	225 kc VCO on other RF channel	Negligible	F_{90} F_o	5	
	b) Shift in output level	Part degradation or parameter shift	Hardly any	225 kc VCO on other RF channel	None, if redundant unit is known to be stable & unchanged	F_{90} F_o	5	Normally the shift is not discernible unless comparison can be made against unchanged VCO in other channel. However, , some question may arise as to which one is correct and which is not.
Channel 8 Voltage-Controlled Oscillator (Figure D-12)	a) No output	Internal part failure (purchased item)	Loss of cruise telemetry data output	None until terminal telemetry readout starts	No cruise-mode telemetry	F_{15} F_o		
	b) Shift in output level	Part degradation or parameter shift	Hardly any	Same as above	Probable erroneous or unreliable cruise-mode telemetry	A_{15} D_o		Normally the shift is not discernible until terminal-mode telemetry duplication points start their readout.
Cruise-Mode Commutator (Figure D-12)	1) Opens	Contactor failures	Loss of telemetry data points	None	Loss of some telemetry data	A_{15} D_o	3	
	2) Noisy	Same as above	Possible loss of telemetry data points	None	Same as above	A_{15} D_o		

TABLE D-8
FAILURE EFFECTS ANALYSIS OF TELEMETRY EQUIPMENT (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Terminal-Mode Commutator (Figure D-12)			Same as Cruise-Mode Commutator given above					

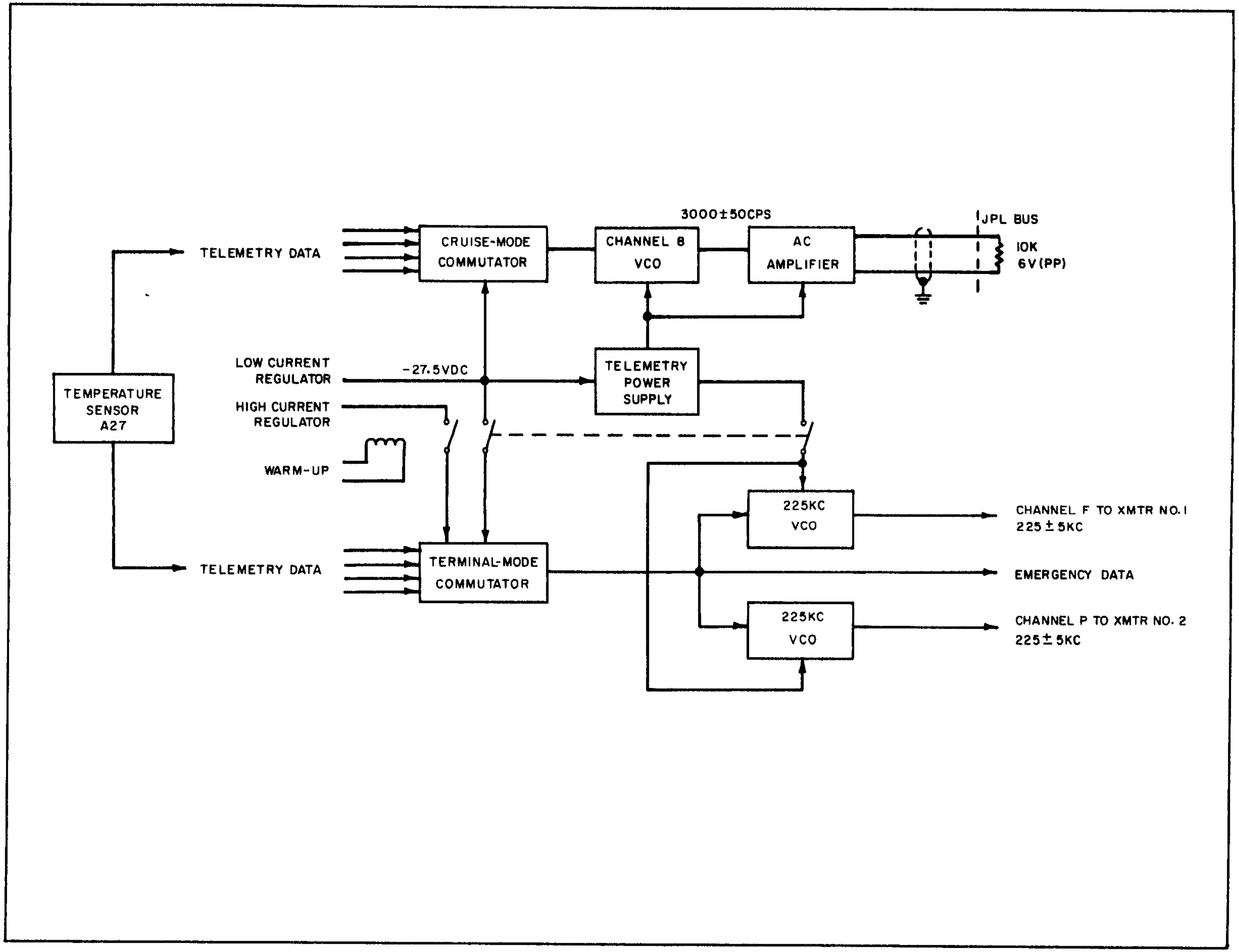


Figure D-12. TV Subsystem Telemetry Equipment

TABLE D-9
FAILURE EFFECTS ANALYSIS OF POWER DISTRIBUTION AND CONTROL EQUIPMENT

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-Current Regulator (A12), (Figure D-13)	a) No output	1) Open SCR	No power applied to camera electronics or sequencer power supply F_a or transmitter power supply	None	No video or RF from this channel	A_f D_o	5	Parallel SCR's would improve reliability against open failures, but in regard to early short failures the system would be put in greater jeopardy. The net gain or loss of reliability should be determined, therefore, before a decision is made.
		2) SCR will not turn on	Same as above	None	Same as above	A_f D_o	5	With parallel-pass transistors, each should be capable under worst case or at least under nominal load levels of carrying full load.
		3) Either one or both series pass transistors Q6 or Q7, open C-E, open base, short, B-E, also Q5 failures same as Q6 or Q7	No power applied to camera electronics or sequencer power supply F_a and terminal commutator	Terminal telemetry derived from low-current regulator	No video from this channel	A_f D_o	4	
		4) Open base or collector in Q1 and/or Q2 or loss of reference voltage	Same as above	Same as above	Same as above	A_f D_o	5	
		5) Open series resistors R10 and/or R11	Same as above	Same as above	Same as above	A_f D_o	5	
		6) Open starting circuit of R13, 14, and CR2	Regulator may not start, in which case there is no output; however, this circuit is basically a redundant one to ensure regulator starting	None	None if regulator starts; no video or RF from this channel if it doesn't	A_f D_o	5	Basically this is redundant and is required to operate only if the regulator does not start by itself.
		7) Short circuit in output filter capacitors	No regulator output, thus no power applied to camera electronics or sequencer power supply; however, the capacitors may burn open before regulator fails, and some output is regained	None	No video from this channel for permanent short circuit; operation possible if short circuit burns open; also, terminal still available	A_f D_o	5	Redundant series parallel capacitor arrangement will negate to a large extent the effect of either open or short capacitor failures.
	b) Loss of regulation	1) Short circuit in Q6 and/or Q7 and failure that puts Q5 in a saturated state	No regulation of battery input; output follows battery voltage; dissipation increased in sequencer power supply and camera electronics	None	TV Subsystem should continue to operate; some overloading should occur in some circuits but power drain should pull battery peak down rapidly	F_f F_o	4	Some circuits may be temporarily overloaded due to initially high battery EMF. However, most of this will be regulated out by other regulators hung on this regulator, and only these regulators will dissipate more than normal.

TABLE D-9
FAILURE EFFECTS ANALYSIS OF POWER DISTRIBUTION AND CONTROL EQUIPMENT (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
High-Current Regulator (Continued)		2) Open base, short C-B on Q4. Open emitter, open base on Q3. Short circuit in C22 Open circuit in R1, 2 and/or 3.	Same as above	None	Same as above		5	No corrective action deemed necessary or advisable.
	c) No unregulated output	Open SCR	Same as open SCR in high-current regulator; no output			A_f D_o	5	
Battery No. 1	No battery output	1) No SCR turn-on 2) Defective cells 3) Open cabling	Same as no SCR turn-on No channel F operation	None	No video or RF this channel and no terminal-mode telemetry	A_f D_o A_{t90}	5	Remove battery heaters if not required. Redundant cabling to SCR's.
Command Switch (Board A1) (Figure D-13)	a) No switch to warm-up on receipt of RTC-7 command	Open C-Es, open Cs, open bases of Q3 and/or Q4; open R17, 18, or 16; open or shorted coil in S1	Command switch does not step from zero position to warm-up. TV Subsystem not sequenced on. This is a redundant turn on mechanism itself and is required only if the CC&S command system has failed to operate	Pre timer Electronic clock	Loss of all video and terminal T/M if electronic clock fails; otherwise time of terminal mode is dependent upon electronic clock.	A_s F_o	4	Added redundancy is provided in the electronic clock and relays in DCU. (This is already incorporated in the system.) Also, this board can be made redundant itself if back-up clock operation gives minimal system-return due to preset timing.
	b) Premature command-switch operation	Short C-E of either Q3 and/or Q4 prior to CC&S or RTC-7 or spurious command	Command switch gated to warm-up before receipt of RTC-7 or CC&S command; system operation is commenced prematurely; power-control unit, if functioning properly, can gate TV Subsystem off.	Power-control unit turn-off command	Early operation of turn-off accomplishes safe mode; but Q3 or Q4 short circuit keeps on-command present, and removal of turn-off gates system back on.	A_f D_o	5	Suppression of spurious commands necessary as safeguard. Other failures appear to be remote in probability of occurrence since circuit is in a cut-off state until receipt of turn-on command.
Command Switch (Board A12) (Figure D-13)	a) No SCR turn-on signal to F chain	1) Open circuit in R2, CR1, base of Q1, C-E of Q1, R5 and/or R7	No F-camera chain operation; no video, no RF, no operation	None	No F camera chain output, video or RF .	A_f D_o	5	
		2) Open connector pin, J1-28 or short-circuited C1	Same as above	None	Same as above	A_f D_o	5	
	b) No SCR turn-on signal to P camera chain		Same as No SCR turn-on signal to F camera chain, except part numbers change accordingly					
Battery No. 2	a) Loss of Battery No. 2 output	1) Bad cells 2) Faulty connector	No power to P-scan cameras and transmitter circuits	None	Complete loss of P-scan camera pictures;	A_p C_o	3	

TABLE D-9
FAILURE EFFECTS ANALYSIS OF POWER DISTRIBUTION AND CONTROL EQUIPMENT (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Battery No. 2 (Continued)		3) Short circuit 4) Excessive drain			loss of telemetry during cruise mode	B_{t15} E_o		
High-Current Regulator No. 2 (A22)	Loss of gated unregular voltage	1) Faulty SCR gate 2) Faulty cable or connectors 3) Loss of turn-on gate signal	No power to P-scan cameras and transmitter circuits	None Telemetry is redundant in F channel	Complete loss of P-scan pictures.	A_p C_o	4	Remove battery heater if not required.
	Loss of regulated -27.5 volts	1) Faulty regulator 2) Faulty cable or connectors	No power to P-scan cameras	None	Complete loss of P-scan pictures	A_p C_o	4	
Board A-2	a) No low-current regulator turn-on	Failure of K-1 or connector pins associated with LCR turn-on.	No cruise data	None	No cruise telemetry; also, will effect decision-making if other troubles are present or develop	A_{t15} E_o	4	
	b) No switch to emergency mode	Substantially the same as "No switch to warm-up on receipt of RTC-7 warm-up command"					4	
Distribution Control Unit (Figure D-13) Module A1)	a) No unregulated output	Open fuses, connectors	No power available to F camera chain transmitter power supply; no RF output this channel	None	No F camera chain transmitter RF	A_f D_o	5	
	b) No regulated output	Same as above	No F camera video	None	No F camera chain video, but RF should be present	A_f D_o	5	
Module A2		(Same as DCU-Module A1 given above, except P camera chain)						
Module A3	a) No SCR turn-on, channel F or channel P	Open CR-4	CC&S command closing K2 and grounds SCR control junction through this diode; open diode inhibits this action. However, redundancy in RTC-7 and clock circumvents this failure	RTC-7 command and Preset Clock		A_o F_o		
	b) No clock start and hold signals	Open CR-7 and/or CR-8	Not normally required to operate, provided either CC&S or RTC-7 operate properly, as this is a third level of redundancy. No system operation, though, if this is required.	None	No RF or video from either channel if other sequenced modes fail	F_o	5	This is a third-level-of-redundancy applications as it presently exists. Thus, the failure class factor is reduced in criticality by the probability of failure of both CC&S and RTC-7 commands.
Distribution Control Unit K1 K2	Same as above No SCR turn-on, both channels	Open contacts or coil K2 Failure	Same as above (Same as Module A3, no SCR turn-on)	None	Same as above	F_o A_o F_o	4 4	

TABLE D-9
FAILURE EFFECTS ANALYSIS OF POWER DISTRIBUTION AND CONTROL EQUIPMENT (Continued)

Item	Assumed Failure	Possible Causes	Symptoms and Local Effects	Compensating Provisions	Effects on Mission	Failure Class Factor	Failure Probability Factor	Remarks/Recommended Compensating Provisions/etc.
Low-Current Regulator (Figure D-13)	a) No unregulated output	Open CR-3, or failed cabling and/or connector	No cruise-on power	None	No telemetry during cruise mode	B_{t15} E_o	5	Delete CR3 in the low-current regulator and provide circuits involved.
	b) No regulated output	Open-pass transistor, 2N1486; open base or C-E in Q1, open RG, short circuit in CR1	No low-current voltage regulator output available; no telemetry data available during cruise mode	None	No cruise telemetry data. Affects decision-making in presence of other failures.	B_{t15} E_o	5	
	c) Loss of regulation	C-E short in 2N1486 pass transistor; C-E, C-B shorts in Q1; opens in Q2; open CR1, Zener	Unregulated bus voltage applied to voltage-sensitive telemetry circuits, some probable over-dissipation high battery voltage	None	Telemetry calibration changes with battery voltage			
Power Control Unit (PCU) (A36) (Figure D-13)	a) No turn-off signal when required	Faulty relays, SCR's, cabling, including connectors	TV Subsystem operation at other than desired interval	None	Probably no return during terminal mode	A_o F_o	4	This is a back-up feature and is required to operate normally only if and when an inadvertent turn-on occurs.
	b) Erroneous turn-off signal	Spurious commands, failed components	Loss of power to system	None	During cruise mode, the effect is negligible; during terminal mode loss of TV Subsystem functioning	A_o F_o	5	Turn-off output should be bypassed during terminal mode.
Electronic Clock (A35) (Figure D-13)	No turn-on signals	Failures in counting chain; Failures in cabling, connectors, and/or switching	(Same as DCU Module A3, except F is affected only)			F_o		Same as DCU Module A3
Command Switch	Faulty stepping switch	1) Open coil, jammed in one position	If in Zero position, no warm-up command transmitted to remainder of TV Subsystem	Electronic clock relay in DCU	Optimum terminal-mode interval not attained	A_o C_o	3	Solid-state switching desired in lieu of electro-mechanical switching.
			If in warm-up it jams or fails, no effect unless stepping to emergency mode is desired	None (None necessary, if other operational sequences of mode are okay)	No emergency-mode capability	F_o		
		2) Stepping switch double steps-zero thru warm-up to emergency mode	Instantaneous turn-on of transmitter with possible IPA and PA damage due to cold start	PCU turn-off	If damage to tubes in IPA and PA loss of RF capability	B_o	5	Insure stepping-switch operation based upon minimum time-power relation. Also, suppression of any but legitimate turn-on signals by filtering, etc.

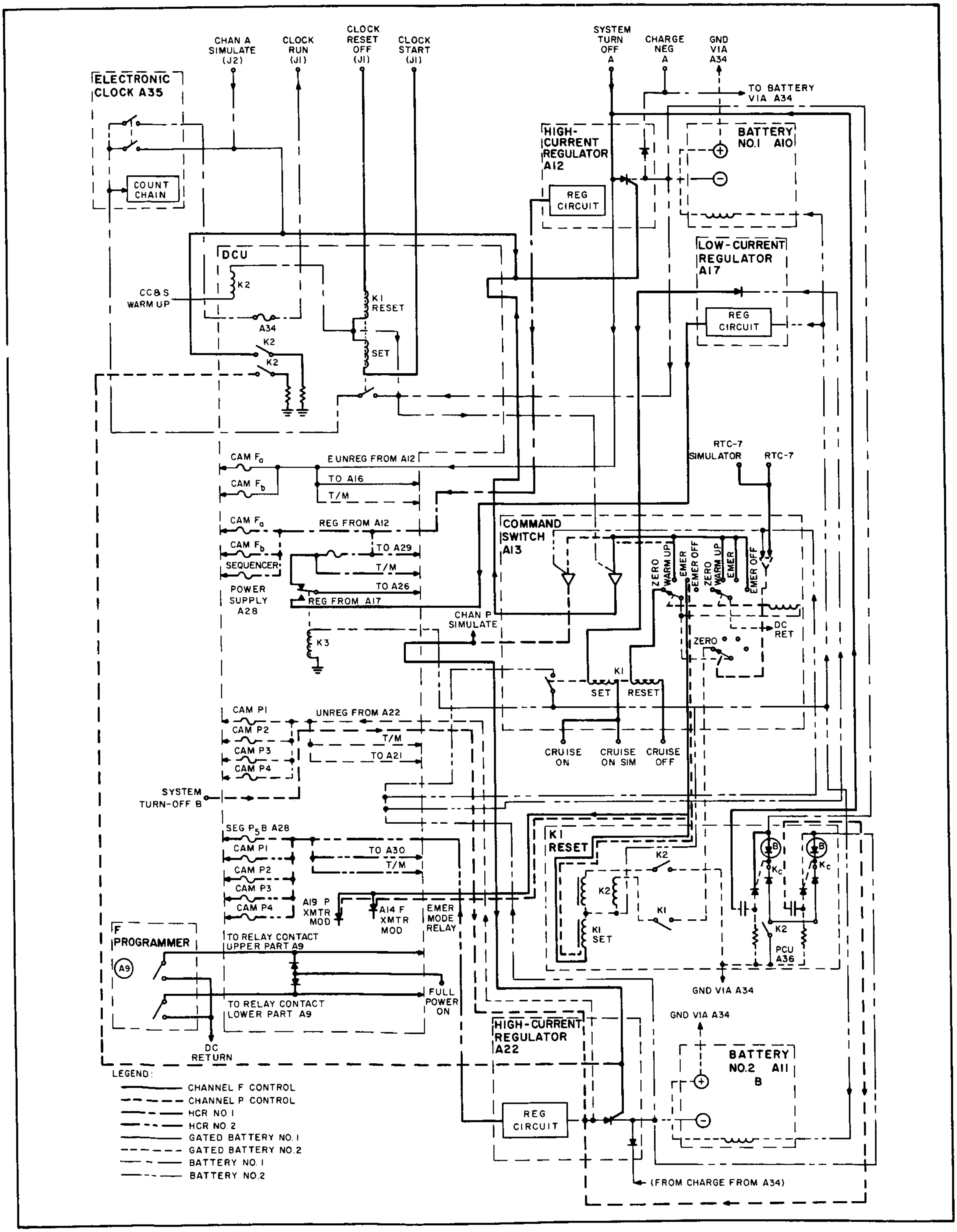


Figure D-13. Power Distribution and Control Assembly

Appendix E

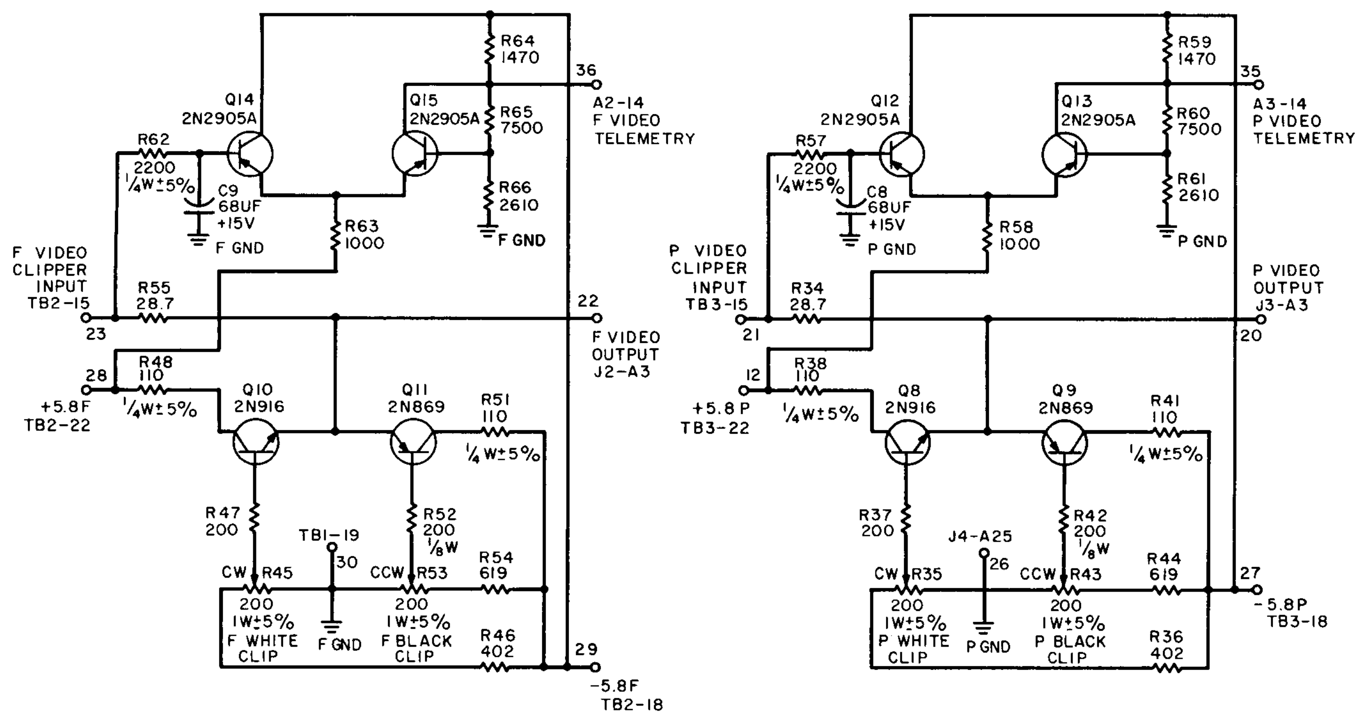
Failure Effects Analysis of POST RANGER VI System Configuration

TABLE E-1
FAILURE EFFECTS ANALYSIS OF F-AND P-CHANNEL VIDEO COMBINER

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Overall Effect	Remarks
F-CHANNEL					
R62	Open	No telemetry signal output and no input to differential amplifier.	None	F-video telemetry point of 90-point telemetry goes to zero.	
R63	Open	No telemetry signal output. Differential amplifier does not draw any collector current.	None	F-Video telemetry readout goes to 5V level.	
R64	Open	Differential amplifier acts as an emitter-driven low-impedance-input amplifier, being driven through the base diode of Q14. Q14 drive results in a reduced-output swing because of diode effects of base-emitter junction of Q14.	None	F-Video telemetry output approaches zero.	
R65	Open	Collector current of Q15 goes to zero.	None	F-Video telemetry goes to zero. Complete loss of telemetry results.	
R66	Open	No circuit response because Q15 is placed in a fully saturated state.	None		DC output level does not represent video information. Tests for actual level should be made.
C9	Open	Video signal appears in telemetry output. Sampling of telemetry level is variable and useless.	None	Substantial loss of useful telemetry.	Some recovery of useful telemetry may be possible at ground station through proper filtering.
	Shorted	Same as that for opened R62.	None	Same as that for opened R62.	

P-CHANNEL

The analysis of the modified parts in the P-Channel Video Combiner is the same as that of the F-Channel, but affecting P-Channel. R47, R58, R59, R60, R61 and C8 have the same effects on P-Channel operation as R62, R63, R64, R65, R66 and C9 had on F-Channel operation.



NOTES:
1. ALL RESISTANCE VALUE ARE IN OHMS.
2. ALL RESISTORS ARE 1/8 W± 1% UNLESS OTHERWISE NOTED.
3. USED ON RANGER PTM III-2 AND SUBSEQUENT.

Figure E-1. Telemetry Amplifier and Video Clipper Circuits of the F- and P-Channel Video-Combiner Assembly

TABLE E-2
FAILURE EFFECTS ANALYSIS OF F-CHANNEL TIMER OF THE MODULATOR

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
R202	Open	F-Timer telemetry output varies around -1 ± 1 volt.	None	F-Timer telemetry data returned is not correct.	Full power is still obtainable, as designed.
R201	Open	F-Timer telemetry output varies around +2 ± 3 volts.	None	F-Timer telemetry data returned is not correct.	Interpretation of data should reveal where failure has occurred.
R200	Open	F-Timer telemetry output varies around 0 ± 1 volt.	None	F-Timer telemetry data returned is not correct.	
R199	Open	Shift in normal range of telemetry output.	None	F-Timer telemetry data returned is not correct.	Telemetry output shifts from normal range of -2.4 volts nominal to -0.6 volts nominal to a range of -9 volts to +2.5 volts.
CR77	1. Open	No manual reset capability of Relay K1.	None	None	
	2. Short	None	None, normally	None	F-Channel transmitter is susceptible to turn-on by shorted diode. Sufficient isolation should be provided to make this failure trivial.
R195, R198, R196, R197 and CR76	These parts perform the same function in the P-Timer circuit as R200, R202, R201, R199, and CR77 perform in the F-Timer circuit. The same part failure applied to the F-Timer can also be applied to the P-Timer: and the same effects and comments are generally applicable but referenced to the P-Channel Timer.				

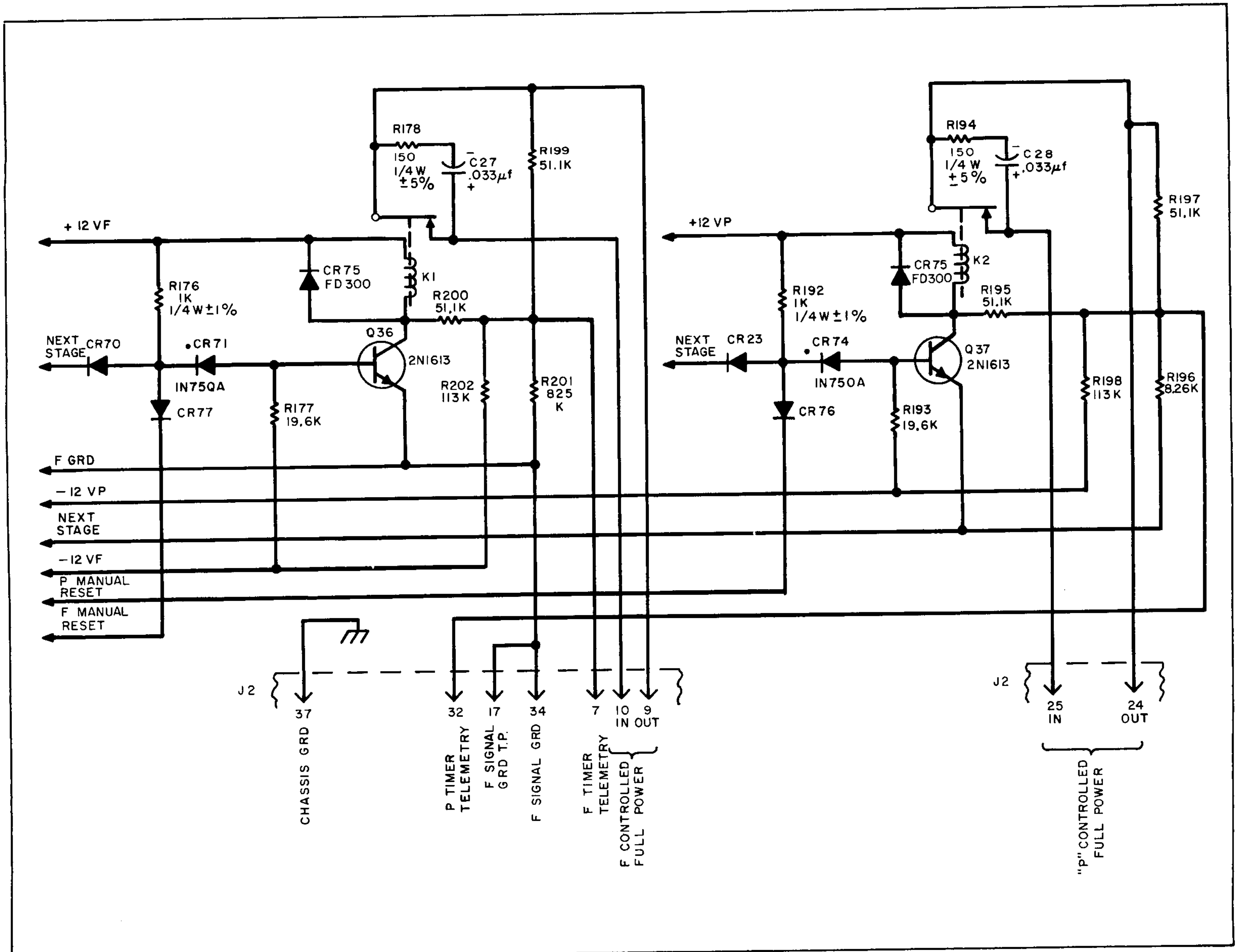


Figure E-2. Modulator Controller

TABLE E-3
FAILURE EFFECTS ANALYSIS OF THE TELEMETRY ASSEMBLY

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
15-Point Telemetry Data Point No.					
1	1. Open thermistor		None	Loss of this data point.	
	2. Change of value	Temperature-scale-factor change.	None, except to refer to other temperature readings for correction factor.	Temperature data received will not be accurate.	
2	See Low-Current Voltage-Regulator output voltage telemetry points.				
3	See analysis of Current Sensor Unit (Table E-4).				
5, 6	See evaluation of CR3 and CR4 and R18 and R19 of F-Channel HCVR (Table E-7).				
9	See evaluation of Ranger Clock (Table E-6).				
10	See evaluation of Current Sensor Unit (Table E-4).				
CR3	1. Open	No power input during cruise mode to: • Telemetry Power Supply; • -5 volt Reference Circuit; • 15-Point Commutator motor.	None during cruise mode. During warm-up mode, the regulator will perform a back-up function and supply the power.	Loss of 15-point telemetry during cruise mode.	A redundant parallel pair of diodes would reduce the probability of this failure.
	2. Short				
	a. During Cruise Mode	None noticeable.	None	None	A redundant series pair of diodes would eliminate the effects of failure in the shorted mode.
	b. Warmup Mode	Current drain from the Regulator to the LCVR could develop.	None	Effect would depend on the magnitude of the current drain into the LCVR.	A quadrature configuration of diodes would reduce the probability of failure due to either a shorted or open failure mode in one diode.
CR4	1. Open	No effect, unless LCVR also fails during warmup.	None	None	The primary function of CR4 and CR5 is to allow the regulator to act as a back-up power supply for the LCVR during warmup mode.
	2. Short	None noticeable.	The reverse voltage rating of CR5 is adequate to provide blocking of LCVR voltage from the regulator, and assure normal circuit performance.	No effect unless CR5 also fails.	Because of the series redundancy provided by CR4 and CR5, a short in one of these diodes would not affect mission performance.
CR5	1. Open	Same as 1 for CR4.	None	None	Same as 1 for CR4.
	2. Short	Same as 2 for CR4.	Same as 2 for CR4 with CR4 in place of CR5.	No effect unless CR4 also fails.	Same as 2 for CR4.
Q1 Transistor	1. Collector-to-Emitter				
	a. Open	a. Relay K1 will not be energized; Channel 8 VCO will not be switched from 15- to 90-point telemetry. b. Relay K2 will not be energized; power will not be applied to the two 225-kc VCO's.	None	Loss of 90-point telemetry data.	Transistor in parallel would reduce the probability of the mission being affected by this failure. 15-point telemetry data would be received during warmup through its cruise-mode path.

TABLE E-3
FAILURE EFFECTS ANALYSIS OF THE TELEMETRY ASSEMBLY (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
Q1 Transistor (Continued)		c. No power is applied to the 90-point telemetry Commutator motor.			
	b. Short	Unregulated-Bus voltage is fed through the series regulator circuit. The performance of all circuits on this line operating with unregulated power would have to be determined.	None	15- and 90-point telemetry systems may be affected. There is a possibility that this failure would damage relays K1 and K2, the 15- and 90-point commutator motors, and the telemetry power supply.	The 15- and 90-point commutator motors would increase in speed.
	2. Emitter-to-Base				
	a. Open	No input current will be supplied to the series regulator. • Relay K1 will not operate; Channel-8 will not be switched from 15- to 90-point telemetry. • Relay K2 will not operate; no power applied to the two 225-kc VCO's. • No power will be applied to the 90-point telemetry commutator motor.	None	Loss of 90-point telemetry data.	Same as 1a.
	b. Shorted	Series regulator is cut-off. No output from regulator. • Relay K1 will not operate; Channel-8 VCO will not be switched from 15- to 90-point telemetry. • Relay K2 will not operate; no power applied to two 225-kc VCO's. • No power applied to 90-point telemetry commutator motor.	None	Loss of 90-point telemetry data.	The 15-point telemetry data would be received through its cruise-mode path during warmup mode.
R9	Open	Same as 2a.	None	Loss of 90-point telemetry data.	Same as 2a for Q1 transistor.
R10	Open	Possible difficulties in turning on regulator	None	Possible loss of 90-point telemetry data.	15-point telemetry data would be received through its cruise-mode path if regulator fails to turn on.
C1	1. Open	Possible oscillation of regulator circuit.	None	Possible erratic operation of telemetry function.	
	2. Short	Transistor Q1 will operate in a saturated state. No regulator control; unregulated voltage will be applied to circuits through the regulator. R9 may burn up.	None	Same as 1b for Q1 transistor.	Same as 1b for Q1 transistor.

TABLE E-3
FAILURE EFFECTS ANALYSIS OF THE TELEMETRY ASSEMBLY (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
VR1	1. Open	Base of Q1 conducts heavily. Q1 operates in a saturated stated. Loss of regulator control; unregulated-bus voltage is fed directly to other circuits.	None	Same as 1b for transistor Q1.	Same as 1b for transistor Q1.
	2. Short	Output of regulator circuit will be approximately 9 volts. Relays K1 and K2 may drop out, and 90-point telemetry commutator motor may turn slowly or stop.	None	Effect depends on state of the K1 and K2 relays.	Provided the 90-point telemetry commutator motor continued to operate, the following conditions will prevail: • If relay K1 does <u>not</u> pull in and relay K2 does, 15- and 90-point telemetry data will be received; • If relay K2 does <u>not</u> pull in, and relay K1 does, only 90-point telemetry data will be received; • If <u>neither</u> relay K1 or K2 pull in, 15-point telemetry data will be received.
R11	Open	Transistor Q2 will be cut-off. Regulator output will be zero.	None	Loss of 90-point telemetry data.	15-point telemetry data will be received through its cruise-mode path during the warmup mode.
Q2	1. Collector-to-Emitter				
	a. Open	No base input current to the series regulator. Series regulator would be cut-off.	None	Loss of 90-point telemetry data.	15-point telemetry data will be received through its cruise-mode path during warmup mode.
	b. Short	Loss of regulator control; series regulator will operate in a saturated state.	None	Same as 1b for transistor Q1.	Same as 1a.
	2. Emitter-to-Base				
	a. Open	No base input current to the series regulator. Series regulator would cut-off.	None	Loss of 90-point telemetry data.	Same as 1a.
	b. Short	Transistor Q2 will cut-off and regulator output will be zero.	None	Loss of 90-point telemetry data.	Same as 1a.
R12	Open	Transistor Q2 cuts-off. No base input current to the series regulator; regulator cuts-off.	None	Loss of 90-point telemetry data.	Same as 1a for transistor Q2.
VR2	1. Open	Transistor Q2 conducts heavily. Series regulator will operate in a saturated state, feeding unregulated-bus voltage directly to the circuits.	None	Same as 1b for Q1 transistor.	Same as 1b for transistor Q1.
	2. Short	Transistor Q2 cuts-off. Series regulator circuit also cuts-off.	None	Loss of 90-point telemetry data.	15-point telemetry data will be received through its cruise-mode path during the warmup mode.
CR6	1. Open	Loss of transient-damping function. Transient is caused by interruption of unregulated-bus voltage.	None	Possible damage to transistors Q1 and Q2, and VR1 and VR2 due to transients.	

TABLE E-3
FAILURE EFFECTS ANALYSIS OF THE TELEMETRY ASSEMBLY (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
CR6 (Continued)	2. Shorted	No noticeable effect. CR7 will perform the transient-damping function.	CR7 performs transient damping function.	None	
CR7	1. Open	Same as 1 for CR6.	None	Same as 1 for CR6.	
	2. Shorted	Same as 2 for CR6.	Same as 2 for CR6	Same as 2 for CR6.	

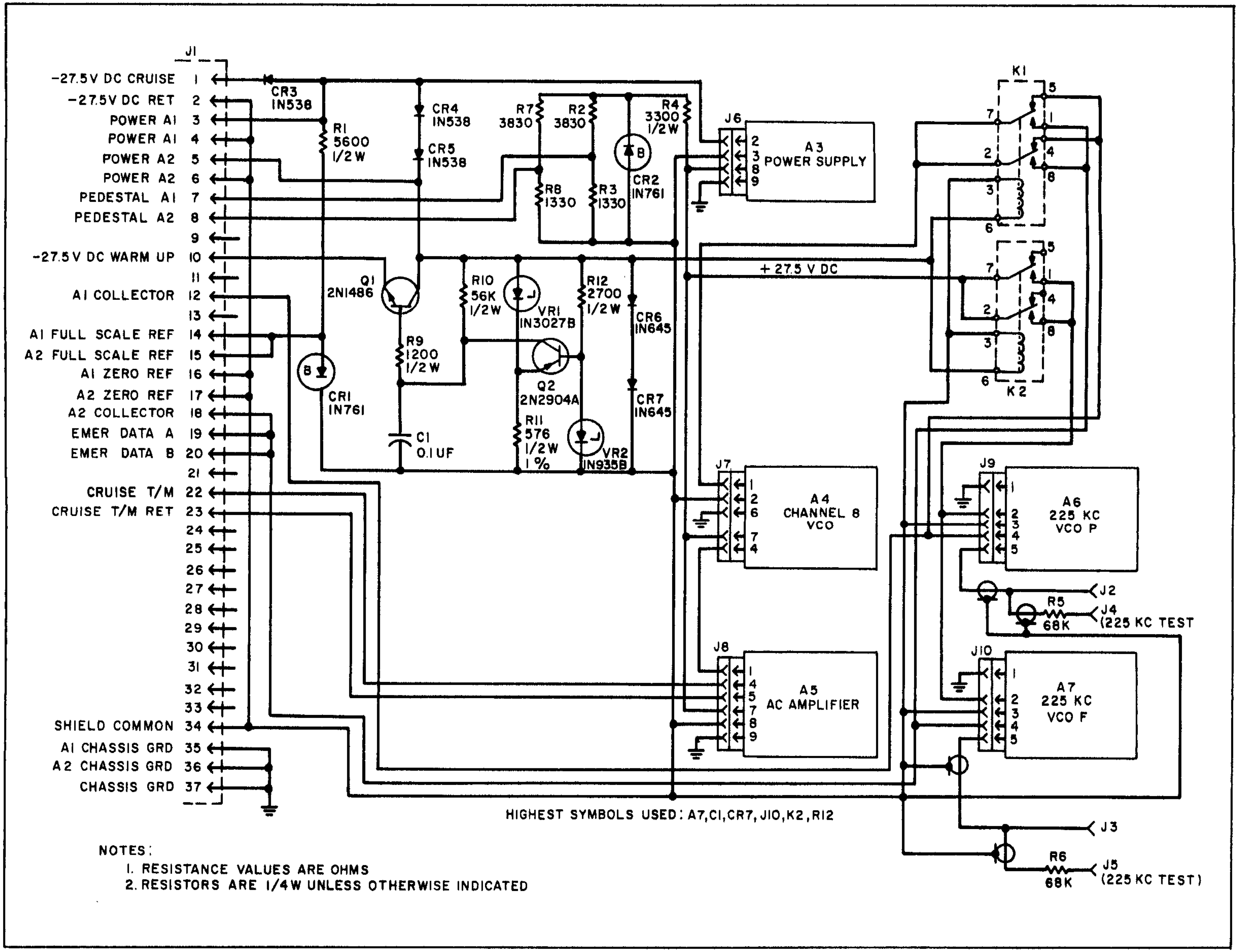


Figure E-3. Telemetry Assembly

TABLE E-4
FAILURE EFFECTS ANALYSIS OF THE CURRENT SENSOR UNIT

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
A2R1 and A2R2 (Series Connected)	Open (either resistor)	Loss of base drive to transistor A40 Q1. Transistor A40 Q1 cuts-off and removes the -27.5 volt input voltage to the inverter. Battery current-sensing capability is inhibited.	None	Loss of telemetry indication for F- and P- Battery currents.	Battery-evaluation capability is not completely lost. Drain on batteries can be estimated from F- and P-Battery voltage telemetry data.
A1A1 R1 (Inverter)	Open	DC bias level to chopper circuits is changed.	None	Negligible	Circuit will still operate. Study of telemetry data will not indicate this failure.
R1	Open	Loss of base bias on transistors Q1 and Q2; no converter oscillation.	None. Power input to circuit goes to zero.	Loss of telemetry indication of F- and P-Battery currents.	
A1A1 R2	Open	Loss of DC effect of F-Channel compensating windings on Transformer T1.	P-Battery current indication still available through other coil.	Loss of telemetry indication for F-Battery current.	Loss of F-Battery current indication does not change P-Battery current indication. Telemetry data will indicate 5 volts with zero load current.
R2	Open	Loss of F-Battery current telemetry signal.	F-Battery current indication is still available. Not affected by the failure.	Loss of telemetry indication of F-Battery current.	Loss of F-Battery current indication does not affect P-Battery current indication. Telemetry output will read approximately 7 volts DC regardless of load current.
R3	Open	Loss of P-Battery current telemetry signal.	Current telemetry signal for F-Battery not affected.	Telemetry indication of P-Battery current is lost.	Loss of one channel input does not affect the other half of this current indicator.
R5	Open	No input current to the A40 Q1 series regulator transistor.	None	Telemetry indication of F- and P-Battery currents goes to zero.	Loss of power input to the telemetry sensor DC-AC inverter results in loss of telemetry indication for F- and P-Battery currents.
A2CR1, A2CR2, and A2CR3	1. Open	Base of transistor A40 Q1 is now driven from A2R1 and A2R2 series combination, increasing current-passing capability beyond 10 ma.	Circuit is still capable of operation.	Maximum failure short-circuit current of transistor A40 Q1 has now increased, with short-circuit input current limited by the beta of A40 Q1.	The A40 Q1 series regulator transistor will still operate, however, at a higher base drive. Both F- and P-Battery current telemetry indications may be slightly higher than normal, due to the lower voltage drop across transistor A40 Q1.
	2. Short	Inverter circuit is still operable. Telemetry signal voltage for F- and P-Battery currents may read slightly high, and will do so together.	A series-connected, constant-current regulator, when shorted, will not inhibit circuit operation.	Constant-current-protection capability is now that of diode short-circuit current.	Constant-current protection capability is now provided by the short-circuit current capacity of diode CR2. The circuit is still protected from a catastrophic failure, such as a collector-to-ground short of transistors Q1 and Q2, by this means. However, the possibilities of such a failure occurring are remote.
CR1 and CR3 Combination	1. Open	Telemetry output voltage will read approximately 2.5 volts DC with zero load current and increases with the load current.	None	Telemetry output voltage of F-Channel.	

TABLE E-4
FAILURE EFFECTS ANALYSIS OF THE CURRENT SENSOR UNIT (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
CR1 and CR3 Combination (Continued)	2. Shorted	Telemetry output voltage reads approximately 1/8 to 1/4 normal value.	None	Telemetry output voltage for both F- and P-Channels.	Telemetry output voltage is zero with zero load current and increases to about 1 volt at 16 amperes of load current.
CR2 and CR4 Combination	1. Open	Same as 1 for CR1 - CR3	Same as 1 for CR1 - CR3	Same as 1 for CR1 - CR3 but for P-Channel.	
	2. Short	Same as 2 for CR1 - CR3	Same as 2 for CR1 - CR3	Same as 2 for CR1 - CR3 but for P-Channel.	
A1A1 C1	1. Open	Operating voltage level of transistors Q1 and Q2 changes. Value of A1A1 R1 will cause spikes in the base drive of transistors Q1 and Q2.	None	No observable change will occur in the telemetry output.	
	2. Short	Base current of transistors Q1 and Q2 increases with no impedance in transformer T1 base-drive windings. The current of transistors Q1 and Q2 collectors is set by series regulator A40 Q1 circuit.	None		No telemetry data received if short occurs before Subsystem turn-on, but it will be received if the short occurs after turn-on.
C2 or C3	1. Open	Apparent rapid shifts in Battery current telemetry data due to ripple appearing at instant of telemetry-data sampling by commutator.	None	Battery-current telemetry levels at instant of readout on F-Channel for C-2, and P-Channel for C3.	Failure can be recognized by telemetry-data interpretation. Ripple will be at a 2-kc rate. Telemetry is sampled at a much slower rate.
	2. Short	Complete loss of telemetry data on channel whose output is shorted, other channel telemetry reads low.	Partial operation of non-shorted channel is possible. Current input to transistors Q1 and Q2 will not change, but secondary of transformer T1 is loaded. However, Q1 and Q2 may fail to oscillate with this load.	F- and P-Channel output telemetry voltage, and calibration is affected.	Load current will increase by approximately 35 ma. Assuming 33 ma for the operable channel, the operation will be limited by the short-circuit current capability of transistor A40 Q1. Operation of the good channel will be marginal at high currents.
CR4	1. Open	2.4 kc inverter not oscillating or oscillating at wrong frequency. Output telemetry voltage is off calibration.	If oscillation is maintained and some telemetry current signal is present at 1-2 and 3-4 of J1, some interpretation of data is possible.	Calibration level of telemetry current is affected, for both the F- and P-Channels.	2-kc noise will appear at output of LCVR.
	2. Short	Complete loss of Battery current telemetry data for both F- and P-Channels.	Short does not cause a large battery current to flow because transistor A40 Q1 is a constant-current regulator.	Telemetry data for both the F- and P-Battery currents goes to zero.	Input current to series regulator is held under control. No mission degradation due to high-current battery drain is possible. (Battery voltage evaluation at other telemetry points would indicate a heavy current.)
Q1 - Q2	Short a. Cathode-to-Emitter	Transistors Q1 and Q2 do not oscillate; Transformer T1 does not furnish power to current-sensing circuit.	Short-circuit current does not appear across -27.5 volt bus due to constant-current regulator A40 Q1.	Telemetry voltage of F- and P-Battery current indications goes to zero.	Collector current of transistor A40 Q1 will not be more than 20-percent higher than when circuit operates normally. Battery currents can be evaluated by reading battery voltage.

TABLE E-4
FAILURE EFFECTS ANALYSIS OF THE CURRENT SENSOR UNIT (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
Q1 - Q2 (Continued)	Short b. Base-to-Emitter	No circuit oscillation of Q1 and Q2.	Current input limited by transistor A40 Q1.	Telemetry voltage of F- and P-Battery current indications goes to zero.	Assumed failure may not be possible if current of transformer T1 base winding is limited by winding resistance. Cross-check of Battery currents can be obtained by readout of Battery voltages.
	c. Collector-to-Base	No 2.4 kc oscillation of Q1 and Q2.	-27.5 volt battery drain is limited by A40 Q1.	Telemetry voltage of F- and P-Battery current indications goes to zero.	Cross-check battery voltages when Battery current indication goes to zero. Circuit is safe under all Q1 - Q2 short-circuit conditions.
A40 Q1	Short a. Cathode-to-Emitter	No series current protection from transistor A40 Q1. Transistors Q1 and Q2 continue to operate, but at higher input voltage.		Calibration of Battery current telemetry for F- and P-Channels changes slightly.	Output of LCVR will go to zero. End result will be no cruise-mode telemetry.
	b. Base-to-Emitter	Collector-to-base junction may hold off collector-to-emitter current flow. No input power to current sensor circuit.	None, except that collector-to-emitter junction may allow conduction and circuit operation.	F- and P-Battery current telemetry signal output.	Base-to-emitter short not very probable because of diodes in parallel with it. (CR1, CR2, CR3.)
	c. Collector-to-Base	A40 Q1 current regulator passes current through CR1, CR2, CR3, and possibly the Collector-to-emitter junction.	Dual path of diodes CR1, CR2, and CR3 provide current for sensor converter.	F- and P-Battery current telemetry signals.	No output. LCVR limited to 360 ma into maximum power transfer load.
T1	1. Shorted turns, any winding (primary or secondary)	No power inverter oscillation. Power input at maximum allowed by A40 Q1.	None, except that Battery drain is limited by transistor A40 Q1.	Battery-current telemetry signals (F- and P-Scan cameras) goes to zero.	Greatly reduced telemetry signal or no signal at all will result if transformer T1 primary or secondary is overloaded or shorted in any manner, as chances are that the inverter will not turn-on.
	2. Any primary winding open	No inverter oscillation at 2.4 kc.	None, except if one-half of any winding is open, the other side will allow maximum conduction of either Q1 or Q2 at approximately 40 ma.	Battery-current telemetry signal for F- and P-Channels will go to zero.	No output signal. Checking of Battery voltage is still possible through other telemetry channels.
	3. V10, GRY, and WHT windings, any one open.	All Battery-current telemetry signals are at one-half their normal values, and battery current appears to vary from sample to sample. This is due to ripple in output of channel that has opened.	Effects have a definite characteristic and can be evaluated if they are known.	Battery-current telemetry voltage is affected.	Effect will be the same on both channels since they are both driven from the same transformer.
	4. Any single winding shorted	Great reduction in output or complete failure of power inverter Q1 - Q2 to turn on. This effect depends upon loading and coupling inherent in transformer T1 design.	Both channels will be affected if any winding is shorted. The channel not completely shorted will have reduced output if the inverter does operate. Battery drain is still limited by A40 Q1.	Battery-current telemetry voltage and calibration levels are affected, if Q1 and Q2 are still functioning.	Actual test for affect is most desirable. Information should be recorded before launch. 1 or 2 Short: Current increases by ≈20 ma. Telemetry voltage is approximately 6.0 volts at any load current. 3 Short: Curve will have much the same shape as R2 open.

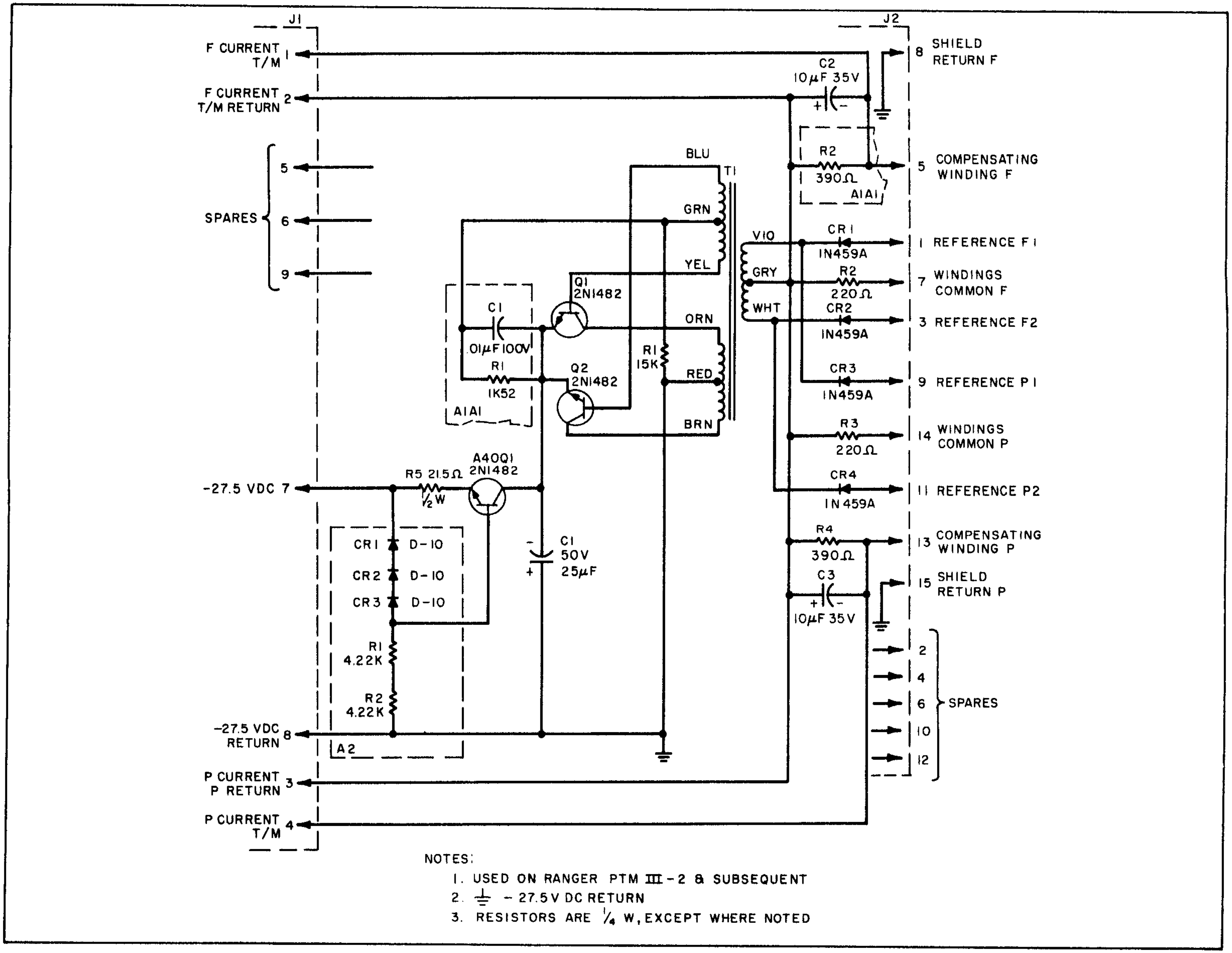


Figure E-4. Current Sensing Unit

TABLE E-5
FAILURE EFFECTS ANALYSIS OF THE COMMAND AND CONTROL UNIT

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
A2C2	1. Open	K1 relay in DCU does not receive set pulse. K4 relay in CCU receives reset pulse; however, it is already in the reset state, and therefore, does not change state.	RTC-7 and CC&S commands.	Loss of Clock output pulse for F-Channel warmup mode turn-on.	Clock does not receive power at Clock-start command. No Clock output pulse will be available for F-Channel turn-on into warmup mode.
	2. Short	K1 relay in DCU cannot be reset if required. K4 relay in CCU cannot be set.		Clock cannot be turned off, but clock output pulse will not reach F-Channel HCVR. Therefore, no F-Channel warmup mode turn-on by Clock output.	The 32-hour Clock output pulses cannot set relay K4 in the CCU. This prevents a RTC-5 command from turning on the Clock, and inhibits the Clock output pulse from energizing F-Channel HCVR.
A2R1	Open	Power applied the K4 relay reset coil and K1 relay set coil (DCU) decays at a low rate.	None	None	Since Relays K4 (in CCU) and K1 (in DCU) are latching relays, the open across the resulting capacitor (C2) in series merely holds voltages up for longer intervals. This failure is inconsequential.
K4 Relay	1. Open Coil				
	a. Set Coil	K4 relay cannot be set. Clock output pulse cannot turn on F-Channel into warmup mode.	RTC-7 and CC&S commands.	Clock output pulse cannot turn on F-Channel into warmup mode.	Clock output pulse cannot reach F-Channel HCVR.
	b. Reset Coil	None, normally	Same as 1a.	None, normally	There is no effect from the failure if operation of the System is normal and only a set command to Relay K4 is required. However, if a reset command is required, relay K4 cannot reset which, in effect, leaves the Clock output tied to the F-Channel HCVR through the closed contact of relay K4. A Clock start command must now be timed appropriately.
	2. Loss of continuity with both normally open and normally closed contacts.	No Clock output pulse available to the F-Channel HCVR.	Same as 1a.	Loss of clock output pulse for turning on F-Channel into warmup mode.	
	3. Inadvertent contact closure from reset to set state.	None	None	None, normally	An inadvertent closure of either set of relay K4 contacts has no immediate affect, since there is normally no signal present on the contacts until after a set command energizes the K4 relay.
A1CR6	1. Open	Relay K4 will not be activated by the 32-hour output pulse from the Clock.	RTC-7 and CC&S commands.	Loss of Clock Command to F-Channel HCVR.	This failure prevents relay K4 from drawing "set" current at signal.
	2. Short	Normal for possibly one command.	Same as 1.	Capability to process more than one relay K4 set command is inhibited.	

TABLE E-5
FAILURE EFFECTS ANALYSIS OF THE COMMAND AND CONTROL UNIT (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
A1Q1	1. Open a. Collector-to-Emitter b. Base	Same as open on A1CR6.	Same as open on A1CR6.	Same as open on A1CR6	
	2. Short a. Collector-to-Emitter	Set coil of relay K4 is placed continuously on.	None		
A1CR5	1. Open	No suppression of inverse decay-voltage spikes.	None	Processing of set command of relay K4.	Safe operating region of transistor Q1 breakdown potential (collector-to-emitter) may be surpassed. Failure of transistor Q1 is likely.
	2. Short	Set coil of relay K4 will be shorted out.	None	Same as 1.	Relay K4 can not be set. All effects associated with failure of relay K4 apply.
A1R9	Open	Clock output pulse to base of transistor A1Q1 is not differentiated by A1R9 and A1C3. The voltage drop across the emitter-to-base junction of A1Q1 and the forward voltage drop across A1CR6 furnish the only resistive loading to the Clock output pulse through C3.	None	Processing of set command to relay K4.	Bias on the base of transistor A1Q1 is not readily determined, but depends upon the leakage resistance of A1C3 and the cut-off base-to-emitter resistance of transistor A1Q1.
A1C3	1. Open	No set pulse to relay K4	None	Effectiveness of an RTC-5 command.	An open on A1C3 inhibits the 32-hour clock pulse from setting relay K4, which in turn, inhibits an RTC-5 command to the clock relay K1 in the DCU. Thus the clock cannot be stopped.
	2. Short	Continuous 32-hour Clock pulse is applied to relay K4 set coil after 32-hour output from Clock. Relay K4 cannot be reset.	None		An RTC-5 command will turn off the clock, even though it is not necessarily intended.
A1CR9	1. Open	Clock relay K1 in DCU can not be reset.	None	Clock can not be turned off.	RTC-5 command will not stop Clock.
	2. Short	None discernable.	None		
Relays K1 or K2 (Ground-test Relays)	1. Open Coil	No cruise-mode capability during ground test.	None	Loss of Cruise-mode telemetry during launch.	Relays K1 and K2 are not used after launch.
	2. Open Contacts	Same as 1. However, one set of contacts is used to ensure clock turn-off. If it does not close, the clock will continue to run.		Loss of Cruise-mode telemetry during launch.	

TABLE E-5
FAILURE EFFECTS ANALYSIS OF THE COMMAND AND CONTROL UNIT (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
Relays K1 or K2 (Ground-test Relays) (Continued)	Inadvertent contact closure during launch.	Low-current voltage regulator (LCVR) is turned on prior to cruise-on command at S + 17. No effect if Cruise-mode has been turned on prior to launch.			This failure alone is not critical. If adds approximately 17 minutes to 65 hours of LCVR operation. However, both relays K1 and K2 must fail for the LCVR to turn on. Relays K1 and K2 should be mounted so that they would not experience the exact same environment during launch (prior to S + 17). After S + 17, there is no failure mode that these relays exhibit which could influence the operation of the TV Subsystem in any manner.
A1R7 and A4C2	These parts are used during ground test only. Their failing, in any manner, during the mission will not have any effect on the Subsystem since they are isolated from the Subsystem by relay K1. It would require a failure of Relay K1 and failure of either or both A1R7 and A4C2 to influence the operation of the Subsystem.				
Relay K3	1. Open a. Set coil	Loss of Channel-8 telemetry during cruise mode.	None, although Channel-8 telemetry will be available during terminal mode.	Mission analysis is hampered by lack of Channel-8 telemetry during cruise mode.	These failures are not critical if no other failures have occurred simultaneously. Loss of cruise-mode turn-off capability affects ground test and is repairable. The contact closure is significant if it occurs before S + 17. In which case, Channel-8 telemetry will be received during launch even though it was not initiated at the Blockhouse Control Panel.
	b. Contacts	Same as 1a.	Same as 1a.	Same as 1a.	
	c. Reset coil	Loss of cruise mode turn-off capability.	None	None	
	2. Inadvertent contact closure	Low-Current Voltage Regulator (LCVR) is energized prior to start of cruise mode at S + 17.	None	Channel-8 telemetry is received prematurely.	
A1R8	Open	Potential across A4C1 is determined by its leakage resistance.	None		The equivalent r-c time constant is increased from 2.2 seconds to approximately 50 seconds. However, this is not critical to the application.
A4C1	1. Open	Same as 1a for relay K3.	Same as 1a for relay K3.	Same as 1a for relay K3.	
	2. Short	Power is applied continuously to the set coil of relay K3.	None		Set coil of relay K3 may overheat and open. However, this should not affect operation since the relay is a latching type. Another concern is the power drain for approximately 66 hours.
A1CR3 or A1CR4	1. Open	None normally discernible.	A1CR7, A1CR8, and LCVR.		Telemetry power is normally derived from Low-Current Voltage Regulator (LCVR). The A1CR3 and A1CR4 combination and the A1CR7 and A1CR8 combination will supply power to the telemetry equipments if the LCVR fails.
	2. Short	Same as 1.	The remaining unshorted diode.		

TABLE E-5
FAILURE EFFECTS ANALYSIS OF THE COMMAND AND CONTROL UNIT (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
A1CR7 or A1CR8	1. Open	Same as 1 for A1CR3 or A1CR4.	Same as 1 for A1CR3 or A1CR4.		Same as for A1CR3 or A1CR4.
	2. Short	Same as 1 for A1CR3 or A1CR4.	Same as 1 for A1CR3 or A1CR4.		

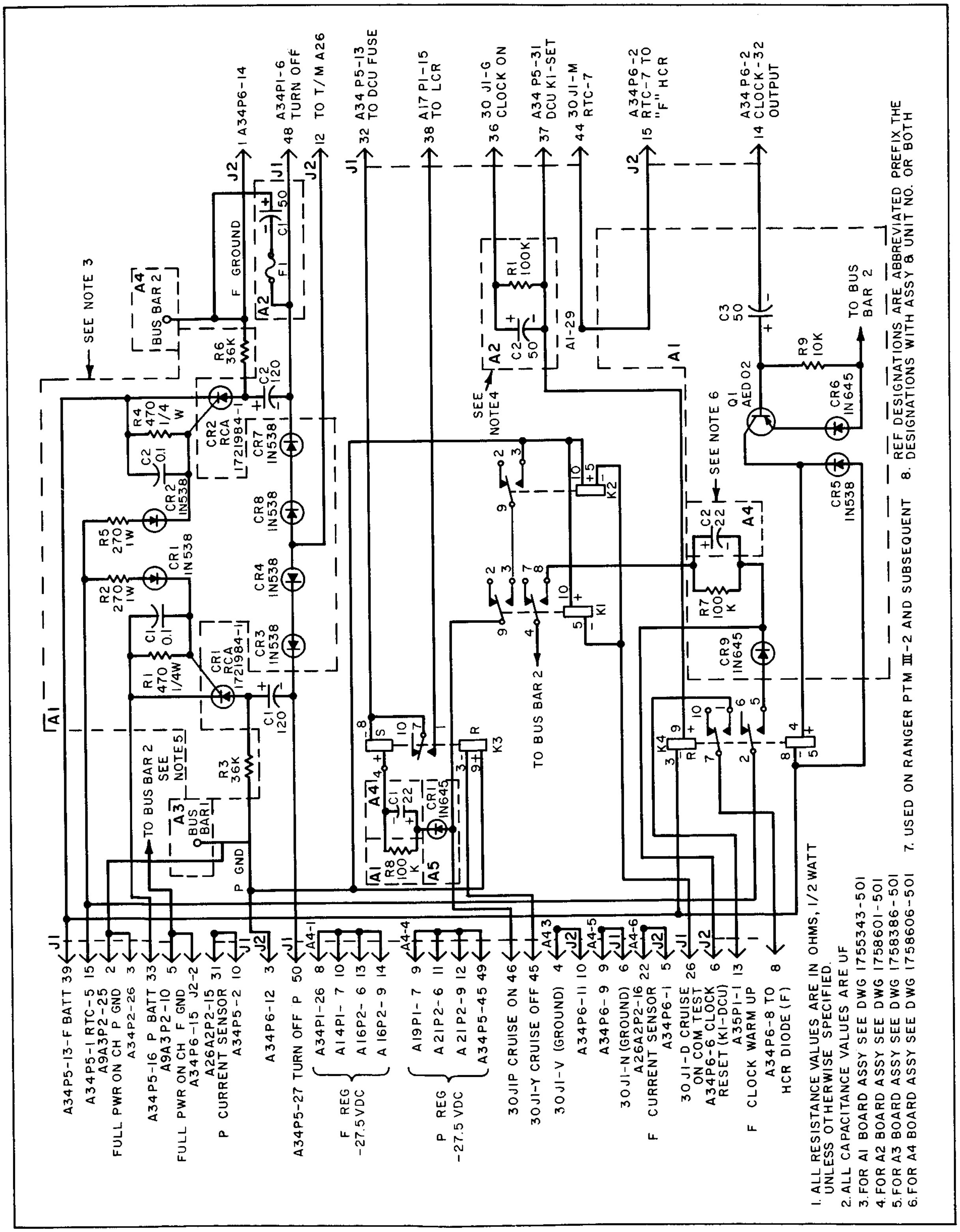


Figure E-5. Command Control Unit

TABLE E-6
FAILURE EFFECTS ANALYSIS OF THE ELECTRONIC CLOCK

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
A2R14	1. Open	Time constant to relay K4 in the Command Control Unit is increased. Clock pulse is still coupled through to the set coil of the K4 relay.	None	Negligible	The charge across C3 in the CCU is indeterminate. However, whether the failure of R14 occurs just prior to the 32-hour clock pulse or significantly prior to it, the charge on C3 in the CCU would have stabilized, due to the relatively high leakage of this capacitor.
	2. Change of value.	Slight change in time constant.	None	Negligible	
A2R15	Open	32-hour Clock pulse will not set the Clock-enable relay (K4) in the CCU.	None	Subsystem cannot be turned on into warm-up mode by Clock output pulse.	Warm-up clock pulse cannot turn-on the TV Subsystem since K4 relay in the CCU has not been set. However, the TV Subsystem can be turned-on by a RTC-7 or CC&S command, if no other failures prevent these commands from functioning properly.
A2 Gate A1	Fails in logical "one" state.	Incorrector 0 to 8-hour telemetry level indication. Eight to 16-hour telemetry level indication appears in telemetry instead.	None	Clock telemetry indication is in error.	24- to 36-hour telemetry level will be received during interval from 16 to 32 hours.
A2FF6	Fails in logical "one" state on output to A1 Gate.	Same as Gate A1 failure.	None	Clock telemetry indication is in error.	Same as A1 Gate failure.
A4 Gate	Fails in logical "zero" state	Incorrect 24- to 32-hour telemetry level indication. Sixteen to 32-hour telemetry level indication does not change.	None	Clock telemetry indication is in error.	At the 32-hour time point a double step occurs in the time telemetry readout. Also, at the 48-hour time point, the time telemetry level does not change as it should. However, at the 64-hour time point, the time telemetry level indicated is correct.
A2FF7	Fails in logical "zero" state.	Continuous logical "zero" input to Gate A4. Incorrect 24- to 32-hour telemetry level indication.	None	Clock telemetry indication is in error.	
A2R7	1. Open	Gate 1 of the A4 board is inhibited from contributing to the telemetry level.			Open failures cause telemetry levels to change. The actual magnitudes of these changes have not been computed, but with open failures in A2R7, A2R8, A2R9, or A2R10, the contribution of that part and its associated gate state is inhibited. A2R8 falling open causes a fixed shift in telemetry level that can be evaluated separately. Small changes in value are not significant. Note: A2R7, A2R8, A2R9, and A2R10 are not new parts but their resistive values have been changed in the new design.
	2. Change of value.	Some loss of telemetry accuracy but not significant.			
A2R8	Open or change of value.	Shift of telemetry value.			
A2R9	Open or change of value.	Gate 2 of A4 board is inhibited from contributing to the telemetry level.			
A2R10	Open or change of value.	Gate 1 of A5 board is inhibited from contributing to the telemetry level.			

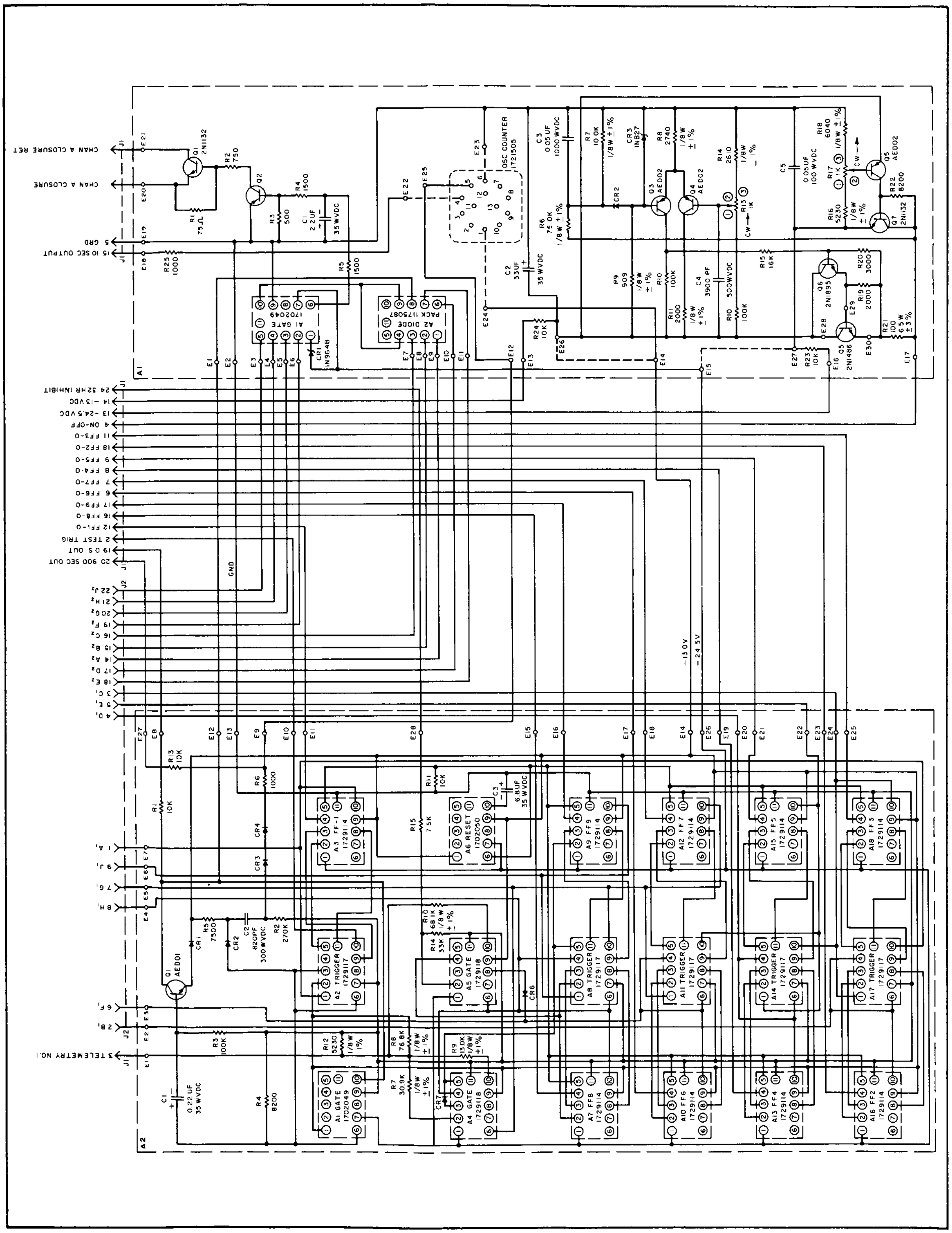


Figure E-6. Electronic Clock Assembly

TABLE E-7
FAILURE EFFECTS ANALYSIS OF P-CHANNEL HIGH-CURRENT VOLTAGE REGULATORS

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
A1K1	1. Open coil	Contact closure of relay A1K1 will not occur. Turn-on of SCR (A37CR5) by RTC-7 command is inhibited.	SCR turn-on can be accomplished by the enabling of relay A1K2 with a CC&S command.	P-Channel turn-on is dependent on the reception, processing, and execution of a CC&S command.	The failure of a single relay in this mode will not abort performance of the HCVR because of the redundancy provided in the SCR turn-on circuitry. If the failure is assumed to be caused by the stress environment imposed during launch or separation, it is advisable to decouple the relays, as much as possible, from seeing the same environment. This will reduce the possibility of the redundancy being negated.
	2. Loss of continuity with either normally open or normally closed contacts.	No contact closure in either relay position; so that relay A1K1 is effectively out of the circuit.	Redundancy provided by enabling of relay A1K2 with a CC&S command.	Same as 1.	Same as 1. In addition, the gate-to-cathode short across the SCR, provided by the normally closed contacts of relays K1 and K2, is lost. This effect provides SCR desensitizing to reduce the probability of an inadvertent turn-on, and is not a direct failure mechanism itself.
	3. Inadvertent contact closure:				
	a. At or prior to Aegena separation ($S \leq 9$)	None, if a path to ground does not simultaneously exist at the following JPL Bus inputs: • RTC-7 • CC&S, and • S + 45.	None	None	Proper operation of the TV Subsystem is entirely dependent on no inadvertent closure of switches in the JPL Bus that are associated with the RTC-7, CC&S, or S + 45 commands. Thus, a positive lockout of the Subsystem does not completely exist during these intervals. An early turn-on of the Subsystem is possible with this inadvertent relay closure if ground is present at any of the mentioned JPL command lines.
	b. Between S + 0 and S + 17	Same as 3a.	None	None	
	c. Between S + 17 and S + 45	Same as 3a.	None	None	
	d. After S + 30	If failure occurs during in-course correction, same as 3a.	None	None	
		If failure occurs during attitude correction, the effects are negligible under the anticipated mission profile.	None	None	
A1K2	Same as failures assumed for relay A1K1.	The notes applicable to relay A1K1 also apply generally to relay A1K2, with the necessary substitution of K2 for K1, etc.			
A1A1R1	Open:				
	a. Prior to A1K1 or A1K2 Activate	None	Shorted contacts of relays A1K1 and A1K2.	None	An open of A1R1 alone is not sufficient to cause problems, since A1R1 is paralleled by A1C1, which presents an AC low-impedance path to negate an inadvertent turn-on of the SCR(A37CR5). The shorted contacts of relays A1K1 and A1K2 also

TABLE E-7
FAILURE EFFECTS ANALYSIS OF P-CHANNEL HIGH-CURRENT VOLTAGE REGULATORS (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
A1A1R1 (Continued)					present a low DC resistance, maintaining SCR in the off state. Thus, only an A1R1 open in conjunction with a bouncing or chattering of the A1K1 or A1K2 contacts and a high potential across A1C1 is a possible failure mode.
	b. After A1K1 or A1K2 Activate	None	None	None	
A1A1C1	1. Short	None prior to S + 45 minutes. At S + 45, it should be burned open if the S + 45 switch contacts in the JPL Bus have the power capability; if not, then the SCR gate remains short-to-cathode.	None	P-Channel turn-on capability if lost if short persists.	A potential sufficiently close to ground should be present, thus enabling the P-Channel to turn on.
	2. Open	None	None	Probability of accidental turn-on of P-Channel is increased.	An open on A1C1 represnnts the loss of an effective AC short, and an increase in susceptibility to turn-on due to transients, etc.
A1A1R2	Open	Same as open in P-Gate Enable line. S + 45 command is inhibited.	None	P-Channel turn-on capability is lost.	
A1A1R3	Open	Negligible	None	None	
A1A1C4	1. Open	Relay A1K1 will note be activated by RTC-7 command.	P-Channel can be turned on by CC&S command activating relay A1K2 through A1A1C3 and A1A1R5.	Loss of P-Channel turn-on by RTC-7 command.	
	2. Short	Relay A1K1 is activated by RTC-7 command and the contacts will remain closed for the duration of the command (momentary-closure capability is lost).	None	None	Coil of relay A1K1 may be overstressed if the P-Battery electromotive force (EMF) is high and the short on A1A1C4 can maintain the current level with-out opening. The value of a second RTC-7 command would be doubtful.
A1A1R6	Open	Negligible	CC&S command capability	None	
A1A1C3 and A1A1R6	Failures associated with these parts have substantially the same effects as A1A1C4 and A1A1R5 described above. The appropriate associated command is CC&S instead of RTC-7.				
A1A1C2, A1A1R4, and A1A1CR1	These parts are not used for P-Channel operation. Normal part failure alone will not result in any Subsystem malfunction				
CR3	1. Open	P-Battery telemetry-voltage output falls to zero.	None	Telemetry data of the P-Battery voltage is lost.	P-Battery telemetry voltage is zero continuously.
	2. Short	P-Battery telemetry output is overloaded. However, failure of CR3 will cause over dissipation in R28.	None	P-Battery telemetry portion of mission.	P-Battery telemetry voltage reads full scale (~5 volts) continuously.
CR4	Failure of CR4 (open or short) will have the same effects as the failure of CR3.				

TABLE E-7
FAILURE EFFECTS ANALYSIS OF P-CHANNEL HIGH-CURRENT VOLTAGE REGULATORS (Continued)

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
R28	Open	Current through P-Battery telemetry line is reduced.	None		R18 and R19 provide sufficient loads for temperature-compensating zener diodes CR3 and CR4. Calibration is displaced by upward shift of zener-diode operating point higher on the knee of characteristic curve. Otherwise, operation is normal.
CR6, CR7, and R29	These parts perform the same telemetry-conditioning function on the output of the HCVR as CR3, CR4, and R28 perform on the output of the P-Battery. Otherwise, the same general comments apply (referenced to the Regulator output).				
C3	1. Open 2. Short	Loss of AC by-pass across the SCR(CR5). Same as 1.	None None		This failure would make the SCR (CR5) more prone to firing under transient conditions. If C3 shorts, it would be destroyed by the power demand on its load side. Thus, its final state would be open. It could exist as a high-impedance short, but this would have little effect.
CR8	1. Open 2. Short	Loss of unilateral action of CR8 and R27. Effectively places C3 across the plate to cathode of CR5.	None None		The effectivity of coupling in the forward direction is reduced, since C3 would now be in series with 47 ohms (R27). Forward coupling is not changed significantly; the reverse coupling is now the same as forward.
R27	Open	Loss of reverse coupling due to blocking effect of CR5.	None		There is an increased sensitivity of the SCR to inadvertent turn-on by transients.
R26	Open	Loss of P-Battery monitoring function at prelaunch phase.		None	
R18	Open	No output to Telemetry Unit	Partial compensation exists in reading out regulated telemetry.	Loss of battery-voltage telemetry data.	
R19	Open	No telemetry-point conditioning; voltage reads high depending upon loading effect of telemetry unit.	Same as R18.	Loss of battery-voltage telemetry data.	

TABLE E-8
FAILURE EFFECTS ANALYSIS OF F-CHANNEL HIGH-CURRENT VOLTAGE REGULATORS

Part	Assumed Failure	Symptoms and Local Effects	Compensating Provisions	Effect on Mission	Remarks
The parts failures and their effects assumed for the P-Channel HCVR (See Table E-7) are also applicable to the F-Channel HCVR, with the following additions.					
A1A1C2	1. Open	Relay A1K2 will not be energized by Clock-pulse input - HCVR will not turn on.	RTC-7 and CC&S commands will still energize HCVR.		
	2. Short	None	Same as 1		
A1A1CR1	1. Open	Relay A1K2 will not be energized by clock pulse. HCVR will not turn on.	RTC-7 and CC&S command will still energize HCVR.		
	2. Short	Possibility that relay A1K2 will not be energized by a CC&S command.	None		The short of A1CR1 is inconsequential to the clock-pulse input. However, with the plate of A1CR1 at or near ground, it is possible that a CC&S command will not energize the A1K2 relay because of the loading now presented by A1A1C2.
A1A1R4	Open	Relay A1K4 will not be energized by clock-pulse. HCVR will not turn on.	RTC-7 and CC&S commands will still energize HCVR.		

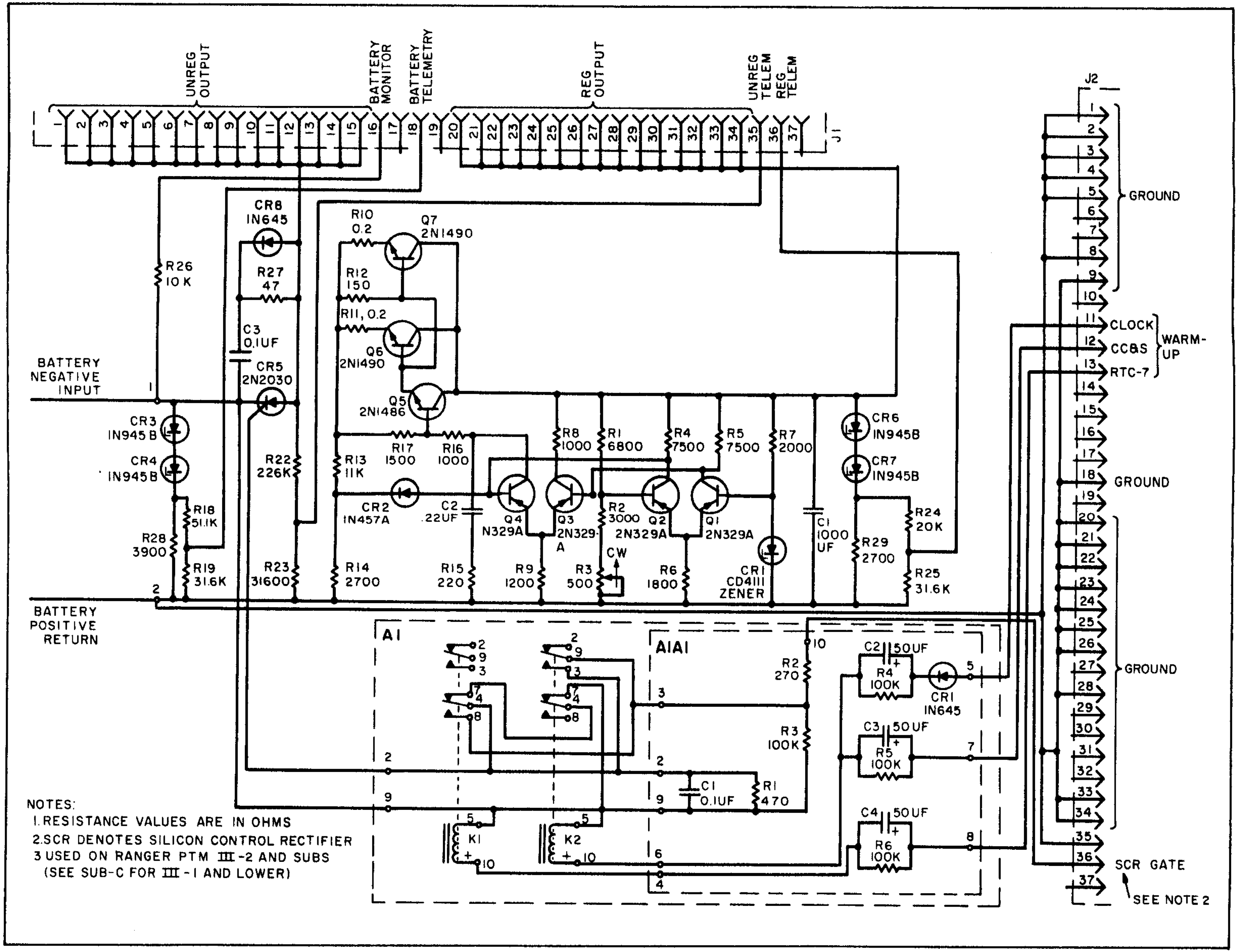


Figure E-7. High-Current Voltage Regulator Assembly

Appendix F

Post Ranger VI Stress Analysis

TABLE F-1
ASSEMBLIES TESTED

Assembly	Designation	Stress Tabulation
Camera	A1	
Decoupler	A1A1 to A1A4	F-4
Preamplifier	A1A1 to A1A6	F-5
Camera Electronics	A2 to A7	
Horizontal Sync Generator	A2	F-6
Vertical Sync Generator	A2	F-7
Deflection Amplifier	A2 to A5	F-8
Deflection Programmer	A2 to A5	F-9
G1 Regulator	A2 to A5	F-10
Video Amplifier	A2 to A6	F-11
Camera High-Voltage Regulator	A2 to A7	F-12
Converter Power Supply	A2 to A7	F-13
Low-Voltage Regulator	A2 to A7	F-14
Deflection Programmer	A6, A7	F-15
Deflection Amplifier	A6, A7	F-16
G1 Regulator	A6, A7	F-17
Shutter and Lamp Drive	A6, A7	F-18
Video Amplifier	A6, A7	F-19
Video Combiner	A8	
F-Scan Video Summing Amplifier		F-20
Isolation Amplifier		F-21
Tone Oscillator		F-22
Control Programmer and Camera Sequencer	A9	
Dual Oscillator		F-24
Controller Modulator		F-24
P-Camera Controller		F-25
P-Channel Counter		F-26
High-Current Voltage Regulator	A12, A37	F-27
Transmitter Power Supply	A16, A21	F-28
Low-Current Voltage Regulator	A17	F-29
Telemetry	A26	
AC Amplifier		F-30
Telemetry Converter		F-31
Telemetry Voltage Regulator		F-32
Sequencer Power Supply	A28	F-33
Telemetry Processor Assembly	A29, A30	F-34
Distribution Control Unit	A34	F-35
Electronic Clock	A35	F-36
Command Control Unit	A39	F-37

TABLE F-2
DRAWINGS AND LISTS OF MATERIAL

G1 Regulator P-Channel	1753177 B	1754355 B
Deflection Programmer P-Channel	1753014	1754132 B
Camera High-Voltage Regulator	1753007	1754136 B
Camera Shutter and Lamp Drive	1753099 D	1754189 D
Camera Low-Voltage Regulator	1754123 B	1754324 D
DC-DC Converter	1754122	1754143
Video Amplifier, P1 Camera	1753157	1754309 C
Camera Vertical Sync Generator	1703809 A	1754145 C
Camera Horizontal Sync Generator	1754163	1754142 A
Video Amplifier F-Camera	1753189	1754362 B
Deflection Amplifier F-Camera	1754360 A	1754363 B
Deflection Programmer F-Camera	1754253	1754376 C
G1 Regulator F-Camera	1753178 C	1754352*
Video Amplifier P2, 3, 4 Cameras	1753122 A	1754284 B
Deflection Amplifier P-Camera	8624826 F	8624846 J
Controller Modulator	1753142	1753144 C
Video Summing Amplifier F-Camera	1754073 C	1706355 J
Tone Oscillator	1725507	1706281 E
AC Amplifier, Channel 8	8481476 A	8626058
Telemetry Regulator	Sketch	---------
Telemetry Processor	8747475 D	
Video Summing Amplifier P-Camera	1173796 E	1706280 H
Telemetry Amplifier and Clipper	1725508	---------
Dual Oscillator	1703811 B	1073575 H
Counter P-Channel	1753140	1753136 B
Controller, P-Channel	1753037	1073571 M
Preamplifier, P- and F-Cameras	8747129 H	8747178 D 8747152 E
High-Current Voltage Regulator	1706631 C	1706820 J 1706852 E
Low-Current Voltage Regulator	1708611 F	1708947 G
Transmitter Power Supply	1183526 G	1182554
Electronic Clock	1753325	1753338 D 1753326 D
Sequencer Power Supply	1753035	1073576 M
Telemetry Assembly, Telemetry Converter	1182555 B	---------
Sipican Modules*	1729114 A	---------
Sipican Modules*	1729117 B	---------
Sipican Modules*	1729118 A	---------
Sipican Modeles*	1702050 B	---------
Sipican Modules*	1702049 B	---------
Sipican Modules*	1175087 B	---------
Camera Decoupling Assembly	1729592	---------

*Vendor supplied data, verified by combination of electrical measurements at terminals and circuit analysis.

TABLE F-3
PARTS OPERATED ABOVE DERATING POLICY LEVELS

Schematic	Subassembly	Circuit Symbol and Part Type	Measured Stress	Maximum Rating	% Stress	Derating Level %
1754122	Camera Electronics A1 Frame Converter	C6 100μf Wet Tantalum	22 volts	30 volts	74	70
1754360	F-scan Unit Deflection Amplifier	C14 10,000 μμf Mica	50 volts	100 volts	50	10
1753189	Video Amplifier F-scan	C-24 2.2μf Solid Tantalum	16 volts	20 volts	80	70
1753178	G1 Regulator F-scan	R5, R7 432K Ω	350 volts, 284mw	1/2 watts	56.5	50
1753178	G1 Regulator F-scan	C13 0.01μμf Ceramic	80 volts	200 volts	40	10
1753177	G1 Regulator P-scan	R34 100K Ω	70 volts to 100 volts 50% each, 75mw	1/8 watts	60	50
1754123	Low-current Voltage Regulator	C5A, B 0.22μf Mica	950 volts	1500 volts	63	10
1754123	Low-current Voltage Regulator	C15 3900μμf Ceramic	50 volts	200 volts	25	10
1754123	Low-current Voltage Regulator	C16 2700μμf Mica	260 volts	1500 volts	17	10
1754123	Low-current Voltage Regulator	CR14 1N648	430 volts	PIV=5000	86	80
1753189	Video Amplifier F-Scan	Q17 2N2432	V_{CE}=27	BV_{CEO}=30	90	80
1703809	Vertical Sync Generator	R15 870	12V, 175mw	1/4 watts	70	50
		C3	11 volts	15 volts	74	70
		C6	11 volts	15 volts	74	70
		C10	12 volts	15 volts	80	70
		C12	12 volts	15 volts	80	70
		C16	12 volts	15 volts	80	70
		C18	12 volts	15 volts	80	70
		C21	12 volts	15 volts	80	70
		Q20	operation appears to be just on threshold of base control over dissipation & voltages not involved			
1753035	Sequencer Power Supply	R2	2.44 watts	3.0 watts	81	50
		R31	2.45 watts	3.0 watts	81	50
		R10	169 mw	250 mw	68	50
		R39	169 mw	250 mw	68	50
		R16	10 watts	14 watts	70	50
		R45	10 watts	14 watts	70	50

TABLE F-3 PARTS OPERATED ABOVE DERATING POLICY LEVELS (Continued)						
Schematic	Subassembly	Circuit Symbol and Part Type	Measured Stress	Maximum Rating	% Stress	Derating Level %
8747129	Preamplifier	C2 CL45, 4μf	50 volts	60 volts	83	70
1706631	High-Current Voltage Regulator	C1 CL15, 1000μf	27.2 volts	36 volts	76	70
1183526	Transmitter Power Supply	R1 470K	560 volts 670 mw	1000 mw	67	50
1183526	Transmitter Power Supply	R2 470K C1 C2 C3 C4 C6 C7	535 volts 610 mw 1120 volts 825 volts 280 volts 111 volts 30 volts 30 volts	1000 mw 1400 at 85° C 1400 at 85° C 600 volts 200 volts 50 volts 50 volts	61 70 59 48 56 60 60	50
1729592	Camera decoupling assembly	C1, C2	1000 volts	1600 volts	62	10
1753142	Counters	C28	35 volts	27.5 volts	82	70
1754360	Deflection Amplifier F-scan	Q3, 2N930	V_{BE} > 12 volts	BV_{BEO}=5 volts	240	80
1754360	Deflection Amplifier F-scan	Q8, 2N1893	V_{BE}=7 volts	BV_{BEO}=7 volts	100	80
1753189	Video Amplifier F-scan	Q12, 2N930	V_{BE}=7 volts	BV_{BEO}=5 volts	140	80
1753122	Video Amplifier P2, 3, 4	Q12, 2N930	V_{BE}=6.25 volts	BV_{BEO}=5 volts	125	80
1753157	Video Amplifier P1	Q6, 2N930	V_{BE}=6.25 volts	BV_{BEO}=5 volts	125	80
1753099	Shutter and Lamp Drive	R45, RC20GF	≈360 mw*	500 mw	72	50
1185526	Transmitter Power Supply	C5	100 volts peak	200 volts	50	10
1753325	Clock	Q2, 2N722	V_{CE}=41 volts	BV_{CEO}	85	80

*Power dissipated depends on the selected value of the resistor. RA-7 values are 40 Ω or greater and has a maximum average power dissipation of 360 wm. Values on RA-8 and subsequent units will be checked for ohmic value and will be replaced by greater power-handling capability if less than 40 ohms.

TABLE F-4
ELECTRICAL STRESS ANALYSIS OF THE CAMERA SUBASSEMBLY DECOUPLER, 1729592

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	10 K Ω, 1/4 watt	0			< 10
C1	1751107-1	0.01 μf, 1600 volts DC	1000			62
C2	1751107-1	0.01 μf, 1600 volts DC	1000			62

TABLE F-5
ELECTRICAL STRESS ANALYSIS OF THE CAMERA SUBASSEMBLY PREAMPLIFIER, 8747129

Part Description			Stress Analysis			
Designation	**Type**	**Rating**	**Voltage (volts)**	**Current (milliamperes)**	**Average Power (milliwatts)**	**Percent Rated Stress**
R1	RC07	1.0 Meg Ω, 1/4 watt	50	0.05	-	< 10
R2	RC07	100 K Ω, 1/4 watt	0 to 50	65 peak	25 peak	< 10
R3	RC07	1.0 Meg Ω, 1/4 watt	4.4	-	-	< 0.1
R4	RC07	330 Ω, 1/4 watt	0.2	-	-	< 0.1
R5	RC07	6.8 K Ω, 1/4 watt	14.8		32	13
R6	RC07	2.2 K Ω, 1/4 watt	4.7		10.5	< 10
C1	8987915-29	0.01 μf, 200 volts	40			20
C2	CL45BK	4 μf, 60 volts	50			83
C3	CL45BK	4 μf, 60 volts	28.5			48
C4	CL45BK	4 μf, 60 volts	28.5			48
C5	8987915-29	0.01 μf, 200 volts	40			20
V1	A15274B	Nuvistor	FIL = 6 to 6.3 P-Grd = 28.5 K-Grd = 15			
L1	8701588-257		0.3			
C1	CL45CE330-MP3	200 volts	6			< 10

TABLE F-6
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY HORIZONTAL SYNC GENERATOR, 1754163

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	10 KΩ, 1/4 watt	5	0.5	2.5	< 10
R2	RC07	10 KΩ, 1/4 watt	0.6	-	-	< 10
R3	8447750-5	25 KΩ, 1/4 watt	5	0.2	1	< 10
R4	RC07	18 KΩ, 1/4 watt	10	0.556	1	< 10
R5	RC07	1.2 KΩ, 1/4 watt	6	5	30	12
R6	RC07	3.1 KΩ, 1/4 watt	0.6	-	-	< 10
R7	RC07	10 K Ω, 1/4 watt	6	0.6	4	< 10
R8	RC07	33 Ω, 1/4 watt	0.1	3.3	<1	< 10
R9	RC07	3.3 KΩ, 1/4 watt	6.5	2	13.3	< 10
R11	RC07	3.9 KΩ, 1/4 watt	3 peak	0.77	2.3	< 10
R12	RC07	27 KΩ, 1/4 watt	7	0.25	1.6	< 10
R13	8447750-3	25 KΩ, 1 watt	5	0.25	1	< 10
R14	RC07	180 Ω, 1/4 watt	1.5	8.3	12.5	< 10
R15	8447750-3	5 KΩ, 1 watt	3.5			< 10
R16	RC07	3.3 Ω, 1/4 watt	6	1.8	1	< 10
R19	RC07	3.9 KΩ, 1/4 watt	7	1.8	12.5	< 10
R20	RC07	3.9 KΩ, 1/4 watt	5.5	1.4	7.8	< 10
R21	RC07	20 KΩ, 1/4 watt	5	-	-	< 10
R23	RC07	1 K Ω, 1/4 watt	4.5	4.5	20	< 10
C1	Ceramic	0.02 μf, 50 volts	-5			< 10
C2	Ceramic	0.01 μf, 200 volts	4.5			< 10
C3	Ceramic	0.05 μf, 50 volts	+5			< 10
C4	Tantalum	15 μf, 10 volts DC	6			60
CR1	1N916	250 mw at 25° C ambient	+0.6, -1.4	0.5 peak	0.3	< 10
CR3	1N916	250 mw at 25° C ambient	+0.4	0.6 peak	-	< 10
CR4	1N916	250 mw at 25° C ambient	+1.1, -1.0	1.3 peak	1.3 peak	< 10
CR5	1N916	250 mw at 25° C ambient	+0.6, -1.2	1.3 peak	1.3 peak	< 10

TABLE F-6
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY HORIZONTAL SYNC GENERATOR, 1754163 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR8	1N916	250 mw at 25° C ambient	-0.5, +4.3	-	-	< 10
CR9	1N916	250 mw at 25° C ambient	+0.5, -5.5	-	-	< 10
CR10	1N916	250 mw at 25° C ambient	+0.5, -13	-	-	< 10
CR11	1N916	250 mw at 25° C ambient	+0.5, -7	-	-	< 10
CR12	1N916	250 mw at 25° C ambient	+0.5, -6	-	-	< 10
CR13	1N916	250 mw at 25° C ambient	+0.5, -4	-	-	< 10
CR14	1N916	250 mw at 25° C ambient	+0.6, -0.9	1.3 peak	1.3 peak	< 10
Q1	2N718A	500 mw at 25° C ambient	BE + 0.6 CE + 10	0.556	0.3	< 10
Q3	2N718A	500 mw at 25° C ambient	BE + 0.6 CE = 6	5	3	< 10
Q4	2N718A	500 mw at 25° C ambient	BE + 0.6, -3.5 CE = 6	3	1.2	< 10
Q5	2N329A	390 mw at 25° C ambient	BE + 4, -4 CE = 5.5	2	1	< 10
Q8	2N916	360 mw at 25° C ambient	BE + 0.2, -0.8 CE = 7	4.5	4	< 10

TABLE F-7
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VERTICAL SYNC GENERATOR, 1703809

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	5.1 KΩ, 5%, 1/4 watt	17		57	23
R2	RC07	5.1 KΩ, 5%, 1/4 watt	17		57	23
R3	RC07	100 Ω, 5%, 1/4 watt	0.75		5.7	2.3
R4	RC07	3.3 KΩ, 5%, 1/4 watt	10		33	13.2
R5	8447750-3	5 KΩ, 5%, 1 watt	5	1.8	9	< 10
R6	RC07	1 KΩ, 5%, 1/4 watt	1.8	1.8	1.8	< 10
R7	RC07	20 KΩ, 5%, 1/4 watt	5		1.25	< 10
R8	RC07	3.3 KΩ, 5%, 1/4 watt	11.2		38	16
R9	RC07	180 Ω, 5%, 1/4 watt	4		89	36
R10	RC07	33 K Ω, 5%, 1/4 watt	12.5	0.38	4.8	< 10
R11	8447750-4	10 KΩ, 5%, 1/4 watt	5	0.38	2	< 10
R12	RC07	20 KΩ, 5%, 1/4 watt	5		1.25	< 10
R13	RC07	22 KΩ, 5%, 1/4 watt	12.5		7.1	< 10
R14	RC07	33 KΩ, 5%, 1/4 watt	2.7		0.22	< 10
R15	RC07	870 Ω, 5%, 1/4 watt	12		175	70
R16	RC07	5.6 KΩ, 5%, 1/4 watt	12		25.8	10
R17	8447750-3	5 KΩ, 5%, 1/4 watt	5.5	3.7	2.04	< 10
R18	RC07	1 KΩ, 5%, 1/4 watt	3.7	3.7	13.7	< 10
R19	RC07	56 KΩ, 5%, 1/4 watt	3		0.17	< 10
R20	RC07	5.6 KΩ, 5%, 1/4 watt	2.5		1.1	< 10
R21	RC07	10 KΩ, 5%, 1/4 watt	10		10	< 10
R22	RC07	5.6 KΩ, 5%, 1/4 watt	11		22	< 10
R23	RC07	22 KΩ, 5%, 1/4 watt	12.5		7.1	< 10
R24	RC07	56 KΩ, 5%, 1/4 watt	3		0.16	< 10
R25	RC07	1.5 KΩ, 5%, 1/4 watt	12		96	39
R26	RC07	5.6 KΩ, 5%, 1/4 watt	7.5		10	< 10
R27	847750-3	5 KΩ, 5%, 1/4 watt	5	1.8	9	< 10
R28	RC07	1 KΩ, 5%, 1/4 watt	4.5		20	< 10
R29	RC07	56 KΩ, 5%, 1/4 watt	3		0.17	< 10
R30	RC07	5.6 K Ω, 5%, 1/4 watt	2.5		1.1	< 10

TABLE F-7
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VERTICAL SYNC GENERATOR, 1703809 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R31	RC07	10 KΩ, 5%, 1/4 watt	12.5		15	< 10
R32	RC07	5.6 KΩ, 5%, 1/4 watt	12.5		28	11
R33	RC07	22 KΩ, 5%, 1/4 watt	12.5		7.1	< 10
R34	RC07	56 KΩ, 5%, 1/4 watt	1		0.02	< 10
R35	RC07	1.5 KΩ, 5%, 1/4 watt	12.5		104	42
R36	RC07	5.6 KΩ, 5%, 1/4 watt	12.5		28	11
R37	847750-3	5 KΩ, 5%, 1/4 watt	2.7	2.5	6.75	< 10
R38	RC07	1 KΩ, 5%, 1/4 watt	2.5	2.5	6.25	< 10
R39	RC07	56 KΩ, 5%, 1/4 watt	3		0.17	< 10
R40	RC07	5.6 KΩ, 5%, 1/4 watt	3		0.17	< 10
R41	RC07	10 KΩ, 5%, 1/4 watt	12.5		15.6	< 10
R42	RC07	5.6 KΩ, 5%, 1/4 watt	12.5		28	11
R43	RC07	22 KΩ, 5%, 1/4 watt	10		4.6	< 10
R44	RC07	56 KΩ, 5%, 1/4 watt	0.63		--	< 10
R45	RC07	1.5 KΩ, 5%, 1/4 watt	11		81	32
R46	RC07	5.6 KΩ, 5%, 1/4 watt	11		22	< 10
R47	8447750-3	5 KΩ, 5%, 1 watt	5	5	25	< 10
R48	RC07	1 KΩ, 5%, 1/4 watt	5	5	25	10
R49	RC07	56 KΩ, 5%, 1/4 watt	2.5		0.1	< 10
R50	RC07	5.6 KΩ, 5%, 1/4 watt	2.7		1.3	< 10
R51	RC07	10 KΩ, 5%, 1/4 watt	11		12.1	< 10
R52	RC07	5.6 KΩ, 5%, 1/4 watt	11		22	< 10
R53	RC07	22 KΩ, 5%, 1/4 watt	11		5.6	< 10
R54	RC07	56 KΩ, 5%, 1/4 watt	0.63		--	< 10
R55	RC07	1.5 KΩ, 5%, 1/4 watt	5		17	< 10
R56	RC07	5.6 KΩ, 5%, 1/4 watt	10		18	< 10
R57	8447750-3	5 KΩ, 5%, 1 watt	5	3.7	18.5	< 10
R58	RC07	1 KΩ, 5%, 1/4 watt	3.7	3.7	14	< 10
R59	RC07	56 KΩ, 5%, 1/4 watt	3.1		0.17	< 10
R60	RC07	5.6 KΩ, 5%, 1/4 watt	3.1		1.7	< 10

TABLE F-7
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VERTICAL SYNC GENERATOR, 1703809 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R61	RC07	10 KΩ, 5%, 1/4 watt	11		12.1	< 10
R62	RC07	5.6 KΩ, 5%, 1/4 watt	11		22	< 10
R63	RC07	22 KΩ, 5%, 1/4 watt	11		6	< 10
R64	RC07	56 KΩ, 5%, 1/4 watt	0.75		--	< 10
R65	RC07	1.5 KΩ, 5%, 1/4 watt	11		81	33
R66	RC07	5.6 KΩ, 5%, 1/4 watt	11		22	< 10
R67	8447750-3	5 K Ω, 5%, 1/4 watt	3.2	1.3	4.2	< 10
R68	RC07	1 KΩ, 5%, 1/4 watt	1.3	1.3	1.7	< 10
R69	RC07	56 KΩ, 5%, 1/4 watt	6.3		0.71	< 10
R70	RC07	5.6 KΩ, 5%, 1/4 watt	3		1.6	< 10
R71	RC07	10 KΩ, 5%, 1/4 watt	12.5		15.6	< 10
R72	RC07	5.6 KΩ, 5%, 1/4 watt	11		21.6	< 10
R73	RC07	22 KΩ, 5%, 1/4 watt	11		5.5	< 10
R74	RC07	56 KΩ, 5%, 1/4 watt	0.63		--	< 10
R75	RC07	1.5 KΩ, 5%, 1/4 watt	12.5		104	42
R77	RC07	20 KΩ, 5%, 1/4 watt	7.5		2.9	< 10
R79	RC07	33 KΩ, 5%, 1/4 watt	10		3.3	< 10
C1	8412778-96	100μ f, 15 volts	6			40
C2	8412778-312	33 μ f, 15 volts	9			60
C3	8412778-312	33 μ f, 15 volts	11			74
C4	CK06	0.01 μ f, 200 volts	17			9
C5	CK06	0.01 μ f, 200 volts	15			8
C6	8412778-57	10 μ f, 15 volts	11			74
C7	CK06	0.01 μ f, 200 volts	10			5
C8	CK06	0.01 μ f, 200 volts	13			7
C9	CK06	0.01 μ f, 200 volts	6			1.5
C10	8412778-71	6.8 μ f, 15 volts	12			80
C11	CK06	0.01 μ f, 200 volts	15			8
C12	8412778-58	68 μ f, 15 volts	12			80
C13	8412778-36	0.1 μ f, 35 volts	17			50

TABLE F-7
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VERTICAL SYNC GENERATOR, 1703809 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
C14	CK06	0.01 μ f, 200 volts	13			7
C15	CK06	0.01 μ f, 200 volts	18			9
C16	8412778-71	6.8 μf, 15 volts	12			80
C17	CK06	0.01 μ f, 200 volts	15			8
C18	8412778-71	6.8 μf, 15 volts	12			80
C19	CK06	0.01 μ f, 200 volts	18			9
C20	CK06	0.01 μ f, 200 volts	12			6
C21	8412778-57	10 μ f, 15 volts	12			80
C22	CK06	0.01 μf, 200 volts	17			9
C23	CK06	0.01 μf, 200 volts	21			10
CR1	1N757	400 mw at 25° C ambient	9.1	3.6	33	< 10
CR2	1N757	400 mw at 25° C ambient	9.1	3.6	33	< 10
CR3	1N746	400 mw at 25° C ambient				< 10
CR5	1N746	400 mw at 25° C ambient	+0.6, -3.0			< 10
CR11	1N746	400 mw at 25° C ambient	±0.6			< 10
CR13	1N746	400 mw at 25° C ambient	+0.6, -5			< 10
CR14	1N916	75 ma max at 25° C ambient	+0.6, -0.6	0.38		< 10
CR15	1N916	75 ma max at 25° C ambient	+0.6, -0.6	0.38		< 10
CR16	1N916	75 ma max at 25° C ambient	+0.6, -4	0.38		< 10
CR17	1N916	75 ma max at 25° C ambient	+0.6, -8	0.7		< 10
CR18	1N916	75 ma max at 25° C ambient	+0.5, -10	0.38		< 10
CR19	1N916	75 ma max at 25° C ambient	+0.5, -0.6	0.38		< 10

TABLE F-7
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VERTICAL SYNC GENERATOR, 1703809 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR20	1N916	75 ma max at 25° C ambient	+0.4, -0.6	0.38		< 10
CR21	1N753A	400 mw at 25° C ambient	+0.6, -5			< 10
Q1	2N329A	250 mw at 25° C ambient	BE = 10, -5 CE = -12	3.7	44	18
Q2	2N718A	400 mw at 25° C ambient	BE = 6.0, CE = 12	3.8	46	10.8
Q3	2N722	400 mw at 25° C ambient	BE = +6, -0.6, CE = 12	154	180	45
Q4	2N722	400 mw at 25° C ambient	BE = 2, -0.6 CE = 12	2.2	26	< 10
Q5	2N718A	400 mw at 25° C ambient	BE = 0.6, -0.5 CE = 13	4.4	57	14.2
Q6	2N722	400 mw at 25° C ambient	BE = 1.2, -0.6 CE = 9	8	72	18
Q7	2N722	400 mw at 25° C ambient	BE = 2.5, -0.6 CE = -12.0	2	24	< 10
Q8	2N718A	400 mw at 25° C ambient	BE = 0.8, -0.4 CE = 13	4.4	57	14.2
Q9	2N722	400 mw at 25° C ambient	BE = 0.4, -0.6 CE = 12	8	96	24
Q10	2N722	400 mw at 25° C ambient	BE = 2, -0.6 CE = 11	2	22	< 10
Q11	2N718A	400 mw at 25° C ambient	BE = 0.6, -3 CE = 13	4.4	57	14.2
Q12	2N722	400 mw at 25° C ambient	BE = 0.4, -0.7 CE = 7.5	8	60	15
Q13	2N722	400 mw at 25° C ambient	BE = 2.5, -0.6 CE = 12	2	24	< 10
Q14	2N718	400 mw at 25° C ambient	BE = 0.8, -0.4 CE = 13	4.4	58	14.5
Q15	2N722	400 mw at 25° C ambient	BE = 0.4, -0.7 CE = 12	8	96	24
Q16	2N722	400 mw at 25° C ambient	BE = 2, -0.6 CE = 10	2	20	< 10

TABLE F-8
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 8624826 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q17	2N718A	400 mw at 25° C ambient	CE = 13	4.4	57	14.2
Q18	2N722	400 mw at 25° C ambient	BE = 0.7, -0.5 CE - 10	8	80	20
Q19	2N722	400 mw at 25° C ambient	BE = 0.4, -0.6 CE = 11	2	22	< 10
Q20	2N718A	400 mw at 25° C ambient	BE = 0.5 CE = 13	4.4	57	14.2
Q21	2N722	400 mw at 25° C ambient	BE = 0.3, -0.6 CE = 7.5	8	60	15

TABLE F-8
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS
ASSEMBLY DEFLECTION AMPLIFIER, 8624826

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	10 KΩ, 5%, 1/4 watt	1.0	0.1	0.1	< 10
R2	RN65	5110Ω, 1%, 1/4 watt	2.5	0.49	1.22	< 10
R3	RC07	10 KΩ, 5%, 1/4 watt	1.0	0.1	0.1	< 10
R4	RN65	5110Ω, 1% 1/4 watt	2.5	0.49	1.22	< 10
R5	RN65	2.37 KΩ, 1%, 1/4 watt	4.0	1.69	6.8	< 10
R6	RN65	3.37 KΩ, 1%, 1/4 watt	1.5	0.63	0.95	< 10
R7	RN65	100 KΩ, 1%, 1/4 watt	2.5	0.025	0.063	< 10
R8	RC07	100 KΩ, 5%, 1/4 watt	2.0	0.02	0.04	< 10
R9	8977933-66	47.5Ω, 1%, 1/8 watt	0.75	16.1	12.1	< 10
R10	RC07	1.5 KΩ, 5%, 1/4 watt	5.0	3.33	16.7	< 10
R11	8977939-239	3.01 KΩ, 1%,1/4 watt	2.5	0.83	2.1	< 10
R12	8977933-66	47.5Ω, 1%, 1/8 watt	0.1	2.1	0.21	< 10
R13	8977939-209	1.47 KΩ, 1%, 1/4 w	6.2	4.2	26.1	10.4
R15	RC07	2200Ω, 5%, 1/4 watt	5	2.27	11.4	< 10
R16	8977939-147	332Ω, 1%, 1/4 watt	0.2	0.6	0.12	< 10
R17	RC07	470Ω, 5%, 1/4 watt	--	--	--	
R18	8977939-258	4750Ω, 1% 1/4 watt	5	1.05	5.25	< 10
R19	8977939-289	10 KΩ, 1%, 1/4 watt	30	3.0	90	36
R20	RC07	22 KΩ, 5%, 1/4 watt	22	1.0	22	< 10
R21	RC07	270Ω, 5%, 1/4 watt	0.1	3.7	0.37	< 10
R22	8977939-339	33.2 KΩ, 1%, 1/4 watt	7.5	0.226	1.7	< 10
R23	RC20	27Ω, 5%, 1/2 watt	0.5	19	9.5	< 10
R24	RC20	27Ω, 5%, 1/2 watt	0.1	3.7	0.37	< 10
R25	RC07	4.7 KΩ, 5%, 1/4 watt	7	1.5	10.5	< 10
R26	RN75	511Ω, 1%, 1 watt	5.0	9.8	49	< 10
R27	RC07	10 KΩ, 5%, 1/4 watt	6	0.6	3.6	< 10
R28	RC65	5110Ω, 1%, 1/4 watt	20	3.9	78	31
R29	RC07	10 KΩ, 50%, 1/4 watt	5.0 peak	0.5	2.5	< 10
R30	RN65	5110Ω, 1%, 1/4 watt	2.4	0.47	1.1	< 10
R31	RN65	2.37 KΩ, 1%, 1/4watt	2.5	1.1	2.6	< 10

TABLE F-8
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 8624826 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R32	RN65	10 KΩ, 1%, 1/4 watt	5.0 peak-to-peak	0.5	2.5	<10
R33	RN65	100 KΩ, 1%, 1/4 watt	15	0.15	2.3	<10
R34	RC07	100 KΩ, 5%, 1/4 watt	2	0.02	0.04	<10
R35	8977933-66	47.5Ω, 1%, 1/8 watt	0.12	2.8	0.31	<10
R36	RC07	1.5 KΩ, 5%, 1/4 watt	5.0	3.3	16.5	<10
R37	8977939-239	3010Ω, 1%, 1/4 watt	3.0	1	3	<10
R38	8977933-66	47.5Ω, 1%, 1/8 watt	0.05	1	0.05	<10
R39	8977939-209	1.47 KΩ, 1%, 1/4 watt	6.0	4.1	24.6	<10
R40	RC07	100 Ω, 5%, 1/4 watt	0.05	0.5	0.025	<10
R41	RC07	2200Ω, 5%, 1/4 watt	5	2.1	10.5	<10
R42	8977939-147	332 Ω, 1%, 1/4 watt	1.8	5.4	10	<10
R43	RC07	100Ω, 5%, 1/4 watt	1.2	12	14.4	<10
R44	8977939-258	4750Ω, 1%, 1/4 watt	6	1.3	7.8	<10
R45	8977939-289	10 KΩ, 1%, 1/4 watt	40	4	160	64
R46	RC07	22 KΩ, 5%, 1/4 watt	22	1	22	<10
R47	RC07	270Ω, 5%, 1/4 watt	0.2	0.8	0.16	<10
R48	8977939-339	33.2 KΩ, 1%, 1/4 watt	24	0.7	17	<10
R49	RC20	27Ω, 5%, 1/2 watt	0.2	8	1.6	<10
R50	RC20	27Ω, 5%, 1/2 watt	0.25	9	2.3	<10
R51	RC07	6.2 KΩ, 5%, 1/4 watt	22	3.6	78	31
R52	RN75	316 Ω, 1%, 1 watt	5	1.6	8	<10
R53	RC07	10 KΩ, 5%, 1/4 watt	-- --	--	--	
R54	RC07	10 KΩ, 5%, 1/4 watt	-- --	--	--	
R56	RC07	560Ω, 5%, 1/4 watt	-- --	--	--	
C1	8447748-1	1 μf, 10%, 100 volts	4			<10
C2	8412778-80	0.15 μf, 10%, 35 volts	2.5			<10
C3	CK05CW102K	1000 pf, 10%, 200 volts	22			11
C4	8924416-232	8300 pf, 2%, 300 volts	5			<10
C5	CK05CW102K	1000 pf, 10%, 200 volts	3			<10
C6	8914319-345	750 pf, 5%, 300 volts	24			<10

TABLE F-8
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 8624826 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
C7	8447748-1	1 μf, 10%, 100 volts	4			< 10
C8	CK05CW102K	1000 pf, 10%, 200 volts	3			< 10
C9	CK05CW102K	1000 pf, 10%, 200 volts	24			12
C10	CK05CW102K	1000 pf, 10%, 200 volts	22			11
C11	CK06CW222K	2200 pf, 10%, 200 volts	1			< 10
CR1	1N916	250 mw at 25° C ambient	0.6	19.5	11.7	16
CR2	1N916	250 mw at 25° C ambient	0.6	19.5	11.7	16
CR3	1N916	250 mw at 25° C ambient	0.6	2.3	1.4	< 10
CR4	1N916	250 mw at 25° C ambient	0.6	2.3	1.4	< 10
CR5	1N916	250 mw at 25° C ambient	0.6	3.0	1.8	< 10
CR6	1N916	25 mw at 25° C ambient	0.6	3.0	1.8	< 10
CR7	1N2032	750 mw at 25° C ambient	4	5	20	< 10
CR8	1N916	250 mw at 25° C ambient	0.6	6	3.6	< 10
CR9	1N916	250 mw at 25° C ambient	0.6	6	3.6	< 10
CR10	1N916	250 mw at 25° C ambient	0.6	2.1	1.3	< 10
CR11	1N916	250 mw at 25° C ambient	0.6	2.1	1.3	< 10
CR12	1N916	250 mw at 25° C ambient	0.6	4	2.4	< 10
CR13	1N916	250 mw at 25° C ambient	0.6	4	2.4	< 10
CR14	1N2032	750 mw at 25° C ambient	4	5	20	< 10
Q1	2N943	250 mw at 250° C ambient	CE = +2.5 BE = -7	2	5	< 10

TABLE F-8
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 8624826 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q2	2N943	250 mw at 250° C ambient	EC = 2.5 BE = -3.5	1	2.5	<10
Q3	2N930	300 mw at 250° C ambient	EC = 5 BE = 0.75	<1	<5	<10
Q4	2N722	400 mw at 25° C ambient	EC = 6 EB = 0.5	16	96	24
Q5	2N930	300 mw at 25° C ambient	EC = 3.5 EB = 0.6	2.1	7.4	<10
Q6	2N930	300 mw at 25° C ambient	EC = 4 EB = 0.6	0.6	2.4	<10
Q7	2N722	400 mw at 25° C ambient	EC = 25 EB = 0.5	1.1	27.5	<10
Q8	2N718A	500 mw at 25° C ambient	CE = 30 BE = 0.5	3.7	111	24.5
Q9	2N718A	500 mw at 25° C ambient	CE = 30 BE = 0.6	2	60	12
Q10	2N498	4 watts at 25° C case	CE = 30 BE = 0	19	570	14
Q11	2N1244	1 watt at 25° C case	BE = 0.75 CE = 30	3.7	111	11
Q12	2N943	250 mw at 25° C ambient	BE = 5 CE = 3 peak	1.1	3.3	<10
Q13	2N943	250 mw at 25° C ambient	BE = 1.5 CE = 3	0.5	1.5	<10
Q14	2N930	300 mw at 25° C ambient	BE = 0.5 CE = 5	<0.1	< 0.5	<10
Q15	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 5	2.8	14	<10
Q16	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 3.5	1	3.5	<10
Q17	2N930	300 mw at 25° C ambient	BE = 0.5 CE = 4	5.4	21.6	<10
Q18	2N722	400 mw at 25° C ambient	BE = 0.5 CE = 25	--	--	<10
Q19	2N718A	500 mw at 25° C ambient	BE = 0.9 peak CE = 35	0.8	28	<10

TABLE F-8
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 8624826 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q20	2N718A	500 mw at 25° C ambient	BE = 0.6 CE = 35	4	140	28
Q21	2N498	4 watts at 25° C case	BE = 0.6 CE = 35	8	280	<10
Q22	2N1244	1 watt at 25° C case	BE = 1 CE = 40	9	360	36

TABLE F-9
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1753014

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	4700Ω, 1/4 w	8	1.7	14	<10
R2*	8977939-193	1000Ω, 1/4 w	13 max	13 max	169 max	34
R3	RC07	2200Ω, 1/4 w	6.5 peak	3 peak	19	<10
R4*	8977939-193	1000Ω, 1/4 w	12	12 max	144 max	29
R5	8977933-318	20 KΩ, 1/8 w	11	0.55	6	<10
R6	8977933-318	20 KΩ, 1/8 w	11	0.55	6	<10
R7	RC07	33 KΩ, 1/4 w	17	0.52	9	<10
R8	8977933-289	10 KΩ, 1/8 w	12	1.2	14.4	12
R9	RC07	4700Ω, 1/4 w	4.5 peak	0.94	4	<10
R10	RC07	120 KΩ, 1/4 w	12	0.1	1.2	< 0
R11	RC07	10 KΩ, 1/4 w	5	0.5	2.5	<10
R12	RC07	180 KΩ, 1/4 w	20.5	0.11	2.3	<10
R13	RC07	10 KΩ, 1/4 w	5	0.5	2.5	<10
R14	8447750-5	25 KΩ, 1 w	20	0.8	16	<10
R16	8447750-5	25 KΩ, 1 w	20	0.8	16	<10
R17	RC07	180 KΩ, 1/4 w	20	0.11	2.2	<10
R19	8977933-269	6.19 KΩ, 1/8 w	6	1	6	<10
R20	RC07	120 KΩ, 1/4 w	11	<0.1	10	<10
R21**	8977949-193	1000Ω, 1/4 w	12	12	21	<10
R22	8977933-234	2.67 KΩ, 1/8 w	6	2.18	13.5	11
R23	8977933-234	2.67 KΩ, 1/8 w	5	1.9	9.5	<10
R24	8977933-269	6.19 KΩ, 1/8 w	1	0.13	0.13	<10
R25	8977933-314	18.2 KΩ, 1/8 w	5	0.27	1.4	<10
R26	RC07	75 KΩ, 1/4 w	7	<0.1	<1	< 0
R27	8977939-193	1000Ω, 1/4 w	6	6	36	14
R28	8977933-330	26.7 KΩ, 1/8 w	11	0.41	4.5	<10
R29	8977933-234	2.67Ω, 1/8 w	2.1	0.79	1.7	10
R30	8447750-50	25 KΩ, 1 w	20	0.8	16	<10
R31	8447750-50	25 KΩ, 1 w	20	0.8	16	<10
R33*	8977939-193	1000Ω, 1/4 w	12	12 max	144 max	29

TABLE F-9
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1753014 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R34	RC07	2200Ω, 1/4 w	6	2.8	17	<10
R35*	8977939-193	1000Ω, 1/4 w	12	12 max	144 max	29
R36	8977933-318	20 KΩ, 1/8 w	11	0.55	6	<10
R37	8977933-318	20 KΩ, 1/8 w	11	0.55	6	<10
R38	RC07	33 KΩ, 1/4 w	14	0.5	6	<10
R39	8977933-289	10 KΩ, 1/8 w	13	1.3	17	14
R40	RC07	4.7 KΩ, 1/4 w	4	0.8	3.5	10
R41	RC07	120 KΩ, 1/4 w	12	0.1	1.2	< 0
R42	RC07	10 KΩ, 1/4 w	5	0.5	2.5	<10
R43	RC07	180 KΩ, 1/4 w	20	0.1	2.2	< 0
R44	RC07	10 KΩ, 1/4 w	6	0.6	3.6	10
R45	8447750	25 KΩ, 1 w	20	0.8	16	<10
R47	8447750-5	25 KΩ, 1 w	20	0.8	16	<10
R48	RC07	180 KΩ, 1/4 w	20	0.11	2.2	< 0
R50	8977933-269	6.19 KΩ, 1/8 w	5	0.8	4.1	<10
R51	RC07	75 KΩ, 1/4 w	6	0.08	<1	< 0
R52	8977939-193	1000Ω, 1/4 w	6	6	36	14
R53	8977933-234	2.67 KΩ, 1/8 w	2.5	0.94	2.4	< 0
R54	8977933-330	26.7 KΩ, 1/8 w	12	0.45	5.4	<10
R55	8447750-5	25 KΩ, 1 w	20	0.8	16	<10
R57	8447750-5	25 KΩ, 1 w	20	0.8	16	<10
R58	RC07	2.7 KΩ, 1/4 w	2.6	0.97	2.5	<10
R59	RC07	2.7 KΩ, 1/4 w	26	0.97	25	10
R60	RC07	6.8 KΩ, 1/4 w	10 peak-to-peak	1.5 peak	15 peak	<10
R61	RC07	6.8 KΩ, 1/4 w	10 peak-to-peak	1.5 peak	15 peak	<10
R62	RC07	6.8 KΩ, 1/4 w	10 peak-to-peak	1.5 peak	15 peak	<10
R63	RC07	6.8 KΩ, 1/4 w	5.3			<10
R68	8977933-289	10 KΩ, 1/8 w	Test Point			<10
R75	8977933-318	20 KΩ, 1/8 w	10 peak-to-peak			<10
R76**	8977933-269	6.19 KΩ, 1/8 w	13 peak-to-peak			<10

TABLE F-9
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1753014 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R77	RC07	470 KΩ, 1/4 w	7			<10
R78	8977933-281	8.25 KΩ, 1/8 w	12 peak-to-peak			<10
R79	8977933-330	26.7 KΩ, 1/8 w	20			12
R80	RC07	1.1 KΩ, 1/4 w	5.5			11
C1	8987915-6	120 pf, 200 volts	10			<10
C2	8987915-6	120 pf, 220 volts	12			<10
C3	CK05CW102K	0.001 μf, 200 volts	14			<10
C4	8987915-6	120 pf, 200 volts	4			<10
C5	8987915-6	120 pf, 200 volts	11			<10
C6	8987915-6	120 pf, 200 volts	11			<10
C8	8987915-6	120 pf, 200 volts	10			<10
C9	8987915-6	120 pf, 200 volts	13			<10
C10	8924416-131	6200 pf, 300 volts	8			<10
C11	CK05CW102K	0.001 μf, 200 volts				<10
CR1	1N2039	750 mw at 25° C ambient	18			<10
CR2	1N916	75 ma max at 25° C	-5.5			<10
CR3	1N916	75 ma max at 25° C	+0.4			<10
CR4	1N916	75 ma max at 25° C	-6			<10
CR5	1N916	75 ma max at 25° C	0.5			<10
CR7	1N916	75 ma max at 25° C	-5			<10
CR8	1N916	75 ma max at 25° C	-4.5			<10
CR9	1N916	75 ma max at 25° C	-17			<10
CR10	1N916	75 ma max at 25° C	-5			<10
CR12	1N916	75 ma max at 25° C	-9			<10
CR13	1N916	75 ma max at 25° C	-9			<10
CR14	1N916	75 ma max at 25° C	-6			<10
CR15	1N916	75 ma max at 25° C	-9			<10
CR16	1N916	75 ma max at 25° C	-9			<10
CR17	1N916	75 ma max at 25° C	-7			<10

TABLE F-9
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1753014 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR18	1N916	75 ma max at 25° C	-6			<10
CR19	1N916	75 ma max at 25° C	0.5			<10
CR20	1N916	75 ma max at 25° C	-6			<10
CR21	1N916	75 ma max at 25° C	0.5			<10
CR23	1N916	75 ma max at 25° C	-9			<10
CR25	1N747	400 ma at 25° C ambient	2			<10
CR26	1N916	75 ma max at 25° C	0.8			<10
CR27	1N916	75 ma max at 25° C	0.8			<10
Q1	2N1132	600 mw at 25° C ambient	EB=0.8, CE=4			<10
Q2	2N916	360 mw at 25° C ambient	EB=-0.8, 0.4 CE=12, 0.5			<10
Q3	2N916	360 mw at 25° C ambient	EB=-0.8, 1.2 CE=12, 0.3			<10
Q4	2N869	360 mw at 25° C ambient	EB=0.5, 6 CE=6, 11			<10
Q5	2N943	250 mw at 25° C ambient	EB=0.5, 10 CE=0, 11			<10
Q6	2N943	250 mw at 25° C ambient	EB=0.5, 10 CE=12, 0.6			<10
Q7	2N916	360 mw at 25° C ambient	EB=0.5, 5 CE=3, 14			<10
Q8	2N916	360 mw at 25° C ambient	EB=-5 CE=-14.5			<10
Q9	2N916	360 mw at 25° C ambient	EB=-5 CE=-12			<10
Q10	2N916	360 mw at 25° C ambient	EB=-5.5 CE=-5.5			<10
Q11	2N916	360 mw at 25° C ambient	EB=-0.8 CE=-11.5			<10
Q12	2N916	360 mw at 25° C ambient	EB=0.8 to -1.1 CE=1, 12			<10
Q13	2N869	360 mw at 25° C ambient	EB=7 CE=5.5, 6.5			<10

TABLE F-9
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1753014 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q14	2N943	250 mw at 25° C ambient	EB=0.4 CE=0.4			<10
Q15	2N943	250 mw at 25° C ambient	EB=0.4 CE=1.1			<10
Q16	2N916	360 mw at 25° C ambient	EB=5 CE=1.5, 2.7			<10
Q17	2N916	360 mw at 25° C ambient	EB=5.5 CE=2.2, 2.7			<10
Q18	2N916	360 mw at 25° C ambient	EB=0.7, -0.6 CE=6.3, 5.5			<10
Q19	2N916	360 mw at 25° C ambient	EB=+6.0, -0.5 CE=-10			<10

*Approximately 50% duty cycle
**Approximately 14% duty cycle

TABLE F-10
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR, 1753177B

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	8977933-384	100 KΩ, 1/8 w	Test Point			<10
R2*	8977933-261	5.11Ω, 1/8 w	9 peak-to-peak			13
R4	RC07	120 KΩ, 1/4 w	9 peak			<10
R5	8977933-385	102 KΩ, 1/8 w	22 peak			<10
R6	8977933-353	46.4 KΩ, 1/8 w	14 peak			<10
R7	RC07	82 KΩ, 1/4 w	5.5 peak			<10
R8	8977933-293	11 KΩ, 1/8 w	13 peak			12
R9	8977933-97	100Ω, 1/8 w	1.5 peak			18 peak
R10	847750-4	10 KΩ, 1 w	10 peak			<10
R11	847750-5	25 KΩ, 1 w	4 peak			<10
R12	8977933-243	3.32 KΩ, 1/8 w	11.5 peak			32 peak
R13**	8977933-243	3.32 KΩ, 1/8 w	7 VDC avg. plus 7 peak			18
R14	RC07	470 KΩ, 1/4 w	1.0			<10
R15	RC07	1 MegΩ, 1/4 w	1.0			<10
R16	8977933-369	68.1 KΩ, 1/8 w	30			11
R17	RC07	100 KΩ, 1/4 w	2.5			25
R18	8977933-369	68.1 KΩ, 1/8 w	25			<10
R20	8977933-326	24.3 KΩ, 1/8 w	3.5			<10
R21	8977933-371	73.2 KΩ, 1/8 w	28			<10
R22	8977933-328	24.3 KΩ, 1/8 w	7			<10
R23	8977933-289	10 KΩ, 1/8 w	14			<10
R24	8447750-3	5 KΩ, 1 w	7			<10
R25	8977933-269	6.19 KΩ, 1/8 w	4.5			<10
R26**	8977933-281	8.25 KΩ, 1/8 w	15 to 25			30
R27	8977933-289	10 KΩ, 1/8 w	4			<10
R28	8977933-377	84.5 KΩ, 1/8 w	7			<10
R29**	8977933-409	182 KΩ, 1/8 w	20 to 26			<10
R30**	8977933-365	61.9 KΩ, 1/8 w	6 to 18			<10

TABLE F-10 ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR, 1753177B (Continued)						
Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R31**	8977933-325	23.7 KΩ, 1/8 w	6 to 26			11
R32	847750-5	25 KΩ, 1 w	10			<10
R33	8977933-329	26.1 KΩ, 1/8 w	10			<10
R34**	8977933-384	100 KΩ, 1/8 w	70 to 100			40 max
R35**	RC07	56 KΩ, 1/4 w	50			<10
R36	8977933-384	100 KΩ, 1/8 w	Test Point			<10
R37	RC07	10 KΩ, 1/4 w	2.5 peak-to-peak			<10
R38	RC07	91 KΩ, 1/4 w	20 peak			<10
R39	RC07	3.3 MegΩ, 1/4 w	19			<10
R40	RC07	47 KΩ, 1/4 w	3.0			<10
R41	RC07	2.4 MegΩ, 1/2 w				
R42	RC07	2.4 MegΩ, 1/2 w				
R43	RC07	2.4 MegΩ, 1/2 w				
R44	RC07	2.4 MegΩ, 1/2 w				
R45	RC20	3.3 MegΩ, 1/2 w				
R46	RC07	18 KΩ, 1/4 w	3.5			<10
R47	RC07	10 KΩ, 1/4 w	2.0			<10
R48	RC07	10 KΩ, 1/4 w	2.0			<10
R49	RC07	10 KΩ, 1/4 w	2 peak			<10
R50	RC07	91 KΩ, 1/4 w	20 peak			<10
R51	RC07	3.3 MegΩ, 1/4 w	10			<10
R52	RC07	47 KΩ, 1/4 w	3.0 peak			<10
R53	RC07	1 KΩ, 1/4 w	-	-	-	<10
R54	RC07	100 KΩ, 1/4 w	Test Point			<10
R55	RC07	10 KΩ, 1/4 w	1.4			<10
R56	RW59	1Ω, 3 w	0.1			<10
R57	RC07	39 KΩ, 1/4 w	25			<10
R66	RC07	10 KΩ, 1/4 w	2.5 peak-to-peak			<10
R67	RC07	270 KΩ, 1/4 w	5			<10

TABLE F-10
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR, 1753177B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R68	RC07	18 KΩ, 1/4 w	45			45
R69**	RC07	1000 Ω, 1/4 w	9 peak			15
R70	RC07	330 KΩ, 1/4 w	3 peak			11 peak
R71	RC07	330 KΩ, 1/4 w	9 peak			<10
R72	RC07	75 KΩ, 1/4 w	3.5 peak			<10
R73	RC07	24 KΩ, 1/4 w	1.6 peak			<10
R74	RC07	20 KΩ, 1/4 w	1.0			<10
C2	CP09A1KE 154K	0.15 μf, 400 volts	280			70
C3	8412778-41	4.7 μf, 35 volts	-	-	-	<10
C4	8412778-76	22 μf, 15 volts	5			33
C5	8412778-76	22 μf, 15 volts	3.5			23
C6	CK06CW103K	0.01 μf, 200 volts	7 peak			<10
C7	CK06CW103K	0.01 μf, 200 volts	7 peak			<10
C8	8412778-41	4.7 μf, 35 volts	7 peak			20 peak
C9	8412778-50	100 μf, 20 volts	0.8			<10
C10	8412778-53	47 μf, 35 volts	14			40
C11	8412778-44	2.2 μf, 35 volts	25			71
C12	8914319-316	47 pf, 500 volts	4			<10
C13	8914319-316	47 pf, 500 volts	19			<10
C14	CK06CW103K	0.01 μf, 200 volts	45			23
C15	8412778-10	15 μf, 20 volts	2			10
C16	8412778-10	15 μf, 20 volts	2.6			13
C19	8412778-19	47 μf, 6 volts	1.1			18
C20	8412778-61	22 μf, 35 volts	12			34
C21	8412778-61	22 μf, 35 volts	10			29
CR1	1N457	200 mw at 25° C ambient	-1.4 peak	-	-	<10
CR2	1N457	200 mw at 25° C ambient	2 peak	-	-	<10

TABLE F-10
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR, 1753177B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR3	1N457	200 mw at 25° C ambient	0.6	0.5	-	<10
CR4	1N457	200 mw at 25° C ambient	0.6 peak	0.5	-	<10
CR5	1N457	200 mw at 25° C ambient	0.6 peak	0.5	-	<10
CR6	1N746A	400 mw at 25° C ambient	-1.6	-	-	<10
CR7	1N962B	500 mw at 25° C case	10	1	10	<10
CR8	1N457	200 mw at 25° C ambient	2.5	-	-	<10
CR9	1N457	200 mw at 25° C ambient	3.0	-	-	<10
CR10	1N457	200 mw at 25° C ambient	2.0	-	-	<10
CR11	1N457	200 mw at 25° C ambient	+0.7	1	1	<10
CR16	1N645	400 ma max at 25° C ambient	-70	-	-	<10
CR17	IN3041B	1 w at 25° C case	70	1	70	<10
CR18	1N916	205 mw at 25° C case	+0.7 -12	9	6.3	<10
CR19	1N916	250 mw at 25° C case	+0.4	-	-	<10
CR20**	1N963	500 mw at 25° C case	12	9	<54	10
Q1	2N930	300 mw at 25° C ambient	BE=0.4 CE=3 to 6	<1	< 3	<10
Q2	2N718A	500 mw at 25° C case	BE=7.5 CE=12	<1	<12	<10
Q3	2N722	270 mw at 25° C ambient	BE=2 peak CE=3 peak	<4	12	<10
Q4	2N722	270 mw at 25° C ambient	BE=0.5 CE=25	-	-	<10
Q5	2N930	300 mw at 25° C ambient	BE=0.25 CE=18	<1	<18	<10

TABLE F-10
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR, 1753177B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q6	2N718A	500 mw at 25° C case	BE=0.4 CE=1.2	1	1.5	<10
Q7	2N930	300 mw at 25° C ambient	BE=0.5 CE=16	0.3	4.8	<10
Q8	2N1656	250 mw at 25° C ambient	BE=0.5 CE=20	1	20 peak	<10
Q9	2N722	270 mw at 25° C ambient	BE=0.5 CE=18	-	-	<10
Q10	2N1656	250 mw at 25° C ambient	BE=6 CE=50	0.25	13	<10
Q11	2N1656	250 mw at 25° C ambient	BE=0.7 CE=25 to 75	1 peak	25 peak	<10
Q12	2N930	300 mw at 25° C ambient	BE=0.5 CE=10	-	-	<10
Q13	2N722	270 mw at 25° C ambient	BE=0.5 CE=8	0.2	<2	<10
Q14	2N930	300 mw at 25° C ambient	BE=0.5 CE=9	-	-	<10
Q15	2N722	270 mw at 25° C ambient	BE=0.5 CE=1.5	<1	1.5	<10
Q18	2N930	300 mw at 25° C ambient	BE=0.5 CE=25	-	-	<10

*Square wave
**50% duty cycle
***Less than 50% duty cycle

TABLE F-11
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1754284, 1753157, OR 1753189

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	47 KΩ, 5%, 1/4 w	2.5	<0.1	<1	<10
R2	RC07	47 KΩ, 5%, 1/4 w	2.5	0.06	<1	<10
R3	RC07	10 KΩ, 5%, 1/4 w	18	1.8	32.5	13
R4	RC07	5100Ω, 5%, 1/4 w	4.2	0.8	3.4	<10
R5	RC07	4.7 KΩ, 5%, 1/4 w	1.9	0.4	0.8	<10
R6	RC07	47 KΩ, 5%, 1/4 w	0.6	<0.1	<1	<10
R7	RC07	68Ω, 5%, 1/4 w	0.05	0.7	<1	<10
R8	RC07	1500Ω, 5%, 1/4 w	0.25	0.2	<1	<10
R9	8447750-3	5 KΩ	0.75	0.2	<1	<10
R10	RC07	6200Ω, 5%, 1/4 w	10	1.6	16	<10
R11	RC07	39Ω, 10%, 1/4 w	0.025	0.6	<1	<10
R12	RC07	1000Ω, 5%, 1/4 w	7	7	49	20
R13	RC07	3600Ω, 5%, 1/4 w	3	0.8	2.5	<10
R14	RC07	1500Ω, 5%, 1/4 w	11.0	7.5	80	32
R15	RC07	47 K, ±5%, 1/4 w	0.6	<0.1	<1	<10
R16	RC07	47 K, ±5%, 1/4 w	1	<0.1	<1	<10
R17	RC07	220Ω, ±5%, 1/4 w	0.25	1.1	<1	<10
R18	RC07	6200Ω, ±5%, 1/4 w	11	1.8	19.5	<10
R19	RC07	4700Ω, ±5%, 1/4 w	6	1.3	8	<10
R20	RC07	220Ω, ±5%, 1/4 w	0.3	1.4	<1	<10
R21	RC07	430Ω, ±5%, 1/4 w	5	11.6	58	23
R22	RC07	47Ω, ±5%, 1/4 w	0.65	13.8	9	<10
R23	RC07	10 KΩ, ±5%, 1/4 w	18	1.8	33	13
R24	RC07	56 KΩ, ±5%, 1/4 w	-	-	-	<10
R25	RC07	100 KΩ, ±5%, 1/4 w	5	<0.1	<1	<10
R26	RC07	100 KΩ, ±5%, 1/4 w	5	<0.1	<1	<10
R27	RC07	100 KΩ, ±5%, 1/4 w	5	<0.1	<1	<10
R28	RC07	10Ω, ±5%, 1/4 w	0.1	10	<1	<10
R29	RC07	27 KΩ, ±5%, 1/4 w	6	0.22	1.3	<10

TABLE F-11
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1754284, 1753157, OR 1753189 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R30	RC07	4.7 KΩ, ±5%, 1/4 w	6	1.3	7.8	<10
R31	RC07	33 KΩ, ±5%, 1/4 w	5	0.15	<1	<10
R32	RC07	5600Ω, ±5%, 1/4 w	2 peak	0.36	<1	<10
R33	RC07	2200Ω, ±5%, 1/4 w	1.5	0.68	<1	<10
R34	RC07	8200Ω, ±5%, 1/4 w	3 peak	0.37	<1	<10
R35	RC07	10 KΩ, ±5%, 1/4 w	10	1	10	<10
R36	RC07	180Ω, ±5%, 1/4 w	0.75	4.2	3.1	<10
R37	RC07	10Ω, ±5%, 1/4 w	0.01	1	<1	<10
R38	RC07	10 KΩ, ±5%, 1/4 w	10 peak	1	10	10
R39	RC07	470Ω, ±5%, 1/4 w	2.5	5.3	13.4	<10
R40	RC07	4.7 KΩ, ±5%, 1/4 w	12	2.6	31	12
R41	RC07	10 KΩ, ±5%, 1/4 w	12	1.2	14.4	<10
R42	RC07	3.3 KΩ, ±5%, 1/4 w	10	3	3	<10
R43	RC07	10 KΩ, ±5%, 1/4 w	5	0.5	2.5	<10
R44	RC07	1.2 KΩ, ±5%, 1/4 w	7.5	6.3	47	19
R45	844750-3	5 KΩ, 0.8 w at 70° C	3.5	0.7	2.5	<10
R46	RC07	11 KΩ, ±5%, 1/4 w	5.5	5	27.5	11
R47*	RC07	6.2 KΩ, ±5%, 1/4 w	10	1.6	16	<10
R48	RC07	10 KΩ, ±5%, 1/4 w	10	1	10	<10
R49	RC07	10 KΩ, ±5%, 1/4 w	0.65	<0.1	<1	<10
R50*	RC07	20 KΩ, ±5%, 1/4 w	5	0.25	1.3	<10
R51	RC07	3.3 KΩ, ±5%, 1/4 w	3	1	3	<10
R52	RC07	27 KΩ, ±5%, 1/4 w	10	0.37	3.7	<10
R53*	RC07	47 KΩ, ±5%, 1/4 w	7.0	0.15	1.1	<10
R54	RC07	270 KΩ, ±5%, 1/4 w	0.75	<0.1	<1	<10
R55*	RC07	6.2 KΩ, ±5%, 1/4 w	6	1	6	<10
R56	RC07	6.2 KΩ, ±5%, 1/4 w	6.5	1.1	7.1	<10
R57	RC07	8.2 KΩ, ±5%, 1/4 w	20	2.4	48	20
R58	RC07	3900Ω, ±5%, 1/4 w	0.7	0.2	<1	<10

TABLE F-11
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1754284, 1753157, OR 1753189 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R59	RC07	560Ω, ±5%, 1/4 w	6	10.7	64	26
R60	RC07	15 KΩ, ±5%, 1/4 w	5	0.33	1.6	<10
R61	RC07	10 KΩ, ±5%, 1/4 w	2	0.2	<1	<10
R62	RC07	1 KΩ, ±5%, 1/4 w	0	0	0	<10
R63	RC07	100 KΩ, ±5%, 1/4 w	7.5	<0.1	<1	<10
R64	RC07	18 KΩ, ±5%, 1/4 w	28	1.6	45	18
R65	RC07	100 KΩ, ±5%, 1/4 w	0	0	0	<10
R67	RC07	6.2 KΩ, ±5%, 1/4 w	10	1.6	16	<10
R68	RC07	22 KΩ, ±5%, 1/4 w	12	0.55	6.6	<10
C1	8412778-95	6.8 μf, ±20%, 35 volts	7.5			21
C2	8412778-95	6.8 μf, ±20%, 35 volts	14			40
C3	8412778-70	1 μf, ±20%, 35 volts	6.8			19
C4	CK06	3300 pf, 200 volts	2			<10
C5	8414319-340	470 pf, 300 volts	11.5			<10
C6	8412778-95	6.8 μf, ±20%, 35 volts	11.5			33
C7	8412778-95	6.8 μf, ±20%, 35 volts	7.5			21
C8	8412778-95	6.8 μf, ±20%, 35 volts	12			34
C9	8412778-7	2.2 μf, ±20%, 35 volts	11			31
C10	8414319-340	470 pf, 300 volts	11			<10
C11	8412778	4.7 μf, ±20%, 35 volts	11			31
C12	8412778-95	6.8 μf, ±20%, 35 volts	9.0			26
C13	8412778-95	6.8 μf, ±20%, 35 volts	12			34
C14	8914319-316	47 pf, ±5%, 400 volts	20			<10
C15	CP09A1KB 104K3	0.1 μf, ±10%, 100 volts	20			20
C16	8914319-341	510 pf, ±5%, 300 volts	10			<10
C17	8412778-30	40 μf, ±20%, 10 volts	6			60
C18	8987915-25	0.0047 μf, ±10%, 200 volts	2.0			<10
C20	8412778-30	4.0 μf, ±20%, 10 volts	6			60

TABLE F-11
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1754284, 1753157, OR 1753189 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
C23	8914319-316	47 pf, ±5%, 500 volts	2.5			<10
C24	8412778-7	2.2 μf, ±20%, 20 volts	6			30
C25	8412778-95	6.8 μf, ±20%, 35 volts	AC 5 peak-to-peak, 11 Total			31
C26	8412778-58	68 μf, ±20%, 15 volts	AC = 1.2 on 2 DC			20
CR1	1N755AZ	400 mw at 25° C ambient	7.5	1	7.5	<10
CR2	1N755AZ	400 mw at 25° C ambient	7.5	15.2	114	28.5
CR3	1N963B	400 mw at 25° C ambient	12	15.2	182	45.5
CR4	1N757A	400 mw at 25° C ambient	9	11.6	105	26
CR5	1N963B	400 mw at 25° C ambient	11	11.6	128	32
CR7	1N916	75 ma at 25° C ambient	+0.7	3.5	<2.5	<10
CR8	1N916	75 ma at 25° C ambient	+0.7, -10	3.5	2.5	<10
CR9	1N457	75 ma at 25° C ambient	+0.7	1.6	1.1	<10
CR10	1N457	75 ma at 25° C ambient	+0.6, -5	-	-	<10
CR11	1N459	100 ma at 25° C ambient	-7.5	-	-	<10
CR12	1N457	75 ma at 25° C ambient	-10	-	-	<10
CR13	1N758A	400 mw at 25° C ambient	-10	2.4	24	<10
CR14	1N459	100 ma at 25° C ambient	+0.7 -7	1	<1	<10
CR15	1N457	75 ma at 25° C ambient	+0.7 -7	1.1	1	<10
CR16	1N968B	400 mw at 25° C ambient	19	10.7 peak	202 peak	51 peak
CR19*	1N916	75 ma at 25° C ambient and 250 mw max dissipation	+0.7 -6	3	2.1	<10

TABLE F-11
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1754284, 1753157, OR 1753189 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR20*	1N916	75 ma at 25° C ambient and 250 mw max dissipation	+0.7 -7.5	3	2.1	<10
CR18**	1N746A	400 mw at 25° C ambient	3.3	2.4	8	<10
CR18*	1N747B	400 mw at 25° C ambient	3.6	2.4	8.7	<10
Q1	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 4	0.4	1.6	<10
Q2	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 7.5	0.8	6.0	<10
Q3	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 7.5	0.8	6.0	<10
Q4	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 10	1.1	11	<10
Q5	2N930	300 mw at 25° C ambient	BE = 0.65 CE = 10	1.4	14	<10
Q6	2N930	300 mw at 25° C ambient	BE = 0.7 to -4 CE = 6	1.8	11	<10
Q7	2N943	250 mw at 25° C ambient	BE = 0.6 to -6.5 CE = -12.5	1.3	8	<10
Q8	2N916	1.2 w at 25° C case	BE = 1.25+ CE = 12.5	5.3	66	<10
Q9	2N916	1.2 w at 25° C case	BE = -2.7 CE = +12	4.2	51	<10
Q10	2N943	250 mw at 25° C ambient	BE = -9 peak CE = +7, -10	0.5	5	<10
Q11	2N722	220 mw at 25° C ambient	BE = +0.6 CE = +7	6.3	44	20
Q12	2N930	300 mw at 25° C ambient	BE = -5 peak CE = +6.3 peak	1	6.3	<10
Q13	2N916	1.2 w at 25° C case	BE = +0.75 CE = +0.75	1	0.75	<10
Q14*	2N916	1.2 w at 25° C case	BE = -6 CE = +6	1	6	<10

TABLE F-11
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1754284, 1753157, OR 1753189 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q15	2N722	220 mw at 25° C ambient	BE = +0.5, -3 CE = +12.5	1.1	13.7	<10
Q16	2N930	300 mw at 25° C ambient	CE = 15 BE = +0.5	0.2	3	<10
Q17	2N916	1.2 w at 25° C case	CE = +28 BE = +0.65	1.6	45	<10
Q18	2N943	250 mw at 25° C ambient	BE = -4 CE = +0.15	-	-	<10

*Used in partial-scan camera video amplifier only.
**Used in full scan video amplifier only.

TABLE F-12
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY HIGH-VOLTAGE REGULATOR, 1753007

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RB17	20Ω, 1/2 w	1.8	90	162	32
R2	8977933-218	1820Ω, 1/8 w	3	1.7	5	<10
R3	8977933-261	5.11 KΩ, 1/8 w	16	3.1	50	40
R4	8977933-289	10 KΩ, 1/8 w	20	2	40	32
R5	8977933-261	5.11 KΩ, 1/8 w	3.5	<1	2.4	<10
R6	8977933-128	200Ω, 1/8 w	1.5	<8	<12	<10
R8	8977933-184	806Ω, 1/8 w	6	7.5	44.5	36
R10	8977933-289	10 KΩ, 1/8 w	10	1	10	<10
R11	8977933-229	2.37 KΩ, 1/8 w	10	4.2	42	34
R12	8977933-289	10 KΩ, 1/8 w	10	1	10	<10
R13	8447750-1	100Ω, 1 w	0.7	7	5	<10
R14	RC07	22 KΩ, 1/4 w	5.5	<0.5	<1	<10
R15	RC20	1 KΩ, 1/2 w	0.06	-	-	<10
R16	RC07	12 KΩ, 1/4 w	11	1	10	<10
R17	8977939-293	11 KΩ, 1/4 w	11.5	1	12	<10
R18	RC07	470Ω, 1/4 w	-	-		<10
R19	RC07	4.7 KΩ, 1/4 w	1.8	<0.5	<1	<10
R20	RC07	4.7 KΩ, 1/4 w	2.5	0.5	1.3	<10
R21	8977939-285	9.09 KΩ, 1/4 w	8	<1	9	<10
R22	RC07	22 KΩ, 1/4 w	5	-	-	<10
R23	RC20	1 KΩ, 1/2 w	0.1	-	-	<10
R24	RC07	12 KΩ, 1/4 w	11	1	10	<10
R25	8977939-293	11 KΩ, 1/4 w	11	1	10	<10
R26	RC07	470Ω, 1/4 w	-	-		<10
R27	RC07	4.7 KΩ, 1/4 w	1.3	-	-	<10
R28	RC07	4.7 KΩ, 1/4 w	2.5	0.5	1.3	<10
R29	8977939-285	9.09 KΩ, 1/4 w	8	<1	9	<10
R33	RC07	39 KΩ, 1/4 w	3.5	-	-	<10
R34	RC07	2.7 KΩ, 1/4 w	2	-	-	<10

TABLE F-12
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY HIGH-VOLTAGE REGULATOR, 1753007 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R35	RC07	39 KΩ, 1/4 w	3	-	-	<10
R36	RB58	500 KΩ, 2 w	500	1	500	40
R37	RB58	500 KΩ, 2 w	500	1	500	40
R38	8977939-197	1.1 KΩ, 1/4 w	12	1.1	127	52
R39	RC07	39 KΩ, 1/4 w	8	-	-	<10
R40	RC07	39 KΩ, 1/4 w	24	0.6	15	<10
R41	RC07	39 KΩ, 1/4 w	18 peak	-	-	<10
R42	RB56	5 KΩ, 0.15 w	6	1.2	7.2	<10
R43	8447750-3	5 KΩ, 1 w	4.5	-	-	<10
R44	8977933-384	100 KΩ, 1/8 w	Test Point			<10
R45	8977933-384	100 KΩ, 1/8 w	Test Point			<10
R46	8977939-125	196Ω, 1/4 w	1.1 peak	-	-	<10
R47	8977933-	16.4 KΩto 150 KΩ, selected at 1/8 w	8	0.5	<4	<10
R48	8977939-125	196Ω, 1/4 w	4	20.4	81.5	33
R49	8977933-361	56.2 KΩ, 1/8 w, selected value	8	-	-	<10
R51	8977933-169	562Ω, 1/8 w	-	-		<10
R52	RC32	1000Ω, 1 w	18	18	324	32
R53	RC07	100Ω, 1/4 w	0.5 peak	5	2.5	<10
R54	RC07	5.6 KΩ, 1/4 w	5.6	1	5.5	<10
C7	CK06CW103M	0.01 μf, 200 volts	20			10
C8	CL45BH400SP3	40 μf, 30 volts	20			67
C9	CK06	0.01 μf, 200 volts	20			10
C10	CL45	40 μf, 30 volts	20			67
C13	1729503-1	0.001 μf, 1500 volts	1000			67
C14	1751107-1	0.01 μf, 1600 volts	1000			63
C16	CL45	100 μf, 30 volts	18			60
C17	CK06	3900 pf, 200 volts	3.5			<10
C18	HP5B30D1	5 μf, 30 volts	16			53

TABLE F-12
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY HIGH-VOLTAGE REGULATOR, 1753007 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR16	8447747-1 (1N1530A)	250 mw at 25° C ambient	8	11	88	35
CR19	1N816	150 mw at 25° C ambient	+0.6	1	0.6	<10
CR20	1N816	150 mw at 25° C ambient	+0.6	1	0.6	<10
CR21	1N816	150 mw at 25° C ambient	+0.6	-	-	<10
CR22	1N816	150 mw at 25° C ambient	+0.6	-	-	<10
CR25	8447747-1 (1N1530A)	250 mw at 25° C ambient	8	1.1	9	<10
CR26	1N765	250 mw at 25° C ambient	2	<5	<10	<10
Q10	8447743-1 (2N389)	85 w at 25° C case	BE = 0.6 CE = 8.5	100 peak	850	<10
Q11	2N1132	600 mw at 25° C ambient	BE = 0.6 CE = 22	2	44	<10
Q12	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 14.5	1	15	<10
Q13	2N718A	500 mw at 25° C ambient	BE = 0.6 CE = 0.6	3.1	2	<10
Q14	2N718A	500 mw at 25° C ambient	BE = 0.6 CE = 13.5	1	14	<10
Q15	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 14.5	1	15	<10
Q17	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 5	5	25	<10
Q18	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 6	1	6	<10
Q19	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 21	1	21	<10
Q20	2N718A	500 mw at 25° C ambient	BE = 0.6 CE = 7	0.5	3.5	<10

TABLE F-12
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY HIGH-VOLTAGE REGULATOR, 1753007 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q21	2N718A	500 mw at 25° C ambient	BE = 0.6 CE = 6	0.5	3	<10
Q22	2N718A	500 mw at 25° C ambient	BE = 0.7 CE = 1.8	20.4	38	<10
Q23	2N718A	500 mw at 25° C ambient	BE = 0.5 CE = 5	2	10	<10
Q24	2N718A	500 mw at 25° C ambient	BE = 0.6 CE = 20	1	20	<10
Q25	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 7	1	7	<10
Q26	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 7	0.5	3.5	<10
Q28	2N718A	500 mw at 25° C ambient	BE = 0.5 CE = 8.0	1	8	<10
Q29	2N1656	250 mw at 25° C ambient	BE = 0.4 CE = 21	0.6	13	<10
Q30	2N1656	250 mw at 25° C ambient	BE = 0.4 CE = 35 peak	0.6	<20	<10
Q31	2N718A	500 mw at 25° C ambient	BE = 0.4 CE = 8	1	8	<10
Q33	2N1613	800 mw at 25° C ambient	BE = 0.6 CE = 3.0	5	15	<10

TABLE F-13
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY CONVERTER POWER SUPPLY, 1754122

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R3*	RC20	100 Ω, 1/2 w	3	3	9	18
R4*	RC07	22 Ω, 1/4 w	0.5	23	14	<10
R5	RC20	1800 Ω, 1/w	26	14.5	375	38
R6*	RC20	120 Ω, 1/2 w	2.5	20	52	10
R8*	RC20	180 Ω, 1/2 w	2.8	8	11	<10
R9*	RC07	22 Ω, 1/4 w	0.5	23	14	<10
R11	RC32	5.6 KΩ, 1 w	23	4.1	94	<10
R12*	RC32	120 Ω, 1/2 w	2.5	20	52	10
C2	CL45	60 μf, 50 volts	26			52
C5	CL45	25 μf, 50 volts	23			46
C6	CL45	100 μf, 30 volts	22			73
C8	8924416-310	1000 pf, 500 volts	25			<10
CR3	1N645	600 mw max at 25° C ambient	+0.75, -1.8	14.5	11.4	<10
CR6	1N645	600 mx max at 25° C ambient	+0.8, -0.2	4.1	3.3	<10
Q1**	2N1486	25 w at 25° C case	BE = 0.6, -5 CE = 50	92	90	<10
Q2**	2N1486	25 w at 25° C case	BE = 0.6, -5 CE = 50	92	90	<10
Q3**	2N1486	25 w at 25° C case	BE = 0.6, -5 CE = 43	188	180	<10
Q4**	2N1486	25 w at 25° C case	BE = 0.6, -5 CE = 43	188	180	<10
Q5**	2N1485	25 w at 25° C case	BE = 0.6 DC CE = 4	188	750	<10
L1	8701590-263	I rating = 760 ma R = 0.65 Ω	0.3 DC		NA	
L2	8701590-263	I rating = 760 ma R = 0.65 Ω	0.3 DC		NA	
T1	1175301-1	Toroidal Transformer	Not Ascertained			
T2	1175301-2	Toroidal Transformer	Not Ascertained			

*Square wave
**Approximately 50% duty cycle

TABLE F-14
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY LOW-VOLTAGE REGULATOR, 1754123B

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1*	RC07	220 Ω, 1/4 w	Peak 3 Avg. d-c 1	13.7 peak	4.1	40
R2	RC07	220 Ω, 1/4 w	-	-		<10
R3	8977933-1	10 Ω, 1/8 w	0.01	1.0	0.01	<10
R4	8977933-	10 Ω, 1/8 w	-	-	-	<10
R5	8977939-24	3.16 KΩ, 1/4 w	6	1.9	11.4	<10
R6	RC07	4.7 KΩ, 1/4 w	0.8	0.17	0.136	<10
R7	8977939-26	5.11 KΩ, 1/4 w	5.5	1.08	6.0	<10
R8	RC07	220 Ω, 1/4 w	2 peak-to-peak	9.1 peak	18 peak	<10
R9	RC07	220 Ω, 1/4 w	-	-	-	<10
R10	RC20	2.7 KΩ, 1/2 w	26	9.6	250	50
R11	RC20	1.8 KΩ, 1/2 w	20	11.1	222	44
R12	8977933-	196 Ω, 1/8 w	0.1	0.51	0.05	<10
R13	8977933-	90.9 Ω, 1/8 w	0.1	1.1	0.11	<10
R14	8977939-241	3.16 KΩ, 1/4 w	6.5	2.06	13.4	<10
R15	RC07	4.7 KΩ, 1/4 w	0.5	0.106	0.053	<10
R16	8977739-261	5.11 KΩ, 1/4 w	6	1.17	7.02	<10
R17	RC07	39 KΩ, 1/4 w	42	1.08	45.5	18
R19	RC07	470 Ω, 1/4 w	1.5 peak	3.2	4.8	<10
R20	RC07	470 Ω, 1/4 w	1.5 peak	3.2	4.8	<10
R21**	8447750-5	25 KΩ, ww 1w, P51	25 d-c +50 peak	4 peak	5.0	<10
R22	RC20	360 KΩ, 1/2 w	290 peak	0.81	235 peak	47 peak
R23***	RC07	270 Ω, 1/4 w	0.5 d-c + 4 peak	52 peak	43.4	17.5
R24***	RC07	270 Ω, 1/4 w	1.0 d-c + 4 peak-to-peak	3.52 peak	52.2	21
R25	RC20	130 KΩ, 1/2 w	115	0.113	13.0	<10
R26	RC20	4.7 Ω, 1/4 w	1 peak-to-peak	106	53	21
R27	RC20	4.7 Ω, 1/4 w	1 peak-to-peak	106	53	21
R28	8977933-384	100 KΩ, 1/8 w	Test Point			<10
R29	RC07	470 Ω, 1/4 w	1.2 d-c + 9 peak	19.2 peak	4.8	<10
R30	RC07	470 Ω, 5%, 1/4 w	1.2 d-c + 9 peak-to-peak	19.2 peak	4.8	<10

TABLE F-14 ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY LOW-VOLTAGE REGULATOR, 1754123B (Continued)						
Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R31	847750-5	25 KΩ, 1 w	50	2	100	<10
R32	RC07	51 KΩ, 1/4 w	1.8	0.035	0.06	<10
R33	8977933-384	100 KΩ, 1/8 w	2.5	0.025	0.063	<10
R34	RC20	360 KΩ, 1/2 w	290 peak	0.8 peak	232	47 peak
C1	CL45	170 μf, 15 volts	7			47
C2	CL45	100 μf, 30 volts	6			47
C3	CL45	170 μf, 15 volts	7			47
C4	CL45	100 μf, 30 volts	6			20
C5A	1175388-2	0.22 μf, 1500 volts	950			63
C5B	1175388-2	0.22 μf, 1500 volts	950			63
C7	8980848-576	0.15 μf, 600 volts	290			48
C8	8980848-576	0.15 μf, 600 volts	280			47
C9	8980848-514	0.15 μf, 200 volts	120			60
C10	8980848-514	0.15 μf, 200 volts	115			58
C11	CL45	60 μf, 50 volts	25			50
C12	CL45	40 μf, 75 volts	30			40
C13	CL45	40 μf, 75 volts	48			64
C14	CL45	40 μf, 75 volts	32			43
C15‡‡	CK06	3900 pf, 2000 volts	50			25
C16‡‡	UDM	2700 pf, 1500 volts	260			17
CR1 ♦	1N3189		0.8	300	240 peak	12
CR2 ♦	1N3189		0.8	300	240 peak	12
CR3 ♦	1N3189		0.8	300	240 peak	12
CR4 ♦	1N3189		0.8	300	240 peak	12
CR5	1N827		6.0	9	54	22
CR6	1N816		0.6	1.2	0.7	<10
CR7 ♦	1N3189		0.8	300	240 peak	12
CR8 ♦	1N3189		0.8	300	240 peak	12
CR9 ♦	1N3189		0.8	300	240 peak	12
CR10 ♦	1N3189		0.8	300	240 peak	12

TABLE F-14
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY LOW-VOLTAGE REGULATOR, 1754123B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR11	1N827		6.0	9	54	22
CR12	1N816		0.6	1.2	0.7	<10
CR13	PS2419		+4, -1200	1.2	5	< 10
CR14	1N648		+1,	3.5	3.5	<10
CR15	1N648		+1	3.5	3.5	<10
CR16	1N648		+1	3.5	3.5	<10
CR17	1N648		+1	3.5	3.5	<10
CR18	1N646		+1, -120	22	2	<10
CR19	1N646		+1, -120	22	2	<10
CR20	1N646		+1, -120	22	2	<10
CR21	1N646		+1, -120	22	2	<10
CR22	8982499-1 1N645	400 mw at 25° C ambient	+0.7, -28	105	75	<20
CR23	8982944-1 1N645	400 mw at 25°C ambient	+0.7, -28	105	75	<20
CR24	8982944-1 1N645	400 mw at 25°C ambient	+0.7, -28	105	75	<20
CR25	8982944-1 1N645	400 mw at 25°C ambient	+0.7, -28	105	75	<20
CR26	8982944-1 1N645	400 mw at 25°C ambient	+0.7, -36	100	70	<20
CR27	8982944-1 1N645	400 mw at 25°C ambient	+0.7, -36	100	70	<20
CR28	8982944-1 1N645	400 mw at 25°C ambient	+0.7, -36	100	70	<20
CR29	8482944-1 1N645	400 mw at 25°C ambient	+0.7, -36	100	70	<20
CR30	8482944-1 1N645	400 mw at 25°C ambient	+0.7, -50	2.6	18	<10
CR31	8482944-1 1N645	400 mw at 25°C ambient	+0.7, -50	2.6	18	<10
CR32	8482944-1 1N645	400 mw at 25°C ambient	+0.7, -50	2.6	18	<10

TABLE F-14
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY LOW-VOLTAGE REGULATOR, 1754123B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR33	8482944-1 1N645	400 mw at 25°C ambient	+0.7, -50	2.6	18	<10
Q1	2N722	270 mw at 25°C ambient	BE = 0.6 CE = 6.0	13.7	82	30
Q2	2N1485	9.4 w at 25°C ambient	BE = 0.7 CE = 0.8	1000	800	<10
Q3	2N7184	500 mw at 25° C ambient	BE = 0.4 CE = 5.0	1	5	<10
Q4	2N1485	9.4 w at 25° C ambient	BE = 0.6 CE = 0.9	1000	800	<10
Q5	2N722	270 mw at 25°C ambient	BE = 0.6 CE = 5.0	9	45	17
Q6	2N718A	500 mw at 25°C ambient	BE = 0.6 CE = 5.0	1	5	< 10
L1	1X3000L			NOT ASCERTAINED		
L2	1X3000L					
L3	1X3000L					
L4	1X3000L					

*10% duty cycle
**5% duty cycle
***7.5% duty cycle
†1% duty cycle
‡square wave
♦50% duty cycle

TABLE F-15
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1754253

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	1100Ω, 1/4 w	6	5.45	32.7	13
R2	RC07	4700Ω, 1/4 w	7	1.5	10.4	<10
R3	RC07	10 KΩ, 1/4 w	Test	Point		<10
R4	8977933-269	6190Ω, 1/8 w	12	1.95	23.3	19
R5	8977933-318	20 KΩ, 1/8 w	8.5	0.425	3.5	<10
R6	8977933-269	6190Ω, 1/8 w	5	0.83	4	<10
R7	8977933-289	10 KΩ, 1/8 w	3	--	--	<10
R8	RC07	6.2 KΩ, 1/4 w	7	1.5	10.4	<10
R9	RC07	6.2 KΩ, 1/4 w	5.5	0.85	5	<10
R10	8977933-346	39.2 KΩ, 1/8 w	12.5	0.32	0.3	<10
R11	RC07	39 KΩ, 1/4 w	1	--	--	<10
R12	RC07	120 KΩ, 1/4 w	13	--	--	<10
R13	8977933-193	1 KΩ, 1/8 w	0.8	0.8	0.64	<10
R14	RC07	100 KΩ, 1/4 w	18	--	--	<10
R15*	8977939-193	1000Ω, 1/4 w	2 VDC plus 12 peak	12 peak	18	<10
R16	8977933-234	2670Ω, 1/8 w	2.5	1	2.4	<10
R17	8977933-330	26 KΩ, 1/8 w	22	0.83	18.4	15
R18	RC07	10 KΩ, 1/4 w	12	1.2	14	<10
R19	RC07	6.2 KΩ, 1/4 w	12	2	24	<10
R20	RC07	15 KΩ, 1/4 w	11	7.5	8	<10
R21	RC07	10 KΩ, 1/4 w	16	1.6	25.6	<10
R22	RC07	6200Ω, 1/4 w	18	3	54	21
R23	RC07	15 KΩ, 1/4 w	10	0.67	7	<10
R24	RC07	33 KΩ, 1/4 w	10	0.33	3	<10
R25	RC07	1 KΩ, 1/4 w	4	4	16	<10
R26	RC07	1 KΩ, 1/4 w	6	6	36	14
R27	8977933-314	18.2 KΩ, 1/8 w	12.5	0.69	8.6	<10
R28	1700383-5	2 KΩ, 1 w	2	--	--	<10
R29	1700383-9	25 KΩ, 1 w	6.5		1.7	<10
R30	RC07	33 KΩ, 1/4 w	5	--	--	<10

TABLE F-15
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1754253 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R31	RC07	1 KΩ, 1/4 w	5	5	25	<10
R32	RC07	680Ω, 1/4 w	5	7.35	37	15
R33	1700383-9	25 KΩ, 1 w	18	0.72	15	<10
R34	RC07	4300Ω, 1/4 w	4	1	4	<10
R35	RC07	15 KΩ, 1/4 w	30	2	60	24
R36	RC07	120 KΩ, 1/4 w	20	0.167	3.3	<10
R37	RC07	100 KΩ, 1/4 w	11	0.11	1.2	<10
R38	RC07	1 KΩ, 1/4 w	0.2	--	--	<10
R39	RC07	1 KΩ, 1/4 w	0.3	--	--	<10
R40	1700383-9	25 KΩ, 1 w	20	0.8	16	<10
R41	RC07	120 KΩ, 1/4 w	20	0.167	3.3	<10
R42	RC07	100 KΩ, 1/4 w	11	0.11	1.2	<10
R43	RC07	51 KΩ, 1/4 w	18	0.4	6.4	<10
R44	RC07	100 KΩ, 1/4 w	10	--	--	<10
R45	1700383-7	10 KΩ, 1 w	20	2	40	<10
R46	1700383-9	25 KΩ, 1 w	20	0.8	16	<10
C1	CK05	0.001 μf, 200 volts	17			<10
C2	CK05	120 pf, 200 volts	3			<10
C3	CK05	0.001 μf, 200 volts	17			<10
C4	CK05	6200 pf, 200 volts	11			<10
CR1	1N916	250 mw at 25°C ambient	+0.5, 7.0	1	0.5	<10
CR2	1N2039B	750 mw at 25°C	20	1.5	30	<10
CR3	1N916	250 mw at 25°C ambient	+0.5, -10.0	2 plus 12 peak	6 peak	<10
CR4	1N916	250 mw at 25°C ambient	+0.4, -11.0	2 plus 12 peak	5 peak	<10
CR5	1N916	250 mw at 25°C ambient	+0.5, -16	--	--	<10
CR6	1N916	250 mw at 25°C ambient	+0.6, -7.0	4	2.5	<10

TABLE F-15
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION PROGRAMMER, 1754253 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR7	1N916	250 mw at 25°C ambient	+0.5, -15	1 peak	0.5	<10
CR8	USAF 1N645	600 mw at 25°C ambient	+0.7	12 peak	8.4	<10
CR9	USAF 1N645	600 mw at 25°C ambient	+0.7, -5.5	12 peak	8.4	<10
Q1	2N2432	300 mw at 25°C ambient	BE = -10, +0.7 CE = 11.5	2 peak	1.4	<10
Q2	2N1132	600 mw at 25°C ambient	BE = 0.6 CE = 4.0	5.5	3.3	<10
Q3	2N916	360 mw at 25°C ambient	BE = 1.2 CE = 5.5	1	1.2	<10
Q4	2N2432	300 mw at 25°C ambient	BE = 10 CE = 9	12 peak	7.2 peak	<10
Q5	1175999 (2N943)	250 mw at 25°C ambient	BE = 4.5, -0.7 CE = 0.9	2	2	<10
Q6	2N869	360 mw at 25°C ambient	BE = 0.9 CE = 12	2	2	<10
Q7	2N916	300 mw at 25°C ambient	BE = -3.5, +0.8 CE = 11.5	6	25	<10
Q8	2N2432	300 mw at 25°C ambient	BE = 0.7, -1.5 CE = 7.5	1	1	<10
Q9	1175999	250 mw at 25°C ambient	BE = 7.5 CE = 4.0	1	1	<10
Q10	1175999	250 mw at 25°C ambient	BE = 5.0 CE = 6.5	1	1	<10
Q11	2N2432	300 mw at 25°C ambient	BE = 5.5 CE = 11.0	7.5	5	<10
Q12	2N2432	300 mw at 25°C ambient	BE = 11, 0.6 CE = 0.5	12	7	<10
Q13	2N2432	300 mw at 25°C ambient	BE = 11.5 CE = 0.5	10	5	<10
Q14	1175999	250 mw at 25°C ambient	BE = 16 CE = 0.6	10	5	<10

*10% duty cycle

TABLE F-16
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 1754360

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	10 KΩ, 5%, 1/4 w	5	0.5	2.5	<10
R2	RN65	5.11 KΩ, 1/4 w	10	2	20.	<10
R5	RN65	2.37 KΩ, 1/4 w	5	--	--	<10
R7	RN65	100 KΩ, 1/4 w	4	--	--	<10
R8	RC07	100 KΩ, 5%, 1/4 w	3	--	--	<10
R9	8977933-66	47.5 Ω, 1/8 w	0.3	7	2	<10
R10	RC07	1.5 KΩ, 5%, 1/4 w	5	3.3	16.5	<10
R11	8977939-239	3.01 KΩ, 1/4 w	4	--	--	<10
R12	8977933-66	47.5 Ω, 1/8 w	0.04	--	--	<10
R13	8977939-209	1.47 KΩ, 1/4 w	5 to 9	6.2 max	55 max	22
R15	RC07	1 KΩ, 5%, 1/4 w	5	5	25	<10
R16*	8977939-147	332 Ω, 1/4 w	0 to 4	12 max	24	<10
R17	RC07	27 Ω, 5%, 1/4 w	0.02 to 0.12	--	--	<10
R18	8977939-258	4.75 KΩ, 1/4 w	5	--	--	<10
R19	8977939-289	10 KΩ, 1/4 w	45	4.5 peak	200 peak	40
R20	RC07	22 KΩ, 5%, 1/4 w	24	1.1	28	11
R21**	RC07	270 Ω, 1/4 w	0.5	--	--	<10
R22*	8977939-339	33.2 KΩ, 1/4 w	+24 to -24	<1	18	<10
R23	RC20	27 Ω, 1/2 w	1.6 peak	60	96 peak	19 peak
R24	RC20	27 Ω, 1/2 w	2.2 peak	81	180 peak	36 peak
R25*	RC07	4.7 KΩ, 5%, 1/4 w	+20 to -20	50 peak	103	41
R26	RN75C	511 Ω, 1 w	+ 5 to -7	14 peak	96 peak	<10
R27	RC07	6.2 KΩ, 1/4 w	1.7	--	--	<10
R28	RN65C	2.37 KΩ, 1/4 w	7.5	3.1	24	<10
R29	RC07	6.2 KΩ, 1/4 w	--	--	--	<10
R30	RN65C	2.37 KΩ, 1/4 w	8	3.3 peak	27	11 peak
R31	RN65C	1.0 KΩ, 1/4 w	3	3.0 peak	9	<10
R32	RN65C	1.0 KΩ, 1/4 w	3.5	3.5 peak	13	<10
R33	RN65C	100 KΩ, 1/4 w	8	--	--	<10

TABLE F-16
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 1754360 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R34	NC07	100 KΩ, 1/4 w	2	--	--	<10
R35	8977933-66	47.5 Ω, 1/8 w	0.5	3	0.5	<10
R36	RC07	1.5 KΩ, 1/4 w DC	5	3.3	17	<10
R37	8977939-239	3.01 KΩ, 1/4 w	3.5	1.5	4.1	<10
R38	8977933-66	47.5 Ω, 1/8 w	0.10	2	0.2	<10
R39	8977939-209	1.47 KΩ, 1/4 w DC	6	4	24	<10
R40	RC07	100 Ω, 1/4 w	--	--	--	<10
R41	RC07	2.2 KΩ, 1/4 w	5	2.3	11	<10
R42	8977939-147	332 Ω, 1/4 w	0.8	2.4 peak	2.4	<10
R43	RC07	100 Ω, 1/4 w	--	--	--	<10
R44	8977939-258	4.75 KΩ, 1/4 w	5	1.1	5.5	<10
R45	8977939-289	10 KΩ, 1/4 w	40	4 peak	160 peak	64 peak
R46	RC07	22 KΩ, 1/4 w	22	1	22	<10
R47	RC07	270 Ω, 1/4 w	0.2	<1 peak	<1	<10
R48	8977939-339	33.2 KΩ, 1/4 w	22	<1 peak	<22	<10
R49	RC20	27 Ω, 1/2 w	0.5	18	9	<10
R50	RC20	27 Ω, 1/2 w	0.5	18	9	<10
R51	RC07	6.2 Ω, 1/4 w	27 peak-to-peak	2.2	59	23
R52	RN75C	316 Ω, 1 w	+3.5 to -6	19 peak	79	<10
R53	RC07	10 KΩ, 1/4 w	Test Point			<10
R54	RC07	10 KΩ, 1/4 w	Test Point			<10
R56	RC07	560 Ω, 5%, 1/4 w	0.1	<1	<1	<10
R59**	RC07	1.5 KΩ, 1/4 w	15 peak-to-peak	10 peak	50	<10
R60	RC07	30 Ω, 5%, 1/4 w	-	-	-	<10
C1	1729236-1	3.0 μf, 150 volts	8			<10
C2	1729236-1	3.0 μf, 150 volts	8			<10
C3	1729236-1	3.0 μf, 150 volts	8			<10
C4	8412778-87	1.0 μf, 35 volts	6			17
C5	VK30	6200 μf, 200 volts	22			11
C6	1171712-3	10,000 μf, 100 volts	6			<10

TABLE F-16
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 1754360 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
C7	CK05	1000 pf, 200 volts	3			<10
C8	8914319-345	750 pf, 300 volts	50 peak			17
C9	CK05	1000 pf, 200 volts	25			13
C10	CK05	1000 pf, 200 volts	25 peak			13
C11	CK05	1000 pf, 200 volts	3			<10
C12	CK06	2200 pf, 200 volts	1.5			<10
C13	1171712-3	10,000 pf, 100 volts	6			<10
C14	8914319-336	330 pf, 100 volts	+25 to -25			25
C15	CK05	6.2 pf, 200 volts	22			11
CR1	1N916	250 mw at 25° C ambient	0.7	<7	<5	<10
CR2	1N916	250 mw at 25° C ambient	0.7	<7	<5	<10
CR3	1N645	600 mw at 25° C ambient	0.65	<6	<5	<10
CR4	1N645	600 mw at 25° C ambient	0.65	<6	<5	<10
CR5	1N916	250 mw at 25° C ambient	0.7	<6	<5	<10
CR6	1N916	250 mw at 25° C ambient	0.7	<6	<5	<10
CR7	1N2032	750 mw at 25° C ambient	4	1	4	<10
CR8	1N916	250 mw at 25° C ambient	0.7	<5	<5	<10
CR9	1N916	250 mw at 25° C ambient	0.7	<5	<5	<10
CR10	1N916	250 mw at 25° C ambient	0.6	<5	<5	<10
CR11	1N916	250 mw at 25° C ambient	0.6	<3	<5	<10
CR12	1N916	250 mw at 25° C ambient	0.75	<6	<5	<10

TABLE F-16
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 1754360 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR13	1N916	250 mw at 25° C ambient	0.7	<6	<5	<10
CR14	1N2032	750 mw at 25° C ambient	4	5 peak	20	40
Q1	2N943	250 mw at 25° C ambient	BE = +3, -0.4 CE = 10	2 peak	1	<10
Q3	2N930	300 mw at 25° C ambient	BE = +0.6 CE = 6	6	3.6	<10
Q4	2N722	400 mw at 25° C ambient	BE = +0.6 CE = 6	12 peak	72	18
Q5	2N930	300 mw at 25° C ambient	BE = 0.6, -2.5 CE = 4	1	4	<10
Q6	2N930	300 mw at 25° C ambient	BE = +0.7 CE = 4.5	12 max	54	18
Q7	2N722	400 mw at 25° C ambient	BE = +0.6 CE = 24	1	24	<10
Q8	2N1893	800 mw at 25° C case	BE = +0.6, -7 CE = 50 peak	1.8	93	12
Q9	2N1893	800 mw at 25° C case	BE = 0.6, -3 max CE = 50	4.5	225	27
Q10	2N498	4 w at 25° C case	BE = 0.6 CE = 50	18	900	23
Q11	2N1244	1 w at 25° C case	BE = 12.5, -1.8 CE = 50	81	145	14.5
Q12	2N943	250 mw at 25° C ambient	BE = 0.6, -5 CE = 0.5, -7.5	3 peak	1.5	<10
Q13	2N943	250 mw at 25° C ambient	BE = 0.6, 8 CE = 0.5, 8	3.5 peak	2.2	<10
Q14	2N930	300 mw at 25° C ambient	BE = +0.6, -3 CE = -5, -6 peak	<0.1	<1	<10
Q15	2N722	400 mw at 25° C ambient	BE = 0.8, -0.7 CE = 5, -6 peak	3	18	<10
Q16	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 4	2	8	<10
Q17	2N930	300 mw at 25° C ambient	BE = 0.6 to -2.5 CE = 4.5	2.4	11	<10

TABLE F-16
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY DEFLECTION AMPLIFIER, 1754360 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q18	2N722	400 mw at 25° C ambient	BE = 0.6 CE = 25	1.1	28	<10
Q19	2N718A	500 mw at 25° C ambient	BE = 0.6, -0.3 CE = 40	1 peak	40	<10
Q20	2N718A	500 mw at 25° C ambient	BE = 0.6, -6 CE = 50	4	40	<10
Q21	2N498	4 w at 25° C case	BE = 0.6, -0.3 CE = 40	18	720	18
Q22	2N1244	1 w at 25° C case	BE = 0.6, -1 CE = 15, 54	18	270	27

*Approximately 50% duty cycle
**Square wave
***30% duty cycle

TABLE F-17
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR; 1753178

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	8977933-384	100 KΩ, 1/8 w	Test Point			< 10
R2	8977933-384	100 KΩ, 1/8 w	Test Point			< 10
R3	RC07	180 KΩ, 1/4 w	6			< 10
R4	RC07	300 KΩ, 1/4 w	8			< 10
R5	8977940-437	432 KΩ, 1/2 w	300	0.70	210	42
R6	RC07	8200 Ω, 1/4 w	6	0.73	4.4	< 10
R7	8977940-437	432 KΩ, 1/2 w	350	0.81	283	57
R8	8977933-281	8250 Ω, 1/8 w	15 to 25	1.82 to 3.04	51	42
R9	8977933-289	10 KΩ, 1/8 w	1 to 10	1	10	< 10
R10	8977933-377	84.5 KΩ, 1/8 w	25	0.30	7.5	< 10
R11	RC07	1 MegΩ, 1/4 w	1			< 10
R12	RC07	470 KΩ, 1/4 w	1.5			< 10
R13	8977933-269	6190 Ω, 1/8 w	2	0.32	0.65	< 10
R14	8447750-5	25 KΩ, 1 w	35	1.4	49	< 10
R15	RC07	100 KΩ, 1/4 w	2.5	-	-	< 10
R16	8977940-429	294 KΩ, 1/2 w	250	0.85	220	43
R18	8977933-325	23.7 KΩ, 1/8 w	6 to 25	0.38 to 1.1	1.6 to 27	< 10 to 21 max
R19	8977933-365	61.9 KΩ, 1/8 w	5 to 18	0.08 to 0.29	0.4 to 5.2	< 10
R20	8977933-409	182 KΩ, 1/8 w	20 to 52	0.11 to 0.14	2.2 to 3.4	< 10
R21	RC07	100 KΩ, 1/4 w	70 max	0.70	49	20 max
R22	8977933-365	61.9 KΩ, 1/8 w	15	0.24	3.6	< 10
R23	8447750-5	25 KΩ, 1 w	8	0.32	2.5	< 10
R24	844749-1	200 KΩ	40	0.2	8	< 10
R25	8977933-421	243 KΩ, 1/8 w	120	0.50	60	48
R26	RC20	2.4 MegΩ, 1/2 w 350 volts	320	0.144	40	< 10
R27	RC20	2.4 MegΩ, 1/2 w	220	0.096	20	< 10

TABLE F-17
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR; 1753178 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R28	RC20	2.4 MegΩ, 1/2 w 350 volts	180	0.075	17	<10
R29	RC20	2.4 MegΩ, 1/2 w	3.5	-	-	<10
R30	RC20	3.3 MegΩ, 1/2 w	290	-	-	<10
R31	RC07	18 KΩ, 1/4 w	3.5	0.2	7	<10
R32	RC07	10 KΩ, 1/4 w	3	0.3	1	<10
R33	RC07	10 KΩ, 1/4 w	6.3	0.63	4	<10
R41	RC07	10 KΩ, 1/4 w	2	-	-	<10
R42	RC07	75 KΩ, 1/4 w	10	0.13	1.3	<10
R43	RC07	3.3 MegΩ, 1/4 w	10	-	-	<10
R44	RC07	47 KΩ, 1/4 w	6.3	-	-	<10
R45	RC07	10 KΩ, 1/4 w	3	0.3	1	<10
R46	RC07	100 KΩ, 1/4 w	25	0.25	6.25	<10
R47	RC07	3.3 MegΩ, 1/4 w	8	-	-	<10
R48	RC07	4.7 KΩ, 1/4 w	6.3	0.14	1	<10
R49	RW59	1 KΩ, 3 w		150	22	<10
R50	RC07	1KΩ, 1/4 w	-	-	-	<10
R51	RC07	10 KΩ, 1/4 w	5	0.5	2.5	<10
R52	RC07	39 KΩ, 1/4 w	27.5	0.7	19	<10
R53	RC07	100 KΩ, 1/4 w	Test Point			<10
R55	RC07	18 KΩ, 1/4 w	45	2.5	112	45
R56	RC07	330 KΩ, 1/4 w	-	-	-	<10
R57	RC07	330 KΩ, 1/4 w	5	-	-	<10
R58	RC07	330 KΩ, 1/4 w	7	-	-	<10
R59	RC07	75 KΩ, 1/4 w	3	-	-	<10
R60	RC07	24 KΩ, 1/4 w	1	-	-	<10
R61	RC07	43 KΩ, 1/4 w	1.5	-	-	<10
C1	CP09	0.033 μf, 600 volts	295			49
C2	CP09	0.015 μf, 600 volts	295			49
C3	8412778-76	22 μf, 15 volts	6			40

TABLE F-17
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR; 1753178 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
C4	8914319-316	47 pf, 500 volts	10			<10
C5	8412778-76	22 μf, 15 volts	7			47
C6	CK06	0.01 μf, 200 volts	70 max			35 max
C7	8914319-316	47 pf, 500 volts	20			<10
C10	8421778-304	180 μf, 6 volts	1.5			25
C11	8421778-10	15 μf, 20 volts	3			15
C12	8421778-10	15 μf, 20 volts	4			20
C13	CK06	0.01, 200 volts	80			40
C14	8421778-61	22 μf, 35 volts	8			23
C15	8421778-61	22 μf, 35 volts	10			29
CR1	JAN1N457	75 ma at 25° C ambient	0.7	4	28	<10
CR2	JAN1N457	75 ma at 25° C ambient	4	0	0	<10
CR3	USN1N978B	400 mw at 25° C ambient	4.0	0	0	<10
CR4	JAN1N457	75 ma at 25° C ambient	+0.6, -5.0			<10
CR5	JAN1N457	75 ma at 25° C ambient	+0.6, -5.0			<10
CR6	USN1N989B	400 mw at 25° C ambient	140	0.24	36	<10
CR7	USN1N989B	400 mw at 25° C ambient	140	0.24	36	<10
CR11	JAN1N457	75 ma at 25° C ambient	+0.6, -7.0	-	-	<10
CR12	JAN1N457	75 ma at 25° C ambient	+0.6, -10	-	-	<10
CR13	JAN1N457	75 ma at 25° C ambient	0.6	-	-	<10
CR14	1N916	75 ma at 25° C ambient	+0.6 peak, -0.4	0.73		<10
CR15	USN1N645	400 ma at 25° C ambient	-75 peak	100	7.5	<10
CR16	USAF1N3041	1 w at 25° C case	75	4	300	30
CR17	1N916	75 ma at 25° C ambient	-0.5	$I_R = 0$	-	<10

TABLE F-17
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY G1 REGULATOR; 1753178 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR18	1N916	75 ma at 25° C ambient	-10	-		<10
CR19	1N916	75 ma at 25° C ambient	-	-		<10
CR20	1N963	400 mw at 25° C ambient	9	-		<10
Q1	2N916	360 mw at 25° C ambient	BE = 2.0, 0.6 CE = 6 to 0.6	0.73	4.2	<10
Q2	2N722	400 mw at 25° C ambient	BE = +0.6 to -0.6 CE = 0 to 19		23	6
Q3	2N718A	500 mw at 25° C ambient	BE = 0.6 to 0 CE = 0.6 to 0	0.32	0.2	< 10
Q4	2N722	400 mw at 25° C ambient	BE = 0.5 CE = 25	0.025	0.6	<10
Q5	2N1656	250 mw at 25° C ambient	BE = 1.0 CE = 75		53	21
Q6	2N1656	250 mw at 25° C ambient	BE = 8 CE = 27	0.32	11	<10
Q7	2N722	400 mw at 25° C ambient	BE = 0.5 CE = 8	0.3	2.4	<10
Q10	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 26	0.05	1.3	<10
Q11	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 10	0.134	1.34	<10
Q12	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 10	0.14	1.4	<10
Q13	2N722	220 mw at 25° C	BE = 0.6 CE = 4	0.7	2.8	<10

TABLE F-18
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY SHUTTER AND LAMP DRIVE, 1753099D

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	6.2 KΩ, 1/4 w	7.5	1.2	9.0	<10
R2	RC07	10 KΩ, 1/4 w	4	0.4	1.6	<10
R3	RC07	10 KΩ, 1/4 w	1	0.1	0.1	<10
R4	RC07	3.3 KΩ, 1/4 w	5	1.5	7.5	<10
R5	RC32	1 KΩ, 1 w	16	16	256	26 peak
R6	RC07	330 KΩ, 1/4 w	2	--	--	<10
R7*	RC07	3.3 KΩ, 1/4 w	+5 to +15	4.5 peak	68 peak	27 peak
R8	RC07	120 KΩ, 1/4 w	18	0.15	2.5	<10
R9	RC07	20 KΩ, 1/4 w	12	0.6	7.2	<10
R10	RC07	6.2 KΩ, 1/4 w	15	2.4	36	<10
R11	RC07	6.2 KΩ, 1/4 w	15	2.4	36	<10
R12	RC07	20 KΩ, 1/4 w	11	0.55	6.0	<10
R13	RC07	120 KΩ, 1/4 w	18	0.15	2.5	<10
R14	RC07	3.3 KΩ, 1/4 w	15	4.5	67.5	27
R15	RC07	330 KΩ, 1/4 w	2	0.006	0.012	<10
R16	RC07	33 KΩ, 1/4 w	27	0.82	22	<10
R17	RC07	1 KΩ, 1/4 w	4.5	4.5	20	<10
R18**	RC20	1 KΩ, 1/2 w	20	20	19	<10
R19	RC07	1 KΩ, 1/4 w	4	4	16	<10
R20	RC20	220 Ω, 1/2 w	3	13.7	41.1	<10
R21	RC07	1 KΩ, 1/4 w	0.7	0.7	0.49	<10
R22	RC32	22 Ω, 1 w	1.2	55	66	<10
R23	RC07	820 Ω, 1/4 w	1	1.25	1.25	<10
R24	RC07	220 Ω, 1/2 w	3.5	16.0	56	11
R25	RC32	10 Ω, 1 w	0.5	50	25	<10
R26*	Type RS-2	1.0 Ω, 3 w	1.6	1600	122	<10
R27*	Type RS-2	1.0 Ω, 3 w	1.6	1600	122	<10
R28	RC32	10 Ω, 1 w	0.6	60	36	<10
R29	RC20GF	220 Ω, 1/2 w	4	18.2	72.8	15
R30***	Type RS-2	1.0 Ω, 3 w	1.6	1600	225	<10

TABLE F-18
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY SHUTTER AND LAMP DRIVE, 1753099D (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R31	RC32GF	22 Ω, 1 w	1.0	45.5	45.5	<10
R32	RC20GF	220 Ω, 1/2 w	3	13.6	40.8	<10
R33	RC07GF	1 KΩ, 1/4 w	0.8	0.8	0.64	<10
R34	RC07GF	1 KΩ, 1/4 w	0.8	0.8	0.64	<10
R35**	RC20GF	1 KΩ, 1/2 w	20	20	19	<10
R36	RC20GF	1 KΩ, 1/4 w	5	5	25	10
R37	RC07GF	33 KΩ, 1/4 w	27	0.82	22	<10
R38	RC07GF	10 KΩ, 1/4 w	0.3	0.03	0.009	<10
R39	RC07GF	10 KΩ, 1/4 w	0.3	0.03	0.009	<10
R41***	RC07GF	200 Ω, 1/4 w	6	30	18	<10
R42	RC07GF	2.2 KΩ, 1/4 w	+2.5 to -4.5	3.2	11.2	<10
R43	RC07GF	5.6 KΩ, 1/4 w	-3, +6	1.6	14.4	<10
R44	RC07GF	10 KΩ, 1/4 w	15	1.5	22.5	<10
R45	RC07GF	68 Ω, 1/2 w	17 peak	250 peak	400 (P) 27 (F)	80 (P) <10 (F)
R46	RC07GF	10 KΩ, 1/4 w	Test Point			<10
C1	8987915-129	0.01 μf, 200 volts	+11 to -10			<10
C2	8987915-129	0.01 μf, 200 volts	+11 to - 9			<10
C4	8412778-10	15 μf, 20 volts (150 D)	11			55
C6****	CS13AD680K	68 μf, 15 volts	0			--
CR1	1N916	75 ma at 25° C ambient	+0.6, -2	1.2	<1	<10
CR3	1N3020B	1 w at 25° C ambient	10	16	160	16
CR4	1N916	75 ma at 25° C ambient	+0.7	3	2.1	<10
CR5	1N916	75 ma at 25° C ambient	-13	--	--	<10
CR6	1N916	75 ma at 25° C ambient	-13	--	--	<10
CR7	1N916	75 ma at 25° C ambient	+0.7	3	2.1	<10
CR8	1N916	75 ma at 25° C ambient	+0.5, -10	1	9	<10
CR9	1N916	75 ma at 25° C ambient	+0.4 to +0.6	--	--	<10
CR10	1N916	75 ma at 25° C ambient	+0.6, -0.7	1	1	<10
CR11	1N538	750 ma at 25° C ambient	-24	--	--	<10

TABLE F-18
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY SHUTTER AND LAMP DRIVE, 1753099D (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR12	8447742-1 (1N1583)	6 amps	+0.4 to +0.9	1600 max	1400 max	16
CR13	1N538	750 ma at 25° C ambient	-24	--	--	<10
CR14	8447742-1 (1N1583)	6 amps	+0.9	1600 max	1400 max	16
CR15	1N916	75 ma at 25° C ambient	+0.6, -10	2.4	1.5	<10
CR16	1N916	75 ma at 25° C ambient	+0.6, -4	--	--	<10
CR17	1N916	75 ma at 25° C ambient	+0.6, -0.7	2.5	1.6	<10
CR19	1N916	75 ma at 25° C ambient	+0.6, -1.2	<2 peak	--	<10
Q1	2N916	360 mw at 25° C ambient	BE = +0.7, -0.9 CE = -12	1.5 max	18 max	<10
Q2	2N916	360 mw at 25° C ambient	BE = +0.7, -1.2 CE = 12	4.5 peak	54 max	15
Q3	2N916	360 mw at 25° C ambient	BE = +0.8, -1.2 CE = -12	4.5 peak	54 max	15
Q4	2N1132	600 mw at 25° C ambient	BE = +0.6, -0.7 CE = -32	20 peak	12 peak	<10
Q5	2N1132	600 mw at 25° C ambient	BE = -0.9, +3 CE = -22	5	110 peak	<20
Q6	8447741-1 (2N1208)	45 w at 25° C case	BE = 0.8 CE = +27	55	1500	<10
Q7	2N697	800 mw at 25° C case	BE = +0.6, 5 CE = 1.8, 32	18	33	<10
Q8	8447741-1 (2N1208)	45 w at 25° C case	BE = +1, -0.5, CE = 32	45	1440	<10
Q9	8447741-1 (2N1208)	45 w at 25° C case	BE = +1, -0.5 CE = 32	45	1440	<10
Q10	2N697	800 mw at 25° C case	BE = +0.9 CE = 32	18	33	<10
Q11	2N722	270 mw at 25° C case ambient	BE = -0.7 CE = 5	1.25	6.25	<10
Q12	8447741-1 (2N1208)	45 w at 25° C case	BE = 0.9 CE = 0.9 to 22	1600 peak	1440	<10

TABLE F-18
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY SHUTTER AND LAMP DRIVE, 1753099D (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q13	2N1132	600 mw at 25° C ambient	BE = +3, -1 CE = 22, 0.7	13.6 peak	10 peak	<10
Q14	2N1132	600 mw at 25° C ambient	BE = +5, -5 CE = 32, 0.7	20 peak	14 peak	<10
Q15	2N916	360 mw at 25° C ambient	BE = -0.5, +0.8 CE = 6, 0.7	30	21	<10
Q16	2N722	270 mw at 25° C ambient	BE = 0.7 CE = -28, 0.7	30	21	<10
Q18	2N1486	25 w at 25° C case	BE = +0.8, 0.4 CE = 28, 0.7	250	175	<10

*Square wave
**5% duty cycle
***10% duty cycle
*****Not used in P1 Camera

TABLE F-19
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1753189B

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	47 KΩ, 1/4 w	3	--	--	<10
R2	RC07	47 KΩ, 1/4 w	+2.4	--	--	<10
R3	RC07	10 KΩ, 1/4 w	20	2	40	16
R4	RC07	5.1 KΩ, 1/4 w	2.2	--	--	<10
R5	RC07	4.7 KΩ, 1/4 w	1.8	--	--	<10
R6	RC07	47 KΩ, 1/4 w	1.0	--	--	<10
R7	RC07	68 Ω, 1/4 w	--	--		<10
R8	RC07	1.5 KΩ, 1/4 w	1.2	--	--	<10
R9	8447750-3	5 KΩ, 1/4 w	0.5 peak-to-peak	--	--	<10
R10	RC07	6.2 KΩ, 1/4 w	10	1.6	16	<10
R11	RC07	39 Ω, 1/4 w	0.07 peak-to-peak	--	--	<10
R12	RC07	1 KΩ, 1/4 w	7	7	49	20
R13	RC07	3.6 KΩ, 1/4 w	6	1.7	10	<10
R14	RC07	1.5 KΩ, 1/4 w	1.2	--	--	<10
R15	RC07	47 KΩ, 1/4 w	3	--	--	<10
R16*	RC07	47 KΩ, 1/4 w	-3 to +2	--	--	<10
R17*	RC07	82 Ω, 1/4 w	0 to +0.8	10	8	<10
R18*	RC07	6.2 KΩ, 1/4 w	+10 to +13	1.9	24	<10
R19*	RC07	4.7 KΩ, 1/4 w	8	1.7 peak	14 peak	<10
R20*	RC07	82 Ω, 1/4 w	0.5	6	3	<10
R21	RC07	430 Ω, 1/4 w	6	14	84	33
R22	RC07	47 KΩ, 1/4 w	0.6	--	--	<10
R23*	RC07	10 KΩ, 1/4 w	10 to 20	2 peak	23	<10
R24*	RC07	56 KΩ, 1/4 w	±5	--	--	<10
R25	RC07	100 KΩ, 1/4 w		Test Point		<10
R26	RC07	100 KΩ, 1/4 w		Test Point		<10
R27	RC07	100 KΩ, 1/4 w		Test Point		<10
R28	RC07	10 Ω, 1/4 w	0.15	15	3	<10
R29	RC07	56 KΩ, 1/4 w	+6 to -10	--	--	<10
R30	RC07	4.7 KΩ, 1/4 w	-10	2	20	<10

TABLE F-19 ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1753189B (Continued)						
Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R31	RC07	33 KΩ, 1/4 w	5	--	--	<10
R32	RC07	5.6 KΩ, 1/4 w	2	--	--	<10
R33	RC07	2.2 KΩ, 1/4 w	1.8	--	--	<10
R34	RC07	8.2 KΩ, 1/4 w	6	--	--	<10
R35	RC07	10 KΩ, 1/4 w	10	--	--	<10
R36	RC07	180 Ω, 1/4 w	0.4 to 1.2	4.5	4	<10
R37	RC07	10 Ω, 1/4 w	0.13	--	--	<10
R38	RC07	10 Ω, 1/4 w	9	--	--	<10
R39	RC07	470 Ω, 1/4 w	3.0 to 0.6	3.8	8	<10
R40	RC07	4.7 KΩ, 1/4 w	11	2.4	26.4	11
R41	RC07	10 KΩ, 1/4 w	11	--	--	<10
R42	RC07	3.3 KΩ, 1/4 w	8	2.4 max	19	<10
R43	RC07	10 KΩ, 1/4 w		0.7 peak	--	<10
R44	RC07	1.2 KΩ, 1/4 w		10	96	39
R45*	8447750-3	5 KΩ, 1 w	5	--	--	<10
R46*	RC07	11 KΩ, 1/4 w	5			<10
R48*	RC07	10 KΩ, 1/4 w	9	>1	2	<10
R49*	RC07		0.6	--	--	<10
R51	RC07	3.3 KΩ, 1/4 w	0.8	--	--	<10
R52	RC07	27 KΩ	15 max	0.56 max	8.4	<10
R54	RC07	270 KΩ	2.5 max	--	--	<10
R56	RC07	6.2 KΩ	5 max	--	4	<10
R57*	RC07	8.2 KΩ, 1/4 w	5 to 17	2.1 max	15	<10
R58*	RC07	3.9 KΩ, 1/4 w	1.5	--	--	<10
R59	RC07	560 Ω, 1/4 w	7.0	12.5	90	38
R60	RC07	5.6 KΩ, 1/4 w	9 peak	1.6 peak	14.5 peak	<10
R61	RC07	10 KΩ, 1/4 w	5	0.5	<3	<10
R62	RC07	1 KΩ, 1/4 w		Test Point		<10
R63	RC07	30 KΩ, 1/4 w	7	--	--	<10
R64	RC07	18 KΩ, 1/4 w	28	1.6	43.5	17

TABLE F-19
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1753189B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R65	RC07	100 KΩ, 1/4 w		Test Point		< 10
R67	RC07	10 KΩ, 1/4 w	10 max	1 max	10 max	< 10
C1	8412778-95	6.8 μf, 35 volts	7			20
C2	8412778-95	6.8 μf, 35 volts	15			43
C3	8412778-70	1 μf, 35 volts	7			20
C4	8987915-25	4700 pf, 200 volts	2.5			< 10
C5	8914319-340	470 pf, 300 volts	12			< 10
C6	8412778-95	6.8 μf, 35 volts	12			34
C7	8412778-95	6.8 μf, 35 volts	8			23
C8	8412778-95	6.8 μf, 35 volts	12			34
C9	8412778-7	2.2 μf, 20 volts	10			50
C10	8914319-340	470 pf, 300 volts	11			< 10
C11	8412778-24	4.7 μf, 10 volts	0.6			< 10
C12	8412778-95	6.8 μf, 35 volts	10			29
C13	8412778-95	6.8 μf, 35 volts	12			34
C14	8914319-316	47 μf, 500 volts	20			< 10
C15	CP09	0.1 μf, 100 volts	20			20
C16	8914319-341	510 pf, 300 volts	±5			< 10
C17	8412778-30	40 μf, 10 volts	6			60
C18	8987915-25	0.0047 μf, 200 volts	2			< 10
C20	8412778-30	40 μf, 10 volts	6			60
C24	8412778-7	2.2 μf, 20 volts	15			80
C26	8412778-95	6.8 μf, 35 volts	10			29
CR1	1N755A	400 mw at 25°C ambient	7.2	2	14	< 10
CR2	1N755A	400 mw at 25°C ambient	7.2	8	58	< 15
CR3	1N963B	400 mw at 25°C ambient	12	8	96	25
CR4	1N757A	400 mw at 25°C ambient	9	15	135	34

TABLE F-19
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1753189B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR5	1N963B	400 mw at 25 °C ambient	12	15	180	45
CR7	1N916	250 mw at 25 °C ambient	-10, +0.6	3 peak	2	< 10
CR8	1N916	250 mw at 25 °C ambient	-8, +0.6	3 peak	2	< 10
CR11	1N916	250 mw at 25 °C ambient	-5, +0.5	< 1	--	< 10
CR12	1N916	250 mw at 25 °C ambient	-10, +0.5	< 1	--	< 10
CR13	1N964B	400 mw at 250 °C ambient	13	1.4	18.5	< 10
CR14	1N916	250 mw at 250 °C ambient	+0.6, +5	2	--	< 10
CR15	1N916	250 mw at 250 °C ambient	+0.6, -10	2	--	< 10
CR16	1N968B	400 mw at 250 °C ambient	20	10.4	208	52
CR18	1N946	400 mw at 250 °C ambient	0.6 to 2.1	--	--	--
Q1	2N930	300 mw at 250 °C ambient	BE = 0.6 CE = 5	1	5	< 10
Q2	2N930	300 mw at 250 °C ambient	BE = 0.6 CE = 8	1	8	< 10
Q3	2N930	300 mw at 250 °C ambient	BE = 0.6 CE = 8	1.7	14	< 10
Q4	2N930	300 mw at 250 °C ambient	BE = 0.6 CE = 12	10 peak	60	20
Q5	2N930	300 mw at 250 °C ambient	BE = 0.6 CE = 9.0	6	54	< 20
Q6	2N930	300 mw at 250 °C ambient	BE = 0.6 CE = 9	2	18	< 10
Q7	2N943	250 mw at 25 °C ambient	BE = 0.6, -0.6 CE = 12.5	2	25	10

TABLE F-19
ELECTRICAL STRESS ANALYSIS OF THE CAMERA ELECTRONICS ASSEMBLY VIDEO AMPLIFIER, 1753189B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q8	2N916	360 mw at 24° C ambient	BE = +0.8 CE = 12.5	4	50	14
Q9	2N916	360 mw at 24° C ambient	BE = 0.6, - 2.5 CE = 12.5	4.5 max	56	<16 max
Q10	2N943	250 mw at 25°C ambient	BE = 0.6, -12 CE = 0.7, +7	3 peak	<3	<10
Q11	2N722	400 mw at 25°C ambient	BE = 0.6 CE = 8	10	80	29
Q12	2N930	300 mw at 25°C ambient	BE = 0.6, -7 CE = 7.0	1	7	<10
Q13	2N916	360 mw at 25°C ambient	BE = 0.6 CE = 2.0	1	2	<10
Q14	2N722	400 mw at 25°C ambient	BE = 0.4, -4 CE = 0.7, +12	2	1.5	<10
Q16	2N930	300 mw at 25°C ambient	BE = 0.6 CE = 15	2	30	10
Q17	2N2432	300 mw at 75°C ambient	BE = 0.6, -5 CE = 0.8, 27	2	1.2	<10
Q18	2N943	250 mw at 25°C ambient	BE = 0.6, -4 CE = 1.5	-2	3	<10

*Square wave

TABLE F-20
ELECTRICAL STRESS ANALYSIS OF THE VIDEO COMBINER ASSEMBLY F-SCAN VIDEO SUMMING AMPLIFIER, 1754073C

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC07	8.2 KΩ, 1/4 w	1.6		0.31	<10
R3	RC07	25 KΩ, 1/4 w	3.5		0.5	<10
R16	RC60C	10 KΩ, 1/8 w	2.4		0.625	<10
R17	RN60B	200 Ω, 1/8 w	0.025		0.03	<10
R19	RN60B	200 Ω, 1/8 w	0.025		0.03	<10
R20	RC60C	10 KΩ, 1/8 w	2.4		0.62	<10
R21*	RN60C	100 Ω, 1/8 w	0.05 to 0.1		0.1	<10
R22	RN65C	1 KΩ, 1/4 w	1.6		2.6	<10
R23*	RN60C	100 Ω, 1/8 w	0.05 to 0.1		0.1	<10
R24*	RN60C	4.32 KΩ, 1/8 w	3 to 5.5		7	<10
R25*	RC07	1.2 KΩ, 1/4 w	5 to 7.5		47	19
R26*	RC07	100 Ω, 1/4 w	0.5 to 0.75		5.6	<10
R27*	RN60C	10.5 KΩ, 1/8 w	0 to 0.8		0.064	<10
R28	RC07	2 KΩ, 1/4 w	0.4		--	<10
R29*	RN60C	10.5 KΩ, 1/8 w	0 to 0.8		0.064	<10
R30	RN60C	1.3 KΩ, 1/8 w	--		--	<10
R44	RC07	12 KΩ, 1/4 w	12		12	<10
R45	RC07	10 KΩ, 1/4 w	0.12		0.014	<10
R46	RC07	2.7 KΩ, 1/4 w	7		18	<10
R47	RC07	2 KΩ, 1/4 w	5		12.5	<10
R48	RC07	5.1 KΩ, 1/4 w	7		10	<10
R49	RC07	820 Ω, 1/4 w	6		44	18
R50	RC07	1.5 KΩ, 1/4 w	4		10	<10
R51	RC07	1.5 KΩ, 1/4 w	4		10	<10
R52	RC07	820 Ω, 1/4 w	6		44	18
R53	RC07	5.1 KΩ, 1/4 w	7		10	<10
R54*	RN60C	10 KΩ, 1/8 w	0 to 0.75		0.056	<10
R64	RN60C	182 KΩ, 1/8 w	--		--	<10
R79	RC07	820 Ω, 1/4 w	Test Point			

TABLE F-20
ELECTRICAL STRESS ANALYSIS OF THE VIDEO COMBINER ASSEMBLY F-SCAN VIDEO SUMMING AMPLIFIER, 1754073C (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R80	RC07	1 KΩ, 1/4 w	--		--	<10
R83	RC07	3.9 KΩ, 1/4 w	--		--	<10
R84	RN60C	10 KΩ, 1/8 w	5		2.5	<10
R85	RC07	680 KΩ, 1/4 w	5.5		--	<10
R86	RC07	910 Ω, 1/4 w	0.01		0.0001	<10
R87	8883168-5	200 Ω, 1/8 w	--		--	<10
C2	CS13	6.8 μf, 35 v	4			11
C4	8914319-316	47 pf, 500 v	2			0
C7	8924416-307	750pf, 500 v	0.8			0
C8	CL45	15 μf, 15 v	5			34
C9	CL45	15 μf, 15 v	5			34
CR4*	4-1N916's	75 ma each at 25° C ambient	-0.6, -1.8	0.5	0.9	<10
CR7	1N645	400 ma at 25° C ambient	+0.75, -6	12	9	<10
CR8	1N645	400 ma at 25° C ambient	+6, -0.75	12	9	<10
CR9	1N645	400 ma at 25° C ambient	+6, -0.7	12	9	<10
CR10	1N645	400 ma at 25° C ambient	-6, +0.7	12	9	<10
Q3	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 4	0.6	2.4	<10
Q4	2N930	300 mw at 25° C ambient	BE = 0.6 CE = 4	0.6	2.4	<10
Q5	2N869	360 mw at 25° C ambient	BE = 0.65 CE = 9	11.6	100	28 max
Q6	2N869	360 mw at 25° C ambient	BE = 0.7 CE = 5	2.2	11	<10
Q7	2N869	360 mw at 25° C ambient	BE = 0.95 CE = 5	5	25	<10

TABLE F-20
ELECTRICAL STRESS ANALYSIS OF THE VIDEO COMBINER ASSEMBLY F-SCAN VIDEO SUMMING AMPLIFIER, 1754073C (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q10	2N869	360 mw at 25^{o} C ambient	BE = 0.9, +5 CE = 0.25, 7	<1	<5	<10
Q11	2N869	360 mw at 25^{o} C ambient	BE = 0.75, 0.15 CE = 0.6, 8	7	4.2	<10

*Sine wave

TABLE F-21
ELECTRICAL STRESS ANALYSIS OF THE VIDEO COMBINER ASSEMBLY ISOLATION AMPLIFIER, 1725508A (F-CHANNEL ONLY)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R45	8983168-5	200 Ω, 1 w	2	40	20	<10
R46	8977933-155	402 Ω, 1/8 w	3.5	8.7	30	25
R47	8977933-258	200 Ω, 1/8 w	0.01	--	--	<10
R48	RC07	110 Ω, 1/4 w	--	--	--	<10
R51	RC07	110 Ω, 1/4 w	0.01	--	--	<10
R52	8977933-126	200 Ω, 1/8 w	0.01	--	--	<10
R53	8983168-5	200 Ω, 1 w	1.2	12	14.4	<10
Q10	2N916	360 mw at 25° C ambient	BE = 1 CE = 0.7 to 6	52 peak	52	<15
Q11	2N869	360 mw at 25° C ambient	BE = 0.6 CE = 0.7 to 5.5	52 peak	40	11

TABLE F-22
ELECTRICAL STRESS ANALYSIS OF THE VIDEO COMBINER, TONE OSCILLATOR, 1725507

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R8*	RC07	240 KΩ, 1/4 w	+4.5 -1	--	--	<10
R9*	RC07	39 KΩ, 1/4 w	10 to 14	0.3	3.4	<10
R10	RC07	200 Ω, 1/4 w	0.02 peak	--	--	<10
R11*	RC07	20 KΩ, 1/4 w	1.1	--	--	<10
R12	RC07	1 KΩ, 1/4 w	5	5	25	10
R13*	8977933-249	3.83 KΩ, 1/8 w	0.35	--	--	<10
R14*	8977933-249	3.83 KΩ, 1/8 w	0.5	--	--	<10
R22*	8977933-153	383 Ω, 1/8 w	0.05	--	--	<10
R23*	8977933-153	383 Ω, 1/8 w	0.05	--	--	<10
C8	8924416-322	3600 pf, 500 volts	3.5			<10
C9	8924416	Selected, 500 volts	8			<10
C10	Mica	7500 pf, 100 volts	8			<10
C11	Mica	1500 pf, 500 volts	8			<10
C12	Mica	200 pf, 500 volts	8			<10
C13	Mica	1600 pf, 500 volts	16			<10
C14	Tantalum	0.47 μf, 35 volts	2			<10
C22	Ceramic	0.02 μf, 30 volts	6			20
C23	Ceramic	0.02 μf, 30 volts	6			20
Q3*	2N916	360 mw at 25° C ambient	BE = +0.7 to -1.4 CE = 0 to 3.5	0.3	1	<10
Q4*	2N916	360 mw at 25° C ambient	CE = 1.7 to 2.4	5	9.5	<10
L2*	1175627	1.12 mh	+4 to -4			--
Y2	1175498	144 kc	--			--

*Sine wave

TABLE F-23
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER DUAL OSCILLATOR, 1703811B

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	8977933	1.78 KΩ, 1/8 w	6	3.4	20	16
R2	8977933	2.61 KΩ, 1/8 w	4.5	1.7	7.6	<10
R3	8977933	2.61 KΩ, 1/8 w	5	1.9	9.5	<10
R6	8977933	5.11 KΩ, 1/8 w	10	2	20	16
R7	8977933	2.61 KΩ, 1/8 w	5	1.9	9.5	<10
R8	8977933	2.61 KΩ, 1/8 w	4.5	1.7	7.6	<10
R9	8977933	1.78 KΩ, 1/8 w	6	3.4	20	16
R10	8977933	5.11 KΩ, 1/8 w	10	2.0	20	16
R13	8977933	39.2 KΩ, 1/8 w	9	0.23	2	<10
R14	8977933	10.0 KΩ, 1/8 w	2.5	-	-	<10
R15	8977933	3.32 KΩ, 1/8 w	3.0	1	2.7	<10
R16	8977933	1.21 KΩ, 1/8 w	1.5	1	1.9	<10
R17	8977933	2.37 KΩ, 1/8 w	3.4	1.5	4.9	<10
R18	8977933	4.22 KΩ, 1/8 w	8.0	2	15	12
R20	RC07	220 Ω, 1/4 w	3	13.6	41	16
R21	RC07	1.8 KΩ, 1/4 w	14	7.8	109	43.6
R22	RC07	3.3 KΩ, 1/4 w	4.5	1.5	6.1	<10
R23	RC07	33 KΩ, 1/4 w	15	0.5	6.8	<10
R25	8977933	6.81 KΩ, 1/8 w	7	1	7.2	<10
R31	8977933	39.2 KΩ, 1/8 w	9.0	0.23	2	<10
R32	8977933	10.0 KΩ, 1/8 w	2.5	-	-	<10
R33	8977933	3.32 KΩ, 1/8 w	3.0	1	2.7	<10
R34	8977933	1.21 KΩ, 1/8 w	1.5	1	1.9	<10
R35	8977933	2.37 KΩ, 1/8 w	3.4	1.5	4.9	<10
R36	8977933	4.22 KΩ, 1/8 w	8.0	2	15	12
R38	RC07	220 Ω, 1/4 w	3	13.6	41	16
R39	RC07	1.8 KΩ, 1/4 w	14	7.8	109	43.6
R40	RC07	3.3 KΩ, 1/4 w	4.5	1.5	6.1	<10
R41	RC07	33 KΩ, 1/4 w	15	0.5	6.8	<10
R44	RC07	6.2 KΩ, 1/4 w	2	-	-	<10

TABLE F-23
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER DUAL OSCILLATOR, 1703811B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R45	8977933	3.83 KΩ, 1/8 w	5	1.3	6.5	<10
R46	8977933	3.83 KΩ, 1/8 w	5	1.3	6.5	<10
R47	8977933	19.6 KΩ, 1/8 w	11	0.5	6.7	<10
R48	8977933	3.83 KΩ, 1/8 w	3.5	1	3.5	<10
R49	8977933	6.81 KΩ, 1/8 w	3.5	0.5	1.8	<10
R50	8977933	6.81 KΩ, 1/8 w	3.5	0.5	1.8	<10
R51	8977933	3.83 KΩ, 1/8 w	3.5	1	3.2	<10
R52	8977933	3.83 KΩ, 1/8 w	5	1.3	6.5	<10
R53	8977933	3.83 KΩ, 1/8 w	3.5	1	3.2	<10
R54	8977933	3.83 KΩ, 1/8 w	5	1.3	6.5	<10
R55	RC07	3.0 KΩ, 1/4 w	7	2.3	16	<10
R56	RC07	1.5 KΩ, 1/4 w	10	6.7	67	27
R57	RC07	3.0 KΩ, 1/4 w	7	2.3	16	<10
R58	RC07	1.5 KΩ, 1/4 w	10	6.7	67	27
R59	8977933	6.81 KΩ, 1/8 w	7	1	7.2	<10
R60	8977933	3.83 KΩ, 1/8 w	3.5	1	3.2	<10
C1	CP09	0.047 μf, 100 volts	12	-	-	12
C2	CP09	0.1 μf, 100 volts	8	-	-	<10
C3	CP09	0.047 μf, 100 volts	6	-	-	<10
C5	CP09	0.047 μf, 100 volts	12	-	-	12
C6	CP09	0.1 μf, 100 volts	8	-	-	10
C7	CP09	0.047 μf, 100 volts	6	-	-	<10
C8	CS13	33 μf, 35 volts	7	-	-	20
CR3	1N916	250 mw at 25° C ambient	+0.7, -7.0	1.5	1.1	<10
CR4	1N916	250 mw at 25° C ambient	+0.7, -7.0	1.5	1.1	<10
CR5	1N916	250 mw at 25° C ambient	+0.7, -7.0	1.5	1.1	<10
CR6	1N916	250 mw at 25° C ambient	+0.6, -7.0	1.5	1.1	<10

TABLE F-23
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER DUAL OSCILLATOR, 1703811B (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR7	1N916	250 mw at 25° C ambient	+0, -5	-	-	<10
CR8	1N916	250 mw at 25° C ambient	+0, -6.0	-	-	<10
CR9	1N916	250 mw at 25° C ambient	+0.6	2.6 peak	1.6	<10
Q1	2N916	360 mw at 25° C ambient	BE = 0.6 CE = 10 peak	2 peak	5	<10
Q2	2N869	360 mw at 25° C ambient	BE = 0.7 to 2.2 CE = 8 peak	2.4 peak	11	<10
Q3	2N916	360 mw at 25° C ambient	BE = 0.6 CE = 11 peak	14 peak	80	22
Q4	2N869	360 mw at 25° C ambient	CE = 4	1	4	<10
Q5	2N916	360 mw at 25° C ambient	BE = 0.7 CE = 8 peak	4.4	35	<10
Q6	2N916	360 mw at 25° C ambient	BE = 0.7 CE = 8 peak	4.4	35	<10
Q8	2N916	360 mw at 25° C ambient	BE = 0.6 CE = 10 peak	2 peak	5.3	<10
Q9	2N869	360 mw at 25° C ambient	BE = 0.7 to 2.2 CE = 8 peak	2.4 peak	11	<10
Q10	2N916	360 mw at 25° C ambient	BE = 0.6 CE = 11 peak	14 peak	80	22
Q11	2N869	360 mw at 25° C ambient	CE = 4	1	4	<10
Q12	2N916	360 mw at 25° C ambient	BE = 0.7 CE = 5.5 peak	-	-	-
L1	8723001-401	1.5 mh	-	-	-	<10
L2	8723001-401	1.5 mh	-	-	-	<10
Y1	1077463-1	RH-8, 18 kc	-	-	-	<10
Y2	1077463-1	RH-8, 18 kc	-	-	-	<10

TABLE F-24
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER CONTROLLER MODULATOR, 1753142

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R146	RC07	1 KΩ, 1/4 w	4.5	4.5	20	<10
R147	RC07	3.3 KΩ, 1/4 w	3	1	3	<10
R148	RC07	10 KΩ, 1/4 w	24	2.4	57.6	23
R149	RC07	6.8 KΩ, 1/4 w	12	1.8	21.2	<10
R150	RC07	4.7 KΩ, 1/4 w	10	2.11	21	<10
R151	RC07	6.8 KΩ, 1/4 w	12	1.8	21.2	<10
R152	8977939	1 KΩ, 1/4 w	11	11	121	48
R153	8977933	19.6 KΩ, 1/8 w	11	0.56	6.2	<10
R154	RC07	6.8 KΩ, 1/4 w	0	-	-	<10
R192	8977939	1 KΩ, 1/4 w	7	14 peak	98 max	39 max
R193	8977933	19.6 KΩ, 1.8 w	14	10	10	<10
R194	RC07	150 Ω, 1/4 w	0	-	-	<10
R195	RN60B	51.1 KΩ, 1.8 w	17 max	0.33	5.7	<10
R196	RN60B	8.25 KΩ, 1/8 w	5 max	0.61	3	<10
R197	RN60B	51.1 KΩ, 1/8 w	27 max	0.53	14	11
R198	RN60B	113 KΩ, 1/8 w	12 max	0.1	10	<10
C26	CS13	6.8 μf, 35 volts	2			<10
C28	150D	0.033 μf, 35 volts	27.5			82
CR51	1N758A	400 mw at 25° C ambient	11	26	66	17
CR52	1N758A	400 mw at 25° C ambient	11	6	66	17
CR53	1N916	250 mw at 25° C ambient	0, +1	3	3	<10
CR54	2N1871A	1.25 amps	CA = 0.8 CG = 0.8	12	9.6	<10
CR55	1N916	250 mw at 25° C ambient	+1.0, 0	11	11	<10
CR56	1N750A	400 mw at 25° C ambient	4	1.5	6	<10

TABLE F-24
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER CONTROLLER MODULATOR, 1753142 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR74	1N750A	400 mw at 25° C ambient	6	4	16	<10
CR75	FD300	500 mw at 25° C ambient	-12			<10
CR76	1N916	250 mw at 25° C ambient	+0.6	-	-	<10
Q27	2N869	360 mw at 25° C ambient	BE = 0.7 CE = 0.3		2	<10
Q28	2N1613	800 mw at 25° C ambient	BE = 2.2		-	<10
Q37	2N1613	800 mw at 25° C ambient	CE = 0.8	2.5		<10
K2	1077484-1	Contacts Closed - V Coil	12			

TABLE F-25
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER ASSEMBLY, P-CAMERA CONTROLLER, 1753037A

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R30	8977933	3.83 KΩ, 1/8 w	6	1.57	9.1	<10
R31	8977933	3.83 KΩ, 1/8 w	1.2	-	-	<10
R32	8977933	19.6 KΩ, 1/8 w	11	0.56	6.2	<10
R279	RC07	1.5 KΩ, 1/4 w	12	8	91	38
C3	CYFM15C	1000 pf, 300 volts to 500 volts	7.0			2 max
C13	8945696-403	5000 pf, 100 volts	14			14
CR21	1N916	250 mw at 25° C ambient	-3.5, +0.6	+0.6	0.4	<10
CR22	1N916	250 mw at 25° C ambient	-5.5, +0.6	+0.6	0.4	<10
CR23	1N916	250 mw at 25° C ambient	-2.5, +0.6	0.6	0.4	<10
Q10	2N916	360 mw at 25° C ambient	CE = 7.0 BE = 0.75	8	6	<10

TABLE F-26
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER ASSEMBLY P-CHANNEL COUNTER, 1753140

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
	NOTE:	There are 18 identical flip-flop circuits including steering networks and 82 identical gates. One flip-flop circuit and one gate were measured and the results are recorded below.				
R73*	8977933-249	3.83 KΩ, 1/8 w	11 peak	2.9 peak	12	10
R74	RC07	220 Ω, 1/4 w	0.7	-	-	<10
R75	8977933-249	3.83 KΩ, 1/8 w	0.07	-	-	<10
R76	8977933-249	3.83 KΩ, 1/8 w	11 peak	2.9	31	25
R77	8977933-249	3.83 KΩ, 1/8 w	0.05	-	-	<10
R78	RC07	220 Ω, 1/4 w	0.7 peak	-	-	<10
R79	8977933	2.26 KΩ, 1/8 w	7.5 peak	3.3	25	20 peak
R80	8977933	2.26 KΩ, 1/8 w	7 peak	3.1	22	17 peak
R81	8977933	2.26 KΩ, 1/8 w	6 peak	2.7	16	13 peak
R82	8977933	2.26 KΩ, 1/8 w	12 peak	5.4 peak	32 peak	52 peak
R83	8977933	11.5 KΩ, 1/8 w	12 peak	1	12	<10
R84	8977933	11.5 KΩ, 1/8 w	12 peak	1	12	<10
C13	CYFM15C	1000 pf, 300 volts to 500 volts	11			<10
C14	CYFM15C	1000 pf, 300 volts to 500 volts	8			<10
CR13	1N916	250 mw at 25°C ambient	-13 +0	-	-	<10
CR14	1N916	250 mw st 25°C ambient	-10 +0	-	-	<10

TABLE F-26
ELECTRICAL STRESS ANALYSIS OF THE CONTROL PROGRAMMER AND CAMERA SEQUENCER ASSEMBLY P-CHANNEL COUNTER, 1753140 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q13	2N914	360 mw at 25° C ambient	CE = 0.75, 7.5 BE = 0.75, -1.8	5.4 peak	4.1	<10
Q14	2N914	360 mw at 25° C ambient	CE = 0.75, 7.5 BE = 0.75, -1.8	5.4 peak	4.1	<10

*40% duty cycle

TABLE F-27
ELECTRICAL STRESS ANALYSIS OF THE HIGH-CURRENT VOLTAGE REGULATOR, 1706631E

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC20	6.8 KΩ, 1/2 w	18.9	2.78	52.5	<11
R2	RC20	3.0 KΩ, 1/2 w	8.2	2.73	22.4	<10
R3	1175270-3	500 Ω, 1 w at 70° C	0.13	0.26	0.026	<10
R4	RC20	7.5 KΩ, 1/2 w	16.9	2.25	38.0	<10
R5	RC20	7.5 KΩ, 1/2 w	16.7	2.22	37.0	<10
R6	RC20	1.8 KΩ, 1/2 w	7.8	4.33	34.6	<10
R7	RC20	2 KΩ, 1/2 w	18.9	9.45	179	36
R8	RC20	1 KΩ, 1/2 w	3.8	3.8	14.5	<10
R9	RC20	1.2 KΩ, 1/2 w	10	8.3	83.0	17
R10	RE70G	0.2 Ω, 15 w	0.45	2250	1000	<10
R11	RE70G	0.2 Ω, 15 w	0.5	2500	1250	<10
R12	RC20	150 Ω, 1/2 w	1.8	13	23.4	<10
R13	RC20	11 KΩ, 1/2 w	25.9	2.36	61.2	12
R14	RC20	2.7 KΩ, 1/2 w	6.4	2.36	15.2	<10
R15	RC20	220 Ω, 1/2 w	-	-	-	<10
R16	RC20	1 KΩ, 1/2 w	4.6	4.6	20.2	<10
R17	RC20	1.5 KΩ, 1/2 w	2.4	1.6	3.84	<10
R18	RN65E	51.1 KΩ, 1/4 w	6.1	0.12	0.73	<10
R19	RN65E	31.6 KΩ, 1/4 w	3.8	0.12	0.45	<10
R22	RN65E	226 KΩ, 1/4 w	27.9	0.12	3.42	<10
R23	RN65E	31.6 KΩ, 1/4 w	4.0	0.12	0.5	<10
R24	RN65E	20 KΩ, 1/4 w	1.9	0.095	0.18	<10
R25	RN65E	31.6 KΩ, 1/4 w	3.0	0.095	0.285	<10
R26	RC20	10 KΩ, 1/2 w	-	-	-	<10
R27	RC20	47 Ω, 1/2 w	-	-	-	<10
R28	RC10GF392J	3.9 KΩ, 1/4 w	14	3.6	50	<10
R29	RC10GF272J	2.7 KΩ, 1/4 w	5.5	2	11	<10
C1	CL15D	1000 μf, 36 volts	27.2			75.5
C2	CP09	0.22 μf, 100 VDC	25			25

TABLE F-27
ELECTRICAL STRESS ANALYSIS OF THE HIGH-CURRENT VOLTAGE REGULATOR, 1706631E (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR1	1709319-1 (CD411)	250 mw at 25° C ambient	8.4	9.4	79	
CR2	1N457A	100 mw at 25° C ambient	-4	-	-	<10
CR3	1N945B	500 mw at 25° C	11.7	2.6	30	<10
CR4	1N945B	500 mw at 25° C	11.7	2.6	30	<10
CR5	C50DR309	90 amps		16000		36
CR6	1N945B	500 mw at 25° C	11.7	2	24	<10
CR7	1N945B	500 mw at 25° C	11.7	2	24	<10
Q1	2N329A	390 mw at 25° C ambient	CE = 2.7 BE = 0.5	2.2	6	<10
Q2	2N329A	390 mw at 25° C ambient	BE = 0.54 CE = 2.7	9.45	26	<10
Q3	2N329A	390 mw at 25° C ambient	BE = 0.6 CE = 14	4	56	15
Q4	2N329A	390 mw at 25° C ambient	BE = 0.54 CE = 15	4.6	69	18
Q5	2N1486	25 w at 25° C case	CE = 3 BE = 0.64	13	69	<10
Q6	2N1490	75 w at 25° C case	CE = 4.3 BE = 1.3	2500	10800	15
Q7	2N1490	75 w at 25° C case	CE = 4.3 BE = 1.3	2250	9700	14
K-1	SCD11DB-36	36 volts nominal coil voltage at 1250 ohms and 2 amps contact rating within specification.				
K-2	SCD11DB-36	36 volts nominal coil voltage at 1250 ohms and 2 amps contact rating within specification.				

TABLE F-27
ELECTRICAL STRESS ANALYSIS OF THE HIGH-CURRENT VOLTAGE REGULATOR, 1706631E (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
A1A1R1	RC20	470 Ω, 1/2 w	-	-	-	-
A1A1R2	RC20	270 Ω, 1/2 w	1	4	4	
A1A1R3	RC20	100 KΩ, 1/2 w	35	0.35	13	
A1A1R4	RC20	100 KΩ, 1/2 w	36	0.36	13	
A1A1R5	RC20	100 KΩ, 1/2 w	36	0.36	13	
A1A1R6	RC20	100 KΩ, 1/2 w	36	0.36	13	
A1A1C1	CS13	0.1 μf, 50 volts	36			60
A1A1C2	CS13	50 μf, 50 volts	36			60
A1A1C3	CS13	50 μf, 50 volts	36			60
A1A1C4	CS13	50 μf, 50 volts	36			60
A1A1C3	CP09A1KB-104K3	0.1 μf, 100 VDC	36			36
A1A1CR1	1N645	400 ma at 25° C ambient	-	0.36	0.4	<10
A1A1CR8	1N645	400 ma at 25° C ambient	36	0.14 peak	5 peak	<10

TABLE F-28
ELECTRICAL STRESS ANALYSIS OF THE TRANSMITTER POWER SUPPLY ASSEMBLY, 1183526

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC32	470 KΩ, 1 w	560	1.19	0.67	67
R2	RC32	470 KΩ, 1 w	535	1.12	0.61	61
R3	RC42	220 KΩ, 2 w	410	1.86	0.765	38.3
R4	RC42	220 KΩ, 2 w	420	1.91	0.8	40
R5	RC42	100 KΩ, 2 w	280	2.8	0.784	39.2
R6	RW57	40Ω, 6.5 w	7	175	1.225	18.9
R7	RW57	40Ω, 6.5 w	7	175	1.225	18.9
R8	RHM-25	250Ω, 25 w	40 peak-to-peak	80	6.8	27.2
R9	RHM-50	7Ω, 50 w	8	1.142	9.15	18.3
R10	RH10-200	200Ω, 10 w	4			40
R11	RH10-200	200Ω, 10 w	12.5		0.78	7.8
C1	118P15501014	1.5 μf, 1400 volts at 85° C	+1120			80
C2	118P15501014	1.5 μf, 1400 volts at 85° C	-825			59
C3	118P25596T4	2.5 μf, 600 volts	+280			47.5
C4	118P12602T4	12 μf, 200 volts	+111			55.5
C5	CP09A1KC3341	0.033 μf, 200 volts	100			50
C6	1709733-502	40 μf, 50 volts	30			60
C7	1709733-502	40 μf, 50 volts	30			60
CR1	PS2813	2000 volts piv, Diode bridge, 150 ma at 4 volts	+4 -1000	135	67.5	45
CR2	PS2812	1000 volts piv, Diode bridge, 100 ma at 2 volts	+2 -750	60	30	30
CR3	PS2813	2000 volts piv, Diode bridge, 150 ma at 4 volts	+4 -280	6	24	<10
CR4	1N1126A	1 w at 25° C case	+0.9 -100	300	270	27
CR5	1N1126A	1 w at 25° C case	+0.9 -100	300	270	27
CR6	1N1126A	400 volts piv, 1a at 1.1 volts	100	300		10
CR7	1N1126A	400 volts piv, 1a at 1.1 volts	100	300		10

TABLE F-28
ELECTRICAL STRESS ANALYSIS OF THE TRANSMITTER POWER SUPPLY ASSEMBLY, 1183526 (Continued)

Part Description			Stress Analysis			
Designation	**Type**	**Rating**	**Voltage (volts)**	**Current (milliamperes)**	**Average Power (milliwatts)**	**Percent Rated Stress**
CR8*	1N1381A	400 volts piv	36			<10
CR9	1N645	400 ma at 25° C ambient	60			<10
CR10	1N645	400 ma at 25° C ambient	18			<10
CR11	1N645	400 ma at 25° C ambient	27.5			<10
CR12	1N645	400 ma at 25° C ambient	27.5			<10
Q1	2N2124	250 mw at 25° C ambient	BE=16 peak-to-peak CE=50 peak-to-peak			1 1
Q2	2N2124	250 mw at 25° C ambient	BE=16 peak-to-peak CE=58 peak-to-peak			1 1
L-1**	MIL-T-27A	Inductor	4		-	<10

*Measured under no load conditions
**Square wave

TABLE F-29
ELECTRICAL STRESS ANALYSIS OF THE LOW-CURRENT VOLTAGE REGULATOR, 1708611F

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC20	2 KΩ, 1/2 w	19	9.5	180	36
R2	RC20	560Ω, 1/2 w	7.8	14	109	22
R3	RC20	1.2 KΩ, 1/2 w	11.1	9.2	102	21
R4	RC20	6.8 KΩ, 1/2 w	18.5	2.7	50	10
R5	Trimpot	500Ω, 1 w	0.85	-	-	<10
R6	RC20	3 KΩ, 1/2 w	7.6	2.53	19.5	< 10
R7	RC20	1.2 KΩ, 1/2 w	5	4.17	21	<10
R8	RC20	56 KΩ, 1/2 w	6.8	0.12	-	-
R9	RN65	20 KΩ, 1/4 w	1.9	0.1	-	-
R10	RN65	31.6 KΩ, 1/4 w	3	0.1	-	-
R11	RN65	221 KΩ , 1/4 w	35	0.16	6	<10
R12	RN65	31.6 KΩ, 1/4 w	5		-	-
R14	RC20	27 KΩ, 1/2 w	4.9	0.2	-	-
C1	Vitramon Q	0.1 μf	34.5		100	34.5
CR1	CR4111	250 mw at 25°C ambient	8.4	9.5	80	32
CR2	1N945B	500 mw at 25°C ambient	11.7	0.3	3.5	-
CR3	1N945B	500 mw at 25°C ambient	11.7	0.3	3.5	-
Q1	2N1132	600 mw at 25°C ambient	CE=26.5 BE= 0.61	0.12	3.3	<10
Q2	2N1132	600 mw at 25° C ambient	CE= 8.4 BE= 0.65	9.2	78	13
The following portion is on Schematic Drawing No. 1708944						
Q1	2N1486	750 mw at 25° C	CE=12.5 BE=0.71	360 max	255 max	34

TABLE F-30
ELECTRICAL STRESS ANALYSIS OF THE TELEMETRY ASSEMBLY A-C AMPLIFIER, 8481476

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC20	18 KΩ, 1/2 w	22	1.2	27	11
R2	RC20	56 KΩ, 1/2 w	2	-	-	<10
R3	RC20	4.7 KΩ, 1/2 w	6.2	1.3	8.2	<10
R4	RC20	3.3 KΩ, 1/2 w	3.7	1.1	4.2	< 10
C1	151D235X9010 WO	2.3 μf, 35 volts				<10
C2	151D235X9010 WO	2.3 μf, 35 volts	3.7			<10
Q1	2N336	150 mw at 25° C ambient	BE= 0.6 CE=23.3	1.1	26	<10
T1	UTC DO T36		1	1		

TABLE F-30
ELECTRICAL STRESS ANALYSIS OF THE TELEMETRY ASSEMBLY A-C AMPLIFIER, 8481476

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC20	4.7 KΩ, 1/2 w	30	6.4	192	38
R2	RC20	120 Ω, 1/2 w	0.7	0.58	< 1	<10
R3	RC20	1 KΩ, 1/2 w	1	1	1	<10
C1	CS13	40 μf, 50 volts	30			60
C2	CS13	40 μf, 50 volts	30			60
C3	CP09	0.022 μ f, 50 volts	28			56
C4	CS13	40 μf, 50 volts	27			54
C5	CS13	40 μf, 50 volts	27			54
CR1	1N645	400 ma avg. at 25° C ambient	+ 0.6, -9 peak	-	-	<10
CR2	1N645	400 ma avg. at 25° C ambient	+ 0.6, -9 peak	-	-	<10
CR3	1N3037	51 volts, 1 w at 25° C case	51	100 peak for 4 μsec	-	<10
CR4	PS2810	22.5 piv Diode Bridge 100 ma at 1 volts fwd.	+ 1.0, -31.5	22	22	22
CR5	1N645	400 ma avg. at 25° C ambient	+ 0.7	<1	<1	<10
CR6	1N645	400 ma avg. at 25° C ambient	+ 0.7	<1	<1	<10
CR7	1N3030	1 w at 25° C case	27	<1	27	<10
Q1	2N1484	25 w at 25° C case	+ 1, -51	100 peak	100 peak	<10
Q2	2N1484	25 w at 25° C case	+ 1, -51	100 peak	100 peak	<10
Q3	2N338	800 mw at 25° C case	CE=1.5	2	3	<10
Q4	2N1485	25 w at 25° C case	CE=2.5	62	155	< 10
L1	BP1140	120 μh, 750 ma	-	100	-	<10
L2	BP1140	120 μh, 750 ma	-	100	-	<10
L3	BP1140	120 μh, 750 ma	-	100	-	<10
T1	E6524-2			Not ascertained		

TABLE F-32
ELECTRICAL STRESS ANALYSIS OF THE TELEMETRY ASSEMBLY TELEMETRY VOLTAGE REGULATOR, 8626007

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC20	1200 Ω, 1/2 w		2.7	8.8	<10
R2	RC20	56 KΩ, 1/2 w		0.07	0.27	<10
R3	RN7OC	576 Ω, 1/2 w		14.6	123	25
R4	RC20	2700 Ω, 1/2 w		7.2	140	28
C1	CP09A1KB104-K3	0.1 μf, 100 volts	34	-	-	34
CR1	1N538	750 ma at 25° C ambient	1	190	190	25
CR2	1N538	750 ma at 25° C ambient	1	190	190	25
CR3	1N538	750 ma at 25° C ambient	1	190	190	25
CR4	1N3027	1 w at 25° C case	20	12	240	24
CR5	1N935B	500 mw at 25° C ambient	9	7.2	65	13
CR6	1N645	600 mw at 25° C ambient	1		<60	<10
CR7	1N645	600 mw at 25° C ambient	1		<60	<10
Q1	2N1486	25 w at 25° C case	10	160	1600	<10
Q2	2N2904A	600 mw at 25° C ambient	25	2.7	67	11

TABLE F-33
ELECTRICAL STRESS ANALYSIS OF THE SEQUENCER POWER SUPPLY, 1753035

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Only one power supply was considered since they are essentially duplicates.						
R1	RW59	20 Ω, 3 w	2.5	125	313	10
R2	RW59	500 Ω, 3 w	35	70	2450	81.5
R3	RW59	0.5 Ω, 3 w	0.25	500	125	<10
R4	RC20	820 Ω, 1/2 w	6	7.3	44	<10
R5	8977933	46.4 Ω, 1/8 w	0.02	-	-	<10
R6	8977933	5.11 K Ω, 1/8 w	6	1.2	7	<10
R7	8977933	46.4 Ω, 1/8 w	0.03	-	-	<10
R8	8977933	6.81 K Ω, 1/8 w	4.5	0.67	3.4	<10
R9	RC07	1.8 K Ω, 1/4 w	0	-	-	0
R10	RC07	1.0 K Ω, 1/4 w	13	13	169	68
R11	RC07	3.3 K Ω, 1/4 w	14	4.3	60	24
R12	RW59	1 Ω, 3 w	0.3	300	90	3
R13	RN60	1 K Ω, 1/8 w	5.5	5.5	30	24
R14	8954937	500 Ω, 1 w	2.5	5	12.5	<10
R15	RN60	1 K Ω, 1/8 w	5	5	25	20
R16	RW56	20 Ω, 14 w	14	700	9800	70
R17	8977933	825 Ω, 1/8 w	3.5	4.25	14.5	12
R18	8977933	46.4 Ω, 1/8 w	0.03	-	-	<10
R19	8977933	5.11 K Ω, 1/8 w	3.5	-	-	<10
R20	8977933	46.4 Ω, 1/8 w	0.02	-	-	<10
R21	8977933	6.81 K Ω, 1/8 w	2.5	-	-	<10
R22	RC07	1.8 K Ω, 1/4 w	0	-	-	<10
R23	RC07	15 K Ω, 1/4 w	19	1.3	24	10
R24	RC07	3.3 K Ω, 1/4 w	18	5.5	98	39
R25	RW56	50 Ω, 14 w	9	180	1620	12
R26	RW59	1 Ω, 3 w	0.15	150	23	<10
R27	RN60	1 K Ω, 1/8 w	5.5	5.5	30	24
R28	8954937	500 Ω, 1 w	2.5	5	12.5	<10
R29	RN60	1 K Ω, 1/8 w	5.5	5.5	30	41

TABLE F-33
ELECTRICAL STRESS ANALYSIS OF THE SEQUENCER POWER SUPPLY, 1753035 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R45	RW56	25 Ω, 14 w	14	560	8000	73
C1	CL65	47 μf, 50 volts	30			60
C2	118P10402S4	0.1 μf, 200 volts	70			35
C3	CL65	47 μf, 50 volts	28			56
C4	CL65	47 μf, 50 volts	28			56
C5	118P22302S4	0.022 μf, 200 volts	9			<10
C6	CL65	47 μf, 50 volts	12			24
C7	CL65	47 μf, 50 volts	12			24
C8	118P22302S4	0.022 μf, 200 volts	10			<10
C9	CL65	47 μf, 50 volts	12			24
C10	CL65	47 μf, 50 volts	12			24
CR1*	USAF 1N1204	6 amps	+0.7, -28	500	350	<10
CR2*	USAF 1N1204	6 amps	+0.7, -28	500	350	<10
CR3*	USAF 1N1204	6 amps	+0.7, -28	500	350	<10
CR4*	USAF 1N1204	6 amps	+0.7, -28	500	350	<10
CR5	USN 1N821	250 mw at 25° C ambient	6.2	10	62	25
CR6	USN 1N750A	250 mw at 25° C ambient	5.2	13	68	27
CR8	USN 1N821	150 mw at 25° C ambient	6.3	4	25	10
Q1	99240-177 (2N1486)	21 w at 25° C case	BE= 2 CE=60	200	6000 peak	25
Q2	99240-177 (2N1486)	21 w at 25° C case	BE= 1 CE=60	200	6000 peak	25
Q3	2N916	310 mw at 25° C ambient	BE= 0.6 CE= 7	1.2	9	<10
Q4	2N916	310 mw at 25° C ambient	BE= 0.6 CE= 1.6	1.2	2	<10
Q5	2N869	310 mw at 25° C ambient	BE= 0.6 CE= 9	0.3	2.7	<10

*50% duty cycle

TABLE F-33
ELECTRICAL STRESS ANALYSIS OF THE SEQUENCER POWER SUPPLY, 1753035 (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
Q6	2N916	310 mw at 25° C ambient	BE= 0.6 CE= 8	4	32	10
Q7	2N1485	21 w at 25° C case	BE= 0.7 CE=14	300	4200	20
Q8	2N869	310 mw at 25° C ambient	BE= 0.6 CE= 7	0.6	4.2	<10
Q9	2N869	310 mw at 25° C ambient	BE= 0.6 CE= 5	0.6	3	<10
Q10	2N335	150 mw at 25° C ambient	BE= 0.6 CE=11	1.2	13	<10
Q11	2N916	310 mw at 25° C case	BE= 0.6 CE=12	5.3	64	20
Q12	2N1485	21 w at 25° C case	BE= 0.7 CE=12	150	1800	<10

TABLE F-34
ELECTRICAL STRESS ANALYSIS OF THE TELEMETRY PROCESSOR ASSEMBLY, 8747475

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
R1	RC32	1 Meg Ω, 1 w	370			14
R2	RC32	1 Meg Ω, 1 w	320			10
R3	RC32	1 Meg Ω, 1 w	339.6			<12
R4	RC07	10 K Ω, 1/4 w	0.1			<10
R5	RC20	3900 Ω, 1/2 w	26.5			36
R6	RC20	2200 Ω, 1/2 w	18.5			31
R7	RC07	10 K Ω, 1/4 w	6.7			<10
R8	RC07	10 K Ω, 1/4 w	1.8			<10
R11	RC07	10 K Ω, 1/4 w	0			<10
R13		1 K Ω, 3 w	4.8			<10
R14	RC07	10 K Ω, 1/4 w	0			<10
R15	RC07	68 K Ω, 1 w	37.2			<10
R18	RC20	10 Ω, 1/2 w	1.2			29
R19	RH10	3500 Ω, 10 w	61.2			11
CR1	1N761	400 mw at 25° C ambient	-0.5	7.5	38	15.2
CR2	1N758A	400 mw at 25° C ambient	-8.5	1	8.5	<10
CR3	1N761	400 mw at 25° C ambient	4.8	11.8	56.6	23
Q1	2N424	85 w at 25° C case	37.8	120	4536	5.3

TABLE F-35
ELECTRICAL STRESS ANALYSIS OF THE DISTRIBUTION CONTROL UNIT, 1703981G

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
C1	8938348-16	50 μf, 60 VDC	36			60
CR1	1N538	750 ma at 25° C ambient		30	30	<10
CR2	1N538	750 ma at 25° C ambient		30	30	<10
CR3	1N538	750 ma at 25° C ambient		30	30	<10
CR5	1N538	750 ma at 25° C ambient		relay coil transient	-	<10
CR6	1N538	750 ma at 25° C ambient		relay coil transient	-	<10
CR7	1N538	750 ma at 25° C ambient		30	30	<10
F1	17500596-1	fuse, Slo-Blo, 5A		3500	NA	
F6	1175965-4	fuse, wire 3A, (2.2 amp vacuum)		3500	NA	

TABLE F-36
ELECTRICAL STRESS ANALYSIS OF THE ELECTRONIC CLOCK ASSEMBLY 1753325D

Part Description			Stress Analysis			
Designation	**Type**	**Rating**	**Voltage (volts)**	**Current (milliamperes)**	**Average Power (milliwatts)**	**Percent Rated Stress**
		BOARD A1				
R1	RC07	75 Ω, 1/4 w	1.5			12 peak
R2*	RC07	750 Ω, 1/4 w	41	54		
R3	RC07	1.5 K Ω, 1/4 w	0.2 to 0.9			<10
R4	RC07	1.5 K Ω, 1/4 w	-5			<10
R5	RC07	1.5 K Ω, 1/6 w	12			38 peak
R6	RN60C	75 K Ω, 1/8 w	33	-	15.6	12
R7	RN60C	10 K Ω, 1/8 w	5	0.5	2.5	<10
R8	RN60C	2.74 K Ω, 1/8 w	-6	2.2	13.5	11
R9	RN60C	909 Ω, 1/8 w	7	7.7	54	43
R10	RC07	100 K Ω, 1/4 w	18	-	-	<10
R11	RN60C	2.0 K Ω, 1/8 w	4	-	-	<10
R12	RN60C	2.67 K Ω, 1/8 w	6	2.24	13.4	11
R13	1175270-12	1000 Ω, 1 w	2.2	2.2	5	<10
R14	RN60C	2.61 KΩ, 1/8 w	6	2.25	13.4	11
R15	RC07	16 K Ω, 1/4 w	6	-	-	<10
R16	RN60C	5.23 K Ω, 1/8 w	9	1.7	15.5	12
R17	1175270-12	1000 Ω, 1 w	2.2 to 1.8	2.2	5	<10
R18	RN60C	6.04 K Ω, 1/8 w	12	2	24	19
R19	RC07	2.0 K Ω, 1/4 w	-1.3	1.3	1.7	<10
R20	RC07	3.0 K Ω, 1/4 w	0.6	-	-	<10
R21	RW57	100 Ω, 6.5 w	3.5	35	110	<10
R22	RC07	8.2 K Ω, 1/4 w	15	1.8	27	11
C1	Sprague 150 D	2.2 μf, 35 volts	6			17
C2	Sprague 150 D	33 μf, 35 volts	13			37
C3	1175259-14	0.05 μf, 100 volts	4			<10
C4	1175251-225	3900 μf, 500 volts	3			<10
C5	1175259-14	0.05 μf, 100 volts	24.5			25

TABLE F-36
ELECTRICAL STRESS ANALYSIS OF THE ELECTRONIC CLOCK ASSEMBLY 1753325D (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
		BOARD A2				
R1	RC07	10 K Ω, 1/4 w	0.3	-	-	<10
R2	RC07	270 K Ω, 1/4 w	+0.8 to -5	-	-	<10
R3	RC07	100 K Ω, 1/4 w	12	0.2 peak	4 peak	<10
R4**	RC07	8.2 K Ω, 1/4 w	13 peak	1.6 peak	10	<10
R5	RC07	7.5 K Ω, 1/4 w	6	0.8	4.8	<10
R6	RC07	1 K Ω, 1/4 w	-	-	-	<10
R7	RN60C	30.9 K Ω, 1/8 w	-	-	-	<10
R8	RN60C	76.8 K Ω, 1/8 w	-	-	-	<10
R9	RN60C	13.0 K Ω, 1/8 w	4.5	-	-	<10
R10	RN60C	68.1 K Ω, 1/8 w	2.5	-	-	<10
R11	RC07	10 K Ω, 1/4 w	-	-	-	<10
R12	RN60C	5.23 K Ω, 1/8 w	4	< 1	3	<10
R13	RC07	10 K Ω, 1/4 w	-	-	-	<10
R14	RC07	33 K Ω, 1/4 w	13	0.4	5.2	<10
R15	RC07	7.5 K Ω, 1/4 w	7.5 peak	1	7.5	<10
C1	Sprague 150 D	0.22 μf, 35 volts	6	-	-	20
C2	1175250-349	820 μf, 300 volts	-13			<10
C3	Sprague 150 D	6.8 μf, 35 volts	15			43
CR1	USN1N914	250 mw at 25° C ambient	-0.5	1.5 peak	0.75	<10
CR2	USN1N914	250 mw at 25° C ambient	-	-	-	<10
CR3	USN1N914	250 mw at 25° C ambient	+0.4	-	-	<10
CR4	USN1N914	250 mw at 25° C ambient	-	-	-	<10
CR5	USN1N914	250 mw at 25° C ambient	+0.4	-	-	<10
CR6	USN1N914	250 mw at 25° C ambient	+0.4, -6.5	-	-	<10
				-	-	

TABLE F-36
ELECTRICAL STRESS ANALYSIS OF THE ELECTRONIC CLOCK ASSEMBLY 1753325D (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
CR7	USN1N914	250 mw at 25° C ambient	+0.6, -1.3	-	-	<10
CR8	USN1N914	250 mw at 25° C ambient	+1.7, -0.8	-	-	<10
Q1	2N718A		BE= 0.4, 1.7 CE=+0.4	1.5 peak	2 peak	<10
		BOARD A3				
R23	RC07	10 K Ω, 1/4 w	-	-	-	<10
R24	RC07	10 K Ω, 1/4 w	0.4	-	-	<10
R25	RC07	1 K Ω, 1/4 w	-	-	-	<10
CR1	1N964B	500 mw at 25° C ambient	13	7	91	23
CR2	1N914	250 mw at 25° C ambient	-1.3	-	-	<10
CR3	1N827	250 mw at 25° C ambient	6.3	7	44	18
Q1	2N1893	800 mw at 25° C ambient	BE=+0.7 CE=-41	100	70 peak	<10
Q2	2N722	400 mw at 25° C ambient	BE= 0.7 CE=-0.7, 41	34	24 peak	<10
Q3	2N722	400 mw at 25° C ambient	BE=+0.4 CE= 4	1	0.5	<10
Q4	2N722	400 mw at 25° C ambient	BE=+0.5 CE= 4	1	0.5	<10
Q5	2N1486	25 mw at 25° C ambient	BE= 1.3 CE=24	34	840	<10
Q6	2N1893	800 mw at 25° C ambient	BE= 1.3 CE= 2.4	1.5	36	<10
Q7	2N1132	600 mw at 25° C ambient	BE= 0.3 CE=17	2	34	<10
Q8	2N722	400 mw at 25° C ambient	BE= 0.3 CE=13	2	26	<10

*0.2% duty cycle
**50% duty cycle

TABLE F-37
ELECTRICAL STRESS ANALYSIS OF THE COMMAND CONTROL UNIT, 1755337A

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
COMP. BOARD A1						
R7	RC20	100 KΩ, 1/2 w	36	0.36	<1	<10
R8	RC20	100 KΩ, 1/2 w	36	0.4	<1	<10
R9	RC20	10 KΩ, 1/2 w	7.5	0.8	6 peak	<10
C3	CL65CK500KP	50 µf, 60 volts DC	13			26
CR3*	1N538	750 ma at 25° C ambient		1) 180 2) 370	1) 110 2) 225	1) 17 2) 35
CR4*	1N538	750 ma at 25° C ambient		1) 180 2) 370	1) 110 2) 225	1) 17 2) 35
CR5	1N538	750 ma at 25° C ambient	35	26	29	<10
CR6	JAN1N645	400 ma at 25° C ambient		26	29	<10
CR7*	1N538	750 ma at 25° C ambient		1) 180 2) 370	1) 110 2) 225	1) 17 2) 35
CR8*	1N538	750 ma at 25° C ambient		1) 180 2) 370	1) 110 2) 225	1) 17 2) 35
CR9	JAN1N645	400 ma at 25° C ambient		26	29	<10
Q1	2N722	400 ma at 25° C ambient	36	26	39 peak	16
COMP. BOARD A2						
R1	RC20	100 KΩ, 1/2 w	34	0.36	<1	<10
C2	CL65	50 µf, 60 volts DC	34			57
COMP. BOARD A4						
C1	CS13A	22 µf, 50 volts	34			68
C2	CS13A	22 µf, 50 volts	34			68
K1**	1708001-1	Coil:36 volts Nom., 1250 Ω Contacts: 2A	36	29	1000 peak	

TABLE F-37
ELECTRICAL STRESS ANALYSIS OF THE COMMAND CONTROL UNIT, 1755337A (Continued)

Part Description			Stress Analysis			
Designation	Type	Rating	Voltage (volts)	Current (milliamperes)	Average Power (milliwatts)	Percent Rated Stress
K2**	1608001-1	Coil: 36 volts Nom., 1250Ω Contacts: 2A	36	29	1000 peak	
K3	1708871-1	Coil: 36 volts Nom., 1400 Ω, 1 w Contacts: 2A	36	26	900 peak	
K4	1708871	Coil: 36 volts Nom., 1400 Ω, 1 w Contacts: 2A	36	26	900 peak	

*Condition 1) represents normal operation
Condition 2) represents operation in the event of an LVCR failure
**Used for ground tests only

Appendix G

Ranger Standard Parts Lists

TABLE G-1
STANDARD PARTS LIST

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Resistor	CC 1/4W, ±5%, 75	RC07GF750J	A.B.	MIL-R-11C	A35
Resistor	CC 1/4W, ±5%, 750	RC07GF751J	A.B.	MIL-R-11C	A35
Resistor	CC 1/4W, ±5%, 1500	RC07GF152J	A.B.	MIL-R-11C	A35, A5 (4, 5, 6) A8 (A10, 2, 4)
Resistor	CC 1/4W, ±5%, 100K	RC07GF104J	A.B.	MIL-R-11C	A35, A2 (13), A2 (3)
Resistor	CC 1/4W, ±5%, 16K	RC07GF163J	A.B.	MIL-R-11C	A35
Resistor	CC 1/4W, ±5%, 2K	RC07GF202J	A.B.	MIL-R-11C	A35, A2 (A10)
Resistor	CC 1/4W, ±5%, 3K	RC07GF302J	A.B.	MIL-R-11C	A35, A9 (A6)
Resistor	CC 1/4W, ±5%, 1K	RC07GF102J	A.B.	MIL-R-11C	A35 (A2) (A11-2), A9(2) A2 (1, 2, 11-1-3) A2(6)
Resistor	CC 1/4W, ±5%, 10K	RC07GF103J	A.B.	MIL-R-11C	A35, A2 (10, 3)
Resistor	CC 1/4W, ±5%, 8.2K	RC07GF822J	A.B.	MIL-R-11C	A35, A2 (11-1)
Resistor	CC 1/4W, ±5%, 270K	RC07GF274J	A.B.	MIL-R-11C	A35
Resistor	CC 1/4W, ±5%, 7.5K	RC07GF752J	A.B.	MIL-R-11C	A35
Resistor	1/2W, ±5%, 2.2K CC	RC20GF222J	A.B.	MIL-R-11C	A27
Resistor	1/2W, ±5%, 820 CC	RC20GF821J	A.B.	MIL-R-11C	A27
Resistor	1/2W, ±5%, 36K CC	RC20GF363J	A.B.	MIL-R-11C	A36
Resistor	1/2W, ±10%, 1K CC	RC20GF102K	A.B.	MIL-R-11C	A26-3
Resistor	1/2W, ±10%, 120 CC	RC20GF121K	A.B.	MIL-R-11C	A26-3, A2(10)
Resistor	1/2W, ±10%, 4.7K CC	RC20GF472K	A.B.	MIL-R-11C	A26-3
Resistor	1/4W, ±5%, 12K CC	RC07GF124J	A.B.	MIL-R-11C	A2 (A11-2, 11-1, 3)
Resistor	CC, 1/4W, 5%, 56K	RC07GF563J	A.B.	MIL-R-11C	A2 (A11-2, A11-1)
Resistor	CC, 1/4W, 5%, 47K	RC07GF473J	A.B.	MIL-R-11C	A2 (A11-1, A11-2)
Resistor	CC, 1/4W, 5%, 470K	RC07GF474J	A.B.	MIL-R-11C	A2 (11-1, 11-2), A2(3)
Resistor	CC, 1/4W, ±5%, 91K	RC07GF913J	A.B.	MIL-R-11C	A11-A2
Resistor	CC, 1/4W, ±5%, 20K	RC07GF203J	A.B.	MIL-R-11C	A2 (11-2) A2(2)
Resistor	CC, 1/4W, ±5%, 330K	RC07GF334J	A.B.	MIL-R-11C	A2 (11-2)
Resistor	CC, 1/4W, ±5%, 75K	RC07GF753J	A.B.	MIL-R-11C	A2 (11-1, 11-2)
Resistor	CC, 1/4W, ±5%, 24K	RC07GF243J	A.B.	MIL-R-11C	A2 (11-1, 11-2), 3
Resistor	CC, 1/4W, ±5%, 330	RC07GF331J	A.B.	MIL-R-11C	A2 (12, 13)
Resistor	CC, 1/4W, ±5%, 6.8K	RC07GF682J	A.B.	MIL-R-11C	A2 (A12, 10, 13, 3)
Resistor	1/4W, ±10%, 1K CC	RC07GF102K	A.B.	MIL-R-11C	A9 (2, 4)
Resistor	1/4W, 5%, 220 CC	RC07GF221J	A.B.	MIL-R-11C	A2 (10, 9) A9(6)
Resistor	1/4W, 5%, 47 CC	RC07GF470J	A.B.	MIL-R-11C	A2 (10)
Resistor	1/4W, 5%, 1 meg CC	RC07GF105J	A.B.	MIL-R-11C	A2 (10)
Resistor	1/2W, ±5%, 470 CC	RC20GF471J	A.B.	MIL-R-11C	A2 (10)
Resistor	1/4W, ±5%, 560 CC	RC07GF561J	A.B.	MIL-R-11C	A2 (A10)
Resistor	1/4W, ±5%, 5.1K CC	RC07GF512J	A.B.	MIL-R-11C	A2 (A10)
Resistor	1/4W, ±5%, 68 CC	RC07GF680J	A.B.	MIL-R-11C	A2 (A10)
Resistor	1/4W, ±5%, 82 CC	RC07GF820J	A.B.	MIL-R-11C	A2 (A10, 12)

TABLE G-1
STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Resistor	1/4W, ±5%, 3.6K CC	RC07GF362J	A. B.	MIL-R-11C	A2(A10)
Resistor	1/4W, ±5%, 430 CC	RC07GF431J	A. B.	MIL-R-11C	A2(10)
Resistor	1/4W, ±5%, 11K CC	RC07GF113J	A. B.	MIL-R-11C	A2(10)
Resistor	1/4W, ±5%, 3.9K CC	RC07GF392J	A. B.	MIL-R-11C	A2(10, 1) A9(7)
Resistor	1/4W, ±5%, 560 CC	RC07GF561J	A. B.	MIL-R-11C	A2(10)
Resistor	1/4W, ±5%, 30K CC	RC07GF303J	A. B.	MIL-R-11C	A2(10)
Resistor	1/4W, ±5%, 4.7K CC	RC07GF472J	A. B.	MIL-R-11C	A2(10, 3, 4)
Resistor	1/4W, ±5%, 39K CC	RC07GF393J	A. B.	MIL-R-11C	A2(11-1, 3)
Resistor	1/4W, ±5%, 18K CC	RC07GF183J	A. B.	MIL-R-11C	A2(1), A(8)
Resistor	1/4W, ±5%, 1.2K CC	RC07GF122J	A. B.	MIL-R-11C	A2(1), A9
Resistor	1/4W, ±5%, 33 CC	RC07GF330J	A. B.	MIL-R-11C	A2(1), 8
Resistor	1/4W, ±5%, 27K CC	RC07GF273J	A. B.	MIL-R-11C	A2(1, 3)
Resistor	1/4W, ±5%, 180 CC	RC07GF181J	A. B.	MIL-R-11C	A2(1, 2, 10)
Resistor	1/4W, ±5%, 820 CC	RC07GF821J	A. B.	MIL-R-11C	A2(2)
Resistor	1/4W, ±5%, 100 CC	RC07GF101J	A. B.	MIL-R-11C	A2(2, 4)
Resistor	1/4W, ±5%, 3.3K CC	RC07GF332J	A. B.	MIL-R-11C	A2(2, 6)
Resistor	1/2W, ±5%, 2K CC	RC20GF202J	A. B.	MIL-R-11C	A17
Resistor	1/2W, ±5%, 560 CC	RC20GF561J	A. B.	MIL-R-11C	A17
Resistor	1/2W, ±5%, 1.2K CC	RC20GF122J	A. B.	MIL-R-11C	A17
Resistor	1/2W, ±5%, 6.8K CC	RC20GF682J	A. B.	MIL-R-11C	A17
Resistor	1/2W, ±5%, 3K CC	RC20GF302J	A. B.	MIL-R-11C	A17
Resistor	1/2W, ±5%, 1.2K CC	RC20GF122J	A. B.	MIL-R-11C	A17
Resistor	1/4W, ±5%, 2.7K CC	RC07GF272J	A. B.	MIL-R-11C	A8
Resistor	1/4W, ±5%, 680K CC	RC07GF684J	A. B.	MIL-R-11C	A8
Resistor	1/4W, ±5%, 910 CC	RC07GF911J	A. B.	MIL-R-11C	A8
Resistor	1/4W, ±5%, 110 CC	RC07GF111J	A. B.	MIL-R-11C	A8
Resistor	1/4W, ±10%, 10K CC	RC07GF103K	A. B.	MIL-R-11C	A29, A14-(5), A13(98)
Resistor	1/2W, ±10%, 680 CC	RC20GF681K	A. B.	MIL-R-11C	A14(1)
Resistor	1/4W, ±10%, 27 CC	RC20GF270K	A. B.	MIL-R-11C	A14(1)
Resistor	1/4W, ±10%, 5.6K CC	RC20GF562K	A. B.	MIL-R-11C	A14(1)
Resistor	1/4W, ±10%, 1.5 Meg CC	RC20GF155K	A. B.	MIL-R-11C	A14(1)
Resistor	1W, ±10%, 18K CC	RC32GF183K	A. B.	MIL-R-11C	A14(1)
Resistor	1/4W, ±10%, 22K CC	RC07GF223K	A. B.	MIL-R-11C	A14(2)
Resistor	1/4W, ±10%, 47 CC	RC07GF470K	A. B.	MIL-R-11C	A14(2)
Resistor	1/4W, ±10%, 27K CC	RC07GF273K	A. B.	MIL-R-11C	A14(2)
Resistor	1/4W, ±10%, 5.6K CC	RC07GF562K	A. B.	MIL-R-11C	A14(2)
Resistor	1W, ±10%, 10 CC	RC32GF100K	A. B.	MIL-R-11C	A14(2)
Resistor	1W, ±10%, 150 CC	RC32GF151K	A. B.	MIL-R-11C	A14(2)
Resistor	1/2W, ±5%, 1.8K CC	RC07GF182J	A. B.	MIL-R-11C	A2(9)
Resistor	1/2W, ±5%, 360K CC	RC20GF364J	A. B.	MIL-R-11C	A2(9)

TABLE G-1 STANDARD PARTS LIST (Continued)					
Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Resistor	1/2W, ±5%, 420 Meg CC	RC20GF427J	A. B.	MIL-R-11C	A2(9)
Resistor	1/4W, ±5%, 300K CC	RC07GF304J	A. B.	MIL-R-11C	A2(11-1)
Resistor	1/4W, ±5%, 180K CC	RC07GF184J	A. B.	MIL-R-11C	A2(11-13)
Resistor	1/4W, ±5%, 330K CC	RC07GF334J	A. B.	MIL-R-11C	A2(11-1)
Resistor	1/4W, ±5%, 43K CC	RC07GF433J	A. B.	MIL-R-11C	A2(11-1)
Resistor	1/4W, ±5%, 82K CC	RC07GF823J	A. B.	MIL-R-11C	A2(A11-1)
Resistor	1/2W, ±10%, 18K CC	RC20GF183K	A. B.	MIL-R-11C	A26(5)
Resistor	1/2W, ±10%, 56K CC	RC20GF563K	A. B.	MIL-R-11C	A26(-5)
Resistor	1/2W, ±10%, 4.7K CC	RC20GF472K	A. B.	MIL-R-11C	A26(5)
Resistor	1/2W, 10%, 3.3K CC	RC20GF332K	A. B.	MIL-R-11C	A26(5)
Resistor	2W, 10%, 39 CC	RC42GF390K	A. B.	MIL-R-11C	A14(5)
Resistor	2W, 10%, 120K CC	RC42GF124K	A. B.	MIL-R-11C	A14(5)
Resistor	1W, 10%, 1 Meg CC	RC32GF105K	A. B.	MIL-R-11C	A14(5), A29, A30
Resistor	1/4, 10%, 1 Meg CC	RC07GF105K	A. B.	MIL-R-11C	A14(3)
Resistor	2W, 10%, 56 CC	RC42GF560K	A. B.	MIL-R-11C	A14(5)
Resistor	1/4W, 5%, 2.2K CC	RC07GF222J	A. B.	MIL-R-11C	A2(13)
Resistor	1/4W, 5%, 1.1K CC	RC07GF112J	A. B.	MIL-R-11C	A2(3)
Resistor	1/4W, 5%, 6.2K CC	RC07GF622J	A. B.	MIL-R-11C	A2(3, 4) A9(6)
Resistor	1/4W, 5%, 680 CC	RC07GF681J	A. B.	MIL-R-11C	A2(3)
Resistor	1/4W, 5%, 15K CC	RC07GF153J	A. B.	MIL-R-11C	A2(3)
Resistor	1/4W, 5%, 51K CC	RC07GF513J	A. B.	MIL-R-11C	A2(3)
Resistor	1/4W, 5%, 10 CC	RC07GF100J	A. B.	MIL-R-11C	A12
Resistor	1/4W, 5%, 33K CC	RC07GF333J	A. B.	MIL-R-11C	A12
Resistor	1/2W, 10%, 3.9K CC	RC20GF392K	A. B.	MIL-R-11C	A(29, 30)
Resistor	1/2W, 10%, 2.2K CC	RC20GF222K	A. B.	MIL-R-11C	A(29, 30)
Resistor	1W, 10%, 68K CC	RC32GF683K	A. B.	MIL-R-11C	A(29, 30)
Resistor	1/4W, 5%, 22K CC	RC07GF223J	A. B.	MIL-R-11C	A2(4)
Resistor	1/4W, 5%, 820 CC	RC07GF821J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 200 CC	RC07GF201J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 5.6K CC	RC07GF562J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 15 CC	RC07GF150J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 18 CC	RC07GF180J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 22 CC	RC07GF220J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 27 CC	RC07GF270J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 33 CC	RC07GF330J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 68 CC	RC07GF680J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 10 CC	RC07GF100J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, 5%, 20 CC	RC07GF200J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 30 CC	RC07GF300J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 36 CC	RC07GF360J	A. B.	MIL-R-11C	A2(6)

TABLE G-1
STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Resistor	1/4W, +5%, 39 CC	RC07GF390J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 43 CC	RC07GF430J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 47 CC	RC07GF470J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 51 CC	RC07GF510J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 56 CC	RC07GF560J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 62 CC	RC07GF620J	A. B.	MIL-R-11C	A2(6)
Resistor	1/4W, ±5%, 75 CC	RC07GF750J	A. B.	MIL-R-11C	A2(6)
Resistor	1/8W, ±1%, 75K FF	RN60C7502F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 10K FF	RN60C1002F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 2740 FF	RN60C2741F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 909 FF	RN60C9090F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 2K FF	RN60C2000F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 2670 FF	RN60C2671F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 2610 FF	RN60C2611F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 6.04K FF	RN60C6041F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 17.8K FF	RN60C1782F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 28.7K FF	RN60C2872F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 11K FF	RN60C1102F	Electra Weston	MIL-R-10509D	A(35)
Resistor	1/8W, ±1%, 5230 FF	RN60C5231F	Electra Weston	MIL-R-10509D	A(35)
Resistor	WW 6.5W, ±5%, 100 ohms	RW57V101	Ohmite, Ward-Leonard	MIL-R-26C	A(35)
Resistor	WW 3W, ±5%, 1	RW59V1R0	Ohmite	MIL-R-26C	A(35), A2(11-1)
Resistor	Fix Film, 1/8W, 5110	8977933-261	Corning Glass & Electra	MIL-R-10509D	A2(11-2), A(28)
Resistor	Fix Film, 1/8W, 46400	8977933-353	Corning Glass & Electra	MIL-R-10509D	A2(11-2)
Resistor	Fix Film, 1/8W, 68100	8977933-369	Corning Glass & Electra	MIL-R-10509D	A2(11-2)
Resistor	Fix Film, 1/8W, 46.4	8977933-65	Corning Glass & Electra	MIL-R-10509D	A28
Resistor	Fix Film, 1/8W, 6810	8977933-273	Corning Glass & Electra	MIL-R-10509D	A28, A9(6)
Resistor	Fix Film, 1/8W, 3830	8977933-249	Corning Glass & Electra	MIL-R-10509D	A9(5)
Resistor	WW, 6.5W, ±5%, 300	RW57V301	Ohmite, Ward-Leonard	MIL-R-26C	A13
Resistor	WW, 6.5W, ±5%, 160	RW57V161	Ohmite, Ward-Leonard	MIL-R-26C	A13
Resistor	Fix Film, 1/8W, 19600	8977933-317	Corning Glass & Electra	MIL-R-10509D	A9(2), A9(6)
Resistor	Fix Film, 1/8W, 18200	8977933-314	Corning Glass & Electra	MIL-R-10509D	A2(10, 3)
Resistor	Fix Film, 1/8W, 1000	8977933-193	Corning Glass & Electra	MIL-R-10509D	A2(10), A(8)
Resistor	Fix Film, 1/8W, 221000	8977933-417	Corning Glass & Electra	MIL-R-10509D	A2(10)
Resistor	Fix Film, 1/8W, 200,000	8977933-413	Corning Glass & Electra	MIL-R-10509D	A2(10)
Resistor	Fix Film, 1/8W, 2150	8977933-225	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 46.4	8977933-65	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 56200	8977933-361	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 4220	8977933-253	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 11,000	8977933-293	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 825	8977933-185	Corning Glass & Electra	MIL-R-10509D	A(8)

TABLE G-1
STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Resistor	Fix Film, 1/8W, 4750	8977933-258	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 28.7	8977933-45	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 402	8977933-155	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 200	8977933-126	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8, 464	8977933-161	Corning Glass & Electra	MIL-R-10509D	A14(1)
Resistor	Fix Film, 1/8, 5620	8977933-265	Corning Glass & Electra	MIL-R-10509D	A14(1)
Resistor	Fix Film, 1/8W, 10,000	8977933-289	Corning Glass & Electra	MIL-R-10509D	A14(1), A9(3)
Resistor	1/4, ±1%, 31.6K FF	RN65E3162F	A. B.	MIL-R-10509D	A17
Resistor	1/4, ±1%, 221K FF	RN65E2213F	A. B.	MIL-R-10509D	A17
Resistor	1/4, ±1%, 158K FF	RN65E1583F	A. B.	MIL-R-10509D	A17
Resistor	1/8W, ±1%, 182K FF	RN60C1823F	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	1/8W, ±1%, 100K FF	RN60C1003F	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	1/8W, ±1%, 2K FF	RN60C2001F	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	1/8W, ±1%, 10K FF	RN60C1002F	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/8W, 1%, 200	RN60B2000F	Corning Glass & Electra	MIL-R-10509D	A8
Resistor	1/8W, ±1%, 100 FF	RN60C1000F	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	1/8W, ±1%, 10.5K FF	RN60C1052F	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	1/8W, ±1%, 1.3K FF	RN60C1301F	Corning Glass & Electra	MIL-R-10509D	A(8)
Resistor	1/4W, ±1%, 1K FF	RN65C1001F	Electra Weston	MIL-R-10509D	A(8)
Resistor	Fix Film, 1/2W, 10	8977940-1	Corning Glass & Electra	MIL-R-10509D	A(29)
Resistor	Fix Film, 1/8W, 10	8977933-1	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 196	8977933-125	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 10	8977933-1	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 19.6	8977933-29	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 28.7	8977933-45	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 38.3	8977933-57	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 51.1	8977933-69	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 68.1	8977933-81	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 90.9	8977933-93	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 121	8977933-105	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/8W, 147	8977933-113	Corning Glass & Electra	MIL-R-10509D	A2(9)
Resistor	Fix Film, 1/2W, 357,000	8977940-437	Corning Glass & Electra	MIL-R-10509D	A2(11-1)
Resistor	Fix Film, 1/8W, 100,000	8977933-384	Corning Glass & Electra	MIL-R-10509D	A2(11-1)
Resistor	Fix Film, 1/8W, 243,000	8977933-421	Corning Glass & Electra	MIL-R-10509D	A2(11-1)
Resistor	Fix Film, 1/8W, 84,500	8977933-377	Corning Glass & Electra	MIL-R-10509D	A2(11-1)
Resistor	Fix Film, 1/8W, 61,900	8977933-365	Corning Glass & Electra	MIL-R-10509D	A2(11-1)
Resistor	WW, 14W, ±5%, 220 ohms	RW56V221	Ohmite	MIL-R-26C	A(34)
Resistor	Fix Film, 1/8W, 6190	8977933-269	Corning Glass & Electra	MIL-R-10509D	A2(3)
Resistor	Fix Film, 1/8W, 39,200	8977933-346	Corning Glass & Electra	MIL-R-10509D	A2(3)
Resistor	Fix Film, 1/8W, 2670	8977933-234	Corning Glass & Electra	MIL-R-10509D	A2(3)

TABLE G-1
STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Resistor	Fix Film, 1/8W, 26,700	8977933-330	Corning Glass & Electra	MIL-R-10509D	A2(3)
Resistor	Fix Film, 1/8W, 8250	8977933-281	Corning Glass & Electra	MIL-R-10509D	A2(3)
Resistor	Fix Film, 1/8W, 3650	8977933-247	Corning Glass & Electra	MIL-R-10509D	A9(3)
Resistor	Fix Film, 1/8W, 2610	8977933-233	Corning Glass & Electra	MIL-R-10509D	A9(3)
Resistor	Fix Film, 1/8W, 3010	8977933-239	Corning Glass & Electra	MIL-R-10509D	A2(4)
Resistor	Fix Film, 1/2W, ±1%, 140	RN70B1400F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, ±1%	RN70B78R7F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, 1.47K	RN70E1471F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, ±1%, 1.91K	RN70B1911F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, ±1%, 511	RN70B5110F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, ±1%, 562	RN70B5620F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, ±1%	RN70B26R1F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, ±1%, 2.15K	RN70B2151F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1/2W, ±1%, 10.7K	RN70B1072F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1W, ±1%, 3.92K	RN75B3921F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 1W, ±1%, 3.83K	RN75B3831F	Corning Glass & Electra	MIL-R-10509D	A12
Resistor	Fix Film, 2W, ±1%, 232	RN80B2320F	Electra Weston	MIL-R-10509D	A12
Resistor	WW Variable, 200 Submin.	8954937-55(236P-1-201)	Bourns	MIL-R-93B	A12
Resistor	Fix Film, 1W, ±1%, 511	RN75C5110F	Corning Glass & Electra	MIL-R-10509D	A2(4)
Resistor	Carbon Film, 9.09K, ±1%, 1/8W	RN60B9093F	Electra		A35
Resistor	Carbon Film, 7.5K, ±1%, 1/8W	RN60B7503F	Electra		A35
Resistor	Carbon Film, 56.2K, ±1%, 1/8W	RN60B5624F	Electra		A35
Resistor	17.8K, ±1%, 1/10W	CF - 1/10	Electra		A35
Resistor	15K, ±1%, 1/10W	CF - 1/10	Electra		A35
Resistor	100K, ±1%, 1/10W	CF - 1/10	Electra		A35
Capacitor	Solid Tant., 68µf ±10%, 15V	CS13AD680K	Sprague Kemet	MIL-C-26655B	A2(6)
Capacitor	Ceram., 0.01µf ±20%, 200V	CK06CW103M	Glenco Vitramon	MIL-C-11015B	A2(6)
Capacitor	Paper, 0.033µf, 0.022µf ±20%, 200V	CP09A1KC223M	Cornell Dublier Sprague	MIL-C-25C	A26(3)
Capacitor	Wet Tant., 4µf ±20%, 60V	CL45BK040MP3	Fansteel	MIL-C-3965B	A2(12, 13)
Capacitor	Ceram., 0.01µf ±15%, 200V	8987915-29	Glenco Vitramon	MIL-C-11015B	A2(12)
Capacitor	Glass, 1000µµf ±5%	CYFM15C102J	Corning Glass	MIL-C-11272B	A9(1, 5, 4)
Capacitor	Mica, 91 µµf ±5%, 500V	8914319-323	Elmenco	MIL-C-5B	A2(10)
Capacitor	Mica, 270µµf ±1%, 500V	8914319-34	Elmenco	MIL-C-5B	A2(10)

TABLE G-1
STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Capacitor	Paper, 0.1μf ±10%, 200V	CP09A1KC104K3	Cornell Dublier Sprague	MIL-C-25C	A2(10)
Capacitor	Ceram., 4700μμf ±15%, 200V	8987915-25	Glenco Vitramon	MIL-C-11015B	A2(10)
Capacitor	Mica, 1000μμf ±5%, 500V	8924416-310	Elmenco	MIL-C-5B	A2(8)
Capacitor	Wet Tant., 60μf $^{+30\%}_{-15\%}$, 50V	CL45BJ600SP3	Fansteel	MIL-C-3965B	A2(8)
Capacitor	Wet Tant., 25μf $^{+30\%}_{-15\%}$, 50V	CL45BJ250SP3	Fansteel	MIL-C-3965B	A2(8)
Capacitor	Wet Tant., 100μf $^{+30\%}_{-15\%}$, 30V	CL45BH101SP3	Fansteel	MIL-C-3965B	A2(3), A2(9)
Capacitor	Ceram., special dielectric 125° C, 0.02μf, 50V	8945696-405	Aerovox		A2(1), A9(7)
Capacitor	Solid Tant., 0.47μf ±20%, 35V	CS13AFR47M	Sprague Kemet	MIL-C-26655B	A9(7)
Capacitor	Mica, 3000μμf ±5%, 500V	8924416-320	Elmenco	MIL-C-5B	A9(7)
Capacitor	Mica, 6200μμf ±5%, 300V	8924416-331	Elmenco	MIL-C-5B	A9(7)
Capacitor	Mica, 1100μμf ±5%, 500V	8924416-311	Elmenco	MIL-C-5B	A9(7)
Capacitor	Mica, 3600μμf ±5%, 500V	8924416-322	Elmenco	MIL-C-5B	A9(7)
Capacitor	Mica, 150μ μf ±5%, 500V	8914319-328	Elmenco	MIL-C-5B	A9(7)
Capacitor	Mica, 220μ μf ±5%, 500V	8914319-332	Elmenco	MIL-C-5B	A9(7)
Capacitor	Mica, 180μ μf ±5%, 500V	8913419-330	Elmenco	MIL-C-5B	A9(7)
Capacitor	Paper, 0.1μf ±10%, 100V	CP09A1KB104K3	Sprague	MIL-C-25C	A17, A9(6)
Capacitor	Wet Tant., 15μf ±20%, 15V	CL45CE150MP3	Fansteel	-	A8
Capacitor	Mica, 750μ μf ±5%, 500V	8924416-307	Elmenco	MIL-C-5B	A8
Capacitor	Mica, 300μ μf ±5%, 500V	8914319-335	Elmenco	MIL-C-5B	A8
Capacitor	Mica, 750μ μf ±5%, 300V	8914319-345	Elmenco	MIL-C-5B	A8, A2(4)
Capacitor	Mica, 120μ μf ±5%, 500V	8914319-326	Elmenco	MIL-C-5B	A8
Capacitor	Ceram., special dielectric 125° C, 0.005μf +20%, 50V	8945696-3	Aerovox	-	A14(1)
Capacitor	Ceram., special dielectric 125° C, 0.01μf +20%, 50V	8945696-4	Aerovox	-	A14(1)
Capacitor	Mica, 4300μf ±5%, 300V	8924416-324	Elmenco	MIL-C-25C	A14(1)
Capacitor	Mica, 130μμf ±5%, 500V	8914319-327	Electr Motive	MIL-C-25C	A14(1)
Capacitor	Mica, 430μμf ±5%, 300V	8914319-339	Electr Motive	MIL-C-25C	A14(2)
Capacitor	Mica, 15μμf ±5%, 500V	8914319-305	Electr Motive	MIL-C-25C	A14(2)
Capacitor	Mica, 12μμf ±5%, 500V	8914319-304	Electr Motive	MIL-C-25C	A14(2)
Capacitor	Mica, 8200μμf ±2%, 300V	8924416-232	Elmenco	MIL-C-25C	A2(4)
Capacitor	Ceram., 22μμf ±10%, 200V	CK06CW22K	Glenco Vitramon	MIL-C-11015B	A2(4)
Capacitor	Ceram., 3900μμf ±10%, 200V	CK06CW392K	Glenco Vitramon	MIL-C-11015B	A2(9)
Capacitor	Wet Tant., 170μf $^{+30\%}_{-15\%}$, 15V	CL45BE171SP3	Fansteel	MIL-C-3965B	A2(9)
Capacitor	Paper, 0.033μf ±10%, 600V	CP09A1KF333K3	Cornell Dublier	MIL-C-25C	A2(11-1)

TABLE G-1
STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Capacitor	Paper, 0.015μf ±10%, 600V	CP09A1KF153K3	Cornell Dublier	MIL-C-25C	A2(11-1)
Capacitor	Ceram., 0.01μf ±10%, 200V	CK06CW103K	Glenco Vitramon	MIL-C-3965B	A2(11-1)
Capacitor	Mica, 47μμf ±5%, 500V	8914319-316	Elmenco	MIL-C-25C	A2(11-1)
Capacitor	Solid Tant., 33μf ±20%, 35V	CS13AF330M	Sprague Kemet	MIL-C-26655B	A9(6)
Capacitor	Ceram., 120μμf ±20%, 200V	CK05CW121M	Glenco Vitramon	MIL-C-11015B	A2(3)
Capacitor	Ceram., 1000μμf ±10%, 200V	CK05CW102K	Glenco Vitramon	MIL-C-11015B	A2(3)
Capacitor	Ceram., 6200μμf ±10%, 200V	CK05CW622K	Glenco Vitramon	MIL-C-11015B	A2(3)
Capacitor	Mica, 6200μμf ±1%, 300V	8924416-131	Elmenco	MIL-C-5B	A2(3)
Capacitor	Ceram., 120μμf ±10%, 200V	8987915-6	Glenco Vitramon	MIL-C-11015B	A2(3)
Capacitor	Glass, 100μμf ±5%	CYFM15C101J	Corning Glass	MIL-C-11272B	A9(4)
Capacitor	Solid Tant., 6.8μf ±10%, 6V	CS13AB6R8K	Sprague Kemet	MIL-C-26655B	A9(3)
Capacitor	Ceram., 56μμf ±10%, 200V	8987915-2	Glenco Vitramon	MIL-C-11015B	A2(13)
Capacitor	Ceramic 820μf ±10%, 200V	CK05CW821KW	Vitramon		A35
Capacitor	Paper Dielectric, 0.33μf, 300V	CP09A1KC339K	Sprague		A16
Capacitor	Plain Foil Polarized, 40μf ±20%, 50V	1709733(6K105AA)	GE		A16
Transistor	2N1132	MIL-S-19500/173	TI, Hughes, Fairchild	MIL-S-19500	A(35), A(17)
Transistor	2N1893 (USN)	MIL-S-19500/182	Fairchild, GE	MIL-S-19500	A(35), A(12)
Transistor	2N388 (USN)	MIL-S-19500/69	GE	MIL-S-19500	A26(3), A14(1)
Transistor	2N916	-	Fairchild, GE	-	A9(1, 7), A(8), A2(10, 6 11-1, 9)
Transistor	2N914	-	Fairchild, GE	-	A9(1, 5)
Transistor	2N722	-	Fairchild, TI, Hughes	MIL-S-19500/177	A2(10, 6, 11-1, 9)
Transistor	2N930	-	Fairchild, GE, TI	-	A2(10, 11-1)
Transistor	2N718A	-	Fairchild, GE, TI	-	A2(1, 11-1, 9)
Transistor	2N869		Fairchild, TI, Hughes, Raytheon	-	A9(7, 6), A(8)
Transistor	2N1613	MIL-S-19500/181	Raytheon, Fairchild	MIL-S-19500	A(12)
Transistor		(AED-01) 2N718A	Fairchild		A35
Diode	USN 1N964B	MIL-S-19500/117	Motorola	MIL-S-19500	A(35)
Diode	USN 1N914	MIL-S-19500/116	TI	MIL-S-19500	A(35)
Diode	USN 1N827	MIL-S-19500/159	Transitron	MIL-S-19500	A(35), A(12)
Diode	1N1583	MIL-E-1/1108	Westinghouse	MIL-E-1	A(17)
Diode	1N645 - USAF	MIL-E-1/1143	TI	MIL-E-1	A26(3), A2(11-2, 3)
Diode	USN 1N3043-B	MIL-S-19500/115	Motorola	MIL-S-19500	A14(3)
Diode	USN 2N1871A	MIL-S-19500/198	Solid State Products	MIL-S-19500	A9(3)

TABLE G-1 STANDARD PARTS LIST (Continued)					
Type	**Description of Part**	**Procurement No.**	**Vendor**	**MIL SPEC**	**Subassemblies Where Used**
Diode	USN 1N746A	MIL-S-19500/127	TI	MIL-S-19500	A2(11-2)
Diode	USN 1N962B	MIL-S-19500/117	Motorola	MIL-S-19500	A2(11-2)
Diode	JAN 1N457		TI		A2(11-2, 11-1)
Diode	USN 1N963B		Motorola		A2(10)
Diode	1N757A	MIL-S-19500/159	TI	MIL-S-19500	A2(10)
Diode	USN 1N978B	MIL-S-19500/117	Motorola	MIL-S-19500	A2(11-1)
Diode	USN 1N989B	MIL-S-19500/117	Motorola	MIL-S-19500	A2(11-1)
Diode	1N816W	MIL-S-19500/199	Transitron	MIL-S-19500	A2(9)
Diode		USN 1N438B	PSI		A35
		1N1126A	N. A. E.	MIL-S-19500/104	A16, A21
Connector	JACK Submin. SKT-1 1000 VRMS (50,000 ft)	8983191	Sealectro	MIL-F-6751	A(29)
Connector	RF Cable Connector	8722717	Sealectro	MIL-F-6751	A14(5)
Connector	RF Cable Connector	8722717	Sealectro	MIL-F-6751	A14(5)
Choke	RF Molded 39μh Q=60 at 2.5 Mc, 0.65ΩDC	8701590-263	Delvan	MIL-C-15305	A2(8)
Transistor		2N335	TI		A(28)
		2N329A	Raytheon		A2(1, 2)
		2N498	GE, TI		A2(4, 5)
		2N706	TI, Fairchild		A14(1)
		2N1490	RCA		A(13)
		2N1485	RCA		A12, 34, A2(4, 8, 9), A(28)
Resistor	Fixed Comp., 1/2W, 1 megohm ±10%	RC07GF105K	A. B.	MIL-R-11	A14(3)
Transistor		2N1486	RCA		A28
Diode		1N3189	Motorola	MIL-S-19500/155	A2(9)
Diode		1N648	TI	MIL-E-1/1193	A2
Diode		1N821	Transitron	MILS/19500	A2, A28

TABLE G-2
NON-STANDARD PARTS LIST

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Resistor	Variable, Comp. 1000 ohms ±10%, 3W	KA1L040S102NC	A. B.		A(29)
Resistor	Variable, Trimmer 1K ±5%, 0.5W	1175270-12	Bourns		A(35)
Resistor	3250L 1-502, 1K ±5%, 0-1W	8447750-3	Bourns		A2(11-2, 10, 9, 2)
Resistor	3250L-1-103, 10K ±5%, 0-1W	8447750-4	Bourns		A2(11-2, 2)
Resistor	3250L-1-253, 25K ±5%, 0-1W	8447750-5	Bourns		A2(11-2, 1, 9, 11-1, 3)
Resistor	Variable Trimmer 500 ohms ±5%, 0.5W	1175270-3	Bourns		A(17)
Resistor	Variable, WW, 200 ohms ±5%, 1W	8983168-5	Bourns		A(8)
Resistor	Variable, WW, 1000 ohms ±5%, 1W	8983168-7	Bourns		A(8)
Resistor	235-1-204, 200K ohms ±20%, 0-0.25W	8447749-1	Bourns		A2(11-1)
Resistor	(RH-50), 100 ±1%, 20W	8483207-2	Dale		A14(5)
Resistor	Variable Trimmer, WW, 25K ohms ±5%, 0.5W	224-S-1-253	Bourns		A14(5)
Resistor	10W, Power WW Chassis Mt.	RHM-10	Dale		A14(5)
Resistor	32501-1-202, 2K ±5%, 1W	1700383-5	Bourns		A2(3)
Resistor	3250L-1-103, 10K ±5%, 1W	1700383-7	Bourns		A2(3)
Resistor	25K ±5%, 1W	1700383-9	Bourns		A2(3)
Resistor	Fixed, 1 ohm ±3%, 3W, WW	RS-2	Dale		A2(6)
Resistor	Axial lead, fixed, 1 meg, 0.33W, WW	1250	Daven		A(27)
Transistor	99240-177 (2N1486)		RCA		A(35)A2(8), A(17)A2(6)
Transistor	1171588-1		Fairchild		A(35)
Transistor	8447741-1 (2N1208)		Transitron		A2(6)
Transistor	1729706		Fairchild Semiconductor		A(12)
Transistor	2N2432		TI		A2(3)
Transistor	2N1493		RCA		A14(2)
Transistor	8536787-1		PSI		A14(2)
Transistor	2N424		TI		A(29)
Relay	1708871-5 (SC11DD)		Potter Brumfield		A(36)
Relay	1708001-9 (SL11DD)		Potter Brumfield		A(36)
Connector	DM53744-0000		Cannon and Cinch Co.		A(29)
Connector	8748046-501		Minicon Corp.		A(29)
Tube	7870		RCA		A14(4)

TABLE G-2
NON-STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Coil	8483720-1		Delvan, RCA		A14(2)
Coil	8483720-2		Delvan, RCA		A14(2)
Coil	8483720-3		Delvan, RCA		A14(2)
Coil	8483720-4		Delvan, RCA		A14(2)
Coil	BP1140		Delvan		A26(3)
Coil	8482231-1		Coil R.F. Part of JFD SC-131		A14(3)
Coil	8530446-1		Coil R.F. Part of JFD SC-131		A14(3)
Coil	1175627		Universal Torroid		A9(7)
Crystal	8530488-2		McCoy		A14(1)
Nuvistor	N5247		RCA		A2(12)
Nuvistor	A15247B		RCA		A2(13)
Switch	1708219-1		Oak Mfg. Co.		A13
Fuse	1700596-1		Little Fuse		A34
Trans-former	DO-T36		U. T. C.		A26(5)
Diode	1N916		Fairchild		A9(1, 4, 2, 3, 5, 6) A(8) A2(10, 2, 1, 6, 3, 4, 11-1)
Diode	1N3057-B		Motorola		A(26)(8)
Diode	1N3041-B		Motorola		A2(11-2), A2(11-1)
Diode	1N754		TI		A(36)
Diode	1N457		TI		A2(10)
Diode	1N968B		TI		A2(10)
Diode	1N967		PSI		A2(10)
Diode	1N747		TI		A2(10, 3)
Diode	1N746A		TI		A2(10, 2)
Diode	848293-1		RCA		A2(10)
Diode	1N753-A		TI		A2(2)
Diode	8482944-1		RCA		A2(8), A2(9)
Diode	1N645		TI		A2(8), A(8)
Diode	1709319		Continental Devices		A17
Diode	1N761		Transitron		A(29), A(30)
Diode	8447742-1 (1N1583)		TI		A2(6)
Diode	1N2039-B		Motorola		A2(3)
Diode	1N704		PSI		A14(1)
Diode	1N251		Transitron		A14(1)
Diode	1N3031B		Motorola		A14(1)
Diode	1N3027B		Motorola		A14(1)
Diode	PSI122 (8536786-7)		PSI		A14(2)
Diode	1N2032		Transitron		A2(4)

TABLE G-2
NON-STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Diode	1N963		TI		A2(11-1)
Diode	1N646		TI		A2(9)
Diode	PS2419		PSI		A2(9)
Diode	2N683		TI, Motorola		A(36)
Capacitor	Solid Tant. Polar 15μf ±20%, 20V	8412778-10	Sprague Kemet		A2(6, 11-2, 11-1)
Capacitor	Solid Tant. Precond.	1175260-194	Sprague		A(35)
Capacitor	Solid, Tant. Precond.	1175260-208	Sprague		A(35)
Capacitor	Solid, Tant. Precond.	1175260-182	Sprague		A(35)
Capacitor	Solid, Tant. Precond.	1175260-200	Sprague		A(35)
Capacitor	Dipped Mica, Precond.	1175250-349	El-Menco		A(35)
Capacitor	Dipped Mica, Precond.	1175251-225	El-Menco		A(35)
Capacitor	Fixed Ceram. Plate 560μμf, ±10%, 200V	1175255-14	Aerovox		A(35)
Capacitor	Solid Tant. Polar 4.7μf, 35V	8412778-41	Sprague		A2(11-2, 10)
Capacitor	Solid Tant. Polar 22μf, 15V	8412778-76	Sprague		A2(11-2, 11-1)
Capacitor	Solid Tant. Polar 100μf, 20V	8412778-50	Sprague		A2(11-2)
Capacitor	Solid Tant. Polar 47μf, 35V	8412778-53	Sprague		A2(11-2, 10)
Capacitor	Solid Tant. Polar 3.2μf, 35V	8412778-44	Sprague		A2(11-2)
Capacitor	Solid Tant. Polar 47μf, 6 VDC	8412778-19	Sprague		A2(11-2, 11-1)
Capacitor	Solid, Polar 22μf, 35 VDC	8412778-61	Sprague		A2(11-2, 11-1)
Capacitor	Wet Slug Tant. 47μf	CL65CJ470MP3	Sprague, GE		A(28)
Capacitor	Fixed Tant. 6-100W VDC 109D's 4μf, 270μf	8938348	Sprague		A(13)
Capacitor	Solid Tant. Polar 15μf, 20V	150D156X0020B-2-10	Sprague		A2(10)
Capacitor	Solid Tant. Polar (150D) 4.7μf, 20V	8412778-34	Sprague		A2(10)
Capacitor	Solid Tant. Polar 60μf, 6V	8412778-11	Sprague		A2(10)
Capacitor	Solid Tant. Polar 330μf, 6V	8412778-86	Sprague		A2(10)
Capacitor	Solid Tant. Polar 40μf, 10V	8412778-30	Sprague		A2(10)
Capacitor	Solid Tant. Polar 6.8μf, 35V	8412778-95	Sprague		A2(10) A14(1)
Capacitor	Solid Tant. Polar 1μf, 35V	8412778-70	Sprague		A2(10)
Capacitor	Solid Tant. Polar 2.2μf, 20V	8412778-7	Sprague		A2(10) A14(1)

TABLE G-2
NON-STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Capacitor	Solid Tant. Polar 4.7μf, 10V	8412778-24	Sprague		A2(10)
Capacitor	Solid Tant. Polar 15μf, 10V	8412778-27	Sprague		A2(1)
Capacitor	Solid Tant. Polar 4.7μf, 6V	8412778-1	Sprague		A2(1,4)
Capacitor	Solid Tant. Polar 100μf, 15V	8412778-96	Sprague		A2(2)
Capacitor	Solid Tant. Polar 33μf, 15V	8412778-312	Sprague		A2(2)
Capacitor	Solid Tant. Polar 10μf, 15V	8412778-57	Sprague		A2(2)
Capacitor	Solid Tant. Polar 6.8μf, 15V	8412778-71	Sprague		A2(2)
Capacitor	Solid Tant. Polar 68μf, 15V	8412778-58	Sprague		A2(2)
Capacitor	Solid Tant. Polar 0.1μf, 35V	8412778-36	Sprague		A2(2) A29, A30
Capacitor	Tant. Foil, Non-Polar 120μf, D75 VDC	CL54CL121-UN3	GE (With Glass A36 (hermetically seal)		A(36)
Capacitor	Glass Trimmer 0.8 - 8.5 pf	SC133	J. F. D.		A14(1)
Capacitor	Tant. Foil, Non-Polar 2μf, 60 VDC	CL22TK020C	GE		A14(1)
Capacitor	Ceramic 1000 pf, 500W VDC	8950912-15	Erie		A14(2)
Capacitor	Tubular Ceramic 0.01μf, 600V	DD6-103	CentraLab		A14(2)
Capacitor	Ceramic Trimmer	538-001	Erie		A14(2)
Capacitor	Metallized Film 15μf, 600 VDC	8980848-576	Sprague		A2(9)
Capacitor	Metallized Film 0.15μf, 200 VDC	8980848-514	Sprague		A2(9)
Capacitor	Dipped Mica 2700 pf, 1000V	UDM30272J	Arco El-Menco		A2(9)
Capacitor	Solid Tant. Polar 180μf, 6 VDC	8412778-304	Sprague		A2(11-1)
Capacitor	Solid Tant. Non-Polar 23μf, 10V	151D235X9010W0	Sprague		A26(5)
Capacitor	Mylar, Mylar Wrap	CTM333VAJ	Arco		A12
Capacitor	Solid Tant. Polar 22μf, 15V	350D226X9015	Sprague		A12
Capacitor	Solid Tant. Polar 15μf, 35V	350D156X9035	Sprague		A12
Capacitor	Solid Tant. Polar 47μf, 35V	350D476X9035	Sprague		A12
Capacitor	Solid Tant. Polar 0.033μf, 35V	150D333X9035A2	Sprague		A9(3)

TABLE G-2
NON-STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Capacitor	Glass Trimmer, SC-131, 0. 8-4. 5 pf	898778-1, 2	J. F. D.		A14(3)
Capacitor	Glass Trimmer, 0. 8 - 4. 5 pf	841434-1	J. F. D.		A14(3)
Capacitor	Fixed Tant. 50μf, 60 W VDC	8938348-16	Sprague		A(34)
Trans-former	Step-Down Res. Load Freq. Range 1500	1076703	RCA	MIL-T-27A	A(28)
Trans-former	Toroidal -23.5 volts to 22.5 volts	1175301	Universal Torroid		A2(8)
Coil		1175626	Forbes and Wagner		A(16)
Trans-former	Power - 29. 5 volts	1180553	Forbes and Wagner		A(16)
Trans-former	Auto - Transformer Step-Up - Transformer	1185083	RCA		A16
Trans-former	OSC-Pwr. Transformer	1185086	Forbes and Wagner	MIL-T-27A	A26
Diode	C50DR309 SCR	1721896-1	GE		A12
Trans-former	2ZPP-2073-Gen	1721981	JPL		A41
Diode	SN-169	8545229-1	National		A14(2)
Transistor	2N389	8447743	TI		A2(3)
Capacitor	Metallized Paper 150 WDC	(121P) 1729623	Sprague		A14(3)
Diode		IN965	PSI		A14
Diode		IN705A	Hughes		A9
Diode		IN703	Hughes		A9
Diode		IN755A	Hughes		A9
Diode		IN2835B	Motorola		A14
Diode		IN3004B	Motorola		A14
Diode		IN3028B	Motorola		A14
Diode	Altered (IN530A)	8447747-1	Hoffman		A12
Diode		IN970B	PSI		A14
Diode		IN976B	PSI		A14
Diode		IN765	Transitron		A28
Diode		IN341B	Transitron		-
Coil	RF Molded 1500h	8723001-401	Delvan		A14
Relay	Coil Res. 1400 36VDC SL11DB-36	1708871-1	Potter and Brumfield		A34
Capacitor	Fixed Silvered Mica	8481434	RCA		A14(3)
Capacitor	Fixed, Ceramic Miniature Tubular	1175259	Aerovox		A35
Capacitor	Encapsulated Fabmika	1175388	Sprague		A2
Capacitor	Ceramic, Disc High Voltage	1751107	Maida Development		A1

TABLE G-2
NON-STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Capacitor	Stacked Foil High Temp.	200M224x9152 8447751	Sprague		
Capacitor	Ceramic Dielectric Special 125° C	8447758 C-80	Aerovox		
Fuse	315005	1700596	Little Fuse		A34
Fuse	Exothermic 0.155 ohms/ft	1175965-1	Pyrofuze		A34
Fuse	Exothermic 0.62 ohms/ft	1175965-4	Pyrofuze		A34
Capacitor	Metallized Paper 1.5μf ±20% at 1400V 85° C	118P155010T4	Sprague		A16
Crystal	RH-8, 18.0 Kc	1077463-1	Reeves, Hoffman		A9(6)
Coil	1X3000L 3.H		Universal Torroid		A2
Capacitor	0.15μf ±10%, 35V	8412778-80	Sprague		A2(4)
Diode	CAP at 9 VDC at 50 Mc Max VDC - 100 10$\mu\mu$f	PSI-PC-115-10	PSI		A(14-1)
Capacitor	1000 $\mu\mu$f 500V	8950912-15	Erie		A(14-1)
Transistor	Diss. at 25° C -0.25W Volt at VCE=18 volts	117599 2N943	Sperry		A2(4-10, 3)
Coil	RF Molded 1.5mh	8723001-401	Delvan		A9(6)
Relay	DPDT Coil Res. 2000 ohms Coil Disap. 1.5W at 25° C	1077484-1	C.P. Clare		A9(3)
Coil	RF 1.5mh		Telonic, RCA		A14-1
Coil	RF 2.2mh		Telonic, RCA		A14-1
Transistor	Disap. 25° C=0.15W Volt at VCB-45V hfe=200	2N336	Fairchild		A26(5)
Diode	Varactor	MA4348D	Microwave Assoc.		A14(3)
Diode	Silicon Low Leaking	8482943 JAN IN457	TI		A2
Coil	Line Filter	E-7266(1185054-1)	Forbes Wagner		A16
Trans-former		E-6463-3	Forbes Wagner		A16
Filter		SP196	Filtron		A28
Diode		MZ 18V05	IRC		A27
Diode		MZ 112V25	IRC		A27
Diode		FA 4000	Fairchild		A(8)
Capacitor	Metallized paper mylar 0.022μf	118P22302S4	Sprague		A28
Transistor		2N1656	Raytheon		A2(7, 11-2)
Transistor		2N2124	Westinghouse		A(16, 21)
Coil		746916	RCA		A14(4)
Coil	RF 8mh	MM3	UTC		A14(1)
Relay	27.50 DC-Hi Voltage RES=2500 ohms R-5	8984958-1	Resitron		A16, 21
Diode		IN758	TI, Transitron		A9, A26
Diode		CD4111	Continental Devices		A17

TABLE G-2
NON-STANDARD PARTS LIST (Continued)

Type	Description of Part	Procurement No.	Vendor	MIL SPEC	Subassemblies Where Used
Diode		IN1204	North American		A9
Diode		IN2032	Transitron		A2
Diode		IN2039	Motorola		A2
Coil	RF 2.2mh	No. VIV-0.22	Nytronics		A14(2)
Crystal	10.960 Mc	8530488-1	McCoy		A14(1)
Relay	DPDT Gen. Purpose J26B1H6A	8748087-2	Filtors		A14(1)

Appendix H

Summary of Malfunction Reports

These tables present a history of malfunctions that occurred to equipment on the TV Subsystem, from the initiation of the split-system through final flight model testing at ETR, prior to the launch of Ranger IX.

The tables are arranged by assembly and by serial number for each assembly.

The malfunctions are in chronological order for each serial number.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 004		
1376 (PFR 3152) 5/28/64		Discon-tinued camera operation	Thermal-vacuum (JPL venting tests)	Nonassignable	Camera operation discontinued, and a fluctuation was observed on the 100-volt monitor. Subsequent testing of the Assembly revealed a 12K-ohm short between two printed-circuit connections of the high-voltage regulator A2 frame. These connections were previously common, but the printed-circuit path had been cut to incorporate a design change. The Camera Electronics Assembly had operated successfully when tested at RCA and JPL prior to the application of conformal coating by JPL. Since the printed-circuit board in all flight models was previously modified to eliminate the close spacing of the 1000-volt and ground terminals, a failure of this nature was not likely to occur in any flight units. The failure in Camera Electronics Assembly, Serial No. 004, has been attributed to a breakdown of insulation between two connections on the printed-circuit board. The cause for such a breakdown could be impurities in the structure of the printed-circuit board, breakdown of the basic material as a result of time or exposure to thermal-vacuum conditions, or random arcing in thermal-vacuum that could result in the formation of a carbon path in the printed-circuit board.
			Camera Failures S/N 006		
3381 6/12/63	Capacitor C16	Poor black-to-white transition	Room (integration)	Design	The pictures obtained from this camera had poor quality black-to-white transition and were unacceptable to JPL. The peaking capacitor (C16) value was changed from 91 pf to 200 pf and the failure was corrected.
2617 8/26/63	Shutter (Serial No. 3011) Detent spring	Excessive noise	Room (JPL)	Wearout	It was noted that this shutter created considerably more noise than the other shutter. A detent spring was found broken. This shutter had accumulated in excess of 666,000 operations.
2620 9/23/63	Shutter Coil	Jammed coil	Special test after MVT No. 2 at JPL.	Workmanship	The shutter coil jammed. This shutter coil is part of the 3050 through 3061 series. Improvements in the manufacturing process prevented the recurrence of this type of malfunction.
4794 3/14/64	Capacitor C3	Polarity reversed	Ambient	Workmanship	Investigation into an incorrect waveform exhibited during the malfunctioning of the shutter revealed that capacitor C3 was installed with polarity reversed. The capacitor was replaced and normal operation of the shutter was restored.
5811 3/19/64	Capacitor C3	Over-stressed	Ambient	Workmanship	Investigation into why the free-running mode would not operate after rework revealed that capacitor C3 was improperly installed. This resulted in a reverse voltage being applied to the capacitor and, although the capacitor checked properly except for being slightly erratic, the capacitor was replaced. (Refer to MR 4794).
			Camera Failures S/N 007		
2616 7/30/63	Shutter (Serial No. 3019)	Failed to operate	Room (JPL)	Design	The shutter failed to operate on half of the cycles because the shutter block would not stay in the up-position due to a broken detent spring. The detent spring was sent for analysis. This disclosed that, along with some wear caused by the detent rubbing across the spring, material fatigue had been accelerated by the improper application of the staking compound used to hold down the detent-spring mounting screw. The compound should have been applied perpendicularly to the spring instead of parallel. An ECN was issued describing the correct method of applying the staking compound.
2619 9/14/63		Broken spring	Room (JPL)	Workmanship	Cause of saturation of P2 camera was broken detent spring. The tool used to fabricate the detent springs put a crease in the spring, resulting in breakage of the spring. Manufacturing then began use of a new tool to fabricate the detent springs.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 007 (Continued)		
4792 3/12/64	Choke L2	Lead broken	Ambient	Nonassignable	Investigation into the loss of 300-volt power revealed that the lead on choke L2 was broken. The location of the Subsystem when this lead was broken could not be pinpointed because no Subsystem test was performed on the PTM upon its receipt from JPL. An instruction entitled "Electrical Test on TV Subsystem Received from the Field" was issued. This specified that all Subsystems, when received, be tested in accordance with Appendix G of RTSP-1100A. (Chokes L2 and L3 were also replaced because the leads were potted together. Refer to MR 4793 and 5802.)
4793 3/12/64	G1 Regulator	No +1000 volts	Ambient	Design	Investigation into the loss of the +1000 volts revealed that the coaxial cable into connector A3J3A1 was broken. Refer to MR 5826 for analysis. The connection was resoldered, inspected, and conformally coated.
5821 3/24/64	Coaxial Connector	Loss of video	Ambient	Wearout	This coaxial connector has been pushed out. The retaining shoulder of the connector had been worn by the lateral motion of the insert. The vendor was consulted about this malfunction and recommended the use of back potting or nylon rings. The coaxial connectors on Flight Model III-2 were back-potted. This process was continued on Flight Models III-3 and III-4. The nylon ring was not used.
5826 3/28/64	Harness A3A3P3-A1	Wire broken	Ambient	Design	A broken wire at A3A3P3-A1 was attributed to lack of potting. Although the potting was applied as required by the latest drawing, it did not provide strain relief. All harness drawings were then modified to extend potting on all right-angle connectors for a distance of 0.50 ± 0.12 inch. This was then included on all Ranger TV Subsystems.
2171 6/30/64	Shutter	Mounting screw missing	Ambient (postvibration inspection)	Accident	During the postvibration inspection, it was noticed that a screw was missing from the shutter mount. A screw, with the shock mount still attached, was found on the floor and was probably the missing one. Examination showed that the nylock button on the screw was deformed so badly that no selflocking was possible. Flight Models III-2, III-3, and III-4, and the spares, all had Kel F long-lok screws (rather than the nylock button) which have high driving torque and are limited to one insertion for flight use. Thus, no further corrective action was required.
			Camera Failures S/N 008		
5825 3/27/64	Harness 30W10, Serial No. 0005	Wire broken	Ambient	Accident	Wire A6A3P3-A1 of harness 30W10 was found to be broken off at the solder joint in the connector. The wire was quite stiff because of the heavy insulation required for the 1000 volts for the vidicon mesh. The wire entered the connector at right angles to the pins and it is believed that it was broken because of careless handling during disconnection and reconnection of the plug. Personnel were instructed not to exert any force on the wire itself.
2172/3770 7/7/64	Shutter, Serial No. 004	Shutter jammed	Ambient (system test following a special vibration test)	Workmanship	When the shutter was disassembled, an excessive amount of metallic particles and a scar mark were found on the aluminum guide of the pole piece. The cause of the failure was attributed to the metal particles being wedged between the inside of the coil and the coil guide thus jamming the shutter. Extra precautions were since taken to remove all residual metallic particles from the shutter during the assembly process.
			Camera Failures S/N 009		
2986 4/1/63	Connector and Cable	Connector contact not making contact	Ambient	Accident	Contacts of vidicon connector were distorted and failed to make contact; improper insertions and extraction.
2984 4/2/63	Camera Head	Camera out of focus	Ambient	Workmanship	Cameras were not torqued properly when they were mounted after optical alignment. QC began inspecting mounting on all flight units.
2670 4/4/63	Vidicon 311	Cracked vidicon	Ambient	Accident	Glass accidentally cracked during manipulation of connector. New design reduced mechanical stress on vidicon.
1420 4/4/63	Lens 25-mm Angenieux	Particles of metal on inside surface of lens	Ambient	Nonassignable	Metal particles could have been the result of extensive machining of the camera shutter when the new lens was mounted.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 009 (Continued)		
2680 4/4/63	Transistor 2N1656 Q11	High-voltage arc	Ambient	Secondary	Secondary to (MR 2670): cracked vidicon caused high-voltage arc.
3382 6/12/63	Shutter Blade	Video saturation	Room (integration)	Workmanship	The shutter had a blade aperture of a millisecond rather than the specified 2 milliseconds. The shutter was disassembled and the following were noted: wear on the edge of the shutter blade; shift in position of the detent locknuts; powdery deposits on the housing. The following corrective actions were initiated: replacement of the shutter blade; coating of the detent locknuts with a locktight material; and a chemical analysis of the powdery deposits.
3386 6/12/63	Lenses, Vidicon, Shutter	Loss of picture resolution	Room (integration)	Secondary	Picture resolution was lost during debugging. The camera heads were disassembled and deposits were found on the lenses, shutters, and vidicon face plates. The deposits were chemically analyzed by the RCA Laboratories but could not be identified. The conclusion reached was that normal wear of the shutter could result in this deposition. The subject was discussed at a design review, and design changes were recommended which would keep this deposition to a minimum.
2302 6/30/64	Nuvistor (type 7586)	Open filament	Ambient (post-vibration system test)	Random	P3 camera video was lost at C+49 of postvibration system test 14. It was noted that the P3 Camera had been slow turning on during warmup. In a subsequent system test, P3 Camera video was intermittent. The nuvistor was removed and returned to AED where analysis revealed that the lead soldered to pin 4, (control grid) was loose. The lead, a solid wire, had been wrapped around the pin with a single turn and soldered. Further evaluation of the nuvistor (electrical test with all wire leads removed) indicated that the filament operation was intermittent. A multiple-wrap technique was initiated for use on Cameras serial no. 042 through 049 and on all replacements after July, 1963.
			Camera Failures S/N 010		
1757 3/9/63	Shutter (P) 3003	Open	Room (integration)	Workmanship	Shutter coil checked open; internal inspection revealed a broken contact spring that was twisted. This shutter was assembled by engineering with no QC. Shutters for all flight units were made by RCA under QC inspection.
2851 3/11/63	Shutter (P) 3031	Open	Room (integration)	Design	Shutter coil checked open. internal inspection revealed a broken contact spring. This early shutter model was used on the PTM to maintain test schedules. It did not have all of the modifications made to shutter design for flight units.
2854 3/16/63	Resistor, 20Ω 1/2 W, wire-wound (R1)	Open	Room (integration)	Random	The camera had a faulty video output which was traced to an open resistor in the focus current regulator of the High Voltage regulator. No other parts were bad nor did an analysis reveal any overstress condition. The resistor was a commercial item, and it was recommended that a MIL-R-93 type RB17CE20R00F be substituted. This was the first reported failure of R1.
3383 6/12/63	Shutter Blade	Video saturation	Room (integration)	Workmanship	See MR 3382 on Camera S/N 009.
3385 6/12/63	Vidicon	---	Room (integration)	Workmanship	The vidicon was loose and had a 1/16-inch play. The vidicon was removed and a piece of nylon was found jammed onto the yoke threads. This made it impossible to tighten the vidicon. The nylon was removed and the mounting retorqued.
3384 6/12/63	Loose Shutter Detent Locknuts	---	Room (integration)	Workmanship	The detent locknuts were found to be loose when the shutters were removed to change the blades. This condition was due to a lack of the required locktight coating. The required coating was applied.
2153 6/1/64	P4 Camera Assembly (PTM)	Microphonics on P4 Camera Video	Ambient	Nonconfirmed	Microphonics caused no serious degradation to the picture content. Due to the noncritical nature of the problem and the unavailability of the PTM for replacement of the vidicon, no action was taken at this time.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 011		
2985 4/5/63	Shutter Detent	Shutter detents lost magnetism	Ambient	Random	Loss of shutter action immediately after installation on structure. Detents removed and remagnetized. Reinstalled and operated successfully. First occurrence of this nature.
58ʋ2 3/18/64	Resistor R46	Lead broken	Ambient	Nonassignable	Inspection of the assembly revealed that the lead from resistor R46 was broken. Refer to MR 4792 on Camera Electronics S/N 007 for analysis. The lead was properly resoldered.
			Camera Failures S/N 014		
2943 8/8/63	Capacitor C2 Tantalum Type	High leakage current	Room (manufacturing bench test)	Random (part)	During the flight acceptance testing, the video signal was found to be inverted. Testing of the circuitry revealed that capacitor C2 had an excessive leakage current that caused transistor Q1 to remain saturated.
2947 8/25/63	Shutter (Serial No. 024)	Open coil	Room (manufacturing)	Nonassignable	The shutter would not operate because of an open coil. The strip had broken 1/16 of an inch above the solder joint during the initial manufacturing bench tests. The shutter had only 10,500 operations prior to this failure. This was only the second such failure.
4008 9/22/63	Contact Strip	Broken contact strip	Room (manufacture)	Nonassignable	The shutter failed during manufacturing bench testing. Failure was due to a broken contact strip that had experienced only 34,000 operating cycles. The past history of this full-scan shutter was not determinable since it had no serial number on it. It was believed to be an engineering test shutter. The shutter was thoroughly reworked, tested, and assigned a serial number.
2838 10/11/63	Vidicon Serial No. 66	Microphonic	Room (engineering)	Workmanship (vendor)	This camera had successfully passed flight-acceptance testing. During bench testing of the Block III cameras, the tube exhibited excessive microphonics. It was decided that the tube would not be used for flight but could be used during tests conducted in engineering or manufacturing.
2112 6/28/64		Reported overscan out-of-specification	Therma-vacuum (at 0° C)	None	A minimum overscan was specified as 8% for a P1 Camera; however, no maximum was specified. The measured overscan of 15% at 0° C constituted a more-than-adequate safety margin for this test. Therefore, this was not considered a malfunction.
2113 6/29/64	Vidicon, Serial No. 840	Low resolution	Thermal-vacuum	Random	When initially checked, the resolution of vidicon, Serial No. 840, was 7 percent at 630 lines at 25° C. However, during thermal-vacuum testing at 40° C, the resolution dropped to 1 percent at 671 lines. The Camera Electronics Assembly was functioning properly during this period. It was therefore concluded that the vidicon was temperature-sensitive and it was replaced.
3772 7/9/64		Telemetry voltage not within specified limits	Ambient	Nonconfirmed	The G1 and focus telemetry voltage was measured as -1.72 to 1.82, respectively. The specified minimum range is -2.0 to 3.0 volts. These readings were a function ot the vidicon beam-current requirements for best resolution. This particular vidicon required a high negative G1 voltage. The G1 and focus telemetry circuits performed satisfactorily. MR 100-64-131 was approved by JPL, indicating acceptability of this condition.
3883 8/18/64	---	Excessive vibration	Vibration	Accident	Camera Head received an excessive vibration shock when the input tape recorder of the test equipment failed to operate properly because of a defective connector and a dirty tape head. The camera was exposed to a random burst of noise at approximately 15g for one second. Camera Head, Serial No. 014, was electrically tested, revibrated, and electrically tested once more. No changes in operating characteristics were encountered. A procedure for cleaning the input tape-recorder heads on a regular basis was generated, and the heads were to be inspected prior to operation.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 014 (Continued)
3792 9/19/64	Vidicon, Type C74072-D	Excessive video gain	Ambient	Accident	Vidicon, type C74072-D, is twice as sensitive as the vidicon originally employed. Consequently, the range of the vidicon target voltage should have been reduced in order for the existing adjustment of the Camera Electronics assembly to maintain proper gain control. A reduction of the target supply voltage from 30 to 25 volts restored proper operation. This target-voltage reduction was also required for suppression of vidicon beam oscillations which were experienced with the 30-volt target supply. To prevent a recurrence of this malfunction, increased effort was made to assure that the vidicon parameters established during initial acceptance testing were maintained.
1357 10/9/64	Shutter	Stuck shutter	Ambient	Workmanship	The shutter stuck during the performance of a special engineering test. Analysis indicated that the core assembly of the shutter was defective. Excess epoxy which had not been removed interfered with the movement of the shutter coil. There was also a buildup of brazing material on the cross arm of the coil. These defects were corrected. However, during reassembly of the shutter, the core was cracked. A new core was to be installed when available. The Product Quality Control Check List No. 121 was revised to include special inspection items, so that closer surveillance of shutter assembly workmanship would be undertaken.
1371 10/20/64	Vidicon Serial No. J03360	Loss of video	Ambient	Accident	The malfunction occurred during a special test (investigation of defocusing) when the video signal was lost. The failure was attributed to a broken G2 lead in the connector A1P3 of the test harness. However, upon repair of the connector, the restored video was of poor quality, and further analysis indicated a 1000-ohm short between the cathode and G1 grid of vidicon, Serial No. J03360. Vendor analysis indicated that the broken G2 lead may have caused the internal short. With an open G2 lead, the input to the G1 regulator was not present. Therefore, the G1 grid was operating at zero bias for a brief period of time, possibly several minutes. The G1 grid normally operated at zero bias during the preparation portion of the cycle, but not for the remainder of the cycle. The vidicon was put into the normal aging cycle for new tubes. After operation at a filament voltage of 8 volts, the tube was found to have normal characteristics. Later, at AED, the tube again displayed erratic performance but stabilized after a brief period of operation. Operation at a filament voltage of 8 volts evidently cleared the internal short. The tube was coded to indicate a rejected item not suitable for flight use.
1529 10/29/64	---	Telemetry out of specification	Ambient	Workmanship	The 1000/300 telemetry-point voltage was measured as 2.5 volts, which was not within the specified range of 3.6 to 4.7. Investigation revealed that this low voltage resulted from a break in the 300-volt lead to the telemetry circuit. The break was at the terminal on the printed-circuit board. During repair of the wire, it was found that the wire may have been stressed by a tie wrap adjacent to the printed-circuit terminal. In addition, connector A3J3 was replaced and extensive trouble shooting was performed on this printed-circuit board. The combination of the possible stress and probing in the process of troubleshooting resulted in the break of this wire.
1547 11/19/64	Nuvistor	High noise level	Ambient	Design	(See MR2073) The replacement of microphonic nuvistors in camera preamplifiers was not unusual and not normally reported as malfunctions. This was because nuvistors must be specifically selected for each camera using microphonics as the parameter of primary interest. Due to the construction of the tube and its location in the camera head (close proximity with the shutter), these tubes often become increasingly microphonic, making replacement necessary. Some changes were incorporated to protect the nuvistor when mounted, such as long leads, use of blue-solithane potting material, and the use of improved shutter-shock isolation. Even with the changes, some nuvistors exhibited degraded microphonic performance as a function of time, making replacement necessary.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 014 (Continued)		
1547 11/19/64 (Continued)					A screening test for selection of nuvistors for low microphonics was established. The set-up consisted of a shutter, a camera housing, and a mount for mounting the nuvistor to the housing. Utilizing the same shutter-drive voltages, the relative noise level of nuvistors was readily discernible. Since noise in the tube is a function of the axis involved, the tube was tested twice (at 90°C) to assure a low level of noise in both axes. The set-up was checked utilizing noisy nuvistors for comparison, and the test appeared capable of selecting the better nuvistors.
2074 11/21/64	Video Amplifier	Noise on output	Ambient	Workmanship	During camera calibration tests, there were 10 mv of noise on the video amplifier output. In an attempt to improve camera performance the noise was traced to zener diode CR1. One end of the diode was disconnected. The diode was replaced with a 1N757A and operated satisfactory for a short time. It was discovered that the wrong diode was placed in the circuit. After the proper diode, 1N755A, was put in the circuit, the camera operated at a noise level of less than 5 millivolts. Inspection of color photographs of the board revealed that the original diode was a 1N757, which exceeded leakage specification.
2073 11/22/64	Nuvistor	Nuvistor micro-phonics	Ambient	Workmanship	The camera was rejected due to a high level of nuvistor microphonics. When a replacement nuvistor was installed, the camera still had 35 mv of noise in the white-field video. This nuvistor appeared to cause the preamplifier to go into oscillation. Another nuvistor was installed. The camera operated satisfactorily and the component was potted in the camera preamplifier. The original nuvistor was found to have a mu value of 35.2, which differed from comparable Ranger nuvistors by a factor of four. The nuvistor was returned to the vendor for an analysis. The oscillations were found to be internal to the nuvistor and were the result of a defective grid assembly. A new procedure was put into effect to alert manufacturing to the possibility of this failure.
1545 11/27/64		Double image on video	Thermal-vacuum	Accident (test equipment induced)	During thermal-vacuum testing of Flight Model III-4, the display of the F_b Camera video output exhibited a double image, vertically displaced near the center of the scanned raster. Investigation of the problem revealed that the mirror employed in the collimator prevented simultaneous focusing on bars and numbers. A telescope was used to view the mirror and the double image was again evident. An optical laboratory camera was then used to photograph the collimator target using the mirror. A smear was definitely visible when the photograph was compared to one taken while looking directly into the collimator. This verified a definite mirror defect. Temperature has a definite effect on mirror image. At colder temperatures, the double image worsens, while at higher temperatures, the double-image effect clears. Double image is thought to be an effect caused by the bonding of the mirror to metal with epoxy. This problem is recognized and the design and fabrication of a new mirror was initiated. The optical laboratory continued investigation to obtain a better reflective surface for use over the temperature ranges stipulated for spacecraft tests. When a new mirror was procured, the mounting configuration would be redesigned to prevent stressing of the mirror due to thermal expansion and contraction of its metal supporting structure.
			Camera Failures S/N 015		
3342 5/3/63	Transisotr (Q19) 2N722	External short	Vibration	Design	Loss of horizontal sync output following vibration. Emitter of Q19 was externally in contact with the emitter of Q9 of the horizontal sync. Circuit layout for modification of the horizontal sync board placed the two transistors adjacent to each other. The insulation broke down due to wear during vibration. The circuit layout was corrected to eliminate this failure mode.
3963 7/10/63	Sync Generator	Out of sync	Room	Design	The Sync Disable mode was activated while taking outside pictures. During this period, the camera went out of sync once in every five operations. The vertical sync generator circuit was redesigned. Diode CR8 was changed from a type 1N746 to a type 1N753. The ECN, No. 92705, to RCA drawing No. 1703809 was issued on July 18, 1963.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 015 (Continued)		
3374 7/23/63	Lens (75mm)	Loose lens	Room (integration)	Vendor workmanship	When the Camera was removed for optical alignment it was noted that the front lens element was loose. It appeared that a highspot had existed under the lens element in the lens housing. This highspot had worn down under vibration and the lens no longer fit snugly.
3980 9/10/63	Solenoid Coil Detent Spring	Broken binding	After thermal-vacuum test (integration)	Workmanship	Following removal of the spacecraft from the Thermal-Vacuum Test Chamber and following electrical check-out, shutter P4, S/N 3058 (FR A3979) was removed. When the spacecraft was reassembled, shutter P1, S/N 3056, did not operate due to a jammed coil and broken detent spring. All shutter solenoid coils used in shutters 3050 through 3061 were replaced. A program of testing, review, and inspection was initiated and all responsible persons reviewed procedures and specifications.
5813 3/25/64	Potentiometer R31	Misad-justed	Ambient	Accident	Following an intentional misadjustment of the deflection controls to check for vidicon shading, the subsequent realignment resulted in misalignment of the horizontal centering potentiometer. The resultant mask extension was only 12 microseconds instead of 15. The centering potentiometer was readjusted.
3935 4/3/64	Shutter, Serial No. 3030R1	Loose nut	Ambient	Workmanship	Inspection of Flight Model III-2 by Quality Control revealed that the nut on the screw holding the "C" contact spring was insufficiently torqued. The nut was properly torqued.
3830 3985 4/22/64	Vidicon S/N 708	Noisy video	Thermal-vacuum	Nonassignable	Two malfunction reports were written. MR 3985 covers a malfunction that occurred during thermal-vacuum testing; MR 3830 covers a malfunction that occurred during subassembly testing after the subassembly was removed from the Ranger VII structure. During a post thermal-vacuum test, there was a loss of video for a 10-second period. The loss was caused by external noise triggering the erase flip-flop in the vertical sync generator during a read cycle. The vidicon, Serial No. 708, was returned to the vendor for analysis, was found to be electrically satisfactory, and was not found to be microphonic. The shutter used was not identical to a Ranger shutter. The vidicon was returned to RCA. A shock greater than a single shutter operation was required to start the microphonics. However, once started, the shock from the shutter was sufficient to maintain the microphonics. The tube was returned to the vendor for dissection and examination. The faceplate was removed. The mesh and mesh mounting were found to be normal. The disassembled vidicon was returned to RCA. It was concluded that the vidicon was microphonic and that the microphonics were associated with the mesh structure.
1783 5/7/64		Mask deviation time	Ambient (pre-vibration)	Accident	The mask deviation time during the free-running mode was out of specification. This malfunction occurred because the mask deviation time during free-running mode was not checked during bench test. The test procedure for this assembly was revised to include a check of the free-running mode and any necessary adjustments.
3752 5/16/64		Shading out of specified limits	Thermal-vacuum	Nonconfirmed	The P1 Camera Subassembly was apparently out of the specified limits for shading when tested to RTSP-1112A while in thermal-vacuum condition. RTSP-1112A however, does not require that shading measurements be made under thermal-vacuum conditions. The P1 Camera subassembly was tested at ambient conditions and successfully completed acceptance test. A variation of the shading limits was reviewed with JPL personnel and approved.
2120 8/31/64		Defective test cable	Ambient	Accident	This malfunction was reported as an inoperative shutter. However, a check of the waveform for the shutter revealed that it was operating properly. The trouble was traced to test cable No. 2 where an open existed in the shutter return wire (A1J1-3 to J19). This, then, was a malfunction to the test equipment.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 016
2652 1/24/63	Lamp Drive S/N 016	Short B to C	Bench	Design	Leakage current caused unit to remain in the ON position and stressed the transistor; B to C short resulted. Recommended use of 2N1496 MIL part with tighter leakage-current specification.
2837 8/15/63	Vidicon Serial No. 162P	Noisy	Room (manufacturing)	Wearout	The performance of the vidicon was marginal after being installed in a camera. Further testing disclosed the tube to be defective because it had low sensitivity, poor signal-to-noise ratio, and very poor resolution. This was all attributed to low emission due to aging. The tube was subjected to approximately a year of cycling on and off. This tube was removed from use except for engineering test.
3350 8/22/63	Vidicon (Serial No. 438)	Micro-phonic and loose mesh	Vibration	Random	Vidicon tube was found microphonic and meshy after vibration. The elements inside the vidicon tube were found to have changed their relative position. The grid was in focus on the vidicon photoconductor layer. During readout this tube picked up the mesh and it appeared on the picture.
3555 9/4/63	Transistor Q5 (type 2N930	Short, base to collector	Room (manufacturing)	Accident (test error)	Examination of the failure revealed that the failure could only be attributed to an unnoticed and unreported testing error. This assumption was supported by the fact that immediately after replacement of transistor Q5, it was again destroyed by test error. Test personnel were again instructed to report all test errors.
3556 9/4/63	Transistor Q10 (type 2N1656	Open emitter			
3557 9/4/63	Transistor Q11 (type 2N1656)	Short, emitter to collector			
3558 9/8/63	Transistor Q5 (type 2N930)	Open base			
4403 and 4016 through 4020 9/16/63	Transistor Q11 type 2N1656)	Shorted, collector to emitter	Thermal-vacuum (Manufacture)	Accident (test error)	During thermal-vacuum testing the electrical power was accidentally applied while pumping through the critical pressure point. A review of all previous failures in thermal-vacuum was made to determine which other parts may have been overstressed.
	Transistor Q28 (type 2N718A)	Shorted, base to emitter and collector to emitter			
	Transistors Q29 and Q30 Type 2N1656	Shorted, collector to emitter			
	Transistor Q10 Type 2N389	Shorted, base to emitter and base to collector			
	Transistor Q3 Type 2N718	Shorted, collector to emitter			

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 016 (Continued)		
4005 9/17/63	Vidicon, S/N 896	Blemish on face-plate	Room (manufacture)	Nonconfirmed	It was noted that a spot, caused by a blemish on the vidicon face, was appearing on all monitor photographs. Manufacturing rejected these vidicons for their blemishes. When engineering received the table, they accepted the vidicons since the blemishes did not exceed the specified dimensions.
4004 9/18/63	Transistor Q10 (type 2N1656)	Shorted, collector to emitter and base to collector	Room (engineering test)	Accident (test error)	In an attempt to induce the Q10 and Q11 failures in the Camera Electronics, the plus 1000 volts was shorted to ground. This did not cause either Q10 or Q11 to fail. While doing this, the plus 300 volts was shorted to Q10, destroying it.
4094 12/4/63	Broken wire	Broken wire	Ambient (JPL)	Workmanship	The 275-volt-supply lead of connector A3J6 was found to be broken after the return of the deflection amplifier to JPL. The lead had been too short upon installation, and broke when stress was applied.
4479 12/23/63	Potentiometer R32	Open center contact	Room	Workmanship	The G1 switching voltage was lost during calibration and alignment for the six-camera bench test. Investigation revealed that potentiometer R32 had an open circuit. It was found that the lead into the potentiometer was broken. Microanalysis revealed that the lead had been twisted until it snapped. When the potentiometer was replaced, normal operation was restored.
4480 12/23/63	Transistor Q2 (type 2N718)	Shorted, base to emitter	Room	Nonassignable	During the investigation of the malfunction noted in Malfunction Report 4479, transistor Q2 was found to be shorted: base to emitter. The transistor was found to have failed because of a transient voltage applied between the base and emitter for a short period of time.
4098 12/28/63	G1 Regulator	Broken wire	Room	Accident	Following the repairs necessitated by Malfunction Reports 4479 and 4480, the Assembly was tested. Investigation of abnormal operation revealed that a wire to pin 33 of J6 was broken. It is believed that the wire was broken during the investigation for the two aforementioned MR's. The wire was replaced and normal operation restored.
4588 12/30/63	Transistor Q21 (type 2N722)	Low beta	Room	Nonconfirmed	This transistor was removed from the Assembly because of suspected erratic operation. Testing of the transistor showed that all static characteristics were within specification limits. The DC beta was found to be 55; the specified minimum is 20.
1361 10/12/64		Incorrect waveform	Ambient	Workmanship	When an oscilloscope was connected to the telemetry point for the shutter and lamp voltage on Camera Electronics, Serial No. 016, a sawtooth waveform was obtained, rather than the expected steady d-c waveform. Investigation revealed that a trace existed between terminals on the printed-circuit board, but should have been open, as shown in the photomaster for this circuit. The presence of this trace allowed the shutter input pulse to be routed directly to the base of output transistor Q18. When this trace was opened, the correct waveform was obtained. An analysis of the circuit, with the trace on the printed-circuit board, indicated that no overstresses were introduced, but this effect should be taken into account when telemetry is observed. Since this trace posed no real threat to camera operation, it was not necessary to rework Cameras, Serial Nos. 022 and 037, which also had this extra trace. It was felt that opening of the Camera Electronics Assemblies at this point would only have introduced unnecessary program delay and undue reliability hazards.
1366 10/16/64	Shutter Hardware	Microphonics	Ambient	Design	The measured noise was 80 millivolts, while the maximum specified value is 50 millivolts. The shutter mounting screws were loosened one-half turn, increasing the shutter-to-Camera Head clearance to 0.055 inch. This reduced the measured level of microphonics to 20 millivolts. The clearance was now set at the upper limits of the specification (tolerance for the clearance were given as 0.050 + 0.005, - 0.001 inch).

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 017		
849 2/7/63	Wire	Open	Ambient (integration)	Workmanship	There was insufficient slack in the wire. When laced down, the wire was overstressed resulting in a break at J6. Wire was replaced with proper wire length. Quality Control was instructed to exercise closer checks for this fault.
3274 7/5/63	Transistor Q9 (type 2N1893)	Open emitter	Room	Accident (test error)	The connections for the vertical yoke were reversed. The test positions were more clearly marked to prevent further accidents of this type.
2295 7/25/63	Transistor Q2 (type 2N1485)	Open, emitter to collector	Room (bench)	Accident (test error)	The Assembly was placed in a new test rack and power applied. Smoke and the odor of burning followed. A check of the equipment revealed that the transistor Q2 was burned. This failure was caused when a 6.3-volt line shorted to the shield of a cable.
3349 8/21/63	Transistor Q28 (type 2N718)	Low beta	Thermal-vacuum (engineering)	Accident	Emitter current was being shunted to the base of the transistor.
2554 12/14/64	N/A	Beam oscillations and telemetry out of specification	Ambient	Accident	During a postvibration electrical test of Camera, Serial No. 017/017, beam oscillations with amplitudes of 300 mv were encountered. Also, the horizontal telemetry read -5.23 volts, rather than the nominal -3.4 to -5.0 volts. Review of previous test data revealed that the horizontal sweep telemetry had a reading of -4.8 to -5.26 volts on 12/11/64; the beam oscillations were eliminated by adjustment of the G1, G2, and focus currents MRA-100-64-216 was written to cover the telemetry readings, and MRA-100-64-217 was written to cover the beam oscillations.
			Camera Failures S/N 018		
3962 7/6/63	Shutter S/N 3035	Open coil	Room (integration)	wearout	This shutter had experienced approximately 300,000 operations when one of its beryllium-copper contact springs broke. The design life of the P-Scan Shutters was 200,000 operations.
5819 3/27/64	Potentiometer R15	Cracked	Ambient	Accident	Excessive potting used to hold down the G1 regulator cable flowed over on potentiometer R15. During mating of the A2 and A3 frames, this excessive potting stressed the potentiometer and cracked it. Thereafter, when potting was applied, a straight edge was passed over mating surfaces to check for protruding areas.
3776 7/14/64	N/A	Cathode blanking not within specified limits	Ambient	Design	During the previbration electrical test the waveform of the cathode blanking was not within specified limits. Investigation revealed that the deviation resulted from an insufficient "off" bias on transistor Q17 in the video-amplifier circuit during the dark-current sample and shutter intervals. Transistor Q17 was biased slightly in the forward direction during this interval, resulting in low noise at the base of the transistor being amplified and displayed at the collector. This condition was corrected by alleviating the low-bias situation on transistor Q17, and decreasing the worst-case zero level of the erase pulse to 0 volts dc.
3840 7/24/64		Video waveform out of specification	Ambient	Accident	During previbration testing, the mask scan of the clamped video waveform was read at 116 microseconds. Investigation revealed that during electrical check prior to assembly, the value of the waveform was 110 microseconds, at the upper limit of the specified value. The adjustment had accidentally been made on the high limit of the specified value.
1362 10/13/64		G1 and focus telemetry voltage out of specification	Ambient	Random	During test of P1 Camera Electronics, Serial No. 018, the G1 and focus telemetry voltage was out of specification in the fail mode. This telemetry voltage measured -1.43 volts, while the specified range was 0 to 0.5 volt in the fail mode. The G1 failed should have been -0.7 to -1.3 volts, but read -2.28 volts.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 018 (Continued)
1362 10/13/64 (Continued)					An investigation revealed that all vidicon operating voltages were within the specified range; however, the voltage of the 1000/4 high-voltage test point was higher than normal (222 volts rather than 216 volts). This caused the +27.5-volt supply voltage to read +27.8 volts, which forward-biased transistor Q1 in the telemetry circuit and permitted a 3-volt, peak-to-peak, 20-msec pulse to be applied to charging capacitor C5. The telemetry output transistor, therefore, remained turned on and resulted in the out-of-specification telemetry readings in the fail mode. By adjusting the high-voltage (1000/4) test point from 222 to 216 volts, the supply voltage was reduced from 27.8 to 27.0 volts, removing the forward bias from transistor Q1. With this adjustment, normal operation was restored. Test Method -1-1754616 was revised, so that telemetry voltages would be checked immediately after any adjustment of vidicon operating voltages.
1551 10/26/64		Loss of Video	Ambient	Accident	During test of P1 Camera Electronics, Serial No. 018, the video signal was lost. The malfunction was traced to an intermittent failure of the -27.5-volt supply. The loss of voltage was attributed to a broken wire at connector A2J4-36. The wire was frayed and appeared to have been holding by only a few strands prior to the break. The wire was repaired and normal video was restored.
					Camera Failures S/N 020
2613 6/12/63	---	No +1000 volts	Ambient	Random	In the F-Scan Camera Electronics for the LTM, the 1000-volt supply was lost because of the arcing between the 1000-volt terminal and a printed circuit carrying 40 volts. A secondary failure was the shorting of the 1000 volts to a 300-volt wire with broken insulation.
2825 6/24/63	Transistor Q8 (type 2N2436)	Open	Room (bench)	Workmanship	During the preliminary tests it was found that the +1000-volt supply was producing only +645 volts and all other positive voltages were low. Trouble-shooting revealed that the emitter of transistor Q6 was grounded by the cathode lead of diode CR7. Diode CR18 in the video amp was wired in backwards and the lead that was supposed to go to the anode side of this diode was missing. Further, the wire in the deflection amplifier that supplied the +6 volts for sweep was broken off.
					Camera Failures S/N 021
2646 3/7/63	Vidicon	Cracked envelope	Room	Accident	Vidicon envelope developed a crack across the base; the crack extended along the side of tube. Failure occurred during one of the repeated socket insertions and withdrawals. The harness connection to the vidicon was modified to remove the mechanical loading from the vidicon pins.
2647 4/17/63	Bourns Trimpot 3250L	Pot open	Ambient	Random	One of the potentiometer leads opened at egress from the molded body. Cause of failure could not be determined.
2648 4/17/63	Transistor Q17 2N916	---	Ambient	Non-assignable	No blanking current from video amplifier. Transistor Q17(2N916) in the Video Amplifier was confirmed as having a low beta and defective E to B junction. This was the first reported failure of Q17. The malfunction occurred during modification of Block III-1.
2822 6/19/63	Vidicon P-Scan Serial No. 102	Micro-phonics	Room (bench)	Random	It was impossible to obtain satisfactory pictures from this vidicon due to High High microphonics.
2823 6/19/63	Nuvistor	Micro-phonic	Room (bench)	Non-assignable	This nuvistor was removed and replaced when the camera still had approximately 250 mv of microphonics with the vidicon disconnected.
4590 1/3/64	Vidicon, Serial No. 181	Low resolution	Room (JPL)	Nonassignable	Following alignment and calibration, the Camera did not pass acceptance tests because of low resolution. All voltages to the vidicon were normal. The tube was replaced with Serial No. 942 and normal operation of the Camera was obtained.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 022
3345 8/15/63	Transistor Q5 (type 2N1485)	Short, collector to emitter	Room (manufacturing)	Accident	The video was lost after approximately 20 hours of bench testing. This was found to be due to an accidental short between transistor Q5 and a voltage source.
4269 1/24/64	Cable Shield	Improperly wired	Room	Workmanship	The G1 regulator was not switching properly during a bench test. The shielded cable from J3 to A3 frame was found to be improperly wired and resulted in ground being placed on the R33-R34 junction when the test cable was connected. The wiring error was corrected and reinspected for quality acceptance.
5817 4/3/64	Lens, Serial No. 1887	Black particles	Ambient	Nonconfirmed	A visual inspection of the lens revealed loose black particles within the lens structure. Although they did not affect camera operation, the lens was disassembled to determine the nature and source of these particles. It was believed that the particles were pieces of black lacquor which resulted from scraping occurring during the past two years. The vendor was informed of the problem to prevent recurrence. Personnel were instructed not to disassemble the lenses for this problem because it did not affect camera operation.
5818 4/5/64	Diode CR9, Resistors R37, R38, R39, and R40 Capacitor C15	Telemetry output out of specified limits	Ambient	Nonconfirmed	The telemetry output of the horizontal scan read -1.3 volts. The specified limits were 0 to -1.25 volts. Various components were removed and found to be satisfactory. A review of the specified limits as well as the failure simulation method resulted in the specified limit being changed to -1.5 volts.
2253 11/11/64	Shutter, Serial No. 3043R-1	Noise spikes in raster	Ambient (JPL)	No failure	A review of the 35-mm film of the video output obtained during a special test at JPL revealed noise spikes in the output of the P2 Camera. The noise usually appeared at alternate operations of the P2 Camera shutter and was generally grouped within a few TV lines near the top of the scanned raster. The duration of the noise spikes varied from a few microseconds to 50 microseconds. . The level went to saturated white but recovered with little or no ringing. The P2 shutter was replaced as an exploratory measure (not because of a shutter malfunction), but this did not provide any improvement. However, in later tests, the noise spikes were somewhat lessened. No additional action was taken since the noise spikes were actually within acceptable limits and the camera was still operating well within requirements.
2252 11/13/64	---	Reversed plugs	Ambient (JPL)	Accident	During installation of the P2 Camera Assembly for a special test, plugs A2P2 and A3P5 were accidentally reversed. Power had been applied for 2 minutes and 15 seconds before the plug reversal was discovered. The A2P2 connector carried supply voltages to the preamplifier, while the A3P5 connector carried telemetry voltages. The plug reversal terminated all camera telemetry circuits in the preamplifier and supply voltages were terminated at the 90-point telemetry commutator. It was determined that no overstressing of parts occurred in the Channel 8 or P-Channel voltage controlled oscillators or in the affected telemetry circuits. All jacks and plugs were clearly stencilled. However, extra care was taken when these particular plugs were mated since they were the same type. In a duplication of the malfunction condition reported in MR 2252, a special test was performed on capacitors C3, C4, and C2 in the camera preamplifier circuit. All of these capacitors were CL45BK040MP3, polarized wet-slug types. During the actual malfunction, the input to C3 and C4 circuit had a reverse voltage of 3.5 volts for 2 minutes 15 seconds, and the circuit of capacitor C2 had a reverse voltage of 2.8 volts for the same period of time. In a series of three test configurations, no significant increase in leakage current was detected when subjected to identical failure modes. This finding supported the previous opinion of capacitor specialists and the vendor that the stress induced by the malfunction of MR 2252 was not severe enough to affect the reliability of the capacitors in P2 Camera, Serial No. 022/022. Two sample capacitors used in the tests were dissected and found to be clean internally. There was no evidence of silver migration in either component.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 022 (Continued)		
6000 2/20/65	---	High Shutter-induced micro-phonics	Ranger VIII Mission	Nonconfirmed	Severe microphonics occurredin the final frames of the P2 Camera during Ranger VIII Mission. The flight data was compared with preflight test performance which indicated that the P2 Camera flight performance was consistent with the test performance at AED and JPL during the thermal-vacuum runs. The increase in microphonics during the mission was due to rising vidicon temperature. This was not considered a malfunction.
			Camera Failures S/N 023		
2615 6/14/63	---	No lamp-drive	Room	Nonconfirmed	The data point used to monitor the lamp-drive circuit indicated a failure. The related circuits were checked and found to operate satisfactorily.
			Camera Failures S/N 024		
1670 4/12/63	Vidicon No. 261	Slow warm-up	Thermal-vacuum	Random	Initially, P4 acted as if it had a slow warm-up. However, it functioned satisfactorily at the end of the run and during all subsequent test runs.
			Camera Failures S/N 025		
3973 8/5/63	Shutter (Serial No. 3047)	Failed to operate	Room (integration)	Design	The analysis and corrective action for this malfunction Report is the same as presented in Malfunction Report 2616 on P2 Camera Assembly S/N 007.
3974 8/10/63	Shutter (Serial No. 3032)	Broken contact strip	Room (integration)	Design	The P-Shutter was found to have a broken contact strip. The shutter had operated for only five days before this failure, its second. The first failure in the shutter occurred after 300,000 operations. One of the contact strips broke and was replaced. However, the remaining contact strip was not changed and after five days of operation, also failed. On all subsequent reworks, both contact strips were to be replaced.
3433 9/16/63	Contact Strips	Broken	Room (JPL) (system test)	Workmanship	A broken contact strip resulted in an open coil in the shutter. Inspection of the strip revealed that it had been soldered to the coil on an angle. Thus the contact strip was subjected to twisting when operated and it snapped. Shutter S/N 3032 was thereafter used only for preliminary testing of flight equipment.
			Camera Failures S/N 026		
2942 8/8/63	Diode CR2 (type 1N2039B)	Open	Room (manufacturing)	Workmanship	The camera sweeps were found inoperative. Investigation disclosed that diode CR2 had been opened by a solder splash on the circuit board shorting the diode to a 6.3 volt source. Upon replacement of the diode and cleaning of the board, the unit operated satisfactorily.
2944 8/10/63	Transistor Q5 (type 2N1656)	Short, collector to emitter	Room (manufacturing)	Accident (test error)	In order to find the vidicon tube that performed best in a camera, several were installed, tested, and then removed. During one of these tests, two wires in the vidicon connector were crossed allowing plus 300 volts to be shorted to G1 resulting in the shorting of transistor Q5.
1312 8/28/64	Nuvistor	Micro-phonics	Postvibration	Vendor workmanship	During a postvibration check of Camera Head, Serial No. 026, microphonics of 100-mv amplitude were experienced on the clamped video signal. The nuvistor was replaced, and the noise was greatly reduced and signal level improved. While removing the original nuvistor, however, a hole was accidently punched in its metal case, breaking the seal and making an electrical analysis impossible. Mechanical analysis of the nuvistor from this unit revealed that the tube had a defective grid structure. Several of the grid supports had not been attached during manufacture of the tube. This permitted the grid to move, and constantly changed the grid-to-cathode spacing.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 028		
3371 3372 3280 7/28/63	Transistor Q11 (Type 2N1656) Transistor Q17 (Type 2N916) Transistor Q10 (Type 2N1656)	Open, base to collector Short, collector to emitter	Room (bench)	Accident	The G1 regulator would not operate constantly with respect to the ground reference and the video amplifier had no cathode blanking. Analysis revealed that only a short between the G1 head and the cathode lead of the vidicon could cause these three transistor failures. The short could have occurred in the cable, the connector, or from an external cause.
2948 8/26/63	Vidicon S/N 288	Loose mounting	Room (manufacturing)	Workmanship	The vidicon turned in the camera head when attempts were made to torque it down during assembly. A visual inspection of the phenolic sleeving on the tube verified that the tube was acceptable. A check of the yoke revealed it to be slightly larger when compared to other cameras. The vidicon S/N 288 was installed in Camera S/N 028 and appeared to fit well.
4473 11/22/63	Connector A1A1J1	Improper mating	Ambient (integration)	Workmanship	Investigation as to the loss of video from the P1 Camera revealed that coax insert A1A1J1 was pushed out. The investigation further revealed that because of improper potting, it was impossible to mate the connector properly. The connector was replaced on the harness. QC has been requested to inspect all connectors very closely.
3802 5/4/64 3809 5/5/64		Variation	Ambient	Nonconfirmed	The average white level of the P1 Camera was considerable lower than that of the P2 Camera when tested with their respective collinators. A check was made by interchanging the P1 and P2 collimators and then using a calibrated light gun. In the test with the interchanged collimators, the difference in the average white levels of the P1 and P2 Camers was approximately 75 mv. The peak white level of the P1 Camera was approximately 15 percent low when determined by the use of the light gun. The P1 and P2 collimators were at 2450 and 4000 foot-lamberts respectively during these tests. The collimator difference was caused by the replacement of the bulbs without recalibration of the collimators. The low sensitivity of the P1 camera was caused by shutter replacement at JPL.
2195 5/15/64	---	Video noise burst	Postvibration	Nonassignable	During a postvibration system test performed in accordance with JPL test procedure 3R 300.12, a very fast noise burst was observed on the 35-mm film of the P1 Camera video (Reference MR 2192). This noise burst occurred near the top of the frame at the time of P3 Camera shutter operation or during F Camera shutter operation. Thus, the noise appeared to be microphonically induced. The interference resulting from the noise burst was minor (much less than 1 percent of the picture), so no immediate action was recommended. The amount of noise varied among tests; e.g., the second thermal-vacuum test (cold) had only a few frames in which the noise appeared.
2192 5/22/64	---	Noise	Ambient (JPL)	Nonconfirmed	Prior to mounting the Subsystem on the JPL Bus, a short test in accordance with Appendix R of RTSP 1100 was performed. The Thermal Shrouds and collimators were mounted on the Subsystem during this test. Examination of the 35-mm film revealed short noise pulses on the P1 video during both normal and sync-disable operation. Although the problem is not serious enough for camera disassembly, the video will be watched for signs of further degradation.
2055 6/26/64	Deflection Yoke	Open	Ambient	Workmanship	A check of the focus coil of the deflection yoke indicated an open between pins 1 and 9. The yoke was disassembled and the coil unwound to locate the open. It was found that the coil wire had been physically cut. The deflection yoke had been previously reworked to correct a stripped thread of a screw hole in the yoke collar. The damage to the coil wire was caused either by the tapping operation to enlarge the screw-hole size from No. 4 to No. 6 or by the use of a screw longer than specified by the deflection-yoke assembly drawing (RCA drawing No. 1754325. Note 5).

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 028 (Continued)
1306 8/1/64 2118 8/21/64	---	Horizontal over-scan Video saturation	Thermal-vacuum Ambient	Workmanship (vendor) Design (AED)	Camera Electronics, Serial No. 018, exhibited shutter mistriggering, horizontal overscan, and out-of-specification resolution at 25° C. Preliminary investigation indicated that the video blank level was 300 mv rather than the nominal 70 mv. Additional investigation revealed the presence of distortion in the unclamped video waveform at the beginning of each horizontal line. Since the clamp circuit sampled during this interval, the action of the clamp caused the vertical black level to set on the distortion. Further investigation of the camera electronics isolated the problem to the vidicon yoke. An attempt was made to disassemble the yoke for analysis; however, the coils were so well potted that they were damaged to the extent that the source of the problem could not be determined visually. Resistance and inductance measurements indicated that the horizontal-deflection coil had approximately 68 turns shorted. Although these shorted turns appeared to be out of the circuit, the shorted portion of the coil was still mutually coupled to the remainder of the coil, providing a dampening effect, which affected the linearity of the waveform at the beginning of each horizontal line. Replacement of the vidicon yoke eliminated the horizontal overscan problem. During subsequent testing of this camera, erratic shutter operation was encountered. During bench tests to determine the cause of the shutter problem, saturated white video problems occurred, which were capable of being induced by adjusting the vidicon-target voltage from 30 to 37 volts. The correction to offset the vidicon was accomplished by reducing the vidicon target potential to 25 volts. Camera operation returned to normal, with only a very slight loss in sensitivity. The shutter problem was attributed to noise on the shutter-pulse output from the vertical sync generator, with the noise occurring almost coincidentally with the trailing edge of the shutter pulse. The noise problem was traced to a faulty transistor (Q21) in the vertical sync generator, whose beta value was too low to maintain saturation for the duration of the shutter pulse. As a result, low-level noise spikes at the transistor base were amplified and impressed on the shutter drive input. Replacement of transistor Q21 restored normal shutter operation. When the camera was again tested in the thermal-vacuum environment, the vertical dark-field shading was out of specification. This is a common occurrence when vidicons undergo temperature variations. However, the shading was still too high at the end of the test, so an investigation was performed to determine the source of the problem. The erase, shading, and resolution characteristics of the camera were normal; however, the light-transfer characteristic (gamma) of the vidicon tube was more than 1.1. The gamma was modified to slightly less than 1.0 by the use of a 75-ohm lamp-driving resistor. The unit was tested in the thermal-vacuum environment and operation was normal. In order to eliminate video-saturation problems, the vidicon target voltage of each camera has been set at a value lower than the 30-volt range; the value of the voltage is established in accordance with a setup procedure. The failure of transistor Q21 from low beta indicates that the unit had been at marginal level at the time of installation. In future modifications or new cameras, transistor type AED-02, which has a minimum beta of 40 at 5-ma collector current, would be utilized as the lamp-drive transistor Q21. In addition the transistor base-drive current would be increased by decreasing the 22-k ohm series resistor to 10-k ohms.
3963 8/20/64	---	Loose shutter	Vibration	Nonconfirmed	During thrust-axis vibration it appeared that the shutter had worked loose. An inspection of the Camera Head by the mechanical-integration activity showed that the shutter mounting and associated hardware met all specifications. This, therefore, did not constitute a true malfunction.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 028 (Continued)
1536 11/14/64	Video Amplifier	No video output	Ambient	Accident	During a test for microphonics, no video signals were obtained. During the previous rework, a lead that had a nick in the insulation was disconnected. A piece of thermo-fit sleeving was placed over the insulation at this point. When the lead was reconnected, the shield was connected to the pre-amp output and the center conductor was connected to ground. When the camera head was attached to the electronics, all video signals were shorted to ground at the pre-amp output. A stress analysis indicated that components C2 and Q1 were the most susceptible to stress. These components were not overstressed.
					Camera Failures S/N 029
2688 2689 2690 6/25/63	Transistor Q8 (Type 2N1208) Resistor R26 Transistor Q7 (Type 2N697)	Short, collector to emitter Open Overstress	Room (integration)	Accident (test error)	Transistor Q8 (2N1208) was shorted from the collector to the emitter. Resistor R26, a 1 ohm 3 watt wire-wound resistor was open and completely destroyed. Transistor Q7 (2N697) was replaced since it was overstrssed. It is unlikely that a component failure would have caused such extensive damage. Therefore, it is believed that an external short-to-ground of the collector on transistor Q8, caused the damage. This short probably occurred at the shutter coil terminals since they were the only accessible points where an external short could be applied.
					Camera Failures S/N 031
4234 12/8/63	"C" Ring Spring	Lost	Ambient (JPL)	Design	During a routine maintenance test, the ring used to lock the shutter block assembly to its drive rod was found to be missing. The shutter had undergone approximately 150,000 operations. Because the ring could not be located, it is believed that it was missing at the time the shutter was installed. However, inspection of the shutter block disclosed staking compound which indicated that a ring had been present. The following recommendations were implemented to prevent a recurrence of this problem: • Impose a 100% inspection of all rings and pins for proper dimensioning, • Bond the ring with staking compound with the opening 90° away from the line of thrust, and • Change the groove dimensions on Drawing No. 1170149 to 0.074 $^{+0.002}_{-0.000}$ for the groove diameter to improve worst-case fit.
2178 5/13/64		Video line missing	Postvibration	Random	A postvibration verification test in the Z-axis was performed on Flight Model III-2. This test was conducted in accordance with JPL test procedure 3R311.03 The review of 35-mm film from the test revealed that on frame No. 45 a line was missing (P1 Camera) and on frame No. 52 a line was missing (P4 Camera). This problem was not observed in any subsequent testing. Therefore, the malfunction was considered to be a random occurrence.
2179 5/13/64		Nuvistor microphonics	Postvibration	Nonconfirmed	During a postvibration electrical test, the P1 Camera exhibited an increase in nuvistor microphonics of approximately 13 kc as compared to previous tests. The magnitude of the microphonics was not known, and to determine this level would have required the opening of several connectors on the TV Subsystem. An investigation of this nature was not warranted at that time. This microphonics condition appeared and disappeared with all cameras. A later test revealed that it existed on a limited number of frames. The phenomena were continually scrutinized when evaluating camera performance.
					Camera Failures S/N 032
4002 9/7/63	Solenoid Coil	Jammed Solenoid	Room (manufacturing)	Vendor Workmanship	During testing of Camera S/N031, the shutter stopped functioning. Inspection of Shutter S/N3054 indicated the solenoid coil was jammed. The glass epoxy coil was removed and quality control performed several measurements. This coil was found to be out-of-round at the narrow end of its taper and was smaller than the minimum as specified on the mechanical specification. An additional number of solenoid coils were ordered and they were to be fabricated under the close supervision of quality control and manufacturing. In addition, several extra coils would be constructed at the same time. These coils would be tested by engineering and quality control.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 032 (Continued)		
4009 9/28/63	Transistor Q4 (Type 2N722)	High voltage	Room (manufacturing)	Nonconfirmed	The G1 and Focus Telemetry point measured out of specification limits, minus 27 volts, during manufacturing test. The transistor was found to be good following its removal.
4262 11/24/63	Shutter Serial No. 013	Magnetic detent not holding shutter	Ambient (JPL)	Design	The F_a Camera was saturating although no light was applied. Although a reading was obtained when the shutter reached the top of its stroke, the magnetic detent was not holding the shutter in the up position. Close inspection revealed the shutter was rebounding off new shock bumpers. An FCN has been issued to shorten the shock bumpers to prevent interference with the shutter.
3870 6/20/64		Broken wire	Ambient	Workmanship	The Camera Electronics Assembly (Serial No. 032) failed to operate during initial bench-check test. Examination of this assembly revealed an open wire in the high-voltage chopper circuit. When the open was corrected, the assembly operated normally.
1302 7/29/64	Preamplifier Serial No. 112	No target voltage	Ambient	Accident	During ambient test, target voltage was not being applied to the vidicon. Investigation revealed that preamplifier, Serial No. 112, had previously been opened for inspection of the nuvistor. In replacing the cover, the target-voltage lead was pinched between the cover and case, breaking through the insulation and shorting the lead. Analysis of the circuit showed that a short at this point did not overstress the low-voltage regulator, preamplifier, or vidicon. The shorted lead was replaced and proper operation was restored.
			Camera Failures S/N 034		
2826 6/19/63	Vidicon (S/N 708)	Dark current tilt	Room (bench)	Nonconfirmed	A defective vidicon test cable caused poor video and improper shutter operation. Even with the new cable the vidicon had an excessive slant on the dark field. The vidicon was tested in several cameras including the engineering bench setup. In all cameras, varying degrees of slope were present. The vidicon was replaced with S/N 402.
3271 7/1/63	Beryllium copper strip	Broke	Room	Wearout	The shutter failed due to a broken beryllium contact strip. This shutter had logged in excess of 350,000 operations. A procedure was established by engineering for the attachment of contract strips to the solenoids requiring the use of minimum solder. The strips previously failed due to flexure at the end of the solder flow. The new procedure would prevent the solder from flowing along the strip and would reduce the failure potential.
3380 8/2/63	Transistor Q4 (type 2N930)	Short, base to emitter	Room (manufacturing)	Workmanship	The vertical sweep telemetry point failed to indicate a malfunction upon the disabling of the sweep, as called for in the bench test procedure. Inspection revealed that excessive heat, probably during either rework or the test program, had been applied externally to the base lead of transistor Q14.
4698 4/10/64		Monitor signal missing	Ambient	Nonassignable	Investigation of the lack of the cathode blanking signal on pin 11 of jack A3A3J1 revealed an open circuit from the isolation resistor to the test point. With the agreement of JPL, this condition was to remain unless the assembly was removed from the Subsystem for some other purpose (because the Assembly was working properly and could not be worked upon while integrated).
			Camera Failures S/N 035		
2833 2834 2835 7/18/63	Diodes CR6 and CR7 (Type 1N989B) Transistors Q5 and Q6 (Type 2N1656) Transistor Q2 (Type 2N722) Transistor Q3 (Type 2N718A)	Open Overstress Open Overstress	Room (bench)	Workmanship	During manufacturing bench test, the G1 Regulator did not operate. Investigation revealed that the plus and minus 27.5-volt lines had been wired in reverse. Diodes CR6 and CR7, and Transistor Q2 all had opened due to the incorrect wiring. Transistors Q3, Q5, and Q6 were all replaced due to an overstress.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 035 (Continued)		
3936 3/21/64		Telemetry out of specification	Ambient	Nonconfirmed	A malfunction at the Vertical Sweep Telemetry Terminal on Test Rack 001 was indicated. Investigation revealed that Test Rack 001 was malfunctioning. Replacement of the test rack restored normal operation of the failure indication circuit.
3937 3/23/64		Clamp pulse and mask level out of specified limits	Ambient	Accident	The measured clamp pulse and mask level measured 65 microseconds. The specification incorrectly stated that 70 microseconds was the specified minimum. The specification was revised on March 30, 1964 so that the minimum is 65 microseconds.
4785 3/23/64	Potentiometer R17	Misadjusted	Ambient	Design	Potentiometer R17 was readjusted to return the horizontal-erase-sweep overscan to within specification limits. The assembly was set aside for 4 to 5 hours, then operated for one hour, and then rechecked. The overscan remained within limits. The Test Specification, RTSP-1111A, did not specifically designate the original adjustments. It was since corrected to detail the necessary adjustments.
3938 3/30/64		No video	Ambient	Workmanship	Investigation into the loss of video from the camera revealed that the wire to A2J1-1 was broken. During the investigation two resistors with incorrect values were found. The wire was repaired, the resistors were replaced, and normal operation, as verified by a subsequent test, was restored.
			Camera Failures S/N 036		
3554 8/29/63	P Vidicon S/N 115	Microphonic and meshy	Thermal-vacuum (manufacture)	Vendor Workmanship	The vidicon S/N 115 became microphonic and very meshy during 40°C thermal vacuum test. When analyzed by engineering, failure was confirmed and vidicon was replaced.
3990 4/26/64		Out of focus	Thermal-vacuum (-10° C)	Nonconfirmed	The video obtained from the P_2 Camera on Flight Model III-2 during the thermal-vacuum testing of the Subsystem provided a resolution near the minimum acceptable individual camera resolution performance. Review of the data by both JPL and RCA personnel resulted in the conclusion that the Camera was acceptable for use.
2194 5/15/64		Superimposed video	Postvibration	Random	During a postvibration system test performed according to JPL procedure 3R 300.12, the video signals of P_2 and P_4 Cameras were superimposed on frame 252 of the 35-mm film. This superimposition of video was an isolated incident attributed to a transient that caused the position pulse of the P_4 Camera to occur at the same level as the position pulse of the P_2 Camera. This condition was not observed on subsequent frames of the film. This failure was therefore classified as random and tests will be closely monitored for recurrence. No action was warranted at this time.
			Camera Failures S/N 037		
3978 9/3/63	Detent Spring	Broken spring	Room (integration)	Wearout	The shutter was operating slowly and erratically. This was caused by a broken detent spring. This shutter had accumulated in excess of 330,000 operations. Both detent springs were replaced along with both contact strips.
3979 9/9/63	Solenoid Coil	Jammed solenoid	Thermal-vacuum (integration)	Vendor Workmanship	The shutter coil became jammed in thermal-vacuum test. When the shutter was disassembled, it was found that the glass epoxy solenoid coils were out of round at the narrow end. Also the minimum dimension measured on this coil was below the minimum allowable.
4022 9/13/63	Solenoid Coil	Jammed coil	Thermal-vacuum test (integration)	Accident (test error)	This shutter was installed on the spacecraft when shutter S/N 3058 failed during thermal-vacuum testing (MR 3979). Shutter S/N 3050 was installed on the spacecraft in order to continue the test, even though the shutter was marked by quality control as a defective part. Shutters S/N 3050 through 3061 had new solenoid coils installed.
3991 4/28/64		Camera out of focus	Thermal-vacuum	Nonconfirmed	During thermal-vacuum testing, the picture obtained from the P_4 Camera appeared to be out of focus; however, the camera was operating within all required specification limits. After a review of camera data by RCA and JPL, a mutual agreement was made to retain the camera on the Ranger VII Spacecraft.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Camera Failures S/N 037 (Continued)					
3599 5/12/64	Wire	Broken	Ambient	Accident	A broken wire was found on pin 17 of connector J6, frame A3. Because of the location of this pin, it was thought that the wire was broken by the handling and unintentional stress applied to the soldered connection when the cable was formed over the receptacle.
2268 12/28/64	N/A	Shutter-induced noise bursts	Ambient (JPL)	Design	Review of the 35-mm film from the SFOF systems test revealed severe noise bursts in the P_3 Camera video output. The noise was concentrated in the top one-third of alternate frames from the camera. The problem was only present during the terminal portion of the SFOF test when the TV Subsystem was mounted in a horizontal position. When the Subsystem was tested in the vertical position, the noise bursts were not present on the P_3 Camera video output (similar situations have been noted with different cameras on every spacecraft). It appears that the electrostatic charge and discharge of shutter components contributed heavily to the appearance of white-level noise spikes in the video presentation. Substantial reduction of the noise was demonstrated experimentally by ground conditions on all shutter parts. A limited number of spare shutters were modified to eliminate the noise and became available as flight spares. Flight experience with the Ranger VII Spacecraft indicated that the frequency of noise occurrence was significantly reduced with operation of the camera in a zero g environment.
Camera Failures S/N 038					
2644 1/12/63	Transistor Q14 (type 2N1068)	Short, B to C	Bench	Design	Leakage current caused unit to remain in the ON position and stressed the transistor; B to C short resulted. Recommended use of 2N1486 MIL part with tighter leakage-current specification.
3275 7/13/63	Transistor Q13 (type 2N916)	No video output	Room (bench)	Secondary	No video output was evident during tests. The trouble was with the Deflection Amplifier, allowing the erase voltage to fall to a negative 1/2 volt. Transistors Q13 and Q18 were damaged when vidicon, Serial No. 573, was cracked. The transistors were overstressed when operated with a damaged vidicon.
3276 7/14/63	Transistor Q18 (type 2N943)			Secondary	
3277 7/15/63	Transistor Q22 (type 2N1244)			Accident	Transistor Q22 of the Deflection Amplifier was found to be shorted collector to emitter caused by a scope probe being placed across the transistor and resistor R52.
4007 9/18/63	Nylon track	Binding coil	Room (manufacturing)	Vendor Workmanship	The F-scan shutter had a steel pin which held the activating rod to the solenoid coil. This pin extended through the coil and slid in two nylon tracks. The presence of some outside material on these tracks caused the shutter coil to bind. The outside material was probably an epoxy from the assembly of the shutter. The tracks were cleaned with a fine pile and a crocus cloth.
4089 11/2/63	Dowel Pin (RCA Dwg. 8482050)	Undersize	Room	Workmanship	A loose dowel pin on the shutter blade became wedged in the gibs, jamming the shutter. When the dowel pin was removed from the actuator block and measured, it was found to be marginal on one end of the pin. Specifications required the pin diameter to be $0.0635 \begin{smallmatrix}+0.0000 \\ -0.0003\end{smallmatrix}$. More rigid quality-control procedures were to be maintained during the manufacture of this part.
4651 12/2/63	Contact Strip	Shutter inoperative	Room (integration)	Workmanship	Investigation into the shutter failure after approximately 13,000 operations revealed that the contact strip had broken because it had not been soldered into its proper location on the actuator. A fixture was devised to hold the coil and contact strip while they were being soldered.
3939 3/24/64	Vertical and Horizontal Telemetry	Output not within specified limits	Ambient	Nonconfirmed	During preliminary testing it was reported only from visual observation that the outputs were not within specified limits. However, during a later test performed with a revised specification, proper operation was noted. It is assumed that the preliminary test was performed with an obsolete issue of the specification.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 038 (Continued)		
3884 8/21/64		Loose lens housing	Vibration	Workmanship	During a two-axis vibration, several bolts on the lens housing were found to be loose. The bolts could be turned by hand, indicating that they had not been properly tightened during mechanical assembly. The Camera Head was returned to mechanical assembly for replacement of shutter hardware. An ECN was generated to assure that all future shutters would have new hardware and grommets with correct spacing.
1580 10/19/64	N/A	Video out of focus	Ambient (JPL)	Accident	During the postshipment operational checkout of Flight Model III-3 at JPL, the F_a-Camera video was out of focus. Since the reticles exhibited sharp focus, the collimator was suspected. This was verified by substituting the PTM collimator. Optical testing reaffirmed defocusing of the F_a Collimator. The defocusing was attributed to the filter being screwed on to its mechanical limits, which also engaged and turned the front element of the collimator, resulting in the defocus. The collimator was re-aligned optically. To prevent a recurrence of the problem, a mechanical stop was provided on the camera adapter so that the stop engaged the end of the collimator barrel before the adapter made contact with the focus ring.
			Camera Failures S/N 039		
2839 8/19/63	Resistor	Open	Ambient (JPL)	Workmanship	As the assembly warmed up, the video signal faded. Investigation with the assembly at 50°C revealed an open circuit in the first stage of the video amplifier. An open resistor allowed the circuit to limit as the temperature increased. The resistor had been potted in such a way that stress was put on a lead and finally broke.
4021 9/12/63	"E" Spring Washer	Jammed shutter	Thermal-vacuum test	Workmanship	The E-spring that was used to hold the rod-end to the shutter-block came off. This lock-spring was not broken nor mechanically stretched. It therefore appeared that this spring was not installed properly during assembly, finally worked loose, and caused the shutter-block to jam under the magnetic shielding.
4097 1/6/64	Transistor Q8 (type 2N1208)	Shorted, collector to emitter	Room	Accident	The shutter stopped functioning during investigation for Malfunction Report 4590. It was found that one of the shutter-drive transistors was shorted, collector to emitter. It is believed that this transistor was shorted during the tests performed on this camera.
4711 1/19/64	Nuvistor V1 (type 7586) Capacitor C4	Erratic filament operation Leaked electrolyte	Thermal-vacuum (35° C)	Workmanship	The video level went to clamp, then reappeared after a short interval. This condition was reproduced experimentally by disconnecting the nuvistor filaments. During the replacement of the nuvistor, capacitor C1 was found to be leaking electrolyte. The opening of this capacitor would not affect camera operation because there was another of the same value in parallel. The electrolyte was found to be acidic. Further investigation of the nuvistor revealed that the leads soldered to the tube pins were not firmly attached. The manufacturer of the nuvistor reported that it met all electrical and mechanical specifications.
2196 5/13/64		Loss of single line of video	Postvibration	Nonassignable	During a postvibration system test performed in accordance with JPL test procedure SR 300.12, investigation of the 35-mm film of video revealed that a single line of P_3 Camera video was lost. This problem did not recur in subsequent tests and was therefore believed to be the result of random noise.
2154 5/31/64		Spot on P3 Camera mask	Thermal-vacuum	Workmanship	During mission verification test no. 2 at low temperature (53° F), a spot was encountered on the P_3 Camera mask. This spot, affecting the clamp function, was probably a defect in the photoconductor. The region was 1 mil in diameter and had a higher dark current than the surrounding photoconductor. The mask appeared to be intact since the spot was also present when the camera viewed a dark field. In the thermal-vacuum test, the spot occurred during the clamped portion of the scan and affected 3 or 4 scan lines. At ambient conditions, only 1 scan line was normally affected. The problem of the spot was discussed with JPL and they did not consider it to be serious.
2102 6/12/64	Vidicon Serial No. 581	Incorrect wiring	Ambient	Accident	Investigation of the loss of video during optical alignment revealed that the vidicon socket had been wired incorrectly. This vidicon had an external mask while the socket was wired for an internal mask. A notch was located on the side of the vidicon to indicate the short pin and to orient the vidicon. The socket must be wired to match the vidicon.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 039 (Continued)		
2102 6/12/64 (Continued)					Manufacturing procedures were revised to ensure proper orientation of the vidicon. A stress analysis of the camera and camera electronics assembly revealed that transistor Q5 (Type 2N1485) of the Converter Power Supply, and resistor R17 (39 K ohms 1/4 watt) of the Low Voltage Regulator were overstressed. These parts were replaced. The vidicon, although it performed satisfactorily, was also replaced.
1350 9/14/64	- - -	Micro-phonics Micro-phonics Micro-phonics	Ambient Ambient Ambient	Nonassignable Nonassignable Nonassignable	Microphonics are not easily eliminated nor is it entirely possible to define the predominant inducing agent of the problem. Three prime contributing factors of microphonics existed in the Ranger TV cameras. They were: the nuvistor and vidicon, both of which were susceptible to external excitation; the shutter and shutter mounting; and the Camera Head Assembly. In order to eliminate the microphonics problem entirely, considerable redesign would be required in the following areas: • Shutter; • Camera Housing; and • Method of mounting the TV cameras to the TV Subsystem structure. The nuvistor and vidicon for each TV camera were specifically selected on the basis that minimum microphonics are a major criterion for determining an acceptable unit. Camera Heads were reworked and retested with the result that the microphonics were reduced to an acceptable level.
1539 11/19/64	Transistor Q9 on Shutter Drive	Non-operative shutter	Ambient	Accident	During test and investigation of noise problems, the P_2 Camera shutter became nonoperative. The electronics was removed from the structure, and the failure was diagnosed as a shorted or open 2N1208 transistor in the shutter-drive circuitry. The problem was traced to transistor Q9, which was shorted emitter to collector. Transistor Q10 and shutter 3053-R2 were also replaced. The malfunction had been encountered previously and resulted when the shutter coil shorted leaving a 1-ohm impedance in the emitter circuitry for current limitations through the transistors. It was believed that a probe was accidentally applied against the shutter coil causing it to short and resulting in nonoperation of the coil.
			Camera Failures S/N 040		
2828 2829 6/21/63	Trimpots R24 and R32 (Bourns No. 3250-L-1)	Open leads	Room	Workmanship	Both trimpots, when checked in the circuit, showed continuity across one side to the wiper but were open from the other side to the wiper. The opens were in the leads under a mound of potting compound used to hold the back to the circuit board. A review of the potting compound and method of applying it failed to reveal any problems.
2832 7/15/63	Transistor Q3 (type 2N930)		Thermal-vacuum (0° C)	Vendor Workmanship	During thermal-vacuum test, at 0° C, there was excessive drift on the vertical read sweeps. Transistor Q3 had a resistance of 5 megohms between collector and emitter. A large cut was found in the internal portion of the emitter lead.
4231 10/8/63	Shutter Serial No. 3054	Broken detent	Ambient	Workmanship	The tool used to fabricate the detent springs put a crease in the spring. The crease later resulted in the spring breaking. Manufacturing began use of a new tool to fabricate the detent springs.
2840 Jan. 64	Vidicon Serial No. 306	Burn spot in center of mask	Room (JPL)	Accident	Investigation into the loss of sensitivity around the center reticle disclosed a burn spot which covered about 20% of the tube. The spot was first noticed following optical alignment and focusing at JPL. It is suspected that the alignment telescope used in the optical alignment was the cause of the burn. A test run on this telescope indicated that it operated at a safe level of 500 foot-candles. However, it is the total illumination dose that causes permanent surface damage once a safe level is exceeded. It is believed, therefore, that the vidicon, Serial No. 306, was exposed to sufficient illumination during optical alignment at JPL to cause a burn. Camera personnel were informed to restrict both the amount and the duration of application of illumination in order to prevent future malfunctions.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 041		
3363 6/7/63	Transistor (2N930) Q6 Q16	Open Open	Room (bench)	Nonassignable	There was no vertical or horizontal sweep. This occurred during the bench debugging of equipment after the split-system revisions had been made.
3344 6/13/63	Beryllium-Copper Contact	Broken contact strip	Room (bench)	Nonassignable	The shutter stopped functioning while the camera was operating on the bench. The camera head was opened and one of the beryllium-copper strips was found broken. The strip appeared to have been properly soldered to the coil and there was no indication of twisting or wear.
2824 6/20/63	Magnetic Pole Piece	Jammed	Room (bench)	Accident (test error)	The magnetic pole piece had broken away from the solenoid guide inside the shutter. This is a chemical, not mechanical bond.
3961 7/11/63	Vidicon S/N 573	Open filament	Room (bench)	Design	The potting compound used to bond the pin cover to the vidicon base failed to set. When the tube was turned for positioning it cracked the glass envelope causing the filament to open. The chemical laboratory added a 6-hour bake at 48° C to the potting procedure, in addition to normal twenty-four hour setting time, to correct this situation.
4789 3/29/64 3951 3/29/64 1776 4/15/64	Shutter Serial No. 001	Shutter slide jammed	Ambient	Workmanship	Investigation into the jamming of the shutter slide revealed that the nylatron coupler was broken, and was undersize. The pins in the side of the solenoid, with which the coupler mates, were found to be to specification. This resulted in a tight fit and a stress being placed on the coupler. The shutter was replaced and normal operation of the Camera was restored.
2187 5/18/64	Shutter Serial No. 021	Loose shutter	Postvibration	Workmanship	The four Nylock screws used to mount the shutter on the F_b Camera Subassembly were found to have no locking action after the system vibration test. This condition permitted shutter to have a side-to-side motion. The screws were replaced as were the bumpers that had been damaged in the removal of the screws. Investigation revealed that the Nylock screws were initially tightened down and then loosened slightly. This caused the locking capability of the screws to be reduced. Nylock screws and bumpers were to be replaced when shutters were replaced.
			Camera Failures S/N 042		
4087 10/25/63	Transistor Q5 (type 2N930)	Open emitter to base	Room	Accident (test error)	During six-camera bench test, a short occurred in the cables to the G1 regulator. The assembly was returned to manufacturing for tests which revealed that the G1 regulator circuit was not functioning properly.
4090 11/6/63	Transistor Q4 (type 2N722)	Open collector lead	Room	Workmanship	One of the camera assembly screws was tightened down on the collector lead of transistor Q4. This caused the lead to open and some arcing. The collector leads will be re-routed to remove the possibility of a short to the assembly screws.
4095 12/6/63	-	Potentiometer R10 turned fully clockwise	Thermal-vacuum (manufacturing)	Accident	A misadjustment of potentiometer R10 induced oscillation causing the G1 and Focus Telemetry point to indicate a malfunction. The potentiometer was properly adjusted.
4692 1/28/64	Solenoid Coil, Serial No. 153	Binding	Room	Workmanship	Investigation of erratic operation of the shutter disclosed a curved ridge inside the solenoid coil. The ridge was similar to the spiral grooves in a rifle bore. Because the ridge was curved, it could not have been caused by operation, because this would have resulted in a straight-line ridge. This curved ridge could only have occurred during construction.
2125 6/5/64		Shorted leads	Ambient	Workmanship	When the A2 and A3 frames of the Camera Electronics Assembly were assembled, the collector lead of transistor Q12 in the A2 frame made contact with the base lead of transistor Q7 in the A3 frame. The leads are normally covered with a sleeving material, and conformally coated to prevent contact. The base lead of transistor Q7 was dressed too close to the collector lead of transistor Q12 and insufficient conformal coatings were applied. The sleeving material on the base lead of transistor Q7 was pierced by the collector lead of transistor Q12 causing a short. Erratic operation of the G1 Regulator occurred until the short was cleared. No parts were subjected to electrical stress as a result of this failure.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 042 (Continued)		
3763 6/22/64		Low resolution	Ambient (pre-thermal-vacuum)	Accident	Resolution of the P1 Camera Assembly was consistently low during the pre-thermal-vacuum electrical test. When the proper equipment was employed and the focus control readjusted, the Camera resolution was restored. Marked changes in the performance indicate trouble in the Camera and Camera Electronics Assemblies and should be the cause of immediate rejection.
3762 6/22/64		Shorted -6.3 volts filament pin of vidicon	Thermal-vacuum	Accident	During the thermal-vacuum, flight-acceptance testing of Camera, Serial No. 042, the -6.3 filament pin of the vidicon was accidentally shorted to ground inside the bell jar. Removal and correction of the short condition restored normal camera operation. The power supply was carefully checked and no overstressed parts were found. The vidicon was not damaged.
3764 6/23/64	Capacitor C3 CL45BK040-MP3	Leaked electrolyte	Ambient	Workmanship	Capacitor C3 was removed because of noise and poor resolution. The capacitor was found to be leaking electrolyte and was returned to the vendor for a failure analysis. Parameter measurements made by the vendor confirmed the failure. A dent was noted in the side of the smaller diameter portion of the case. A hole, which apparently was caused by a pick or probe, was noted in the inner portion of the crimped roll. The hole was probably made before insertion of the capacitor into the circuit because the hole was covered with epoxy. The malfunction was the result of the capacitor leaking electrolyte. This was caused by rough handling and subsequent damage to the unit.
3960 6/25/64		Pressure of bell jar out of specified limit	Thermal-vacuum	Nonconfirmed	During electrical testing of the Camera Electronics Assembly (Serial No. 042) under thermal-vacuum conditions, the pressure in the Bell Jar increased to 1.4×10^{-6} torr (the specified limit is 1.0×10^{-4} torr) while the Assembly was operating. The increase in pressure was probably caused by outgassing of the collimator but the environmental test equipment was at fault since it did not compensate for this increase in pressure. The Bell Jar was supplemented by the addition of a cold trap and the use of liquid nitrogen. The test was repeated with pressures of 4.0×10^{-6} to 6.6×10^{-8} torr, and was successfully completed.
3961 6/27/64		Incorrect voltage reading and erase sweep over-scan	Ambient	Accident	While performing operating-voltage measurements on the P1 Camera Electronics Assembly, a 40-mv reading was obtained where the specified value was 0 volts. The trouble was traced to a wiring error in the test rack. During the sweep-voltage measurement, the erase sweep overscanned the read sweep in excess of the specified value of 15 percent. The 15-percent requirement is not applicable to the P1 Camera since it is set up in the free-run mode of operation. RTSP-1112 was revised to specify a minimum of 8 percent overscan but no maximum for the P1 Camera erase sweep overscan.
1351 and 1352 9/17/64		Scanning of the erase video output	Ambient	Nonconfirmed	During the free-running mode on Camera P1 there exists a 19% probability that the sequencer will stop providing the normal timing at a time when the P1 Camera is in a position to scan the erase video output. This does not represent a malfunction.
			Camera Failures S/N 043		
2830 9/3/63	Transistors Q11 and Q12 (type 2N916)	Open	Room (manufacturing)	Wormanship (Vendor)	Investigation of vertical drift in the sweep circuitry revealed two open transistors that were improperly installed in the deflection programmer. Investigation of horizontal drift revealed many parts incorrectly installed. Transistors Q5 and Q6 were reversed and Transistor Q9 was replaced. The replacement was not due to a failure, however.
4105 9/16/63	Zener Diode CR13 (type 1N758A)	Improper value	Room (manufacturing)	Accident	The reference voltage in the video amplifier could not be adjusted to the proper level. Diode CR13 is specially selected to provide the proper reference level. Replacement restored the proper level.
4006 9/17/63	Vidicon S/N 893	Blemish on faceplate	Room (manufacturing)	Nonconfirmed	It was noted that a spot, caused by a blemish on the vidicon face, was appearing on all monitor photographs. The tubes were accepted, since the blemishes did not exceed the specified dimensions.
2117 7/1/64		Dark field shading not within specified limits	Ambient	Nonconfirmed	During flight-acceptance subassembly testing, the dark-field shading was measured as being out of specification. The measured values were 70+200, -30 mv, while the specified value is 70±40 mv. This condition resulted from recent optimization of the Camera to obtain improved

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Camera Failures S/N 043 (Continued)					
2117 7/1/64 (Continued)					resolution and erase characteristics. MRA No. 100-64-128 was approved by JPL.
3844 10/11/64		Horizontal sweep telemetry reading not within specified limits	Ambient	Design	When a simulated-failure mode was applied to Camera, Serial No. 043, the horizontal-sweep telemetry reading was -2.2 volts. This was not within the specified limits of 0 to -1.5 volts. An investigation of the history of Camera, Serial No. 043, revealed that a Material Review Action (MRA) was issued in October 1963, to modify the deflection-amplifier circuit of the Camera Electronics Assembly. A resistor was moved from the Camera Electronics to the Camera Head to reduce excessive ringing that was being displayed on the clamped video level. This problem was a function of the particular vidicon yoke used with Camera, Serial No. 043, and was not encountered in any other camera. Moving the resistor to the Camera Head provided a better damping circuit. However, the test method used to simulate a malfunction in the horizontal-sweep circuit is to open a lead from the Camera Head to its associated Camera Electronics Assembly, which, in Camera, Serial No. 043, disconnects the damping resistor from the circuit. In all other cameras, the resistor remained in the circuit, and any failure in the circuit provided a telemetry reading that was in the specified limit. But, in Camera, Serial No. 043, the open in the circuit would give an out-of-specification telemetry indication. MRA-100-64-181 was issued to compensate for this defective telemetry data, so that this was not an actual malfunction.
Camera Failures S/N 044					
4582 11/5/63	Lens Mounting (RCA Dwg. 1707688)	Undersize	Room	Vendor Workmanship	Difficulty was incurred in removing the lens from the mounting flange. An examination revealed scoring of the Martin hardcoat surface, indicating the pilot diameter was slightly undersized.
4591 11/18/63	Transistor Q1 (type 2N916)	Short, base-to-collector	Ambient (postvibration)	Accident	This malfunction occurred during board testing and was not detected until final testing. The procedure for board testing was changed. Test personnel were informed to correct a failure of this type as soon as it was detected. The transistor was replaced.
4686 1/8/64	Core Assembly	Core broken	Room	Workmanship	Investigation into the failure of the shutter to operate revealed that the solenoid coil was broken where two pieces of the core were epoxied together. Insufficient epoxy had been applied.
4696 1/23/64	Thermistor Lead	Shorted	Room	Workmanship	The thermistor lead in the F-Camera Electronics Assembly was found to be shorted during a test in accordance with Appendix G of RTSP 1100A and resulted in the reading of the telemetry points Nos. 43, 44, 45, 85, and 86 going to zero volts. The relocation of the lead to prevent shorting returned the outputs to normal values.

3600 3853 5/12/64		Incorrect wiring	Ambient	Workmanship	The Camera Electronics Assembly did not function after assembly. Examination of the unit revealed several wiring errors. The -150 volt supply had been applied to the +6.3 volt supply, resulting in the overstressing of parts. A detailed stress analysis was performed and the following components replaced in the Camera Electronics Assembly:
					• In the Low-Voltage Regulator
					  • Resistors R23 and R24
					  • Coil L3
					• Deflection Programmer
					  • Transistors Q1, Q3, Q4, Q6, and Q7
					  • Resistors R13, R18, and R26
					• Video Amplifier
					  • Transistor Q17
					The Camera Electronic Assembly (Serial No. 044) performed satisfactorily after replacement of the overstressed parts.

3780 8/24/64	Coil L3 and Capacitor C6	Noise spikes in power supply	Ambient	Workmanship	The camera was removed from the spacecraft due to excessive noise in the video output. The noise was traced to a choke in the low-voltage regulator of the power supply.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 044 (Continued)		
3780 8/24/64 (Continued)					It was found from a review of photographs of Camera Electronics Power Supply that capacitor C6 in the dc-to-dc converter was missing. The capacitor had been removed during rework and was not replaced. When capacitor C6 and coil L3 were replaced, normal operation was obtained.
1538 11/16/64	Telemetry	Indication of abnormal operation from telemetry point No. 3	Ambient	Nonassignable	Telemetry point No. 3 of the 90-point commutator indicated 0 volts on the strip chart recordings taken during the Appendix R test. Camera operation during this test was good. An investigation was initiated in which the cables associated with the test point were subjected to continuity checks, the pins were subjected to the pin retention test, and the telemetry commutator operation was reviewed. No anomalies were found. The cabling and connectors were reassembled. The camera was retested, and all telemetry points were normal.
1543 11/30/64	Shutter, Serial No. 033	Alternate video saturation and low response	Ambient	Workmanship	During the final test run for boresighting of Flight Model III-4, F_a-Camera, was saturating on one shutter stroke and had a low response on the other shutter stroke. Examination of shutter, Serial No. 033, showed that the slide assembly would not remain in place on the upstroke, while the shutter was mounted in an upright position. This shutter had been timed and was to specification. The shutter was disassembled, but no dimensional discrepancies of any parts could be found. Another core assembly was installed in the shutter, and timed for an exposure speed of 3.9 msec on the instroke with a detent action sufficient to retain the blade with the shutter in any position. The core assembly that had been removed was remagnetized, installed in the shutter and timed. The exposure time at instroke was 4.0 msec, and the detents held with the shutter in any orientation. It was concluded that the original core assembly in shutter, Serial No. 033, was not fully magnetized and the detenting action was marginal from the time of installation. A method of determining when the shutter pole piece has sufficient magnetization was developed and incorporated into the F-Shutter manufacturing procedure and test procedure.
2263 12/14/64	N/A	Reduced level video for first frame only	Ambient (JPL)	Design	When F-Channel went into full power, the first frame of F_a-Camera video displayed the RETMA pattern at a reduced level (appeared to be a residual image only). This problem with the first F_a-Camera readout after full-power turn-on appears to be an unexposed frame. Transients generated by the operation of the full-power relays in the GSE could reset the steering flip-flop in the shutter drive circuitry of the Camera Electronics Assembly. Thus, the shutter drive was out of synchronization with the shutter position, and one frame of video was lost before synchronization was re-established.
2272 2/1/65		Noise spikes	Ambient (JPL)	Nonassignable	During a special TV Subsystem test in which the Subsystem was oriented at three different angles, noise spikes were exhibited on the output of the F_a-Camera. These noise spikes were at a frequency of approximately 3 kc and were 50 to 75 mv in amplitude as viewed on the scope. The problem was viewed only in the first of a series of four tests. The Subsystem was not in a flight configuration for these tests, as the thermal shields were not installed. Two additional tests were performed with the Subsystem in the same configuration; however, there was no further occurrence of the problem. The interference observed was not coherent on a line-to-line basis and was determined to be approximately 3 kc at 50 mv. Two special tests were performed in an attempt to simulate and isolate the interference, with the Subsystem in the same nonflight configuration.
			Camera Failures S/N 045		
4111 9/27/63	Transistor Q3 (type 2N916)	Shorted to a circuit board	Room (manufacturing)	Workmanship	The horizontal read could not be obtained because the case of transistor Q3 was laying on a printed circuit board trace, causing the transistor to indicate a collector-to-emitter short. The transistor was tested and found to be within specification, but was replaced.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 045 (Continued)
2111 6/28/64		Vertical black shading out of specification	Ambient	Workmanship	Vertical black field shading read 70 +70, -0 mv instead of the specified 70 +40, -30 mv. Readjustment of the clamp reference for an average of 70 mv brought the shading value within specification limits. The Camera successfully completed acceptance testing. It was concluded that the initial shading adjustments were in error.
3572 10/2/64	Shutter Serial No. 3071	Broken contact spring	Ambient	Workmanship	The Shutter stopped during a focusing of the camera and was removed from the camera and examined. A contact strip was found to be fractured approximately one-half inch from the top terminal. This indicated either that the terminal nut was not tightened enough to prevent shifting of the contact strip, or that when the terminal nut was tightened, the contact strip was not correctly positioned. Instructions for a closer inspection of the positioning and tightening of the terminal nuts were issued.
1363 10/14/64	Shutters Nos. 3032R1 3074	Shutter jammed	Room ambient	Accident	During a boresight test, the camera bracket assembly was adjusted. The P3- and P4-Camera shutters did not operate during Subsystem operation. An investigation disclosed that the camera bracket was adjusted almost to the maximum tolerance resulting in shutter contact with the structure, which produced a force sufficient to stop the shutter operation. The bracket was readjusted to provide a sufficient clearance between the shutter and the structure. Specification RTSP-1100A, Appendix H was changed to stipulate a minimum allowable clearance between shutter and structure.
2150 11/10/64	N/A	Noisy Raster	Ambient (JPL)	Nonassignable	During system testing of Ranger VIII at JPL, the raster of P4 Camera, Serial No. 045/045, was noisy. The appearance of the noise was unique and could not be ascribed to any previously experienced failure mode. The unit was returned to RCA, where, after a review of the 35-mm film obtained during previous system tests at JPL, the clamped-video test point of the Camera Electronics was monitored and exhibited high-amplitude, random noise. Further review of the 35-mm films as a function of the record time showed that this noise occurrence was completely random and apparently not attributable to a timing sequence from another camera. The system ground lines were checked and it was found that the preamplifier shield ground of the P4 Camera was connected to the P2-Camera head ground lead. This situation was corrected and a systems test rerun. The 35-mm film of the P4 Camera video output revealed some noise on two out of approximately 200 frames. This noise, however, was more in the nature of a random spike rather than the high-amplitude, random type previously experienced. Further investigation revealed that a screw was missing from the 1000-volt mesh filter ground. This situation would make the camera very susceptible to noise pickup. After replacement of this screw, the output video signal observed on a scope revealed random noise spikes at very infrequent intervals. When monitored over a 5-hour period, it was found that the same type of noise spikes could be induced by the turn-on and turn-off of test equipment in the area. The camera output was then played through the GSE, and 750 frames of video were recorded with no observation of noise. P4 Camera, Serial No. 045/045, was integrated on Flight Model III-4 (Ranger IX). A review of the film record of a systems-test run revealed several frames that exhibited noise. It was also noted that the video output of F_b Camera, Serial No. 017/017, exhibited the same characteristic noise. This noise was attributed to a digital voltmeter which was grounded to the TV Subsystem structure during the test. Camera, Serial No. 045/045, was again disassembled, and microscopic investigation revealed no evidence of problems. The nuvistor tube was replaced at this time to take advantage of the blue-solithane technique of mounting. After assembly, the video output signal from the camera was played through the GSE. Review of 500 frames, taken with an F-type camera grounded to the same mounting bracket and operating, revealed occasional noise induced by the F-shutter. Then, 500 frames of 35-mm film were taken with the vidicon of Camera, Serial No. 045/045, inoperative but with an F-Camera operating. This was to isolate the Camera Electronics as the source of the noise. Review showed these films to be free of noise. The original noisy-raster condition was markedly improved on the Ranger VIII Spacecraft. The 1000-volt mesh-filter return may have been disconnected or making erratic contact with ground when the original, unique noise problem was observed. If a problem does exist with P4 Camera, Serial

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 045 (Continued)		
2150 11/10/64 (Continued)					No. 045/045, it is not exhibited when the camera is operated alone in bench test. The extremely infrequent occurrence of noise in this camera makes further bench testing unprofitable. The shutter was changed on this camera, and the camera was assigned as a spare unit. It was tested in accordance with RTRB No. 127, and the test data submitted to JPL.
2556 12/21/64	Shutter Serial No. 3035-R2	Noise bursts	Ambient	Design	Shutter-induced noise bursts of a minor nature were noted earlier in the Ranger program. This problem was manifested on Shutter, Serial No. 3035-R2, and caused severe blanking of video information. These noise bursts were caused by the discharge of accumulated static electricity on the shutter blade, as the blade traveled past the detent spring. The blade later came to rest on the detent spring causing a second static discharge. This second discharge coincided with the camera readout cycle and caused a noise transient to appear in the video output. A new detent spring, RCA 1754247, Rev. J., was designed to minimize shutter blade overshoot. It has a greater holding force and, therefore, eliminates the occurrence of the second static dissipation. Shutter, Serial No. 3035-R2, was replaced with a modified shutter, Serial No. 3016-R2. The camera was then tested in three different planes, and multiple exposures of the monitor presentation indicated no noise bursts were present. All P-type shutters delivered to JPL on December 28, 1964, were equipped with the redesigned detent spring and rod end (to facilitate assembly). A life test was performed on three shutters to qualify the redesigned detent spring. Two of these shutters (Serial Nos. 3056 and 3024) were old qualification-model shutters, and the third shutter (Serial No. 3044) was a production model selected at random. As of 2/12/65 the following operations had been accumulated: S/N 3044: 925,900 operations, one spring failure; test terminated at failure. S/N 3056: 382,000 operations, one spring failure; test terminated at 500,000 without failure of second detent spring. S/N 3024: 933,700 operations, one spring failure; testing continued on second detent spring, through 1,400,000 operations.
2305 1/25/65	Coaxial Connector A3J7 (type DEM5W1P)	Insert pushout	Ambient (JPL)	Wearout	Pin A1 depressed upon mating with the extension cable at ETR test facilities. The connector body, less the coaxial insert, was replaced and returned to RCA for an analysis. The body was microscopically examined. It exhibited rounded edges of the retaining shoulder and gouges in the wall, which resulted when the insert was put in place and removed from the body. It was indicated that the insulating material could be work down by a lateral motion of the coaxial insert, which could create a push-out condition. A tool is used in repair and removal activities of this insert.
			Camera Failures S/N 046		
4585 11/19/63	Diode CR20 (type 1N963)	Shutter and lamp telemetry voltage out of specification	Ambient (previbration electrical test) (manufacturing)	Accident	During an electrical check prior to vibration, the telemetry readings were believed to be out of specification limits. Diode CR20 was damaged during its removal. Investigation then disclosed that a digital voltmeter of the test rack was improperly calibrated, thus resulting in the incorrect reading. Test racks were then monitored on a weekly basis.
1342 9/5/64	Test Equipment	Telemetry reading out of specification	Room (ambient)	Accident	The G1 and focus telemetry point was out-of-specification. It was discovered that the cause of the malfunction was in the test rack, Serial No. 001. All test rack digital voltmeters were recalibrated. All test racks were to be checked with an F-Camera to verify proper operation of the test racks.
2122 9/15/64		Black-field shading	Ambient	Warmup	The P2-Camera was removed from Flight Model III-3 because of the apparent presence of microphonics and output power fluctuations. When tested on the bench the malfunction report was prepared ascribing the problem to the black-field shading being out of specification. The shading was corrected by an adjustment of the white level. The camera sweep, erase and shading levels were adjusted after assembly on the spacecraft. The original problems of microphonics and power output fluctuations were then studied. The fluctuations were traced to an improperly wired shield

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 046 (Continued)
2122 9/15/64 (Continued)					ground in the G1 Regulator. In addition an instability in the G1 Regulator was corrected by installing a capacitor, C15, across the low-voltage regulator input. This capacitor was installed only when necessary to reduce the effects of the choppers. The microphonics were measured and found to be at an acceptable level.
3797	Transistors Q12 and Q7	Shading out of specification	Ambient	Accident	When the A2 and A3 frames of the Camera Electronics Assembly, Serial No. 046, were mated, the collector lead of transistor Q12 on the A2 frame was accidentally shorted to the base lead of transistor Q7 on the A3 frame. This electrical short resulted in erratic operation of the G1 regulator. When the short was cleared, normal operation was resumed. Quality Control issued PQC Checklist No. 4, Revision A which described a procedure for detecting possible interference between adjacent mating frames. This procedure received wide distribution to cognizant inspection personnel, with additional emphasis on the sections related to interference problems.
3846 10/17/64		Intermittent video	Ambient	Nonassignable	During preliminary bench test the video signal became severely attenuated on two occasions; the signal was compressed to less than 20 mv amplitude. Troubleshooting indicated that the problem existed in the Camera Electronics Assembly. Connector A3J2 was removed and then replaced. The malfunction disappeared and could not be made to recur. Camera Electronics, Serial No. 046, was opened and all interframe connectors cleaned, and a pin retention test performed on all connector pins. Pin A3J7-A1 failed. Significantly, this pin carries the video signal from the preamplifier, and a loose connection or defective contact at that point could be responsible for an intermittent-video condition. The unit was re-assembled and resealed, and the bench test was completed with normal operation. This unit was later disassembled and the frames and connectors scrutinized under a microscope. No further evidence of defective workmanship could be detected, which might be responsible for the intermittent video malfunction. The unit has subsequently operated for 20 hours and was vibration tested, with no further indication of the problem. It is reasonable, at this time, to attribute this malfunction to a defective connector, which has been corrected through the cleaning and repair of the connector.
1370 10/19/64		Shutter-pulse waveform and horizontal overscan not within specified limits	Ambient	Accident	P2 Camera Electronics, Serial No. 046, encountered the following out-of-specification conditions during previbration electrical tests: • Shutter pulse was -27.0 volts, DC; specified limit was 23±3 volts, DC; and • Measured horizontal overscan was 15.5 percent; specified limit was 10+5, -2 percent. The test data obtained, as well as the test procedures, were reviewed and analyzed. Evaluation of the shutter-pulse waveforms and the shutter-drive circuitry indicated that a change in specification limits would be necessary. A worst-case analysis was performed and new limits for the shutter-pulse waveform were established. The specification then became -26±3 volts DC; thus the measured value of -27 volts, DC was acceptable. A special engineering test was performed to determine the out-of-specification condition of the horizontal overscan. The horizontal overscan measured during this test was approximately 13 percent. This was within the specification limit and seemed to refute the value measured during the previbration test. It was therefore concluded that there was actually no malfunction in the horizontal-overscan measurement, but an error in measurement technique.
2306 1/26/65	Capacitor C2, Type CL45BK040 MP3 Ohmite	Noisy raster	Ambient (JPL)	Workmanship (Vendor)	During gain-level adjustment of P2 Camera, Serial No. 046, at JPL, a noisy raster was displayed. The problem was caused by a defective capacitor C2 in the preamplifier circuit. The conformal-coating material in the area of the capacitor was blackened, which is indicative of a leakage of electrolyte from the unit. Initial measurements on the unit under ambient conditions and after thermal cycling indicated some variation of leakage current, but insignificant changes in capacitance.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 046 (Continued)
2306 1/26/65 (Continued)					Examination of the elastomer seal failed to indicate any substantial evidence of electrolyte leakage. The defective unit was then weighed on an analytic balance and was found to be 1.7596 grams. Comparison of the weight of the defective unit with the weights of several identical-type capacitors indicated loss of electrolyte, but the exact amount could not be determined from this type of measurement. Capacitor experts indicate that up to 25 percent of electrolyte could escape and not affect the performance of this type capacitor. An additional seal test using the Turco dye check method was performed at ambient temperature and at +85° C. No further electrolyte leakage was detected. The failed capacitor was returned to the vendor for analysis to determine the cause of the electrolyte leakage. The analysis, consisting mainly of physical measurements of the capacitor case, concluded that the case had been deformed in some manner causing the elastomer seal to be destroyed. Additional tests were performed at AED in an attempt to locate the exact point of the electrolyte leakage. The capacitor was placed in a vacuum chamber so that the seal could be observed through the chamber window. Thymol blue indicator was placed in and around the seal, and the chamber was evacuated. After approximately 10 minutes, the indicator bubbled and turned a deep red color, indicating the presence of acid. The chamber evacuation continued until the entire indicator material had evaporated leaving only a dark red stain on the elastomer seal. The capacitor was removed from the chamber and electrically tested. The capacitance was still 4.35 farads, but the dissipation factor had increased to 2.4 percent indicating some electrical change. The capacitor was again weighed and found to be 1.7596 grams as previously. The capacitor was then dissected and the parts were analyzed. An identical type capacitor was also dissected for comparison. The differences noted in the defective capacitor were: • There was approximately 50 percent less electrolyte in the defective capacitor than in the sample; • Radial cracks were noted in the elastomer seal, in and around the opening through which the lead passes; • The tantalum slug showed evidence of electrolyte leakage around the lead seal by the presence of dye on the tantalum disc; and • There was dirt or grease on the inside surface of the elastomer seal. The radial cracks in the elastomer seal were attributed either to pressure applied before or during installation, or to a manufacturing defect. The malfunction caused a noisy video raster which was the result of an intermittent resistance short to ground through the capacitor. All voltage readings were normal during troubleshooting, indicating that no parts of the preamplifier were overstressed by this failure. Replacement of capacitor C2 restored normal operation to the P2 Camera.
1510 1/30/65		Dark-field shading not within specification	Ambient	Accident	Following replacement of capacitor C2 in the preamplifier circuit, Camera and Camera Electronics Assembly, Serial No. 046, was bench-tested to the requirements of RTSP-1112A. The initial measurement of the dark-field shading failed to meet the specified requirements. The measured value was 70, + 60, -5 mv., while the specified limits were 70, + 40, -20 mv. Review of the history of the camera revealed that it had been mounted and operated on the Spare TV Subsystem. In many instances, the camera sweeps, erase, and shading levels had to be adjusted when taken from the bench and mounted on a Subsystem or vice versa. Therefore, it was possible for a camera to indicate unsatisfactory shading level when no real problem existed. The dark-field shading levels were reset to bench-test level and the bench test was completed satisfactorily.
					Camera Failures S/N 047
3964 10/2/63	Transistors Q6 and Q16 (type 2N930)	Opened	Room	Workmanship	Due to a wiring error that caused a short between the +6.3-volt and 27.5-volt supplies, transistors Q6 and Q16 and the nuvistor filament filter capacitor were destroyed. In addition, many parts were overstressed in the Deflection

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 047 (Continued)
3964 10/2/63 (Continued)					Amplifier, Deflection Programmer Video Amplifier, G1 regulator, and the Low-Voltage Regulator. All suspected components were removed and replaced with preconditioned parts.
4586 4587 4589 11/20/63 4474 11/23/63	Transistors Q16, Q17, and Q6 (type 2N930) Vidicon Serial No. 736	Open Open filament	Ambient	Accident	While investigating the malfunction noted on MR 4093, the horizontal and vertical sweeps were found to be missing. Following the replacement of the three faulty transistors, no video was present. The vidicon filaments were found to be open. The vendor of the vidicon determined that an over-voltage of sufficient duration to melt the alumina coating around the filaments (thus the open filaments) could not have been caused by the short duration of the high voltage which opened the transistors.
4093 11/25/63	Transistor Q1 (type 2N916)	Open	Ambient	Accident	This malfunction was the same as that noted in Malfunction Report for Camera S/N 044, and the same corrective action applies. The transistor was replaced.
3594 5/3/64		Loss of horizontal and vertical scan	Ambient	Accident	Investigation of the loss of the horizontal and vertical scan revealed that the lead on pin 5 on connector J4 was broken, which resulted in the loss of +6.3 volts to the deflection programmer and amplifier. Movement of the connector is believed to have broken the lead which must have been nicked or excessively stressed prior to potting.
3781 3782 8/24/64	Harness 30W12 Serial No. 001	Broken coaxial cable	Ambient	Accident	During camera testing, there was no video output from the F_b Camera. An open connection was found between A1A6P3-A1 and A7A3P3-A1 and between A1A6P3-A3 to A7A3P3-A3. The center conductor on the camera head end of both coaxial cables had broken. The potting had not adhered to the surface of the cable. When the connector was inserted and withdrawn several times all stresses were applied to the solder joint. The cable was resoldered and inspected throughout the entire potting cycle. A continuity check and high-potential test was then performed to assure that the cable conformed to electrical specification.
1578 9/29/64	Test Equipment Collimator	Broken lead	Thermal-vacuum	Accident	The collimator did not light during the hot run. Test and observation disclosed an open lead at lamp socket. The lead was resoldered.
3570 10/2/64	Resistor R17 and Transistor Q5	Vidicon and socket misaligned	Ambient	Workmanship	Following optical alignment, Camera was operated for 2 minutes, when it was discovered that the vidicon was mismated with its connector socket. The connector had been accidentally rotated so that pin No. 1 of the vidicon engaged jack No. 8 of the socket. A stress analysis of the Electronics Assembly resulted in the replacement of two components on the A1 frame: resistor R17 in the low-voltage-regulator circuit, and transistor Q5 in the converter power-supply circuit. The vidicon was not affected. To prevent a recurrence of this malfunction in other cameras without requiring a manufacturing modification, a cognizant Quality-Control representative would be present at the mating of the vidicon and connector to assure proper alignment. Also, prior to assembly of the camera housing, the connector would be inspected by Quality Control to ensure that the pins are properly aligned. These operations would be certified in the appropriate camera log, and Test Method TM-1-1754616, Paragraph 4.6.6, Note 1 would comprise the acceptance criteria.
1358 10/7/64		Poor resolution	Thermal-vacuum	Nonconfirmed	The camera did not meet the minimum resolution specification. During subsequent thermal-vacuum tests, resolution was found to be within acceptable limits.
1364 10/13/64	Cable Harness Connector 30W 12 Serial No. 3	No video	Ambient	Workmanship	Measurements at the G2 test point indicated a short-to-ground. Subsequent testing did not reveal a short. The cable harness indicated leakage and breakdown during high-voltage test. The potting compound was removed, and there was no leakage during a high-voltage test. Inspection of the 300 volt terminal, A3, revealed that the insulation was turning black and that solder was near the wire. The wire was removed and a small burned area, which indicated that leakage and breakdown had occurred, was found. Repair of this item corrected the problem. The immediate recommended corrective action was to pot the inside of the coax connector insert. Consideration was given to replacing this insert with a high-voltage insert in rework

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Camera Failures S/N 047 (Continued)					
1364 10/13/64 (Continued)					or in new units. The action to be taken would be the altering of the present configuration by adding some chemical insulation such as urethane. This change would be implemented as new cabling builds and only on existing cables if rework were required for other reasons.
1368 10/16/64	Transistor Q1 2N916	Shorted base-to-emitter	Room ambient	Secondary	The G1 and focus telemetry point reading was out of specification. Investigation revealed that transistor Q1 in the G1 regulator was shorted base-to-emitter. This failure was considered to be a result of malfunction noted in MR 1364. Transistor Q1 and diode CR14 were replaced. Tests indicated satisfactory performance after the replacement.
Camera Failures S/N 048					
3986 4/22/64 3989 4/28/64 3995 4/30/64	Video Amplifier and Power Supply	Video noise	Thermal-vacuum	Nonconfirmed	Investigation into the video noise observed on the picture taken by the P3 Camera during thermal-vacuum tests revealed that noise of the particular type is not covered by any specification and is not detrimental to camera operation since it can be separated from the picture. However, the camera and camera electronics were removed from the Subsystem for investigation. Diodes CR1, CR2, and CR3, and transistor Q4 were replaced in an attempt to reduce the observed noise. The camera was still considered to be operational within the specification limits.
2376 5/11/64	Vidicon Serial No. 930	Loss of resolution	Ambient	Nonassignable	The center resolution of this vidicon was not within specified limits. A test, performed for gas contamination, indicated that the tube was normal. In order to allow return of the tube to the vendor for further analysis, the pen-end of the tube was soaked in an epoxy solvent to remove the fiberglass base. During this process, it was discovered that some of the solvent was being drawn into the vidicon envelope. When the socket assembly was removed, the glass tip of the tube broke off flush with the vidicon base. Because the solvent had penetrated the vidicon, it was not possible to further analyze the tube except to conjecture that the tube was cracked prior to installing the fiber base cover but that the epoxy prevented it from leaking until subjected to the solvent.
3753 5/18/64 3754 5/19/64		Telemetry voltage indication out of specified limits	Temperature Test (0° C and 40° C)	Nonconfirmed	The shutter and lamp telemetry voltages read -3.48 volts at 40° C and -3.44 volts at 0° C. These were not within the specified limits of -3.5 to -4.5 volts at the time of test. The specification was changed on May 22, 1964 and the recorded telemetry voltages were then within limits and acceptable.
3755 5/19/64		Shading out of specified limits	Thermal-vacuum	Nonconfirmed	The P3 Camera Subassembly was apparently out of the specified limits for shading when tested to RTSP-111A while in thermal-vacuum conditions. RTSP-1112A, however does not require that shading measurements be made under thermal-vacuum conditions. The P3 Camera Subassembly was then successfully tested at ambient conditions.
1338 9/1/64	-	Microphonics	Ambient	Nonassignable	Microphonics are not easily eliminated nor is it entirely possible to define the predominant inducing agent of the problem. Three prime contributing factors of microphonics existed in the Ranger TV cameras. They were: the nuvistor and vidicon, both of which were susceptible to external excitation; the shutter and shutter mounting; and the Camera Head Assembly.
1322 9/17/64	-	Microphonics	Ambient	Nonassignable	In order to eliminate the microphonics problem entirely, considerable redesign would be required in the following areas: • Shutter; • Camera Housing; and • Method of mounting the TV cameras to the TV Subsystem structure. The nuvistor and vidicon for each TV camera were specifically selected on the basis that minimum microphonics were a major criterion for determining an acceptable unit. This method was continued. Camera Heads, Serial Nos. 048 and 039, were reworked and retested with the result that the microphonics were reduced to an acceptable level.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 048 (Continued)
2259 12/7/64		Defocusing	Thermal-vacuum (JPL)	Design	During Mission Verification Test No. 1 in a thermal-vacuum environment (98° F), P4 Camera defocused. Review of the 35-mm film of the P4 Camera video output revealed that optical defocusing occurred, resulting in a limiting resolution of less than 140 TV lines, the lowest frequency on the test chart. The defocusing was characterized by a reversal of signal in the resolution wedges. At 20° C, camera performance exhibited greatly improved focus with a limiting resolution of 180 TV lines. At 12° C, resolution was greater than 200 TV lines. This improved performance at lower temperatures indicated that the camera was focused at one side of the depth of focus for the lens. There was probably a focus change of 0.0025 inch between the high and low temperatures. Since the P4 Camera provided acceptable performance in the temperature range below 25° C, no corrective action was planned. The nominal temperature range for the mission was 14° C to a maximum of 20° C. Focusing the camera to give satisfactory performance at all temperatures would have required removal of the camera from the spacecraft.
					Camera Failures S/N 049
3760 5/26/64		Dark field shading out of specified limits	Ambient	Design	Two conditions were noted in testing the Camera Electronics Assembly (Serial No. 049). The video was underpeaked and dark-field frames shading out of specified limits. Underpeaking was technically not a malfunction and had been covered by a correction procedure. The dark-field shading was reviewed by Material Review Action (MRA) as the overall performance of the Camera was satisfactory.
3786 8/30/64		Saturation of video	Ambient	Design	These four malfunctions occurred during both ambient and thermal-vacuum testing of Flight Model III-3. The malfunctions were all manifested as a loss of video information, either through saturation or by complete loss of video signal. The primary cause of the problem was a loss of the dark reference mask due to secondary emission in the vidicon. When further testing was performed to isolate the cause of the saturation it was also determined that the shutter on this camera was sticking. The saturation problem was alleviated by a reduction in the target voltage, which eliminated the secondary emission and recreated a stable dark reference mask. The preliminary vidicon test procedure has been modified to reflect this change. The shutter, Serial No. 3047-R1, which is believed to be responsible for the loss of video, was sticking.
1346 9/11/64		Saturation of video	Ambient	Design	
3794 9/20/64		Saturation of video	Thermal-vacuum	Design	
1354 9/30/64		Shutter sticking	Ambient	Workmanship	
4112 10/2/64	Capacitor C2	Short	Room (manufacturing)	Workmanship (vendor)	Investigation of why the 27.5-volt power supply was drawing excessive current revealed that capacitor C2 was shorted. Examination of the capacitor disclosed a distorted shoulder on the tantalum slug. The shoulder had been cut through the rubber gasket and allowed the electrolyte to leak out. The vendor was informed of the failure and the defective component was returned to discover what part of the manufacturing cycle could have caused the failure.
1356 10/4/64	Resistor R17 and Transistor Q5	Vidicon and socket misaligned	Ambient	Workmanship	The vidicon and tube socket of Camera, Serial No. 049, were misaligned during assembly, resulting in a mismating of the vidicon pins and connector jacks. This malfunction was identical to MR 3570 for Camera S/N 047 and the analysis of the Camera Electronics Assembly and the recommended corrective actions were also identical.
1360 10/12/64 1367 10/16/64 2068 10/22/64	Shutters 3047-R1 3038-R2	Improper shutter operation	Ambient	Workmanship	Shutter No. 3047-R1 stuck in the half-opened position at room temperature, but operated properly at 55° C (MR 1360). Shutter No. 3038-R2 stopped operating during the second thermal-vacuum test at 0° C (MR 2068). As noted in MR 1367, shutter 3038-R2 failed to meet the specification limits on the time cycle. A test was then run at room ambient conditions. Shutters 3047-R1 and 3038-R2 did not operate. An investigation disclosed that coils 219 and 264 had a change in inside diameter, which appeared to be caused by a glass epoxy blister near the dampening ring. The coils were cut and it was found that glass epoxy did not adhere properly to the dampening ring surface, and that the glass cloth did not cover the sleeve completely. Coil 264 showed definite raising and cracking of the epoxy where the glass cloth was absent. It was recommended that glass sleeving be considered as a replacement for the glass tape and that a cleaning process for

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 049 (Continued)		
1360 10/12/64 1367 10/16/64 2068 10/22/64 (Continued)					the inside copper surface where the glass sleeving is cemented in place be investigated and defined. In the action taken, the glass tape size was increased to assure complete coverage of the dampening ring. A new cleaning procedure for the dampening ring was incorporated in manufacturing specification 2021008. The mandrel was to be covered with a silicone finish to prevent the epoxy from adhering to the mandrel and the general cleaning solvent was changed from methyl ethyl ketone to isopropyl alcohol. Manufacturing specification 2021008 was invoked and procedure MP 2-1707239 was revised. The corrective actions taken as a result of MR 1360, 1367, and 2068 comprised improvements to the manufacturing process of the shutter coils and did not affect the design of the shutter. The design of the coil assembly was not changed by the manufacturing-process improvements, and the shutters fabricated prior to the incorporation of the improvements were the same design parts and met the same specifications. The incorporation of improvements to the manufacturing process was precipitated by a quality problem associated with the manufacturing yield of the coil form. The process improvements were twofold: • A new cleaning procedure for the copper dampening ring was instituted as the result of an analysis which indicated that the encountered binding of the shutters was due to blistering of the potting material in the area of the copper ring. This procedure was also instituted as a result of quality-control rejection of the coil form because of the observation of blistering during the first QC inspection after the coil had been fabricated; and • Covering of the mandrel with a silicone finish to prevent the epoxy from adhering to the mandrel was instituted to increase manufacturing yields. Coils were rejected because the inner walls of the coil form did not meet quality-control requirements. Quality-control standards to which the coil assemblies were fabricated were not changed. Basically, these standards were: • No air bubbles in potting method; • No bare spots on the glass tape; and • Smooth inner surface of the coil. These standards had always been applied to the coil assemblies prior to the additional manufacturing operations required to complete the coil. Review of shutter-malfunction history with respect to early failures revealed that of the 37 P-type shutter malfunctions reported for all classes of defects, exclusive of those shutters replaced after 250,000 operations, 19 malfunctions (51 percent) occurred prior to 36,000 operations, 5 (14 percent) between 36,000 and 296,000 operations, and 13 (35 percent) between 296,000 and 860,000 operations. Analysis of the operating time seen by a P-type shutter during its flight acceptance test, prior to assembly on a camera head, revealed that an average of 31,400 operations were accumulated. The range of this average varied from a minimum of 25,800 to a maximum of 46,000 operations. Based on these facts, P-type shutters having greater than 40,000 operations had passed the infant mortality portion of the failure curve and were in the constant failure-rate portion. Utilizing the 40,000 operation figure as the minimum number of P-type shutter operations desired to assure that a shutter was completely debugged, the shutters for Ranger VIII and Ranger IX were beyond the infant mortality experienced with P-type shutters. The P2 and P3 shutters of Ranger VIII and the P2 shutter of Ranger IX had coils which were part of the lot manufactured with coil 264, one of the failed coils reported in MR's 1360, 1367, and 2068. Examination of the 264 coil lot revealed that coil 264 was the only unit failing with the coil binding.
3892 10/23/64	Capacitor C17	Superimposed signal	Thermal-vacuum	Design	During thermal-vacuum testing of P4 Camera Electronics Assembly, Serial No. 046, a 65-kc signal of 80-mv amplitude was superimposed on the video signal. Capacitor C17 (3900 picofarads) was replaced by a 10-nanofarad capacitor and the problem was eliminated. RCA Drawing No. 1753007 was revised to reflect this modification.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Camera Failures S/N 049 (Continued)
3892 10/23/64 (Continued)					Camera, Serial No. 049/049, displayed low-level, 60-kc noise, which was misinterpreted as mesh noise. The problem was localized as an instability in the focus-current regulator. At the time of the investigation, it was empirically determined that increasing the value of capacitor C17 from 3900 picofarads to 10,000 picofarads eliminated the instability. Inspection of the phase-amplitude worst case for component values indicated that stability should be exhibited with the original capacitance (165°, -0 db; 180°, -30 db). However, the presence of a problem indicated probable parasitic effects that were not accounted for in the theoretical approach. Such effects might be: inductance of capacitor C16; lead inductance of the -27.5 volt bus; stray capacitance of the circuit; and parasitic effects added to the circuit by test-configuration cabling. Through an increase in the capacitance value of capacitor C17, the theoretical phase margin at 60 kc increased by approximately 3 degrees and gain margin by approximately 4 db which was not a substantial safety margin, but was sufficient to suppress any recurrence of instability in the focus-current regulator. This characteristic was monitored closely in all cameras of Ranger VIII and Ranger IX and spares. The instability displayed by P4 Camera, Serial No. 049/049, was limited to the first 10 to 15 minutes of operation, with all interface conditions normal. The problem could be detected in this camera, following the initial turn-on, only by increasing the collector supply voltage of the focus-current regulator (-27.5-volt input). Using this method for margin testing of stability, only Camera, Serial No. 046/046, displayed similar characteristics, and the value of capacitor C17 was increased. Camera, Serial No. 045/045, showed no evidence of instability during test; however, capacitor C17 was changed to 10,000 picofarads during recent rework. Camera, Serial No. 048/048, was tested, but capacitor C17 was not changed. Cameras, Serial Nos. 042/042, 043/043, 044/044, and 047/047, had the value of capacitor C17 changed during previous testing, when instability was detected. This change was approved by a Material Review Action. No other cameras exhibited the instability problem.
3889 11/1/64		Decrease in camera resolution	Thermal-vacuum	Nonconfirmed	During pre-thermal-vacuum tests, the resolution of P4 Camera was 18.8 percent. When the resolution was measured at a pressure of 2.5×10^{-5}mm Hg and a temperature of 25° C, it was 10.9 percent. This was not a true malfunction, since there were no specified limits to the allowable change in resolution between tests. There was only a requirement that the resolution be greater than 5.5 percent under all test conditions. Investigation revealed that the thermal-vacuum resolution measurements were performed incorrectly. The measurements had been taken at the oscilloscope input connector of the test rack, rather than at the video test jack; the readings were being made after the signal had passed through the test rack rather than at the input. When the resolution measurements were made in the proper manner, a response of 16.3 was obtained. Although no true malfunction occurred, a workmanship problem did exist. The importance of exercising care in obtaining and interpreting test data was stressed so as to avoid the unnecessary rejection of an assembly.
3896 11/4/64		Resolution out of specification	Thermal-vacuum	Design	During thermal-vacuum testing at +4-° C, a resolution of 5.2 percent was measured. The specified minimum value was 5.5 percent for all test conditions. Resolution measurements were adequate during test runs at ambient temperature and at 0° C. An evaluation of the effects of temperature variation on resolution was performed. Under vacuum conditions, the resolution improved as the temperature decreased, from 5.2 percent at 40° C to 12.5 percent at 25° C. When returned to normal pressure at 25° C, the resolution was 18.9 percent. The effects of vidicon-yoke displacement on resolution were then evaluated. The resolution was measured for 25 different yoke positions. At the best focus point, the resolution was 18 percent. The vidicon was then moved approximately 1 mil from the lens and the resolution was reduced to 15 percent; at 35° C, the resolution decreased to 7.5 percent. The vidicon was then moved 1 mil closer to the lens and to the point of left focus. At 35° C, the resolution was now measured as 18 percent. When checked under normal ambient conditions, the resolution was 15 percent.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Camera Failures S/N 049 (Continued)		
3896 11/4/46 (Continued)					The camera was retested under thermal-vacuum conditions. The resolution was 14.8 percent at 0° C, and 12.5 percent at +40° C, well above the minimum specified value. In addition to the resolution problem, the horizontal-erase overscan was out of specification during thermal-vacuum testing. The erase overscan measured 6.7 percent of the read sweep size, while the minimum specified value was 8 percent. An evaluation of the test data indicated that the minimum erase overscan at either end of the read sweep should have been 3 percent during thermal-vacuum testing. This change in specification was incorporated into RTSP-1112A.
2072 11/4/64	---	TLM	Room ambient	Nonconfirmed	During final acceptance tests the G1/Focus telemetry value was 1.85 volts, which deviated from the value listed in the test data sheets. However, the statement contained in the RTSP 1112A specification concerning telemetry deviations indicated no malfunction in this unit. On future telemetry deviations, engineering would evaluate data to determine whether or not a malfunction exists.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly and Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Miscellaneous Camera Malfunctions not Assigned to a Single Camera						
3810 3811 5/5/64	P3 and P4 Camera and Camera Electronics Subassemblies, Serial Nos. 021 and 039, and 037 and 040 (Flight Model III-2)		Variation in light levels	Ambient	Nonconfirmed	P1 collimator was at 2450 foot-lamberts and the P2 collimator at 4000 foot-lamberts during the test. This difference was attributed to the replacement of collimator bulbs and failure to recalibrate the collimators. The low sensitivity of the P1 Camera was caused by the shutter replacement at JPL. JPL indicated that these levels were acceptable and the collimators were recalibrated after vibration. During test at JPL, it was determined by use of a calibrated light gun that the average white level of the P3 Camera varied 75 mv between successive shutter strokes. The variation on the P4 Camera was 100 mv between successive shutter strokes. These variations are consistent with test data on these Cameras since their installation in the Flight Model III-2 Subsystem. The variations were related to the up and down stroke-time variations which were within the specified limits. These white-level variations were reviewed with JPL and considered acceptable.
2138 7/2/64	(Flight Model III-2)		RF interference	Explosive safe area (reduced power)	None	Cameras F_a, F_b, and P3 indicated RFI problems during the reduced power test (conducted per JPL Specification No. 3R 317.02) caused by the omni-antenna radating under the Agena shroud; the radiation was picked up by the camera electronics and transmitted with the video. The JPL specification for this test was revised to cause a mode change from the directional to the omni-antenna to evaluate the video during the 30-second null at switch over. This situation was considered a test problem.
3793 9/20/64	P2 Camera Serial No. 22/22		Camera defocusing	Thermal-vacuum	Design	Camera defocusing was found to be caused by the change in the index of refraction in going from ambient pressure to a vacuum and by the increase in distance between the lens and the vidicon caused by the increase in temperature.
3795	P1 Camera Serial No. 42/42 P2 Camera Serial No. 22/22 P3 Camera Serial No. 40/39					
3800 10/5/64	P1 Camera Serial No. 42/42					
1353 9/26/64	Spare Camera Serial No. 014/014 (Flight Model III-3)					
1537 11/14/64	Camera Bracket (Flight Model III-4)	Thermistor	Short	Ambient	Accident	During TV Subsystem electrical tests, telemetry point No. 86, which monitored the camera bracket temperature, read 6.2 volts, indicating that the sensing thermistor was in some way shorted out of the circuit. A check of the temperature sensor revealed no abnormalities. Continuity tests of the thermistor and application of physical pressure failed to reveal any discrepancies. Tests of connectors and cables also failed to reveal any problem. The problem did not recur during subsequent electrical tests.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly and Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Miscellaneous Camera Malfunctions not Assigned to a Single Camera (Continued)			
1537 11/14/64 (Cont.)						It was therefore concluded that the thermistor leads had become frayed or loosened at the terminals. As a result of continuous mechanical manipulation during harness rework, camera-head installation, and general mechanical work, one lead shorted against the other. The thermistor leads were redressed and soldered, and the terminals potted. No further indication of the problem was noted.
			Camera Failures at Subassembly Level (No Serial Numbers)			
2805 8/5/63	P-Scan Camera Electronics	Transistor Q9 (type 2N1208)	Short, collector to emitter	Room (manufacturing)	Workmanship	The shutter would not operate because the shutter return had been incorrectly wired into the cable. This resulted in the shorting and the resultant destruction of transistor Q9.
2807 8/15/63	Camera Electronics, Vertical Sync Generator	Diode CR20 (type 1N916)	Open	Room (manufacturing)	Workmanship	The vertical sync was lost because of the open diode.
2806 8/14/63	Camera Electronics, Deflection Programmer	Transistor Q10 (type 2N916)	Open (base to collector) (base to emitter) (emitter to collector)	Room (manufacturing)	Workmanship	No output from the deflection programmer because of the open transistor.
2808 8/19/63	Camera Electronics, G1 Regulator	Transistor Q5 (type 2N930)	Open emitter	Room (manufacturing)	Workmanship	The output from the G1 regulator was lost because of the open emitter.
			Shutter Failure (Not on a Camera)			
4114 10/30/63	P-Shutter Serial No. 3042	Solenoid Coil Serial No. 120	Binding	Post thermal-vacuum	Workmanship	The shutter failed to meet the specification limits for a timing test on the instroke following three cold tests. The stroke required 0.15 msec longer than the specified maximum of 2.3 msec. Investigation disclosed that the coil was binding at the top of its stroke. Refer to MR4116.
4115 10/30/63	P-Shutter Serial No. 3046	Solenoid Coil Serial No. 122	Binding	Post thermal-vacuum (manufacturing)	Workmanship	During post thermal-vacuum testing the instroke took 2.45 msec, 0.15 msec longer than the maximum limit. Investigation disclosed that the shutter coil was binding at the top of its instroke. Refer t MR4116.
4116 10/30/63	P-Shutter Serial No. 3024	Solenoid Coil Serial No. 116	Binding	Thermal-vacuum (0°C)	Workmanship	The shutter ceased operating during the third cold thermal-vacuum test. An examination disclosed that the solenoid coil was binding along the entire stroke. Investigation disclosed air bubbles through the glass-epoxy form surrounding the coil. It is believed these bubbles were distorting the coil during thermal-vacuum testing. A review of the manufacturing techniques revealed that the glass-epoxy was improperly mixed. The manufacturing procedure was revised. After the revision was completed, several new coils would be subjected to extensive tests to determine the effectiveness of this revision.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly and Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Shutter Failure (Not on a Camera) (Continued)			
4471 11/14/63	P-Shutter, Serial No. 3020	Detent Spring (RCA Dwg. 1171488-1)	Excessive tension	Post thermal-vacuum	Workmanship	The outstroke exceeded specification 2.0 0.3 msec by 0.2 msec. The coil side detent was found to be exerting too much pressure against the shutter blade. The detent was removed and a new one installed along with a thinner shim material under it. A gram gage is now used to check detent spring tension during shutter fabrication.
4472 11/15/63	F-Shutter, Serial No. 020	Shutter	Timing deviation	Room	Design	Following vibration test, shutter in-stroke was timed at 3.9 msec; Specifications: 4.5 msec ±0.3 msec. The voltage source used to drive the shutter in the test has been specified as 18.1 volts.
4600 12/19/63	F-Camera Shutter, Serial No. 030	Loose locknut	Binding	Thermal-vacuum (40°C)	Workmanship	Investigation revealed a loose locknut on the shutter push rod. The nut was replaced. The slide assembly was found to be binding because of either coil deformation or the yoke-driver coupler binding to the core guide. The coil was replaced with one of revised tolerances.
4726 1/17/64	F-Shutter Serial No. 030	Core Piece	Jamming	Thermal-vacuum (0° C and 1 x 10^{-4} torr)	Design	Investigation into binding of the coil during thermal-vacuum testing revealed that excessive compression on the core assembly had caused the forward guide tc bow c .ward causing the solenoid coil to bind. 0.020 inch was milled off the cap piece of the forward guide, relieving the compression.
4727 1/20/64	P-Shutter Serial No. 3054	Magnetic Core	Timing out of specification	Room	Workmanship	The difference in time of the shutter-pulse width between instroke and outstroke of this shutter was 0.34 msec. The specification only allows 0.30 msec. The core was remagnetized and subsequent tests showed that the strokes were within specification limits. Before the cores were considered to be fully saturated, they were now given a test in which they must support a 100-gram weight after they have been magnetized.
4703 4705 1/27/64	P-Channel Shutters, Serial Nos. 3053R1 and 3045R1	Cores	Time of stroke not within specified limits	Ambient	Accident	The difference in timing between the outer and inner strokes of these shutters exceeded the specified maximum of 0.3 msec. In both cases, remagnetization of the core restored operation within specified limits. Refer to Malfunction Reports 4704 and 5816 for recommendations.
4704 1/27/64 5816 4/1/64	P-Shutter, Serial No. 3047R1 Flight Model III-2	Magnetic Core	Time of stroke not within specified limits	Ambient	Accident	The timing difference between the outer and inner strokes was 0.4 msec (the specified maximum is 0.3 msec. A retest was performed, the timing difference was still not less than the specified maximum. Remagnetization of the core resulted in the timing difference being 0.1 msecs.
4706 2/4/64	F-type Shutter Serial No. 034	Dowel Pin and Actuator Block	Intermittent shutter operation	Thermal-vacuum	Workmanship	Investigation revealed that a dowel pin in the actuator block had become loose and was binding against the shutter frame. Further investigation also revealed that the actuator block holes were drilled oversize and out of round. New actuator blocks and dowel pins were to be used on all future refurbished units to ensure that this failure mode would not recur.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly and Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Shutter Failure (Not on a Camera) (Continued)			
4781 2/20/64	P-type Shutter Assembly Serial No. 3073		Shutter stroke timing differential exceeds specified limits	Ambient	Accident	The P-type shutter in-out stroke timing differential exceeded the specified maximum by 1.7 msec. Investigation revealed that the magnetized core was defective. Replacement of the magnetized core restored normal operation of the shutter. Recommendations for corrective action to be taken to ensure against a recurrence of this malfunction have been issued in Ranger Project Office Memo No. 94410-2, dated April 29, 1964.
3992 4/29/64 3997 5/3/64	Shutters, Serial Nos. 3032-R1 and 3026-R	Pole Pieces	Timing deviation	Ambient	Accident	The timing differential between the in and out strokes of these shutters was not within specified limits during testing. Several changes have been made to the maunfacturing and handling processes and procedures to prevent a recurrence of this problem.
3891 10/22/64		Shutter Serial No. 3058-R2	Non-operative shutter	Thermal-vacuum	Workmanship	The shutter stopped operating. Investigation disclosed shutter binding at the gibs at 60° C. A new set of gibs restored operation of shutter. Retesting of the reworked shutter gave no indication of binding at 60° C. A review of gib shutter slide materials indicated that temperature differentials of 35° C can cause change in the spacing between the gib track and slide of approximately 1 mil, which is sufficient to cause binding if the assembly is too tight initially. A shutter-gib alignment tool is now used to prevent this malfunction from recurring. Shutters manufactured prior to this date, which have passed flight acceptance tests, do not exhibit this problem.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Power Control Unit, S/N 001		
3278 7/18/63	Relay K2	Intermittent operation	Room (manufacturing)	Workmanship (vendor)	A set of contacts on relay K2 would not close. When this relay was opened, an excessive gap was found between the set of contacts.
			Power Control Unit, S/N 002		
3358 7/10/63	Silicon Control Rectifier CR6 (type 2N638) Diode CR7 (type 1N754)	Open gate	Room	Accident	While investigating the PCU turn-off problem, the gate of the Silicon Control Rectifier CR6 was shorted to the spacecraft frame. This caused the gate to fuse open and at the same time caused the zener diode CR7 to open. In order to resolve the turn-off problem in the PCU, it was necessary to redesign the circuitry. The SCR gates were then connected together using back-to-back diodes and random gating contacts.
			Thermistor, S/N 2-12S		
3978 4/19/64	-	Physically damaged	Ambient	Accident	Thermistor 2-128 used to monitor temperature on Flight Model III-2 was found to have one of its terminals bent. A resistance check of the circuit measured open. Replacement of the thermistor restored normal operation.
			Thermistor, S/N 3-2 (type 44-20 TE 1)		
1349 9/14/64	-	Changed internal resistance	Ambient	Random	The telemetry data received during test of the TV Subsystem indicated erratic behavior of the thermistor No. 3-2, monitoring the temperature of the F_b Camera Electronics (A7). The thermistor was removed and the internal resistance was measured at 120 K ohms instead of 50 K ohms. Prior to this test the thermistor had been functioning correctly and had been calibrated satisfactorily. The thermistor was carefully inspected, including X-ray, and no external flaws were in evidence in the potting nor were there any noticeable flaws in the thermistor wafer. The fact that no flaws were discovered does not mean that flaws too small to find were not present. There have been very few problems with these thermistors because of the protective assembly procedures and the 100% testing following assembly.
			Video Combiner S/N 001		
3361 5/26/63	Bourns Trimpot (R86) 3250L	Frozen adjustment screw	Room ambient	Workmanship	Potentiometer was conformally coated on all sides, freezing the adjustment screw. This prevented final adjustment of the summing amplifier during camera bench checkout.
			Video Combiner S/N 004		
3425 11/21/63	Transistor Q4 (type 2N930)	Loss of F video	Pre-thermal-vacuum (ambient) (JPL)	Nonconfirmed	Investigation into the loss of hard-line and RF video indicated that transistor Q4 was defective. However, later tests performed on the transistor failed to reveal any defects.
2151 5/28/64		Loss of video from Camera F_a	Ambient	Workmanship	During post-integration checkout, F_a Camera was inoperative. Investigation revealed that a short existed between the center conductor and shield of coax connector A8J2 on the F_a Video Combiner. This connector had been previously sleeved to correct pin retention. Upon removal of the sleeve, the short was cleared. It appears that the connector had an initial discrepancy that normally did not affect the capability. However, the aggravation of the additional sleeving affected it to the point where failure occurred.
			Video Combiner S/N 006		
3930 4800 3/24/64	Printed Circuit Board	Wrong circuit traces	Ambient	Workmanship	The P-Channel telemetry was not as specified because a circuit trace had not been removed as required by the latest configuration. The trace was removed and proper operation resulted.
3931 3/24/64		Reading not within specified limits	Ambient	Accident	The operator was confused by an ambiguity in the test procedure which was since corrected.
			Video Combiner S/N 008		
4081 10/21/63	Printed Circuit Between Resistor R67 and R64	Broken	Ambient	Workmanship	The printed-circuit path between resistors R67 and R64 was found to be open on terminal board TB3 during the determination of no output from the assembly. Quality Control has been instructed to inspect this path on future assemblies.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Video Combiner S/N 008 (Continued)		
A4100 1/6/64	Connector A8J4	Pushed out	Room	Secondary	During the initial electrical checkout of Flight Model III-4, connector A8J4-A2 was pushed out by the crooked pin in cable A2-P. The defective connector was replaced following completion of the electrical checkout of the subsystem.
			Video Combiner S/N 009		
3279 8/8/63	Trimpot R53 (Bourns No. 32506-L)	Would not change value	Room (manufacturing)	Design	The trimpot would not change value when adjusted in the circuit. This type of trimpot failure had occurred before but always during an initial alignment. It was recommended by both Reliability and the vendor that only parts with a date code later than 6143 be used for replacements. Because the part was not considered a reliability risk, it was not recommended to remove all parts with an earlier date code from finished equipment. The malfunction part was date coded 6115 B and, therefore, was suspected of failing because of the design in use at that time.
			Video Combiner S/N 010		
4010 9/30/63	Transistor Q6 (type 2N869)	Open base lead	Room (manufacturing)	Workmanship	Examination of the broken base lead of transistor Q6 disclosed that the lead had been nicked in some manner prior to installation.
4583 11/12/63	Insulating board (RCA Dwg. 1702969)	Not installed	Room	Workmanship	When the Video Combiner was returned from conformal coating for final acceptance testing, all signals were shorted to the chassis ground. An investigation revealed that the insulating board behind the component assembly board had been left out. Quality Control instituted inspection procedures to verify that all insulating boards were cemented down to the chassis prior to the bonding of the component board assembly.
3828 4/20/64	Coaxial Connector	Shorted	Ambient	Workmanship	Investigation into the inability to adjust the P2 Camera video revealed an extraneous wire soldered in the connector causing a short in the inner conductor of the coax. The extraneous wire was removed and normal operation was obtained.
3832 4/21/64	Telemetry Amplifier	Telemetry output not within specified limits	Ambient	Workmanship	Investigation into why the telemetry output was not within specified limits revealed that transistor Q12 was incorrectly wired. Resistor R25 was of the wrong value, and a jumper wire was missing. The transistor and resistor were replaced and correctly wired and the jumper wire was inserted. Normal operation resulted.
3988 4/28/64		Output not within specified limits	Ambient	Accident	Operator failed to connect oscillator through the test panel resulting in incorrect test data being recorded. With test connections corrected, the test was satisfactorily performed.
			Video Combiner S/N 011		
3956 3957 5/5/64	Transistor Q6 (type 2N869)	Shorted	Ambient	Random	Investigation of the DC output of the F-Channel in the Video Combiner with respect to temperature resulted in the replacement of six transistors. The first five components were removed unnecessarily. Review of this malfunction disclosed that because the DC output was only marginally out of specified limits, no other associated components were overstressed.
			Video Combiner S/N (Unknown)		
1957	Transistor Q3 (2N390) Transistor Q4 (2N390)	Drift @ 0°C. 55°C	Acceptance thermal-vacuum	Design	Transistors were used in a different amplifier. Mismatch occurred at extreme temperatures. Transistors for this box would be selected for proper match.
			Control Programmer and Camera Sequencer S/N 0002		
2987 5/2/63	Transistor (Q32) 2N916	Low B-C breakdown voltage	Vibration	Random	Improper operation after vibration. An internal inspection revealed a broken base connection. This equipment was subject to two qualification vibration tests and was probably mechanically overstressed.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Control Programmer and Camera Sequencer S/N 0002 (Continued)		
3769		Wiring errors	Ambient	Nonassignable	During the initial electrical test following rework, improper operation of the Sequencer was experienced. Examination revealed wiring errors to be at fault. A detailed analysis was then performed. No overstressing of parts occurred as a result of this malfunction.
4085 4086 10/23/63	Interconnecting Cable 013, 014	Double pulsing of the shutter pulse and F vertical blanking	Ambient	Workmanship	Although a continuity check of the cables was satisfactorily performed, bubbles were noted in the potting component of the connector and the cables were replaced. The sequencer then operated normally.
4239 2/6/64		Early P-Channel turn-on	Ambient (JPL)	Design	A two-minute early turn-on of the P-Channel was associated with noise spikes that appeared on the manual reset line for the P-Channel 5-minute accumulator. The circuit was redesigned so that only a 79-second time delay was provided. In addition, the manual reset line was eliminated.
1527 1526 10/23/64			Ambient	Nonassignable	During testing it was noted that the horizontal sync pulses of the P1 Camera were of a lower amplitude and shorter duration than the other P-Cameras. A series of tests indicated that the sequencer malfunctioned. The sequencer and power supply were removed and bench tested. Operation was normal. The unit was installed in the spacecraft; operation was not normal. More tests were conducted. Observation of the modulator A video 1, terminal A9A2P2-5, showed a P1 vertical gate pulse of 6.6 volts, 200 msec with no horizontal serrations. An investigation revealed a fault in the fail-safe circuit. The sequencer worked satisfactorily during bench test because the bench test did not simulate the sync generation "not read pulse" from the camera to sequencer. The sequencer and power supply were removed from the structure, tested, and remounted. Throughout tie down and mounting, the signal at A9A2P2-5 was observed to be normal. For a third time, the sequencer was bench tested with the test rack modified. The sequencer operated satisfactorily until A2J1-5 of cable W1-8 was moved. At this time the video serration disappeared. A check of the harness indicated a discontinuity between the male and female contacts. The A2 frame was removed from the sequencer and the potting compound was removed from the contact. The solder connection was found to be acceptable. The harness was remated. The sequencer did not malfunction. No contamination or loose contacts were found. However, contamination could have been present and removed during demating and mating of the connector. All connectors on the sequencer and cable S1-8 were therefore cleaned as specified in ME160 and the bench test racks were modified to test the fail-safe not read circuits. One rack was modified and all remaining equipment was permanently connected. The sequencer was tested after the connector cleaning. At JPL's request, cable W1-8 was replaced by W1-10 and returned to space status.
			Control Programmer and Camera Sequencer S/N 0003		
3375 thru 3379 7/25/63	Diodes CR67 and CR73 (type 1N916) Diode CR74 (type 1N750) Transistors Q37 and Q28 (type 1N1613)	Shorts	Room (after vibration) (manufacturing)	Nonassignable	Relay K2 in the controller modulator would not energize following vibration test. Three diodes and two transistors in the P-Channel Controller Modulator Subassembly, were found to be defective. Indications were that transistor Q37 did operate relay K2 at the start of the investigation, but subsequently became defective.
3348 8/22/63	Transistor Q2 (type 2N914)	Intermittent	Thermal-vacuum (manufacturing)	Workmanship	The F-Channel timer should have operated for a period of 302 seconds. However, the timer failed to operate after 138 seconds. Transistor Q2 of the F controller timer was intermittent during a thermal-vacuum test. While replacing the transistor, a bad solder joint was found on one of the transistor leads. This was corrected.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Sequencer S/N 0004		
1296 2/18/63	SCR (CR 43) 2N1871A	-	Ambient (bench)	Workmanship	The PTM sequencer was being modified for the "split system". Parts were removed, cleaned, rewired, replaced, and potted. During this work, the SCR case was crushed. The part was replaced
			Sequencer S/N 0005		
3981 4/19/64	Wire	Broken	Thermal-vacuum	Workmanship	Investigation into the loss of the black clamp pulses during thermal-vacuum testing revealed that a wire had been severed. The wire was replaced and normal operation restored.
3953 4/23/64	P-Channel Controller	Double pulsing at test point A3	Ambient	Accident	Investigation of double pulsing at test point A3 following repair necessitated by malfunction noted in MR3981, revealed an open circuit between diodes CR105 and CR108. The addition of a jumper wire between the two terminals restored normal operation.
3272 3261 7/8/63	Silicon Control Rectifier CR54 (type 2N1871) Transistor Q11 (type 2N914)	Erratic operation	+55° C	Random	The triggering pulse from the Silicon Control Redtifier CR54 became erratic during the third run in vacuum at +55° C. When the SCR was tested by the Central Engineering Laboratory, they found that the component would turn on by itself at elevated temperature and that the holding current was well below the minimum specified value. Either of these faults could cause this circuit to malfunction.
2831 5/5/63	Transistor (Q31) 2N916	-	+55 °C	Design	The 2N916 transistor, in this particular control circuit, required selection of beta at 75° C. The failure reported was caused by defective startup time at elevated temperatures. The 2N916 transistors of the control circuits were replaced with 2N914 transistors.
4786 4787 3/26/64		Double pulsing	Ambient	Nonconfirmed	Double "Flash B" pulsing existed for about one-half an hour, after which power was turned off. During a retest the malfunction was not present and could not be recreated. Investigation revealed that the most likely cause was an intermittent contact of a connector pin in the W1 cable. Replacement of the cable restored satisfactory operation. It is felt that this malfunction was caused by a white crystal-line deposit found on the contact pins. All connectors were to be examined for such deposits and, if found, cleaned in the prescribed method. All cables on Flight Model III-2 were examined and cleaned where necessary.
			Sequencer S/N 0006		
3551 8/27/63	Control Modulator Capacitor C28 Tantalum Type	Excessive leakage	Thermal-vacuum (+55° C)	Design	The output of the P-Channel timer was drifting and the voltage at the test point was varying from minus 18 to minus 27.5 volts DC. Investigation revealed that capacitor C28 had been installed incorrectly. The assembly drawing did not specify the polarity orientation of this capacitor when installed. An ECN was written to correct the drawing.
4045 12/12/63	Connector A9A1J2	Loose contact	Thermal-vacuum (integration)	Accident	Following the observation of double vertical serrations before the P1 and P2 video during thermal-vacuum testing, an investigation revealed that the movement of the sequencer harness at A1J1 would make the problem appear and disappear. The contact carrying the vertical sync signal at A1J1-9 was found to have a loose napkin ring and was making poor contact to the harness pin.
5832 4/15/64		Intermittent operation	Thermal-vacuum	Workmanship	The 79-second timing operation was unsatisfactory during the thermal-vacuum test, although operation under ambient conditions was normal. The grounds of the F- and P-Channel counters were found to be incorrectly tied together. Correction of this restored operation.
3952 4/20/64	Connector A9A3J1	Loss of signals	Ambient	Workmanship	Investigation into the loss of signal voltages revealed an intermittent open between pins A2J1-17 and A3J1-3. Microscopic examination revealed contamination on the contact pins of the Cannon connector. All Cannon connectors of the harness were cleaned and normal operation was restored.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Sequencer S/N 0008		
3553 8/29/63	Control Modulator Capacitor C28	Installed with wrong polarity	Room (manufacturing)	Design	A visual inspection was performed on Camera Sequencer S/N 0008 and this unit had capacitor C28 wired into the circuit with the wrong polarity. An ECN was issued to correct the affected schematic diagram to show the correct polarity more clearly.
4795 4/2/64	Control Modulator Capacitor C28	Overstressed	Ambient	Accident	The Sequencer test procedure was revised in anticipation of a circuit modification and an unmodified assembly was tested to it. As a result, a reverse voltage was applied to tantalum capacitor C28. The capacitor was replaced.
3950 5/2/64		Loss of full-power output	Ambient (JPL)	Nonconfirmed	The JPL test procedure initiated warm-up of the Subsystem by using a jumper connection at the breakout box. The procedure then required turn-on into full power at 70 seconds. The jumper wire was removed as soon as verification of full power was received; this resulted in the Subsystem returning to warm-up. However, the 80-second accumulator was counting and turned the Subsystem back into full power, resulted in a short loss of output. JPL was notified to change its test procedure to indicate either that the preceding would happen or that the jumper connection should be kept in for longer than 80 seconds.
			Sequencer Power Supply, S/N 0004		
1297 2/25/63	Transistor Q9 (type 2N-1485)	Short	Ambient (bench)	Accident	Noise was noted during camera tests using the "split-system" PTM sequencer and sequencer power supply. To detect the source of the noise, the load was accidently removed from the power supply which resulted in a current overstress of Q9. Camera test personnel were made aware of the precautionary note included in the sequencer test procedure concerning the removal of load from the energized power supply.
3336 6/11/63	Capacitor C7	Short	Room (integration)	Accident	Capacitor C7 in the power supply shorted after the PTM had completed all tests. C7 was replaced, and C6 was replaced because it may have been overstressed.
			Sequencer Power Supply S/N 0005		
3356 6/28/63	Transistors Q13 and Q14 (type 2N1486)		Room (integration)	Secondary	When the High-Current Regulator S/N 0005 failed (MR3355), the unregulated 33 volts DC were allowed through to the Regulator output. The only load on the Regulator at the time was the Sequencer Power Supply. The two F-Channel Choppers (transistors Q13 and Q14) were destroyed.
4075 10/10/63	Capacitor C1 (CL65 CJ470-MP3)	Shorted	Room	Design	The input power supply circuit breaker tripped during manufacturing testing. Investigation led to capacitor C1, which had been installed with incorrect polarity. The mechanical layout drawing has been revised to show the proper polarity of C20. (See RCA Dwg. 1073576, Revision K.)
1534 11/12/64	Capacitor C10	No output	Ambient	Nonassignable	During final bench-testing of sequencer 0005, there was no power output from the supply. It was indicated that capacitor C10 shorted. After the capacitor was removed from the power supply it was tested and found to be good. In a later check it was found that the capacitor could short if the leads were moved. The vendor reported that capacitor C10 was normal at room temperature but exceeded leakage specifications at a temperature of 35° C with rated voltage and stress on the anode lead applied. Internal examination of the capacitor revealed a crystalline silver deposit, which could cause a high leakage or an intermittent short if contact between the anode and cathode were made by this silver deposit. The deposit is caused by a periodic or continuous voltage reversal of slight magnitude. There is no reversal during normal operation. During another investigation of this malfunction, four capacitors of the same type used in the circuit were removed for testing. Leakage currents were within specification. A black deposit found inside the capacitor was considered normal by the vendor.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Sequencer Power Supply S/N 0006		
2950 9/20/63	Transistor Q20 (type 2N869)	Open	Room (manufacturing)	Accident (test error)	This Sequencer Power Supply was being used to check out a new test fixture in the manufacturing area. Several problems in this test rack caused transistor Q20 to be destroyed and at the same time C18 and C19 were removed. The loss of these components removed the -12 volt DC from the F Cameras.
3560 9/20/63	Capacitors C18 & C19 (type CL65CJ-470MP3)		Room (manufacturing)	Accident (test error)	
4084 10/14/64	Zener Diode (type 1N821)	Over-stressed	Room (manufacturing)	Secondary	As a precaution against failure at a later time, this diode was replaced because it had been overstressed during accidental damage to the power supply. The damage occurred during the checking out of a new test stand. Several other components in the circuit were destroyed. Refer to Malfunction Reports 2950 and 3560.
			Sequencer Power Supply S/N 0007		
3998 5/3/64		Improper grounding	Ambient	Accident	Investigation of no isolation between F and P ground circuits revealed that there was a wiring error in the power supply which tied the two grounds together. The wiring error was corrected.
			Sequencer Power Supply S/N 0009		
3940 4/8/64		Reading of thermo-couple off scale	Thermal-vacuum (+55° C)	Nonconfirmed	During a special thermal-vacuum test requested by JPL, the reading of a thermocouple was off scale. The test was performed with the thermocouples stabilized at +55° C prior to turn-on of the equipment. There were no specified limits for temperatures after turn-on as this was a special test. Therefore, this cannot be classified as a malfunction.
			Sequencer Power Supply S/N 0010		
1541 11/24/64	Capacitor C1	Excessive video noise	Ambient	Workmanship	Excessive noise was encountered on the video output of the P1, P2, and P4 cameras during electrical tests on Flight Model III-4. After extensive testing of these cameras failed to reveal any reason for the noise, a check was made of the Sequencer and Sequencer Power Supply, which revealed noise on the P-Channel output of the Sequencer Power Supply. Sequencer Power Supply, Serial No. 0005, was incorporated into Flight Model III-4 and the observed noise was reduced considerably. A bench check showed that Sequencer Power Supply Serial No. 0010, exhibited excessive noise spikes on the -27.5-volt supply line at the emitters of transistors Q1 and Q2. Capacitor C1 was suspected of not filtering the high-frequency component of the signal, and when this component was replaced, the noise dropped to a normal level. The removed capacitor was found to have a value of 48.5 microfarads with a leakage of less than 1 microampere and a dissipation factor of 17.5 percent. The high-dissipation factor indicates that the capacitor would not filter as it should. This change in characteristic indicates a leak in electrolyte. When the capacitor was examined under a microscope a small hole in the rubber seal was revealed, and the entire seal under the conformal coating had changed to a red color, indicating a defective seal. The vendor stated that the seal had been punctured by the tantalum wire. It was postulated that this opening had allowed electrolyte to leak out, thus causing the dissipation factor to increase. Seal tests with blue thymol revealed no evidence of electrolyte leakage. The vendor analysis indicated that there was a presence of silver deposit which suggests some reverse voltage was applied that could cause high internal pressure. The vendor further stated that this increase in internal pressure could loosen the seal to such an extent that the volatile constituents of the electrolyte could escape and affect the conductivity of the electrolyte. This would increase the equivalent series resistance, thus causing an increase in the dissipation factor. It is RCA's position that the hole in the seal was the cause of the loss of electrolyte and the resultant increased dissipation factor. The silver deposits were insufficient to increase the leakage current associated with the capacitor, and therefore, would not have affected the internal temperature of the device.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Filter Assembly, S/N 004					
4791 3/5/64	-	Low resistance	Ambient	Accident	During an inspection performed immediately after the receipt of this assembly, an AC voltage was applied to which resulted in the application of a reverse voltage across polarized capacitors. The capacitors were replaced and the inspection procedure revised so that this malfunction could not recur.
2191 5/21/64	Connector	Loose pin	Ambient (JPL)	Wearout	Wearout of pin 12 of connector A38P1 caused the pin to fail the one-ounce pin retention test. The JPL sleeve was inserted; the pin was retested and passed the test.
Filter Assembly S/N 006					
3596 5/11/64	Filter	Incorrect frequency response	Ambient	Accident	Investigation into the inability of the Filter Assembly to comply with the response specifications of RTSP-1164 resulted in the revision of the response curve. The test specification, RTSP-1164, was revised.
Filter Assemblies, S/N 007 and S/N 010					
4788 3/28/64 4790 4/4/64	Capacitor Capacitor	Low resistance	Room (bench)	Accident	During inspection performed immediately after the receipt of these assemblies, an AC voltage was applied which resulted in the application of a reverse voltage across a polarized capacitor. In each case, the capacitor was replaced. The inspection procedure was revised subsequent to the analysis.
Filter Assembly S/N 012					
2551 11/2/64		Resistance Out of specified range	Ambient	Accident	During previbrational electrical testing, Filter Assembly, Serial No. 012, failed to comply with specified DC resistance values of RTSP-1164. An electrical-continuity measurement between pins 1 and 4 and between pins 9 and 12 of connector J1 indicated 1.7 ohms, while the specified resistance between these contacts is 2.0 ohms $\pm$10 percent. The 1.7 ohm values were obtained with a VTVM, RCA Model WV98C, as specified in Test Method No. TM-1-1752265. When the resistances were remeasured with a wheatstone bridge, J1-1 to J1-4 measured 1.84 ohms, and J1-9 to J1-12 measured 1.82 ohms. These values were considered the correct resistances because of meter tolerances (3 percent for the VTVM, compared to 0.5 percent for the wheatstone bridge). The parts between pins 1 and 4 and pins 9 and 12 are two 5-millihenry choke coils, and the value of resistance for each 0.92 ohm. Therefore, the specified resistance value between these pins should be 1.84 ohms $\pm$10 percent. With this interpretation, the 1.7-ohm resistances measured would be within the specified range. RTSP-1164 has been modified to reflect this change in resistance value.
2070 11/7/64		Response curve out of specification	Thermal-vacuum	Workmanship	During the first 0° C test, the response curve plotted was out of specification at 1000 cycles. This was corrected by connecting the cable shielding to the output load ground. This effectively removed a ground loop caused by the 16 feet of cable at the output of the filter assembly. A test was run and all data points were acceptable. The 0° C test was not necessary. A response test in thermal-vacuum exceeds the acceptance test requirements of Specification RTSP-1164. It was recommended that the test method be revised to reflect the test requirements of the specification.
1533 11/8/64		Frequency response was out of specification	Ambient	Nonconfirmed	The Filter Assembly was rejected during final acceptance tests. The frequency response was out of specification at 2500 and 3000 cycles per second. Filter performance was not degraded. This unit had a better than normal filter response characteristic.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Battery, S/N 001 (type 252)
1386 7/1/63	-	Short	25° C (Engineering)	Design	This battery was undergoing qualifications test. A short from the negative side to the chassis was observed at the conclusion of low-temperature soak test. This was caused by an insulation failure. In addition, shorts were occurring in the separators. A design change has been made to the separator configuration to improve performance.
					Battery, S/N 002 (type 252)
1387 7/15/63		Short	Thermal-vacuum test	Design	The battery was undergoing qualification test. Cell No. 21 reversed polarity during the 16-amp discharge while being submitted to the high temperature Thermal-Vacuum Test. It is believed that the cell shorted. In addition, shorts were occurring in the separators. A design change has been made to the separator configuration to improve performance.
					Battery, S/N 006 (type 252)
1389 8/3/63		Short	25° C (Engineering)	Design	The battery was being submitted to Life Test when Cell No. 14 shorted after 52 hours of cruise-mode operation. Due to lack of other evidence, it was determined that the short occurred due to separator exhaustion. The vendor has recommended that increased separator protection be incorporated into future cells. Various test cells have been fabricated to evaluate which proposed separator improvement provides the best solution.
					Battery, S/N 007 (type 252)
1390 7/31/63	-	Short	25° C (Engineering)	Design	This battery was undergoing qualification test. It had been sent to JPL for shock test. Cell No. 20 was found to be shorted prior to the shock test. The battery was shock tested, and then returned to the vendor for analysis. The previous history taken from the vendor report indicates a dehydration in Cell No. 20 starting after the high temperature soak. The vendor states that the potting level in the cell was not sufficiently low to completely encapsulate the separator envelope tops. It is recommended that clear polystrene RMD-4511 cell cases be substituted for the white cycolac cell cases previously used. The ability to see through the cell case would preclude high epoxy potting. RMD-4511 cell cases have been procurred and pressure tested by the vendor.
					Battery, S/N 008 (type 252)
4051 8/15/63	-	Short	Vibration (engineering)	Design	This battery was undergoing qualification test. Cell No. 20 shorted during vibration test. The battery was sent to the vendor for analysis. Symptoms encountered during final discharge at RCA, suggested that lead-wire breakage had occurred in Cell No. 20 and possibly in Cell No. 22. Inspection showed that in Cell No. 20 all wires except 1 were found to be broken. The vendor has recommended an improvement in the epoxy potting level, in the protective coating, and increasing the number of lug wires from 2 to 3 on each plate. Six test cells incorporating the first two of the above recommendations were scheduled for shock and vibration tests at RCA.
					Battery, S/N 025 (type 202)
4233 12/9/63	-	Cell shorted	Room (JPL)	Wearout	The voltage from cell No. 20 was found to be 0 volts. The battery had been subjected to 5 charges and 4 discharges. Three charge-discharge cycles are the normal life-expectancy of this type of battery.
					Battery, S/N 029
2614	--------	Leakage	Thermal-vacuum	Wearout	The LTM Battery was found to be leaky after final testing at JPL. The battery had been subjected to several deep discharges and had surpassed its design goals.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Battery, S/N 032 (type 202)		
3434 9/17/63	-	Internal short	Room (JPL)	Secondary	The batteries were overcharged, resulting in overheating. This caused the electrolyte to leak onto the battery-monitor connector.
			Battery, S/N 036 (type 202)		
3431 9/14/63		Low battery voltage	Room (JPL)	Nonconfirmed	Batteries were completely discharged. Recharged batteries.
			Battery, S/N 037 (type 202)		
3432 9/14/63		Low battery voltage	Room (JPL)	Nonconfirmed	Batteries were completely discharged. Recharged batteries.
3421 9/24/63		Cell No. 2 was 0.05 volts	MVT No. 2 100° F Test	Wearout	Cell No. 2 would not accept a charge after 20 minutes. Other cells read 1.94 volts. The vendor indicated that the cell had shorted because of normal wearout.
			Battery, S/N 038 (type 202)		
2618 9/17/63		Voltage below specification	Thermal-vacuum (41° F)	Wearout	The battery had been operated with the terminal voltage below the minimum specified level. An attempt to recharge this battery failed. Cell No. 1 measured zero volt when tested. In addition, electrolyte was noted leaking from around the terminal. This battery had been subjected to four charge-discharge cycles prior to its failure. The vendor guarantees this type of silver-zinc battery for only two recharge cycles. These batteries deteriorate very rapidly with increased use.
			Battery, S/N 039 (type 202)		
3438 9/17/63	-	Internal short	Room (JPL)	Secondary	The shorting of the pins on the battery monitoring cable caused further shorting of cells in the battery. The battery sensing switch in the GSE was not operating. Battery voltage was read as 38 volts when it was actually 42.5 volts.
			Battery, S/N 042 (type 202)		
4266 10/4/63	-	-	Thermal-vacuum (low-temp.)(JPL)	Nonconfirmed	During a low-temperature thermal-vacuum test at JPL, a drop in cell voltage was indicated. When the battery was removed from the chamber, the connector was found to be covered with electrolyte. Later investigation proved that Battery Serial No. 44 had failed and leaked onto the connector. Battery Serial No. 42 was checked out by the vendor and found to be satisfactory.
			Battery, S/N 044 (type 202)		
4265 10/4/63	-	Suspected shorted Cell No. 14	Thermal-vacuum (low-temp.)(JPL)	Wearout	During thermal-vacuum testing at JPL, large quantities of electrolyte leaked from cell No. 14. The voltage of the cell dropped to 0.14 volt. This battery had received five charge and discharge cycles prior to its wearout. Battery voltages were to be closely monitored to detect end-of-life before it occurred and, thus, prevent damage caused by leakage of electrolyte.
			Battery, S/N 049 (type 202M)		
4052 7/31/63	-	Leakage of electrolyte	25° C (engineering)	Design	The battery was undergoing qualification test. It was sent to JPL for shock test, at which time an electrolyte lead was observed. A pinhole was detected in the potting. The strong bond between the paint and battery case caused the case to separate from the cell. Teflon tape has been wrapped around the battery to prevent further damage being caused by the bond between the paint and case.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Battery, S/N 050 (type 202M)		
4053 9/3/63	-	Short	+10° C	Design	The battery was undergoing qualification test. A short occurred from the position side to the cassis after the required +10° C soak. The strong bond between the paint and battery case caused the case to separate from the cell. Teflon tape has been wrapped around the battery to prevent further damage being caused by the bond between the paint and case.
			Battery, S/N 051 (type 202M)		
3440 9/25/63	-	Leaky Electrolyte	Ambient	Accident	Refer to MR 4261 (Battery, S/N 053).
			Battery, S/N 052 (type 202M)		
4054 9/4/63	-		+54° C (engineering)	Accident	The battery was undergoing acceptance test. A bulge was noted on the top of Battery after the test. These bulges were believed to have been caused by heat from an external source. The battery was returned to the vendor, the top was milled down, and a new layer of epoxy was put on the top. The battery is now in use.
			Battery, S/N 053 (type 202M)		
4261 9/25/63	-	Leaky electrolyte	Ambient	Accident	Battery was sent to JPL for use during ambient conditions because it was not flight-qualified. It was accidentally placed in cold storage.
			Batteries, S/N 78 and 79		
2176 4/10/64	Belly Bands	Bolts did not fit	Ambient (JPL)	Workmanship	During installation of the batteries for a vibration test, the bolts for the battery belly band could not be installed because of hole misalignment with the TV Subsystem structure. The holes on the structure were enlarged to accommodate battery mounting.
			Battery, S/N 080		
2269 1/5/65		Mounting screw holes misaligned	Ambient (JPL)	Design	During installation of battery, Serial No. 80, on Flight Model III-4, the bellyband screws would not fit because of a misalignment of the screw holes in the Subsystem structure and the mounting holes in the bellyband. Prior to fabrication of Battery, Serial No. 99, the bellyband was installed by the vendor before shipment, and the battery-case mounting holes were drilled upon receipt at RCA. As a result, the drill fixture which tightly controls hole locations could not be used for installation of the bellyband. Starting with battery, Serial No. 99, the battery vendor drills the holes and then installs the bellyband using the drill fixture as a template. The same drill fixture was used to drill the clearance holes in the structure. Thus, this problem should not occur on any batteries with Serial Nos. of 99 or greater, which includes the Ranger IX flight and flight spare batteries. To assure that earlier type batteries can be used in the structure for vibration and test backup requirements, the structure holes were changed from 0.201 to 0.25 inch diameter, as per ECN to be incorporated on RCA Drawing No. 1756545, Appendix C. This change was originally incorporated on all former flight structures, and the PTM structure.
			Batteries, S/N 080 and 081		
3982 4/19/64		Batteries would not fit	Ambient	Design	The batteries would not fit properly during installation in the Subsystem. It was found that the bottom edges of the batteries were not chamfered. Revision D of Drawing No. 1703273 was issued on April 29, 1964 to require chamfering of the edges. The batteries were replaced with ones with chamfered edges.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Battery, S/N 089		
4655 2/17/65	-	Shorted	Ambient (special test)	Not Applicable	A special test was performed to simulate the failure-mode conditions of two flight batteries, Serial Nos. 110 and 111, (see MR 4651 and 4652). The special test was performed on two batteries, Serial Nos. 84 and 89, which had previously passed flight acceptance testing. The initial electrical checks on these batteries were: Battery / Average Cell Voltage / Resistance (+ Terminal to Case) Serial No. 84 / 1.86 volts / 100 K megohoms Serial No. 89 / 1.86 volts / 150 K megohms Thermocouples were attached to the batteries to monitor temperatures during test. Battery, Serial No. 84, was placed in a shipping container, while Battery, Serial No. 89, was left exposed. The test temperature profile was defined utilizing temperature data obtained from the U.S. Weather Bureau for the Trenton, New Jersey, area for the weekend of January 29, 1965 (time of shipment of Batteries, Serial Nos. 110 and 111). The batteries were then placed in a temperature chamber, and the temperature profile was duplicated for 54 hours. The positive terminal-to-case resistance was monitored continuously, and the battery temperature was monitored and controlled. The resistance readings remained within specification during and after the test, indicating that no leakage of electrolyte had occurred from either battery. The batteries were then vibrated in the thrust plane with no abnormal conditions detected in pre- or post-vibration electrical tests. Both previous failures (Serial Nos. 110 and 111) were detected in the thrust-plane post-vibration electrical test. Thirty-six hours later, before vibration in the lateral plane, Battery, Serial No. 89, was found to have a resistance of 300 ohms from positive terminal to case, indicating a leakage of electrolyte to case. Battery, Serial No. 84, successfully completed the lateral-plane vibration tests, with no detected abnormalities. The batteries were returned to the vendor for analysis. Battery, Serial No. 89, had its metal case removed. The cells were cleaned and no cracks were found. A voltage reversal had occurred between cells 13 and 14. Cell 13 was cut, cleaned, and carefully examined, but no signs of cracks or leakage of electrolyte was found in Battery, Serial No. 84. It was concluded that an exposed battery that is subject to a similar temperature profile, followed by vibration in the thrust plane, can be made to experience the same type failure mode experienced by flight Batteries, Serial Nos. 110 and 111. The results of the analysis by the vendor were inconclusive in defining the exact internal failure mode. It should be understood that this malfunction report does not represent an actual failure. Battery, Serial No. 89, was intentionally destroyed in a special test.
			Battery, S/N 106		
4654 2/11/65	Thermistor T2	High impedance	Ambient	Nonassignable	During flight acceptance testing, temperature sensor T2 indicated a high voltage. This condition had existed during the entire test cycle. Resistance checks were made on the thermistor with different measuring devices. The differences in the resistive values (170 k, 430 k, and 530 k ohms) obtained are a function of the heat generated as a result of larger currents in the unit during the test. The thermistor was then X-rayed and two hair-line cracks were detected. The unit was carefully polished to remove the surface material and expose the cracks. This type of thermistor is extremely fragile. The unit is attached to a terminal board and the entire assembly is potted with Stycast 2651 for protection. The part had been checked and was acceptable after the potting operation. The exact cause of the cracks in this thermistor could not be determined. Replacement of the thermistor T2 on Battery, Serial No. 106, restored normal operation.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Batteries, S/N 106, 108, and 109
2311 2/23/65		Batteries did not fit in subsystem	Ambient (ETR)	Workmanship	The batteries did not fit into the +X side of the Subsystem (or in the +X or -X side of the Spare). This was due to the misalignment of the dowel pins in the Subsystem with respect to the holes in the batteries. The battery cases were not square, and the vendor compensated for this during the drilling operation. This compensation caused the interference problem and should not have been allowed.
					Battery, S/N 107
2313 3/7/65		Low telemetry indication	Ambient (ETR)	Workmanship	Telemetry point 90-45, P Battery external temperature, indicated 2.15 instead of 2.6 volts during a special Subsystem test. A review of the test data revealed that the resistance of this thermistor has been high, thereby giving a faulty telemetry reading. This battery has an excellent performance record. The 90-45 point is read only during terminal mode and is redundant. A new calibration curve, which reflected the resistance of the thermistor, was prepared.
					Batteries, S/N 110 and 111
4651 4652 2/4/65		Shorted	Ambient	Accident	During the postvibration electrical check of acceptance testing of Batteries, Serial Nos. 110 and 111, 500 and 300 ohm shorts, respectively, were recorded between the positive terminal and ground. These batteries had been in a shipping environment which varied between -1 and -12° C for 48 hours. During this extended period of time, the internal temperatures of the batteries had sufficient time to stabilize at the low-temperature extremes. There is a 3.4:1 ratio of expansion and contraction between the magnesium casing and the internal plastic materials. Excessive strain was, therefore, placed on the casing, which resulted in cracks and a leakage of electrolyte. The malfunction has been attributed to poor control during the shipping cycle. The remaining Ranger batteries will be shipped on a hand-carry basis, if necessary, to assure that abnormal temperature extremes are not experienced for extended periods of time.
					Battery, S/N 114
2270 1/18/65		Dowel guide holes out of specification	Ambient (JPL)	Workmanship	Battery, Serial No. 114, could not be mounted on the +X side of the TV Subsystem structure because of a misalignment of the dowel pins with respect to the guide holes in the battery. The location of the dowel guide holes is out of tolerance. The battery could be mounted on the -X side since the tolerance on the pins on the TV Subsystem structure is opposite to that on the battery. Battery, Serial No. 114, will be used only as a test backup unit and then, only on the -X side. Batteries, Serial Nos. 106, 108 and 109, were checked and would only fit in the -X side of Ranger IX (Reference MR 2311).
					Battery, S/N 115
2271 1/27/65	Thermistor T85	High impedance	Ambient (JPL)	Nonassignable	The P-Channel Battery, Serial No. 115, that was mounted in the TV Subsystem for the RF Link Test and Antenna Deploy Test was found to have a thermistor that indicated an excessively high impedance. Since this battery is not a flight unit, the thermistor will not be changed. A check of all batteries after Serial No. 100 indicated that all the thermistor values were within tolerance, except for thermistor T2 of Battery, Serial No. 106, (MR 4654), whose thermistor has been replaced.
					Distribution Control Unit (DCU), S/N 002
3357 6/30/63	Fuse F4	Open	Room (integration)	Secondary	This fuse was destroyed when the full scan High-Current Regulator failure placed the unregulated battery voltage on the regulated line. (Refer to MR 3355).
3933 3/24/64		No output	Ambient	Accident	Investigation of no output from the Distribution Control Unit during a test revealed that the power lead in the test equipment was missing. The wire was inserted and the test was successfully completed.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Distribution Control Unit (DCU), S/N 002 (Continued)		
5931 4/15/64		Wiring error	Ambient	Workmanship	The loss of the telemetry from the Clock was the result of an interface wiring error in the DCU. Two changes resulting from Revision H to the wiring list Drawing No. 1703981 had not been incorporated. The unit was reworked and normal operation was obtained.
			Distribution Control Unit, S/N 005		
4778 3980 4/17/64		Low diode reverse resistance reading	Ambient	Accident	Investigation into the low reverse resistance measurement on diode CR3 revealed that a test equipment selector switch was in the wrong position. With the switch in the proper position, a correct measurement was obtained.
3788 9/3/64		Error in wiring	Ambient	Workmanship	Distribution Control Unit, Serial No. 005, was modified to the Flight Model III-3 configuration. During an electrical continuity check prior to vibration, an open circuit was detected. Investigation revealed that a jumper wire between pins 29 and 43 of connector J5 was missing. The jumper was installed and testing resumed with normal performance.
			Distribution Control Unit, S/N 006		
4026 1/4/64		Short in terminal E5	Room	Workmanship	The investigation of why the DCU was drawing 5 amps (instead of 2 amps) when the F Channel was on, disclosed a short from A34J5-33 to chassis ground. This short was caused by a lead on resistor R1 being too long and touching the chassis. The resistor was not affected and only the terminal needed to be replaced. Because of the possibility of this type of short "floating" and going undetected if the chassis is not connected to ground during testing, it was again emphasized that all chassis should be grounded during test.
			Distribution Control Unit, S/N 007		
1759 3/7/63		Short	Room (integration)	Design	Leads within the unit were shorted to ground by one of the mounting screws. The harness was repaired and protected with a chaffing corner. In addition terminal E7 was moved out of line of a mounting screw.
2173 8/26/64	Capacitor C27	No video output from F-channel	Ambient	Design	During test of the PTM, no video output was received from the F-Channel. At first, it was thought that the problem existed in the sequencer. This unit was returned to AED and tested. Operation was normal, except that the telemetry voltage for the F-Channel timer was 0.6 volt rather than the expected -2.14 volts. This problem was traced to connector J2 on the sequencer where two leads had been reversed, placing an incorrect polarity on capacitor C27. Investigation showed that these leads had been deliberately reversed during rework to compensate for a wiring error in PTM harness 30W1, and expedite delivery of the PTM. In modifying the PTM to the Ranger VIII configuration, a new harness was installed. Since the reversed leads in the sequencer had not been corrected, the result was a reversed polarity on capacitor C27 and an incorrect telemetry reading; actual sequencer operation was normal in every other respect. In the meantime, further troubleshooting of the PTM spacecraft revealed that the lack of F-Channel video was due to the fact that a ground circuit was missing in Distribution Control Unit, Serial No. 007, because of the design changes incorporated for the Flight Model III-3 configuration. The PTM was then modified to the Flight Model III-3 configuration by providing the required ground circuit, and the Subsystem then performed normally.
			Distribution Control Unit, S/N 009		
5831 4/16/64	Wire	Extra	Ambient	Workmanship	An extraneous wire was left in the Distribution Control Unit (DCU) following rework of the unit to Revision H of Drawing 1703981. The wire was discovered during a manufacturing test and was removed.
			Command Switch, S/N 003		
3335 5/19/63	Capacitor C1, Fuse F1	Overload Fuse F1	Room ambient	Workmanship	Electrolytic capacitor was found to be wired in backwards. Quality Control had not checked out PTM component modifications.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Command Switch, S/N 004		
2856 3/22/63	Zener Diode CR4 (type 1N2970B)	Short	Room (integration)	Accident	Channel B would not turn on. Diode CR4 in the command switch had been accidentally shorted to ground during test.
3331 5/9/63	Diode CR4 (type 1N2970B)	Shorted	Room ambient	Nonassignable	An internal inspection revealed a burned element due to an applied over-stress condition. Cause of failure could not be determined.
2988 6/3/63	Diode CR3 (type 1N2970B)	Shorted	Room (integration)	Accident	While investigating "turn-on" and "turn-off" transients across diode CR3, the diode was short-circuited to ground. This occurred while an oscilloscope was connected across A13-J1 through the use of a breakout box. Investigation revealed that the scope was grounded to the payload through a digital voltmeter. The diode was replaced and operation was normal.
			Command Switch, S/N 005		
3360 7/13/63	Diode CR4 (type 1N2970)	Short	Room (integration)	Workmanship	P-Channel would not command ON due to a shorted zener diode. This malfunction was caused by the incorrect connection of the Subsystem to the OSE Video Amplifier. A special test cable had not been properly modified for split-system operation and placed the Silicon Control Rectifier gate to OC ground. The battery voltage was thus placed across the zener diode causing it to short.
			Command Switch, S/N 006		
4023 12/7/63	Transistor Q1 (type 2N1720)	Open	Vacuum-chamber (door open) Ambient (integration)	Accident	Investigation into the inability to initiate cruise mode with the RTC-7 command revealed a damaged Command Switch. The connector inside the thermal-vacuum chamber was reversed and, as a result, the wrong polarity had been placed on the Command Switch.
	Transistor Q2 (type 2N1720)	Open			
	Transistor Q4 (type 2N1490)	Shorted			
	Diode CR3 (type 1N2970B)	Stressed			
	Diode CR4 (type 2970B)	Stressed			
	Diode CR5 (type 1N538)	Stressed			
	Diode CR6 (type 1N458)	Stressed			
	Resistor R7	Charred			
	Resistor R12	Charred			
	Resistor R13	Low Value			
	Resistor R17	Burned-up			
	Resistor R19	Charred			
	Resistor R21	Charred			
	Capacitor C1	Stressed			
	Capacitor C2	Stressed			
	Capacitor C3	Stressed			
	Capacitor C4	Stressed			
			Command Switch, S/N 008		
2932 5/31/63	Diode (1N485B) CR7	Opened	Thermal-vacuum (+55° C)	Accident	This Command Switch had successfully passed thermal-vacuum tests at 0, 25, and 55° C, and then was left to soak for several hours. When commanded to "warm-up" during subsequent testing, the K1 relay failed to close because diode CR7 was open. J1-47 was accidentally touched to J1-46 and excessive reverse voltage was applied to CR7.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Command Switch, S/N 008 (Continued)
3343 6/4/63	Diode 1N2970B CR3	Partial short	Room	Nonassignable	The voltage at the SCR gate should have been 32.2 ±1 volt and was actually approximately 35.5 volts. This occurred after the diode CR7 (see MR 2932) had been replaced and potted in the Command Switch and while the Command Switch was being rechecked. Diode CR3 was tested and found to be partially shorted. A new diode was installed and the operation was normal. The defective CR3 diode was lost in the mail, thus making an analysis impossible.
3552 8/27/63	Capacitor C1	Shorted to switch	Room (manufacturing)	Workmanship	Minus 22 volts was found at pin J1-40 during system testing instead of the expected zero volts. Investigation disclosed that the epoxy coating on capacitor C1 had been penetrated, allowing electrical connection with contact 10 on switch S1B. The penetration had occurred after the unit had successfully passed the necessary vibration, thermal-vacuum, and electrical tests.
					Command Switch, S/N 009
2949 9/28/63	Transistor Q1 (type 2N1720)	Open base	Room (manufacturing)	Workmanship	During testing following the reworking of the LTM Command Switch Assembly to the "split system" design, the base of transistor Q1 opened because of an improperly wired circuit.
4028 1/4/64	Transistor Q4 (type 2N1490)	Shorted	Room	Workmanship	During initial electrical check of the Subsystem, an attempt was made to turn-on the Subsystem by the RTC-7 command. The Subsystem did not respond to this command and it was noted that the line current was excessive. Investigation disclosed a shorted Q4 transistor believed caused by a wiring error which resulted in the base of the transistor being shorted to ground. This would have resulted in the battery voltage being placed across the base-to-emitter junction.
					Command Switch, S/N 011
4072 10/3/63	Zener Diodes CR3 and CR4 (type 1N2970B)	Shorted	Room (manufacturing)	Workmanship	An investigation into the failure of the Command Switch Assembly to function properly disclosed two shorted diodes. The diodes had been shorted by a screw that cut into the harness, resulting in a short to the frame. The screw has been shortened to prevent the recurrence of this malfunction.
4088 10/30/63	Diode CR3 (type 1N2970B)	Shorted	Room (post-vibration)	Workmanship (vendor)	The diode was found to be shorted following the vibration tests. Throughout the tests, the voltage output was monitored at the SCR gate. At the end of the test, the voltage was normal. Upon examination of the defective diode, it was noted that a black material was covering the anode lead.
					Command Control Unit, S/N 001
5822 3/24/64	Capacitor C1	Voltage Polarity, Reversed	Ambient	Design	Investigation into the inability to turn-off Cruise Mode revealed that capacitor C1 was installed incorrectly. The schematic drawing showed the capacitor installed with the wrong polarity resulting in the application of reverse voltage and destruction of the capacitor. ECN's have effected manufacturing changes and Revision H to Drawing No. 1755337.
					Command Control Unit, S/N 002
3927 4/2/64	–	Resistance measurements not within specified limits	Ambient	Accident	The operator used a Senior Volt Ohmyst VTVM instead of the specified Simpson Model 270 VTVM to make the resistance measurements. Use of the specified meter provided satisfactory results.
					Command Control Unit, S/N 004
3835 4/28/64	–	Change in charging current	Ambient	Accident	Investigation of the inability of the Command Control Unit to operate properly revealed that the test method was in error. The test method has been corrected.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Command Control Unit, S/N 005		
1348 9/11/64	Capacitor C2	F-Channel would not turn off	Ambient	Accident	During testing of Ranger VIII, F-Channel could not be turned off by the CCU. The problem was traced to a shorted capacitor, C2. A review of part application with a measurement of turn-on and turn-off voltages indicated that at worst-case conditions, the capacitor can was +5 volts with respect to one of the terminals. The capacitor was opened and signs of silver deplating from the inner surface of the case were found. This was similar to a previous failure. Examination of other capacitors suggests that the silver plating occurred before the capacitor was installed in the circuit. Capacitors C1 and C2 of the Command Control Unit are the only applications of this type capacitor in the TV Subsystem. The reverse leakage current of these capacitors has been checked in all Command Control Units and was found to be within the specified value in each case. As follow-up action, capacitors C1 and C2 of CCU, Serial No. 005, were measured for leakage current with the capacitors in the circuit and with current first in one direction through the circuit and then with a reverse-polarity current. Leakage current obtained with this test setup and on the capacitors alone indicated that the capacitors were good. In another test at the vendor, both capacitors were found to be good units.
3592 4/27/64	Capacitor C1	Open	Ambient	Workmanship	Investigation into the inability to turn off the P-Channel led to the replacement of capacitor C1. Although an initial electrical check of the component proved satisfactory, a closer examination revealed that excessive heat had been placed on the capacitor terminal which resulted in melting the seal and opening the seal contact. The replacement of the component restored normal operation of the assembly.
			Command Control Unit, S/N 006		
1345 9/9/64	Relays K1 and K2 (Type SL-110B)	Welded contacts	Ambient	Secondary	Following a series of special measurements of cruise currents, the TV Subsystem could not be turned off using the Cruise On Test and Cruise Off switches. Investigation showed that the plus side of the -23 volt power supply in the OSE was shorted to the AC input to the charger timer. This short in the OSE caused serious damage in the CCU. When the Cruise On Test switch was actuated the contacts of K1 and K2 welded together. The AC was also applied to the 22uf capacitor A4C1, causing it to leak and preventing Subsystem turn-off due to rectified AC being applied to the set side of K3. CCU, Serial No. 006, was repaired by replacing Relays K1, K2, and K3, Capacitor A4C1 and diode A5CR1. The ground power supply on the other OSE units were checked and the charge timer jumper had been removed.
			Command Control Unit, S/N 007		
3778 8/11/64	SCR's CR1 and CR2	Tripped external circuit breaker	Ambient	Accident	When the RTC-5 indicator was depressed during the command-line continuity test of the initial power application and checkout of Flight Model III-3, the external circuit breakers tripped. An investigation traced the trouble to SCR's CR1 and CR2 in Command Control Unit, Serial No. 007, which are used in the TV Subsystem turn-off circuitry. The mica washers on which the SCR's are mounted were not present in this unit. The result was a direct short to ground. During subassembly testing, the CCU is not firmly attached to ground for checkout. However, when mounted on the TV Subsystem structure, the unit is firmly clamped to ground. All other Command Control Units were checked and all SCR's were found to have the mica washers.
			Electronic Clock Assembly, S/N 002		
3861 8/6/63	Oscillator Counter S737	Erratic operation	Thermal-vacuum +65°C	Vendor Workmanship	During the +65°C thermal-vacuum test, the 10-second output triggered spuriously. Since this was a purchased item, it was returned to the vendor to be analyzed and repaired. The vendor found that a capacitor lead was loose.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Electronic Clock Assembly, S/N 002 (Continued)
3863 8/8/63	Oscillator Counter (Serial No. 744)	Out of specification	Room (engineering)	Workmanship (vendor)	Following vibration the 10-second interval was not within specification limits. A test was made at plus 40° C and the 10-second interval was again not within specification limits. These failures occured on the Clocks, two on the QTM, and one on a flight unit. All failures were noted during the postvibration check. The units did not meet the time specification, and were returned to the vendor for failure analysis and repair. These units are completely encapsulated. It is believed that the core of the magnetic oscillator was changing its position with respect to the windings. AN RC oscillator (solid-state) was used to replace the magnetic oscillator.
3511 8/19/63	Oscillator Counter (Serial No. S758)	Out of specification	Postvibration (+65° C)	Workmanship (vendor)	During postvibration, a check at plus 65° C revealed that the 900-second interval was not within specification limits because of drift in the 100-cps oscillator following a qualification-level vibration test. These failures occurred on the Clocks, two on the QTM, and one on a flight unit. All failures were noted during the postvibration check. The units did not meet the time specification, and were returned to the vendor for failure analysis and repair. These units are completely encapsulated. It is believed that the core of the magnetic oscillator was changing its position with respect to the windings. An RC oscillator (solid-state) was used to replace the magnetic oscillator.
					Electronic Clock Assembly, S/N 003
3862 8/8/63	Oscillator Counter (Serial No. S745)	Out of specification	Postvibration (engineering)	Workmanship (vendor)	During postvibration, checks of the 900-second and 10-second intervals revealed them not to be within specification limits because of drifting in the oscillator counter. These failures occurred on the Clocks, two on the QTM, and one on a flight unit. All failures were noted during the postvibration check. The units did not meet the time specification, and were returned to the vendor for failure analysis and repair. These units are completely encapsulated. It is believed that the core of the magnetic oscillator was changing its position with respect to the windings. An RC oscillator is being used to replace the magnetic oscillator.
					Electronic Clock Assembly, S/N 005
3877 3/24/64		Timing not within specified limits	Ambient	Accident	Investigation of why the timing of the Electronic Clock was not as specified revealed that although the counter used to count the pulses had been last calibrated within an acceptable period, it was now out of calibration. A properly calibrated counter was utilized and the timing of the Electronic Clock was found to be within specified limits.
4700 4/15/64		No telemetry	Ambient	Nonconfirmed	Investigation of the inability to receive a telemetry output from the Electronic Clock after sending a Clock Start command resulted in the removal of the Clock. The operation of the Clock, however, was found to be satisfactory and further investigation revealed that the malfunction was caused by a wiring error in the DCU. Refer to MR 5931.
					Electronic Clock Assembly, S/N 007
2075 11/29/64		Failed to operate	Thermal-vacuum	Accident	The TV Subsystem was not turned on by the 63-1/2-hour clock pulse during the simulated-mission thermal-vacuum testing of Flight Model III-4. Investigation revealed that the cruise-mode switch had not been activated by test personnel as required by the test procedure to enable the SCR gates. The SCR gates were enabled by depressing the "Cruise-Mode On" indicator on the test console. This permitted activation of the F-Channel at the 63-3/4-hour clock pulse. The 63-1/2-hour clock pulse would be verified during thermal-vacuum testing at JPL.
					Electronic Clock Assembly, S/N 008
4681 1/6/64		Loose connector	Room	Workmanship	During the initial electrical checkout of the Subsystem, the connector on the clock timer could not be fastened. The nut which secures the connectors together was not mounted tightly to the connector housing. This prevented the screw on the opposite plug from tightening when the units were joined. The locking nut was properly torqued into a locking position.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Electronic Clock Assembly, S/N 008 (Continued)					
2258 12/4/64		Clock turn-on late	Thermal-vacuum (JPL)	Workmanship	Turn-on of F-Channel by a Clock output occurred 5 minutes 53 seconds late during high-temperature thermal-vacuum testing of Flight Model III-3 at JPL. This was not within the specified limits of ±5 minutes for turn on. The Clock, Serial No. 008, was returned to RCA where a series of tests on the regulated voltages and the 900-second count isolated the problem to the Incremag unit. With regulated input voltages of 31 and 41 volts, the 900-second count was recorded at 948.99 and 939.526 seconds, respectively. The Incremag was returned to the vendor, where capacitor C3, a type PN1100 mylar unit, between the oscillator and pulse-forming network, was found to be bad. The capacitor was damaged so that the failure mechanism could not be firmly established. Measurement of the leakage current indicated that the value was less than 1 microampere which is within specification. It had first been thought that the leakage current had increased. Measurement of dissipation factor and capacitance revealed that these parameters varied as a function of the mechanical pressure applied to the component. Microscopic inspection of the damaged area on the capacitor showed evidence of potting material which appeared to adhere to the metal portion of the component. A gouge was found in the capacitor. The vendor indicated that no special tools are utilized during assembly of the SCR dumping circuit and all assembly is by hand. The gouge has been attributed to improper handling of a soldering iron. The vendor concluded that the capacitor was damaged before or during assembly of the Incremag unit and that subsequent environmental testing had caused the unit to receive varying degrees of mechanical stress, which, in turn, caused the capacitance or dissipation factor to vary. The degree of parameter variation is thought to be directly related to the number of environmental stresses encountered by the unit. The failed capacitor C3 was replaced and the Incremag unit performed normally. Clock, Serial No. 008, has been assigned to the spare category. Clock, Serial No. 007, has been installed on the Ranger VIII Spacecraft Spare Clocks, Serial Nos. 003 and 006, were subjected to 2 real-time missions in a thermal-vacuum environment and successfully completed the test.
Electronic Clock Assembly, PTM					
2165 3816 5/8/64		F-Channel did not turn on	Thermal-vacuum (JPL)	Nonconfirmed	During MVT No. 2, F-Channel did not turn on in warm-up when the Clock was to turn on. Investigation revealed that JPL had not provided an enabling of the Subsystem because the "Hydraulic Timer Switch" and "Solar Panel Deployed Switch" were open. The "Solar Panel Deployed Switch" was closed and 30 minutes later, when a second clock turn-on command was sent, F-Channel turned on. Changes were suggested to JPL procedures to ensure that this problem did not recur.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Cable and Harness Assembly Failures						
3972 7/27/63	Cable 30W12, S/N 001(Block III-1)		Broken wire	Room (integration)	Workmanship	Excessive handling of this Cable caused a wire to break, making Camera F_A inoperable. The Cable was resoldered and potted.
3436, 3435, 3437 9/17/63	Cable S/N 001 Cable S/N 004 Cable S/N 004	30W29 30W31 30W34	Damaged by battery shorting	Room (JPL)	Secondary	Failures were the result of MR 3438 and MR 3434. These cables were damaged when the battery monitoring cable shorted.
1687 8/8/63	Harness Assembly 30W27, S/N 004 (Block III-1)	R-F Connector (A24P3)	Binding Mechanically	Room (integration)	Wearout	This type of mechanical failure would have no effect on normal spacecraft operation because this removal would not be necessary except during certain electrical tests. These connectors are not designed to be repeatedly connected and then disconnected. Thus, after several such operations, they tend to bind and become difficult to install or remove.
3975 8/10/63	Thermistor Cables, 30J6, 3014 (Block III-1)	Leads	Short	Room (integration) (pre-thermal-vacuum)	Workmanship	Channel F would not turn on by use of either Simulation or CC&S warm-up commands. By the use of the RTC-7 command, the turn on was finally achieved. However, neither the cruise mode nor the 225-kc telemetry circuits were operating. Upon removal of the spacecraft shrouds, two cables were found to be pinched causing the two low-current voltage regulators to be shorted to ground. This shorting had disabled the telemetry power supply resulting in channel 8 and both 225-kc VCO's being inoperative. The cables were replaced and rerouted so that they no longer interfered with the shrouds.
4263 11/26/63	Cable 30W31, Serial No. 005 (Flight Model III-1)		Orientation of connector and cable	Ambient (JPL)	Design	Attempts to connect the battery monitor cable, 30W21, Serial No. 005, were unsuccessful because the connector was attached to the reversed direction. An ECN has been written to show the orientation of the connector with respect to the cable.
4029 4030 1/6/64	Video Cable A8-P3, Serial No. A2-A3, Video Cable A8-P4, Serial No. A2 (Flight Model III-4)		Epoxy in seating ring plug off-center	Room	Workmanship	During initial electrical test on the Subsystem, these cables were replaced because of poor workmanship.
2193 4/15/64	Harness Assemblies, 30W30 and 30W31 PTM		Harness interference	Ambient (JPL)	Workmanship	When an attempt was made to make the Subsystem to the JPL Bus, it was found that harnesses 30W30 and 30W31 and the midcourse propulsion system fuel tank interfered with one another. The harness location was changed by JPL to eliminate the interference.
3779 8/13/64	Harness 30W29, Serial No. 001, Flight Model III-3		Cable arcing	Ambient	Accident	During the initial power application and check-out test of Flight Model III-3, application of power to the High-Current Voltage Regulators was required by step A-3-1-d of RTSP-1100A, Appendix A. Since the battery cables are not brought through the power control relay at this time, an adapter cable could not be used. Jumper plugs were obtained and when installed sparks occurred that caused the wire between pins B and A of the jumper to burn. Also, pin G of jack 30J14 was scorched.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
		Cable and Harness Assembly Failures (Continued)				
3779 8/13/64 (Continued)						Investigation revealed that the jumper plug employed was of an older variety that had been used on an earlier TV Subsystem which differed from Flight Model III-3. This plug had pins F and G jumpered together and when the plug was inserted into jack 30J14, a direct short was placed across the F-Battery. The 30W29 cable, Serial No. 001, was removed along with the two Current Transformer Units and the Current Sensing Unit. These were replaced with other units.
2274 2/8/65	Cable Harness Connector (Flight Model III-4)		Telemetry reading out of specification	Ambient (JPL)	Random	During a special test of the TV Subsystem, the output of the P-Channel unregulated bus telemetry point (data point 90-46) dropped from the normal 3.8 volts to approximately zero volt. Investigation disclosed that the failure was caused by a considerable increase in the pin resistance in the cable harness connector to the DCU. Since the current carried by the pin in question is only a few microamperes, the connection can be classified as a dry circuit. Operating under this condition for an extended period of time, it is not unusual for the resistance of the connection to increase considerably. When the connector was wiped by mating and demating, the condition was cleared. Since this circuit is a telemetry reading and is semi-redundant (unregulated bus voltage can be detected by at least two other telemetry points), no further action other than cleaning is recommended at this time. The connectors were inspected, cleaned, and remated. A pin retention test was performed and all pins were satisfactory.
1584 3/2/65	Cable Harness 30W318, Serial No. 001 (Spare No. 1)		P_2 Camera malfunction	Ambient (ETR)	Accident	The plotting boot, at right-angle connector A1A2P3 of the cable, separated, and a wire or solder joint opened causing a P_2 Camera malfunction. The connector is subjected to bending stresses after installation on the camera. The connector was laced into place to support the cable. Final system testing has been completed and there were no plans for the operation of the spare. The cable would be replaced prior to further operation of the spare spacecraft.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Transmitter Power Supply Assembly, S/N005					
2894 4/11/63	Relay K2, -750 volt	No -750 volts	Thermal-vacuum	Nonconfirmed	Relay would not operate in thermal-vacuum. Passed bench test. The High-Voltage Relay was tested and found to be good.
3295 6/4/63	2N2124 Q1J Q2 IN645 CR11 Capacitor C6, C7	Overstress	Room	Accident	The input voltage was accidentally applied with the wrong polarity by test personnel. This occurred while the power supply was being used for a special test designed to determine the need for silicon grease. Inspection and test of the power supply showed that Q1 and Q2 were shorted, CR11 had opened, and C6 and C7 may have been overstressed.
Transmitter Power Supply Assembly, S/N007					
2076 2077 6/10/64	Diode CR11 (type 1N645)	Short	Thermal-vacuum	Random	The Transmitter Power Supply was returned to AED for testing and was operated at high temperatures without failure. When exposed to thermal-vacuum testing, the diode shorted, causing the circuit breaker to open (MR 2076). This diode had no previous record of relevant failures. Several failures of the diode had occurred when 28 volts were applied in the forward direction because of wiring errors or reversing of power leads. The replacement diode shorted (MR 2077) because of reverse wiring.
2104 3881 6/12/64	Diode Bridges CR1 and CR2 (type PS2813 and PS2812)	Loss of +1000 volts and -750 volts	Thermal-vacuum	Accident	During an investigation of power fluctuations, this Transmitter Power Supply was operated at a temperature of 55° C and with an input voltage of 33 volts. The input voltage was increased to 35 volts, and after 14 minutes of operation, the -750 volt and +1000 volt diode bridges failed. Investigation showed that one leg of each bridge failed catastrophically; -750 volt bridge (zero ohm short) and +1000 volt bridge (1200 ohm short). The failures were attributed to a special test under abnormal, overstressed conditions, specifically intended to isolate a previous failure.
Transmitter Power Supply Assembly, S/N009					
2879 2/6/63	Resistor R11 200 Ω, 10 w	Open	Ambient (bench)	Secondary	This failure mode was due to a short in the IPA. IPA (S/N 023) (MR 2841) had an intermittent power tube short which overstressed R11.
Transmitter Power Supply Assembly, S/N010					
4032 8/28/63	Diode Bridge CR3 (type PS2813)	High leakage	Room (JPL & engineering)	Nonconfirmed	This power supply was on the LTM. While the failure occurred on 8/20/63, it wasn't reported until engineering worked on the power supply on 9/6/63. No output from the -750 volt power supply was thought to be due to a defective relay, K2 (MR 4034). The diode bridge was checked and showed a low reverse impedance. When the bridge was checked by Reliability, the diodes were found to be good. As a result of this check, the engineering group also reviewed the component and found it to be good. The problem does not appear to be in the power supply. It may be in the test setup or the test equipment.
Transmitter Power Supply Assembly, S/N011					
4033 8/26/63	Transistors Q1 and Q2 (type 2N2124)		Room (engineering test)	Test Error (Accident)	During testing, personnel accidentally put a VTVM, with the ground connected, to +1000 VDC output and grounded it.
Transmitter Power Supply Assembly, S/N012					
2895 4/23/63	Diode 1N645 CR11	Diode open	Bench test	Accident	Test harness had wrong polarity for relay and put wrong polarity on diode; harness was changed.
3307 7/10/63	Resistor R11	Open, and element shorted to core	Room (manufacturing)	Secondary	When the IPA tube shorted, resistor R11 opened and the resistor element shorted to the metallic case.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Power Supply Assembly, S/N 013
3971 7/18/63	Resistor R11 Relays K1 and K3	Arcing	Thermal-vacuum (integration)	Secondary	Extensive arcing had occurred inside the Transmitter Power Supply during a one-hour full-power run under thermal-vacuum conditions. Resistor R11 was found open and the contacts of relay K2 were found welded closed.
4684 1/8/64	Teflon sleeve	Input shorted to ground	Room	Workmanship	Following the discovery of the malfunction in MR 4683 on transmitter power supply S/N 019, a continuity check was performed on this Power Supply. A short was found from the input test point to ground. This was caused by an edge of the cover cutting through the teflon sleeving on the collector lead of transistor Q1. The collector leads of transistors Q1 and Q2 had not been properly located during manufacturing. They were properly aligned.
4695 4751 2/8/64	Resistors R6 and R7	Over-stressed	Vacuum	Secondary	After approximately 49 minutes of full-power operation during thermal-vacuum testing at ambient temperature, the F-Channel output fell to zero. A visual inspection of the Power Supply revealed that resistors R6 and R7 in the +100-volt circuit had been severely overheated. Although bench testing of the Assembly showed them to still be operational, the resistors were replaced because they had been overstressed. This malfunction was found to have occurred because of the thermal runaway of transistor Q2 in the X12 multiplier as noted in MR 4500 on Transmitter S/N 301.
					Transmitter Power Supply Assembly, S/N 015
2124 9/12/64	Connector J1-A1	Coaxial insert pushed out	Ambient	Random	During the testing of the spares for Flight Model III-3, the plus 1000 volts was lost at the F-Channel Power Amplifier. The trouble was traced to coaxial insert pin A1 of Connector J1 which had been pushed out of the connector. This malfunction was found during the performance of RTSP 1100A, Appendix A, which was intended to determine the presence of such problems.
					Transmitter Power Supply Assembly, S/N 016
3300 6/15/63	Resistor R6 and R7 (40 ohms, 6.5 watts)	Burned due to excess current	Postvibration	Workmanship	An excessive current drain (one ampere for approximately 30 seconds) was caused by a missing wire on Transmitter Serial No. 017 (see MR 3298). This drain caused charring of the insulation on resistors R6 and R7. Examination of the resistors indicated that they had not failed. However, they were replaced.
					Transmitter Power Supply Assembly, S/N 017
3301 6/15/63	Captive nut	Bent	Postvibration	Workmanship	It was impossible to torque-down one of the mounting screws to mount the power supply for vibration testing. Visual examination showed that one of the captive nuts was bent. This problem had existed in the past.
4456 1/4/64	Diode CR8 (type 1N1831)	Cracked glass head	Room	Workmanship	JPL applied a conformal coating to all accessible solder joints when the Power Supply was delivered. It is believed that this coating applied an undue stress on the glass seal of diode CR8 resulting in it cracking. In order to make resistance checks, an attempt was made to remove the coating and the anode lead was pulled from the diode.
4457 1/5/64	Diode Bridge CR3 (type PS2813)	Short to case	Room (JPL)	Workmanship	Investigation into the loss of 750 and 500 volts from the P-Channel Transmitter Power Supply indicated that pin No. 1 of the diode bridge CR3 was shorted to the chassis. The diode bridge was removed and a small hole was noted in the potting compound at the bottom of the bridge. Later investigation disclosed that one of the diodes in the bridge was out of place and one of its leads extended through the bottom of the bridge.
2260 12/8/64	Relay K1	Broken weld	Thermal-vacuum (JPL)	Workmanship	During thermal-vacuum test No. 3 on Flight Model III-3 at JPL, the 90-point telemetry indicated the +1000-volt supply from the Transmitter Power Supply was applied to the P-Channel power amplifier at warm-up mode. The Transmitter Power Supply, Serial No. 017, was returned to RCA for investigation of the failure. A resistance check between pins A1 and J1-1 indicated that relay K1 was open, which is normal. An operational check showed that when the power supply was switched to warm-up, the +1000 volt supply appeared at the same instant. Visual inspection revealed no discrepancy. Leads 7 and 8 of transformer T1 were disconnected and an ohmmeter was placed across contacts 1 and 2 of relay K1.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Power Supply Assembly, S/N 017 (Continued)
2260 12/8/64 (Continued)					When the power supply was switched to warm-up, the contacts remained open. When full-power was applied, the contacts closed; and in reduced-power mode, the contacts opened. This is normal operation. Leads 7 and 8 of Transformer T1 were reconnected, and the failure recurred. The contacts of relay K1 were disconnected again and an ohmmeter placed across contacts 1 and 2. This time the failure occurred. Relay K1 was found to be intermittent. A resistance check proved acceptable. However, when the relay was energized, the contacts remained opened. Upon slight shaking of the coil, a rattling noise was heard, and when the coil was de-energized, the contacts closed and remained closed. The glass at the terminal weld was cut and the contact was viewed with a microscope. It was concluded that the weld between the terminal and the moving arm of the contact was improperly made and became loose in the glass capsule. This caused an intermittent failure. This is the second problem of this nature encountered with relay K1. It is attributed to a poor weld joint. The relay contacts were clean and not pitted, and exhibited no evidence of arcing. Evaluation of the inadvertent application of the 1000 volts to the power amplifier concluded that the tube was not damaged and is satisfactory for flight use. The relay K1 was replaced and the Transmitter Power Supply tested in accordance with RTRB No. 128A. The failure is felt to be an isolated instance; however, relays in stock and new procurements would be preconditioned for a minimum of 2000 cycles and a maximum of 3000 cycles of mechanical operation.
					Transmitter Power Supply Assembly, S/N 019
4683 1/8/64		Shorted input	Room	Workmanship	Investigation into the shorted input disclosed a nick or flaw in the hardcoat directly under the collector of the chopper transistor resulting in its being shorted to ground. It is believed that the nick was mechanically caused. An insulating mica washer was installed between the collector and the chassis. Also, a teflon sleeve was placed over the stud on the transistor.
3785 8/24/64	Diode (type 1N1126A) CR4, 5, 6 and 7	Excessive noise	Ambient	Workmanship (vendor)	During an electrical test of Flight Model III-3, noise spikes were noted on P-Channel video output. The problem was traced to the Transmitter Power Supply, where the diodes of the 100-volt diode bridge were ringing excessively. An investigation revealed that the diodes employed in this particular power supply were units manufactured by General Instrument, Inc. rather than diodes manufactured by North American Electronics, which were originally used. Comparison testing of the diodes from the two manufacturers indicated significant differences in characteristics. The diodes manufactured by General Instrument, Inc. resulted in noise that was 4 to 5 times higher than experienced with the North American Electronics units. A specification control drawing was issued and specified the use of 1N1126A diodes manufactured by North American Electronics in the 100-volt diode bridge of the Transmitter Power Supply.
3888	Transformer, Serial No. 701237	High-current surge	Thermal-vacuum	Workmanship	In the cold cycle of thermal-vacuum test on Transmitter Assembly, Serial No. 211, a high-current surge was observed during warm-up mode. Subsequent tests of the transmitter indicated abnormally high line current, varying erratically from 5 to 10 amperes. Normal current is between 4.5 and 5 amperes. Resistance measurements traced the source of the problem to the transformer of Transmitter Power Supply, Serial No. 019. Low-resistance paths were measured from terminals 7, 8, 11, and 12 to case (900 ohms) and between terminals 11 and 12 to 7 and 8 (1400 ohms). A leakage test was performed, which indicated a small leak existed at the potting seal seam in the vicinity of terminal 14; this was indicative of voids in the potting material in the area of that terminal. When the transformer was opened, a void and carbonized area was found at terminals 7 and 11. The leak was not in this area, but this defect could have accelerated the conditions that caused electrical breakdown. During system tests of the Ranger IX Spacecraft at JPL, the chopper pulses from the Transmitter Power Supplies were viewed on a scope for any presence of corona or arc-over. No evidence of corona or arc-over was found.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Transmitter Power Supply Assembly, S/N 020		
4461 12/6/63	Diode Bridge CR1 (type PS2813)	Shorted	Thermal-vacuum (0° C) (eng.)	Secondary	During qualification testing in the thermal-vacuum chamber, the RF power output disappeared. Investigation revealed that pins 2 and 3 of the 1000-void diode bridge were shorted. This failure was caused by the breakdown of the power transformer described in MR 4462.
4545 12/11/63	Diode Bridge CR1 (type PS2813)	Shorted	Thermal-vacuum (eng.)	Secondary	The diode bridge again failed because of the defective power transformer referred to in MR 4462.
4462 12/11/63	Transformer T1	Loss of RF power	Thermal-vacuum (0° C)	Workmanship	Investigation following the loss of power after 8 minutes of full power revealed that transformer T1 had failed. A break in the seal of the transformer was found and air bubbles were noted when the transformer was placed in an oil bath. An epoxy void in the transformer had become filled with air and failed when exposed to a thermal-vacuum environment.
3967 1/4/64	Transformer T1	Shorted turns in high-voltage winding	Vacuum (JPL)	Workmanship	The T1 transformer of the P-Channel Transmitter Power Supply was found to have shorted turns in windings 7 and 8. An analysis on the transformer revealed several discrepancies: (1) air voids in the potting material, (2) insulation around the high-voltage winding not thoroughly impregnated, and (3) definite signs of corona breakdown. All five transformers received in the same lot as this one were removed from equipment. RCA Quality Control personnel then monitored the construction of replacement transformers at the vendor.
4492 1/21/64	Diode CR11 (type 1N645)	Shorted	Room	Accident	Following repairs to the power supply because of the malfunction mentioned in MR 3967, the assembly was being prepared for thermal-vacuum testing. During an electrical checkout, the line current was observed to be excessive when an attempt was made to turn the power supply on. Investigation disclosed the polarity of the 27.5-volt supply had been reversed.
			Transmitter Assembly, S/N 003		
2902 3/11/63	Transistor RCA 2N1493 (Q1)	Intermittent	Room (integration)	Nonassignable	Output power was intermittent, subject to tapping on X12 Multiplier case. Q1 was replaced and X12 Multiplier functioned properly. DC beta checked lower than nominal but was not considered a likely cause of intermittency. Replacement of Q1 and R1, together with cable reconnections, may have cleared a poor solder joint or connection.
2889 3/12/63	Resistor 220 Ω, 1/4 W, (R1) Carbon Composition	Change in resistance	Room (integration)	Accident	Resistor was accidentally shorted to 70-volt line during trouble-shooting.
2890 3/12/63	Trimmer Capacitor, JFD SC-133 (C32)	Jammed piston	Room (integration)	Wearout	Tuning piston jammed. Failure was attributed to wear of adjusting screw due to an excessive number of trimming adjustments performed on the PTM. The MIL specification had a 75-cycle rotational limit. Adjustments were then limited to a maximum of 20.
2901 3/12/63	Transistor, S/N 109 (Q4)	Shorted	Room (bench)	Accident	Transistor was accidently overstressed when input drive was not reduced before tuning the output.
2852 3/13/63	Right-Angle Connector (AVL945-011) in RF Cable	Intermittent	Room (integration)	Wearout	Reduced output power was at first thought to be due to a transmitter malfunction. However, it was discovered that the RF cable from the 4-point hybrid to the antenna had a loose connection which increased the VSWR. The cable had been used for numerous tests at AED and JPL requiring many connections and removals. Metallic filings were found indicating thread wear.
2853 3/14/63	Cable (30W18)	Degradation	Room (integration)	Wearout	No power output. The transmitter and cable impedence could not be matched. The connector was not firmly fastened to the cable and the shielding was loose and frayed. Failure is believed to be due to excessive connections and removals, together with maintenance induced mechanical stress.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Transmitter Assembly, S/N 003 (Continued)		
4044 3/16/63	IPA Cavity Serial, S/N 008	No power output	Room	Design	The Serial No. 008 cavity was replaced with Serial No. 010 following no power output from the transmitter. The cavity, less tube, was returned to the vendor for analysis. A redesign of the Ranger transmitter for Flight Models III-3, and III-4 and spare units replaced the IPA cavity with a Resdel IPA. This redesign made the failed IPA cavity obsolete.
2855 3/22/63	IPA Tube	Low power output	Room (integration)	Accident	Power output was low. The IPA tube was replaced and the unit retuned. The vendor attributed the failure to external overstress of the screen grid. To reduce overloading of the tube, checkout at reduced power was then limited. Also tube handling during test and troubleshooting was carefully controlled to avoid grounding of the -750 volts DC and subsequent overstress of the screen. The second IPA was eliminated by the redesign. The IPA tube performance was to be closely monitored.
2845 4/11/63	Bourns Trim Pot (200R) 207L-51-201 R9	Arcing to metal case. -750 volts shorted to ground	Thermal-vacuum	Design	The resistor was mounted incorrectly. Flight equipment will use a Bourns 3020L which does not have a metal case.
2847 4/11/63	Choke, 0.22 ph.	Choke over-stressed and discolored	Thermal-vacuum	Secondary (see MRA 2845)	IPA tube screen drew excessive current. Choke was discolored. Choke was replaced and passed electrical test.
2846 4/11/63	Tube 7870	Tube over-stressed	Thermal-vacuum	Secondary (see MRA 2845)	R9 shorted -750 volts to ground. This placed ≈0 volt on anode and cathode while +250 volts with respect to cathode was present on screen grid. Screen drew excessive amount of current.
2843 4/11/63	Clark Transistor S/N 109 (Q4)	Shorted C to E	Thermal-vacuum	Workmanship	Transistor not properly fastened to its heat sink. No silicone grease was used around transistor.
3293 6/4/63	Diode 1N3028	Incorrect frequency	Room	Design	It was impossible to align the modulator properly ($F_{Emerg.} = F_N$); there was a difference of 1.5 volts. Examination showed that the diode (CR8) was operating at 18 volts (within specification, the nominal value is 22 volts). An Engineering Change Notice (ECN) was issued which replaced the CR8 (1N3028) with a type 1N3029 which has a nominal value of 24 volts.
3292 6/4/63	50 Dummy Load on J2	Erratic change of bias voltage	Room	Design	The bias voltage at the modulator, J1, was erratic and the DC deviation was twice its normal value. The Dummy Load was visually examined and the connector was found to be damaged. The Dummy Load was redesigned as follows: the coax-connector was capped; the value of R2 was changed to 366 ohms; and the input end was grounded.
4041 9/10/63	Capacitor Mounting Bracket	Broken	Vibration (engineering test)	Wearout	It was not possible to retune the X12 multiplier to regain the IPA power output to ground. This failure was caused by a broken bracket for capacitor C32. This was the first history of this type of a failure. No corrective action was deemed necessary at this time since this subassembly had been exposed to three qualification-level vibration tests.
4468 5885 3/20/64		Low voltage at J1	+40° C bench test	Accident	Investigation of low voltage at connector J1 of the X12 multiplier revealed that a terminal post was shorted. During rework, excessive heat had been placed on the terminal and had caused solder to flow down the center of the terminal. The terminal was replaced.
2182 5/8/64		F-Channel RF power fluctuations	Thermal-vacuum	Secondary	During mission verification test No. 2, F-Channel full power was lost at approximately C+55 minutes. The F-Channel external power supply breaker opened. No reason for the breaker tripping could be found. A 5-second power fluctuation was noted during which time the video was intermittently lost. The telemetered P-Channel regulated bus dropped below 21 volts and three seconds later the P-Channel current was 3 amperes high. The transients in the P-Channel were considered to be caused by intermittent shorting of the P-Channel High-Current Voltage Regulator. Analysis of this High-Current Voltage Regulator, S/N 003, indicated arcing had occurred in the mounting arrangement of transistor Q6 (see MR 2199).

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly, S/N 004
3228 5/22/63	Varactor PSI-122	Loss of RF power	Postvibration	Workmanship	The transmitter operated intermittently during postvibration electrical tests. The transmitter was opened and visual inspection of the X12 Multiplier revealed that the varactor (CR6) was broken. This break was apparently caused by improper wiring of the varactor to the board. The varactor was replaced.
3229 5/23/63	Connector J2	Loose connector	Room (bench)	Accident	Tapping on the X4 Multiplier caused the output power to fluctuate. This occurred after the repair of the X12 Multiplier (see MR 3228). The complete X4 Multiplier was replaced with a spare unit and the replaced unit was returned to RCA for analysis. The spare X4 Multiplier operated satisfactorily when the output jack from the X4 Multiplier to the IPA stage was tightened. Apparently the trouble was caused by a loose connector at the output stage of the X4. Investigation began of methods to limit the number of required removals.
4040 10/7/63	Varactor Diode CR2 (type MA4843D)	Change in characteristics	Room (JPL)	Random	During operation of the Subsystem at JPL, the RF output could not be measured, although all inputs were normal. Investigation disclosed that the varactor diode CR2 was defective. Because of their internal construction, these diodes tend to change characteristics after being subjected to numerous thermal cycles. The vendor produced a new type of varactor diode that would not be subject to this fault.
4464 3/18/64	Transistor Q4 (type S/N 109)	Power output below normal	Ambient	Nonconfirmed	The output of the X12 multiplier during testing following rework was considered to be below normal although within specified limits. Retuning did not increase the output and transistor Q4 was replaced with a type S/N 115. The replaced transistor was later found to be fully operational. The actual cause of the low output is described in MR 4465.
4466 4467 3/18/64	Capacitors C25 and C27	Broken	Ambient	Workmanship	During the replacement of resistor R21 (refer to MR 4465) these components were broken. The components were replaced. Personnel were instructed to use more care during the replacement of components.
4465 3/18/64	Resistor R21	Changed value	Ambient	Workmanship	The inability to correct the below-normal output by the replacement of transistor Q4 resulted in the discovery that the resistance from resistor R21 to ground was 30 rather than 10 ohms. During rework, six components including resistor R21 had been resoldered. Excessive heat had been placed on this resistor resulting in discoloration and a change of value. Replacement of the resistor resulted in higher output.
					Transmitter Assembly, S/N 005
2764 10/13/62	Crystal Y1	a) Cracked crystal - center frequency shift b) Loose wires	Qualification-vibration	Wearout (vibrational fatigue)	Vendor Analysis: Failures in the FM Modulator of the QTM Transmitter following the qualification vibration test were investigated. Observed failures were: (1) a possible cracked crystal; (2) a disconnection of the negative lead of C6; and (3) a loosening of the junction of R18 and R19. The exact cause of these failures could not be determined. This particular modulator had undergone approximately five (5) vibration tests. It is believed that these failures were pomoly directly connected to the excessive number of vibration tests. The crystal and capacitor were replaced and the junction was resoldered. The unit then operated satisfactorily.
2892 4/3/63	Varactor Diode CR1, CR2, MA 4348D	X4 would not start	Thermal-vacuum	Nonassignable	X4 would not start in thermal-vacuum nor on the bench. Varactor diodes were replaced, and X4 operated satisfactorily. The varactor diodes (CR1, CR2) were sent for analysis. One of the diodes was found to be "open" and the other was all right. The cause for the "open" could not be determined.
2844 4/11/63	20R Resistor 6.5 W (R7) Wirewound	Over-stressed and blistered	Thermal-vacuum	Secondary	Resistor was an incorrect type. All other units were checked for correct type.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly, S/N 005 (Continued)
2869 9/6/63	Vacuum tube (type 7870) S/N MIL-B-209	Open filaments	Room	Nonassignable	After less than two hours operation at full power the IPA output went from 9.4 watts to zero. The tube was returned to the vendor for analysis. He determined that the filaments were intermittently opened. In addition to a a static electrical check the tube was opened for a microscopic examination of the interior. Here he noted signs of overheating, arcing and melting of the tube element. A spectrographic analysis was performed on the material on the external heater contact. This material turned out to be a soft solder such as was used in the cavity filament contact. This tube was an original qualification test unit and was exposed to over-voltage in the old power supply configuration.
4043 9/15/63	Relay K1	Open coil	Vibration (engineering qualification-level test)	Random	During the electrical testing of the Modulator following vibration, it was noted that there was no difference in normal frequency and the emergency frequency at a bias of -0.875 volt. When the bias was raised to 1.875 volts (the upper limit) and switched to "emergency", the unit continued to operate at "normal" frequency. Upon investigation it was determined that relay K1 would not operate due to an open coil. No corrective action was deemed necessary since this unit has been subjected to four previous qualification-level vibration tests. The affected relay was replaced with a spare and the unit was tested again.
4045 9/25/63	Transistor Q2 (type 2N706)	Low power output	Ambient	Nonconfirmed	Replacement of transistor Q2 resulted in normal power output. The beta of the transistor was checked and found to be 40. (Specification limits were 20 to 60). However, the RF specifications of the transistor could be checked. Investigation did reveal some signs of degradation.
					Transmitter Assembly, S/N 008
2876	Capacitor C6 6.8 µf, 35 volts	Short	Ambient (bench)	Accident (maintenance induced manipulation)	The capacitor was shorted due to excessive soldering heat during modification of "random rate response" on the PTM No protective heat sink was used. PTM was under engineering redesign, and changes were not made by manufacturing. Changes on all flight models were made by trained wiremen under Q. C. surveillance.
2887 2/27/63	Tube RCA 7870	Intermittent short	Ambient (bench)	Awaiting Analysis	There was no output from IPA when in full-power mode. Shorting occurred in IPA. The tube was replaced and returned to the vendor for analysis. The RCA 7870 IPA tube failures were reviewed by the vendor. The vendor attributed the failures to external overstress of the screen grid. To reduce overloading of the tube, checkout at reduced power was limited. Also, tube handling during test and troubleshooting was to be carefully controlled to avoid grounding of the -750 volts DC and subsequent overstress of the screen. The second IPA was eliminated by the redesign. The IPA tube performance was to be closely monitored.
1678 5/2/63 1680 5/23/63		Power drop-off	Thermal-vacuum	Nonassignable	The transmitter displayed a power drop-off and loss of video which lasted for approximately 23 milliseconds. An examination of the carriers showed an amplitude drop in the P-Channel transmitter carrier. The LTM was returned to AED from JPL, and the communication system was to be examined under the thermal-vacuum environment. These malfunctions were all associated with momentary drop-outs of power that occurred during the testing of the LTM at JPL. This problem was still under investigation by AED and was thought to be associated with the Four-Port Hybrid Assembly. These malfunctions usually could not be associated with a loss of video data. The effect of these malfunctions on an actual mission could not be determined. For detail, refer to the Mission Verification Report for the LTM issued on November 15, 1963.
1677 5/9/63 2900 5/13/63	Tube RCA 7870	Low output	Thermal-vacuum	Nonconfirmed	Low power output from transmitter (008). IPA cathode current was increased in an attempt to increase output, but it was ineffective. Tubes were placed in a good system and output was still degraded. The IPA tube 7870 was removed from the LTV B-Channel Transmitter, and returned to the manufacturer for analysis. The tests indicated that the tube met specifications.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Transmitter Assembly, S/N 007		
2882 2/12/63	Connector A14 A2J7 (Selectro)	Intermittent	Ambient (integration)	Accident (maintenance induced manipulation)	The female connector on RF cable between the X4 and X12 multipliers was distorted. This caused drop-off in power. Mating of connectors was not made with proper alignment. Care was then taken during integration to properly mate connectors.
2886 2/24/63	Capacitor, Varactor JFD-SC 133 C24	Jammed adjusting mechanism	Ambient (bench)	Wearout	It was not possible to adjust capacitor. A similar malfunction was analyzed and attributed to wear of the screw adjustment. Trimming adjustments on flight units were limited to a maximum of 20 adjustments as compared to a limit of 75 cycles in the MIL Spec. Engineering was instructed against applying heavy torques which could force a mechanical stop.
1663 3/30/63	Transistor Q4 TA2084	Transistor shorted	Thermal-vacuum MVT #3 at JPL	Workmanship	Transistor shorted. Heat sink not properly mounted. TA2084 was to be replaced in all flight models with Clark S/N 115.
2911 5/31/63	---	Power drop-off	Thermal-vacuum	Nonassignable	After 49 minutes of operation, the combined power output of the two TV transmitters dropped 5 db for about 0.25 second. Subsequent investigation revealed that the temperature of the system had been dropped below the specified levels.
2612 6/8/63	---	Power drop-off	Thermal-vacuum	Nonassignable	A power drop-off of 3 db occurred approximately 36 seconds after full-power was turned on; the drop-off lasted for about 0.25 second. The transmitters were to be investigated when the LTM was returned to AED from JPL. Malfunctions reported in MR's 1680, 1678, 2911, and 2612 were all associated with momentary drop-outs of power that occurred during the testing of the LTM at JPL. This problem was still under investigation by AED and was thought to be associated with the Four-Port Hybrid Assembly. These malfunctions usually could not be associated with a loss of video data. The effect of these malfunctions on an actual mission could not be determined. For detail, refer to the Mission Verification Report for the LTM issued on November 15, 1963.
			Transmitter Assembly, S/N 010		
2798 1/14/63	Variable Capacitor C15 0.8 to 8.5 pf	Could not adjust	Bench	Wearout	Adjustment screw binding. The vendor attributed the jamming of the trimmer capacitor to either excessive tuning excursions or the application of a heavy torque at a mechanical stop. The MIL Specification rotational limit was 75 cycles. Engineering required a maximum of 20 adjustments to tune the equipment. The engineers were advised to exercise caution when applying turning torques to avoid forcing the "stop," and to minimize the number of trimming cycles to prevent fatigue of the adjustment mechanism.
1673 4/19/63	Power Amplifier	Low power output	Thermal-vacuum MVT #6 at JPL	Nonassignable	Power amplifier was retuned. Previously 2nd IPA required retuning.
1674 4/26/63	Transmitters	RF power drop-off 7 db	Thermal-vacuum MVT #7 at JPL	Design	RF breakdown in the RF cables.
1675 4/29/63	Power Amplifier	Low power output	Post thermal-vacuum MVT #7 at JPL	Nonassignable	C7 was machined down. Reported arcing questioned. Care should be exercised in tuning the communication equipment.
10458 6/15/63	Tube V1 (type 7870)	Open filament	Manufacturing	Workmanship (vendor)	After approximately 4 hours of operation the transmitter power went to zero. A check of the IPA tube revealed that it had an open filament. The QC report verified this open filament. With only four hours this tube could fall into the infant mortality group.
3308 10459 7/10/63	Tube V1 (type 7870	Short, G1 to G2	Manufacturing	Workmanship (vendor)	The tube was only in the system for 1/2 hour when a short occurred between the screen and control grid of the IPA tube. The IPA problem was still under investigation at this time.
4038 9/1/63	IPA Cavity Serial No. 025	Power drop of 1 db	Thermal-vacuum	Nonassignable	The power output dropped 1 db for approximately 1 second. Later, during instrumented test, the power output dropped to zero and then recovered within 3 seconds. The cavity was disassembled and examined. No physical damage was found. The causes of the power drop and loss of power could not be determined.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Transmitter Assembly, S/N 010 (Continued)		
4046 10/20/63	Tube (type 7870)	Drawing excessive current	Postvibration	Workmanship (vendor)	During postvibration testing, the power output dropped to zero, I_L rose to 10.6 amperes, and the test-harness fuse for minus 750 volts opened. The IPA tube was tested and found to have low transconductance and excessive current drain. Inspection under a microscope revealed extensive crazing and some chipping on the cathode.
5886 3/25/64		Oscillating	+40° C previbration test	Accident	Oscillation of the Transmitter during a +40° C operation prior to vibration was found to have been caused by improper tuning of the X4 and X12 multipliers. The assembly was carefully retuned and normal operation was restored.
5861 3/26/64		Low power output	Postvibration	Accident	The output power was found to be less than the specified limit during a postvibration test. Investigation disclosed that the assembly had been improperly tuned during rework. Proper tuning provided an output within specified limits.
3825 4/1/64		RF output too high	Ambient (JPL)	Accident	Investigation of the level of the corrected RF output of the Subsystem being too high resulted in changing the correction factor from 8.3×10^5 to 7.65×10^5. Personnel were instructed to closely monitor the power-measuring equipment.
3949 5/2/64		RF output too high	Ambient (JPL)	Accident	Investigation of the level of the corrected RF output of the Subsystem being too high resulted in changing the correction factor from 1.32×10^4 to 1.062×10^3. Personnel were instructed to closely monitor the power-measuring equipment.
3818 5/8/64		RF power increase	Thermal-vacuum	Nonconfirmed	At T+1 minute, an increase in Transmitter output power from 54.2 to 59 watts occurred within 0.5 second. A similar increase was observed during test at AED and was caused by the inability of the regulator in the Telemetry Processor Assembly to reach and hold the regulated-current level during the initial stabilization period. At turn-on, the Intermediate Power Amplifier and Power Amplifier were detuned to a degree that the regulator could not reach its regulated state. This resulted in a low-power output. The output power generally started at a lower level and gradually increased to its optimum level. The sudden increase in output power, although unusual, could be considered a normal function of the warm-up stabilization period of the cavities and the regulator.
			Transmitter Assembly, S/N 011		
2883 2/15/63	Crystal Y1	Incorrect frequency	Ambient (bench)	Random	The crystal was replaced when it was not possible to bring the transmitter to desired frequency. However, this did not completely correct the fault. When the new crystal failed to bring the transmitter exactly on frequency, the diode was replaced. The unit was then operating on frequency.
2884 2/18/63		Varactor PS115-10 CR10		Random	The suspected varactor in the FM Modulator was sent to RCA Central Engineering for analysis. Capacitance at 50 Mc and minus four volts DC bias was 7.93 pf. The nominal value was 10 pf ±20%. The absolute capacitance value was marginal and under a worst-case combination of tolerances might have accounted for the difficulty in bringing the transmitters to the desired frequency. Replacement of the varactor corrected the problem. This was the first reported malfunction of this nature.
10454 6/3/63	Tube V1 (type 7870)	High plate current	Room	Design	The low-power output and the plate current became intermittently high.
			Transmitter Assembly, S/N 012		
3227 5/9/63	---	Oscillation	Room (bench)	Design	The use of a spectrum analyzer showed that the transmitter was oscillating at approximately 6 Mc on the carrier, thus indicating that the X4 Multiplier was not properly biased at "turn-on". The addition of a 2.2-megohm, 1/4-watt resistor in parallel with the X4 bypass diode corrected this situation and restored normal operation. The 2.2-megohm, 1/4-watt resistor was added to all Block III models.
2864 7/3/63	Tube (type 7870)	Erratic operation	Room (engineering)	Secondary	The proper power output could not be attained even though the biases were twice their normal value. The IPA tube was then removed and tested. During the testing, the filament wire was broken. The wire would weld together when the cavity was jarred sharply. The tube was then broken

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly, S/N 012 (Continued)
2864 7/3/63 (Continued)					open. Inspection under a microscope disclosed that the filament wire had broken at a point between the coiled helix and the ceramic mounting bar. It could be determined that the wire had broken and welded several times. In addition, there was some discoloration on both the plate and grid. This tube had been used in an unmodified power supply. All power supplies were then modified to prevent the conditions which caused the erratic operation.
					Transmitter Assembly, S/N 013
1666 3/30/63	Tube 7870	Low power	Thermal-vacuum MVT #3 at JPL	Nonassignable	Low power output. New tube restored the power. Cause believed to be aging and deterioration of tube. The 2nd IPA stage was then obsolete.
2155 5/31/64		Low F-Channel output power	Thermal-vacuum	Accident	During the first 5 minutes of thermal-vacuum mission test No. 2 at 53° F, the F-Channel Transmitter output power was low and not within the specified limits. The Battery voltage was also low but higher than the specified minimum voltage of 30.5 volts. The cause of the low output power was believed to be the low temperature. The Transmitter was retested at ambient conditions and the power profiles were normal. The Transmitter could be retuned for low-temperature conditions, but this would result in a small decrease in power at high temperature. The present power profile was such that after the Transmitter had warmed up, retuning at low-temperature conditions was not warranted.
2870 8/20/63	Vacuum Tube (type 7870) S/N 792	Power drop-off	Room (engineering test)	Nonassignable	The initial output power was satisfactory but after several minutes of operation it dropped off. When the tube was removed several small spheres of metal were found between filament rings. These spheres were removed and the tube installed in a cavity where it operated properly for some time before having power difficulties. The vendor's static analysis indicated several points of failure and the visual inspection revealed the tube has been excessively overheated. The particles originally found between the heater and cathode are suspected of coming from the cavity. The responsible engineering group has been assigned the task of measuring and monitoring all of the applied voltage, current, and transients applied to these IPA tubes under actual operation.
4031 8/20/63	Vacuum Tube (type 7870) S/N MIL-B-828	Power drop-off	Room (engineering test)	Nonassignable	The power output dropped off after 3 hours operation. When the tube and cavity were inspected, several small metallic particles were found in between the heater regulator and the tube base. When cleaned out and retested, the power again dropped off after approximately 3 hours. The tube was returned to the vendor for analysis. Nothing was found to be wrong with the tube in a static test nor in a Ranger cavity. When the tube was opened and visually inspected, the screen showed signs of having been overstressed. In addition, a heavy deposit of material was noted around the anode, and a slight layer of the same material on the cathode. The deposites were not carbon. The heater coating was still in good condition. As requested by the vendor, extensive monitoring of the voltages, current and transients were to be performed by RCA engineering under actual operating condition. In addition, the engineering group would determine the internal cavity temperature under operating conditions.
3806 5/1/64		RF interference	Ambient (JPL)	Nonconfirmed	The Subsystem without Thermal Shrouds was mated with the Bus for the match-mate test. The interference was noted when the high-gain antenna was in the launch position, but not when the antenna was deployed so that it radiated into free space. It is believed that the interference was caused by the antenna radiating back into the Subsystem. This interference was not considered to be a malfunction because the test was performed with the Subsystem in a nonflight configuration.
3948 5/2/64		Power fluctuations	Ambient (JPL)	Nonconfirmed	During the postshipment test of the Subsystem, 0.15-db fluctuations were noted in the RF power output. These fluctuations were very minor and could be accounted for by changes in light level on the cameras and by changes in tuning. Because the fluctuations were very minor, were not always present, and did not produce a malfunction, they could be classified as noncritical even though they did occur on other Subsystems. This classification could be further substantiated by the fact that there did not appear to be any effect on either camera or telemetry performance. Subsystem operation was to be closely monitored to determine if any degradation occurred.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Transmitter Assembly, S/N 014		
1672 4/19/63	Transistor Q4 (TA 2084)	Low power, low beta	Thermal-vacuum MVT #6 at JPL	Design	Power output low and intermittent. The component was returned to AED. Oscillation occurred in thermal-vacuum. Unit returned to subcontractor for repair and alignment. TA2084 was replaced with Clock S/N 115.
3297 6/13/63	Feedthrough Capacitor C5	Arc-over	Bench, cold (-0° C)	Accident (test procedure)	Arc-over occurred about 50 to 60 seconds after a pan of liquid nitrogen was placed on the baseplate to lower the transmitter temperature to -10° C. Examination showed that some frost and moisture had collected on components when the system was open to atmosphere. The capacitor was replaced.
3296 6/13/63	Transistor Q4 (type 2N115)	Low power	Room (bench)	Random	Initial testing of this transmitter showed low and unstable output power. Closer investigation showed low output power from the X12 and X4 Multipliers. Apparently the low power was due to the new Q4 transistor type S/N 115. Transistor Q4 of the X12 Multiplier in the Transmitter Assembly, Serial No. 014, was replaced. This part was returned to the RCA Central Engineering Laboratory for analysis. The part appeared to be marginal since it measured 2.9 volts as compared with the one-volt maximum specified by RCA for VCE (sat.).
3302 6/18/63	IPA Tube V1 (type 7870)	Open filaments	Room	Secondary	This tube failed after 8 minutes of full-power operation. It had previously been subjected to a severe overstress when capacitor C5 arced to ground. (Refer to MR 3297.) With the -750 volt line grounded, the screen voltage became +250 and it conducted an excessive amount of current. Due to the circuitry and tube configuration when the -750 volt line drew an excessive current, it could have an adverse affect upon the tube filament. The tube was cut open and extensive discoloration and signs of arcing on the screen were noted. In addition, the external base of the tube around the centering pin was discolored and showed signs of solder.
2865 8/22/63	Transistor Q4 (type 2N115)	Short, collector to emitter	Thermal-vacuum (0° C)	Workmanship	During the Thermal-vacuum test, at 0° C, the line current increased and no spectrum feed-through was evident. Investigation disclosed that transistor Q4 in the X12 Multiplier had a resistance of 9 ohms between the collector and ground. Further investigation revealed that there was no silicone grease around the transistor. Assembly methods at that time did not call for the installation of transistors requiring silicone grease until after all cleaning operations were complete. However, subsequent cleaning following rework could wash out the silicone grease. Instructions were then disseminated that warned personnel to avoid erroneous washing away or removal of the silicone grease.
2867 8/23/63	Transistor Q4 (type 2N115)		Room (engineering)	Secondary	Following the repairs required under Malfunction Reports 2865 and 2866, another attempt was made to retune the X12 Multiplier. During the unsuccessful retuning, the collector current of transistor Q4 exceeded the maximum limit. It was replaced. The failure to retune the unit was because of the difficulties discovered under Malfunction Report 2868.
2866 8/23/63	Capacitor C34 (Trimmer)	Broken case	Room (engineering)	Accident (test error)	After the replacement of transistor Q4 under Malfunction Report 2865, the X12 Multiplier had to be returned. In attempting to adjust capacitor C34, which was locked with epoxy, a small section of the rotating cover was broken. Although the capacitor still performed electrically, it was replaced for preventive maintenance reasons.
2868 8/24/63	Transistor Q1 (type 2N338)	Base not connected	Room (engineering)	Accident (test error)	Investigation of an inability to vary the voltage at test point VJ4 revealed that the base lead of transistor Q1 was disconnected. When properly soldered, the modulator functioned correctly. This disconnection probably occurred during the troubleshooting and repairs performed during the investigations for Malfunction Reports 2865 and 2866.
			Transmitter Assembly, S/N 015		
1662 3/14/63	---	Detuned	Room	Design	Low power output during Mission Verification Test No. 1 at JPL. The cause of the second IPA detuning could not be definitely assigned. However, the aging of the tube and parts required retuning of the amplifier. The second IPA was eliminated by the system redesign and would not be included in the flight units. The transmitter was retuned by RCA personnel at the JPL site.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly, S/N 015 (Continued)
10455 6/4/63	Diode CR1 (Varactor No. MA4348)	Intermittent output	Room (manufacturing)	Nonconfirmed	Intermittent output measured from the Timer. The unit functioned satisfactorily when the diode was replaced. The replaced item was checked in QC laboratory, but the intermittence was not observed. (Refer to Malfunction Report 10457).
10456 6/14/63	Capacitor C3		Room (manufacturing)	Workmanship	The mica capacitor, C3, was found to have a crack and the power output from the Transmitter was again intermittent. When the unit was replaced the Transmitter still functioned intermittently. (Refer to Malfunction Report 10457)
10457 6/15/63	240-Mc Cavity	Intermittent output	Room (manufacturing)	Workmanship	The intermittent power problem continued even after replacing diode CR1 and capacitor C3 (10455 and 10456). The 240-Mc cavity was replaced and proper operation was obtained.
2862 7/29/63	Resdel Amplifier (Serial No. 137)	Shorted cavity	Room (engineering)	Workmanship (vendor)	The plus 100-volt test point on the power supply went to zero volt when the transmitter was switched to full power. When the Resdel Amplifier was replaced, the circuit operated satisfactorily. Examination of the malfunctioning amplifier disclosed a broken socket that had shorted the 1000 volts to ground. The 1000-volts supply was so severely loaded by this short, that the 100-volts test point indicated zero volt. The Resdel Amplifier was returned to the vendor for repair. Also, instructions were given the vendor to use tighter quality control inspection procedures on future units.
					Transmitter Assembly, S/N 016
3226 5/18/63	Bourns Pot (3020L) R9	Shorted to ground	Thermal-vacuum (engineering)	Design	A 200-ohm, 5-watt "trimpot" (R9) was shorted to ground. The transmitter was opened and R9 was found to have a metal case. The shorted trimpot was a Bourns type 3020; it was replaced with the Bourns type 207L which was insulated from ground by two layers of mica. The type 207L also eliminated the mounting screw through the metal cap of the trimpot.
3291 6/1/63	Test Cable No. 7	High-voltage standing wave ratio	Thermal-vacuum	Design	Low power output was recorded from the thermal-vacuum chamber. All the cables were tested and Test Cable No. 7, which had a TNC connector rather than the N-type on all other cables, had a high-voltage standing wave ratio (1.34). The connector was changed from a type TNC to a type N.
3303 6/22/63	Capacitor C35	Jammed	Room	Wearout	The threads of the tuning screw were rounded, showing definite sign of wear. This capacitor became more and more difficult to adjust until it would not move at all. This failure had occurred several times before. A replacement part was recommended and was being considered by the skill center.
3304 6/24/63	Transistor Q2 (type 2N1493)	Low power output	Room (engineering)	Nonconfirmed	Transistors Q1 and Q2 had to be selected for the individual circuit in order to obtain the proper output. The output of this transistor was within specification limits, but would not provide proper drive for this individual circuit. Replacement of both transistors Q1 and Q2 provided sufficient output.
2861 7/22/63	Tube V1 (type 7870)	Short	Thermal-vacuum	Design	This tube was in the communications channel that had the Power Supply (S/N 013) failure. (Refer to MR 3971.) When tested in a bench setup the tube indicated a short from screen grid to control grid. Since one failure caused the other, it was now necessary to discover which system failed first and then determine a solution that would prevent this failure. The failure was considered to be part of the turn-on transient problem.
					Transmitter Assembly, S/N 017
10453 5/16/53	Transistor Q1 (type 2N1493)	Open emitter	Thermal (40° C)	Design	No output power; caused by the emitter having burnt open due to excessive current. Further investigation revealed that Tube V1, tube type RCA 7870, of the IPA Cavity, Serial No. 032, in the Transmitter Assembly, Serial No. 011, had failed.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly, S/N 017 (Continued)
3298 6/15/63	Zener CR1 (1N2835B)	Shorted	Room (postvibration)	Workmanship	Diode CR1 was shorted during a repair. Examination showed that the load was not connected and all the current flowed through the zener diode (CR1). At the same time, resistors R6 and R7 were damaged. A new inspection procedure, requiring an engineer or qualified technician to supervise all rework, was instituted. This new procedure also required that all reworked units have the critical B+ points checked with an ohmmeter prior to being electrically checked.
3299 6/15/63	Subminiature Connector A14, A2J10, to A14, A3J1	---	Room	Workmanship	A visual inspection of the cable assembly revealed that one of the connectors was assembled with a teflon insulator missing and that there was a hairline crack on the metal connector. These defects apparently did not affect the cable assembly performance during testing. The defective cable assembly was returned to the vendor, and the vendor was directed to review and enforce the manufacturing and quality control procedures.
3305 6/29/63	Feed-through Capacitors C5 and C7	Chipped and discolored	Room (bench)	Accident (test error)	The transmitter was performing erratically for the first 10 seconds of operation. Capacitor C5 was chipped and capacitor C7 showed signs of arcing. These capacitors were removed and subjected to a 1500-volt high-pot, which they passed successfully. Even with the capacitors replaced, the system did not function properly. (Refer to MR 3306.)
3306 7/5/63	IPA Cavity (S/N 020)	Breakdown of -750-volt circuit	Room (bench)	Secondary	This Cavity had just been returned to the system following repairs caused when arcing occurred on capacitors C5 and C7 due to moisture. A partial shorting in the -750-volt line was indicated. This short did not stop when the tube was replaced. After replacing the entire Cavity, the Transmitter functioned satisfactorily.
4235 12/17/63	Modulator	Frequency shift	Ambient (JPL)	Nonconfirmed	A frequency shift was noted during the electrical test following vibration testing of the Subsystem at JPL. Investigation of a shift in frequency in Transmitter Serial No. 017 of Flight Model III-2 indicated that the L4 coil was defective. The coil was returned to AED for testing. The results of the testing, including test under extreme high temperature, disclosed no abnormal operation.
2103 6/9/64	Transistor Q1 (type 2N1493)	Incorrect wiring	Ambient	Workmanship	This malfunction involved the lack of RF output from the X12 Multiplier. This was attributed to the incorrect wiring of transistor Q1 (type 2N1493). This X12 Multiplier unit had been returned to Manufacturing for rework that involved the removal of transistor Q1. The transistor was incorrectly wired at the completion of the rework.
2105 6/16/64	Diode CR11 (type 1N251)	Open	Ambient	Design	Test point No. 2 which monitored the output of the modulator was void of a reading. Investigation revealed that diode CR11 (type 1N251), which was in series with test point No. 2, was open. Replacement of diode CR11 corrected this condition. CR11 was a protective diode in the test-point circuitry and had no electrical function in the FM modulator. The "fail-open" mode was the intended operation of this diode in the event of an overstress.
2106 6/16/64	Varactor Diode CR1	Low output power	Ambient	Random	Low output power from the Z4 Multiplier was attributed to a faulty varactor diode (CR1). Proper operation was restored with the replacement of the diode. The failed diode was electrically checked and found to have a breakdown voltage of 16 volts (specification called for a 120-volt breakdown voltage). X-ray of the diode revealed no anomalies. This malfunction was detected during the first electrical test following rework of the Transmitter. Since this diode was extremely sensitive to handling, damage probably occurred during rework. The electrical stress was rechecked and was found to be applied properly.
2107 6/18/64	Capacitor C8	Incorrect capacitance value	Ambient	Workmanship	Initial bench check of the Transmitter revealed that the modulation output was high and the modulation range poor. Investigation revealed that capacitor C8 of the X12 Multiplier measured 9 picofarads instead of the specified 15 picofarads. Replacement of this capacitor restored proper Transmitter operation after retuning.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Transmitter Assembly, S/N 201		
4493 1/22/64	Capacitor C15	Cracked	Vibration	Design	Following vibration, the capacitor was found to be cracked in the area of the solder seal and was replaced. It is believed that the crack was caused by an overstress condition during the qualification-level vibration testing. The G-amplification factors were reviewed to determine if mechanical re-design were necessary. (Refer to MR 4496.)
4495 1/23/64	Crystal Holder XY-1	Loose contact	Postvibration	Nonconfirmed	Investigation into the frequency drift of the Transmitter revealed that the crystal holder was not holding the crystal firmly in place. Although there appeared to be nothing wrong with either the crystal or holder, the holder was replaced for preventive maintenance.
4494 1/23/64	Connector A14A4-J2	Loose female contact	Room	Nonconfirmed	A visual inspection of the RF cable connecting the X4 multiplier to the IPA cavity revealed a loose female contact. Although no malfunction had been caused by this, the cable was removed and the contact replaced for preventive maintenance. The contact was found to have been pushed into the teflon insulation and had been spread excessively by repeated connection and disconnection.
4496 1/23/64	Cyrstal Y1	Change in frequency	Ambient (postvibration)	Design	The change in frequency was found to occur when the Y1 crystal was tapped. Microscopic examination revealed a cracked weld along the support interface for the crystal wafer. Because two previous malfunctions had been caused by vibration, this type of malfunction was believed caused by an overstress condition occurring during the qualification-level vibration testing. The G-amplification level was substantially reduced by the application of blue urethane, and new crystals capable of withstanding higher G forces were ordered as replacements.
5901 1/25/64	IPA, Serial No. 139	No output	Thermal-humidity	Workmanship	Investigation of no output from Resdel IPA, Serial No. 139, during a thermal-humidity test disclosed a short across the mica insulator located between the control grid of the tube and the cavity wall (DC ground). The assembly was returned to the vendor where the mica insulator was replaced and a fillet of teflon was bonded around the control grid to increase the resistance of the leakage path. The modified assembly was successfully retested in thermal-humidity. The specifications were changed to require the above modification.
5903 3/7/64	Varactor Diode	Suspected open	Thermal-humidity	Nonconfirmed	Replacement of the varactor diode following the loss of output from the X4 multiplier during a thermal-humidity test restored normal operation. However, examination of the component failed to show any evidence of component malfunction. During a subsequent vibration test, a coil which served as the support for the diode came loose. (Refer to Malfunction Report 5902). It is believed that this malfunction was caused by the coil being loose.
5902 3/14/64	X4 Multiplier Serial No. 302	Loose coil	Vibration	Workmanship	During the second vibration run at qualification levels, the large coil in the X4 multiplier was loosened. Evidence was found of improper manufacturing techniques resulting in a poor solder connection. The location of the other three multipliers manufactured by the same vendor was determined. One was at the Pioneer ground station and was not reworked; however, the remaining two were at AED and were properly reworked.
3777 8/11/64	Transistor Q3 (type 2N1493)	RF power drop-off	Thermal-vacuum (at +60° C)	Workmanship	The QTM Transmitter Assembly, Serial No. 201, failed to operate during the first six thermal-vacuum tests at 55° C. The transmitter then turned on and operated for a short period of time. When the operating temperature reached 60° C, the RF output power dropped off sharply. The trouble was isolated to transistor Q3 in the X12 multiplier circuit. When solder was removed from the transistor, the base and collector leads were found to be broken. In addition, the transistor was found to be loose and not properly sealed on its beryllia wafer. The transmitter had been vibrated three times at qualification levels. It was therefore concluded that the transistor failure was due to fatigue that resulted from the motion during vibration because of the improper mounting of the transitor.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly, S/N 201 (Continued)
2174 8/30/64 2175 8/31/64	Resistor	Overheating and incorrect telemetry indication	Ambient	Nonassignable	When the P-Channel transmitter was turned on following installation on the PTM, smoke came from the transmitter power supply. No RF power was observed during the time power was applied; the only abnormality noted was that the power supply output was 95 instead of 100 volts. Resistance measurements made on the spacecraft indicated a drop in resistance from A21P2 to ground. The zener diode was measured as being shorted to ground. The diode was found to be good. The transmitter and power supply were returned for integration into the spacecraft. The unit operated satisfactorily, but plus 30 volts instead of a minus voltage was obtained at TP1. A check indicated a resistance of 7.5 ohms instead of 100 ohms from TP1 to ground. The plus voltage and low resistance could not be explained. Resistor R3 of the transmitter was charred and indicated that a high-power dissipation had taken place. The only source of plus voltage of this magnitude was the 100 volts. Following this second malfunction, the unit was returned to AED. During testing, a break in the insulation was found in the 70-volt wire going to the X12 multiplier. If the wire had touched the case during operation on the PTM, it would account for the drop in the 100-volt line. In addition, if the voltage to the X12 multiplier had dropped to 50 volts or less, there would have been no RF output. This wire could have been crimped between the X4 multiplier and the modulator cover and could have become loose during removal of the unit from the PTM. The smoke probably came from R6 and R7 wired into the 100-volt circuit of the transmitter power supply.
					Transmitter Assembly, S/N 204
2065 7/6/64	Resdel Intermediate Power Amplifier, Serial No. 124	Drop in output power	At +63° C	Workmanship	At the conclusion of a one-hour operating test at +63° C, a sudden and sharp drop in the transmitter output power from 7 watts to 1 watt was experienced. Tuning the transmitter failed to restore the 7-watt output. The unit was cooled to 50° C, and the normal 7-watt output power was obtained. When the transmitter was allowed to heat to 60° C, a similar power dropoff occurred. Investigation revealed that the aluminum cover of the Resdel IPA cavity was rapidly changing in shape with temperature. The physical change of the cavity shape changed the RF electrical parameters of the cavity and resulted in a detuning of the IPA with an associated reduction of RF power output. A measure of the distance between the cavity sides and the grid separator plate that forms one end of the cavity revealed a spacing of 0.006 inch on one side and 0.007 inch on the other side. These values exceeded the maximum allowable tolerance of 0.003 inch. Also, capacitor C8 was found to have one lead bent, such that the Durez coating had a slight crack. A deposition was noted on the sides of the cavity touching the cover plate. This was later found to be excessive lactate. The cavity of each Resdel IPA was measured and those out of specification were returned to the vendor.
3774 7/10/64	Capacitor C4	Broken	Ambient	Accident	Trimmer capacitor C5 was accidently broken while removing the potting material to retune the X4 Multiplier after incorporation of the Resdel IPA modification. Upon replacement of Capacitor C5, normal operation was restored.
3799 9/24/64	IPA Tube 3CX100A5	Power reduction	Ambient	Random	The P-Channel Transmitter was replaced on Flight Model III-3 after a reduction in output power was noted. When tested, the output of the X4 measured normal, and the problem was traced to an aging of the tube in the IPA. The bias resistor was reduced from 470 to 340 ohms and the power output was restored to 8 watts. A 24-hour test was then performed with no further evidence of aging of this tube. The tube was removed and returned to the vendor for analysis. The vendor tests indicated that the emission of the tube was greatly reduced and that the transconductance was one-half the normal value. Readings indicated that a change in the spacing of the elements had occurred. Further examination revealed that some cathode material was on the plate in the form of a black deposit. The previous history of this tube showed that the IPA, Serial No. 117 had been involved in 3 one-hour runs and 2 one-half-hour runs with a filament voltage of 7.4 volts. It was the conclusion of RCA and the tube vendor that, while it was normal to experience a reduction in the transconductance during

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly S/N 204 (Continued)
3799 9/24/64 (Continued)					the first 100 hours of operation, the severe reduction in power output that was experienced with this particular IPA could only be explained by operation for a long period of time at an excessive filament voltage.
3798 9/24/64	Double Carrier		Ambient	Nonconfirmed	During the testing of the P-Channel telemetry on Flight Model III-3, a double carrier was reported to exist. Investigation disclosed that the double carrier was actually the marker used on the display of the spectrum analyzer.
					Transmitter Assembly, S/N 205
4652 2/28/64		Loss of RF power	Ambient	Accident	During the preshipment test, CC&S Warmup was used to initiate Subsystem operation; full power came on after the 5-minute warmup period. After 8 minutes of full power, the Command Switch was stepped to Emergency. One minute later, the CC&S Warm-up command was released to allow turn-off with RTC-7 commands. At this point the P-Channel RF disappeared. F-Channel remained in full power. The P-Channel emergency telemetry was missing and the telemetry was switched to the F-Channel 225kc VCO. The telemetry indicated that P-Channel had been reset and was in warm-up. An attempt was made to place the P-Channel back in full power by use of the CC&S Full Power command. However, the RF output from P-Channel was barely visible on the spectrum analyzer. The CC&S Full Power command was released and the Subsystem turned off by stepping the Command Switch to zero. The operation of P-Channel was closely monitored during the integration and testing of Flight Model III-3.
3796 9/22/64		Power drop	Thermal-vacuum	Accident (Design)	The F-Channel RF power output displayed a gradual decrease during the one-hour thermal-vacuum test. The measured decrease was from 19.4 to 19.1 watts. The specified minimum output was 19.5 watts both during and at the conclusion of the test. A retuning of this transmitter was accomplished before the test. An additional retuning of the IPA restored the performance to within specification but the output was still considered to be low. The cathode biasing resistor was changed resulting in an increase in power output from the IPA to 9 watts. All future cathode biasing resistors were to be selected to provide a power output of from 8 to 9 watts.
					Transmitter Assembly, S/N 208
1531 11/3/64	Resdel IPA Serial No. 123	RF caused variation in amplifier output	Ambient	Design	RF was present on the minus 500-volt DC line to the 4-pin connector to the RF amplifier. The output of the amplifier varied 1 watt when the DC line was touched. It was recommended that a 330-pf, 1000-volt capacitor be added across capacitor C5. The trouble was traced to the Resdel IPA (serial No. 123), which was removed from the transmitter and returned to the vendor for a failure analysis. The output variations were confirmed, but the oscillation could not be repeated during test. Capacitors C3, C4, and C5 (330 pf, 1000 volts) were replaced without any noticeable improvement. A similar capacitor was placed in parallel with capacitor C5, and the problem was solved. A Material Review was conducted, and MRA 100-64-196 was issued approving the addition of a capacitor in parallel with C5.
3897 11/10/64			Thermal-vacuum (45° C)	Accident	The transmitter operated successfully for three runs at 0° C. During the first run in thermal-vacuum at 45° C, the power output of the Resdel IPA decreased. During a run made at 28° C in thermal-vacuum, the power output continued decreasing. The unit was then operated at normal pressure and at room temperature in an attempt to find the trouble. After capacitor C7 was adjusted, power increased. However, the problem was not completely solved. The potting on the J1 connector was broken. An adjustment was made, but power decreased. The J1 setting was returned to the original position and power did not decrease. Several runs were made at room temperature with no power decrease. The unit was operated in a bell jar at atmospheric pressure with temperature increasing to a maximum of 55° C. Power output decreased. The temperature was stabilized at 55° C and power decreased. The transmitter was retuned. The unit successfully met the requirement of the specification during the complete temperature range of thermal-vacuum flight acceptance test. The unit was accepted as a flight spare. The malfunction was caused by: (1) The transmitter not being retuned to compensate for the mismatch of the longer bell jar cables; (2) This

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Transmitter Assembly, S/N 208 (Continued)
3897 11/10/64 (Continued)					tube being more sensitive to temperature change and being subject to more than normal detuning at the upper temperature tuning at T+8 rather than T+5 minutes compensated for this particular tube characteristic; and (3) A permanent change that may have occurred in the plate capacitance in this tube.
					Transmitter Assembly, S/N 211
3890 10/5/64	Capacitor C18	Transient response not within specified limit	Ambient	Workmanship	The transient response (Paragraph 4.3.7 of RTSP-1150A) of Transmitter, Serial No. 211, was not within the specified limits. A review of the history of this unit revealed that this out-of-specification condition existed previously, but had no effect on the performance of the Transmitter. Closer investigation revealed that capacitor C18 in the modulator circuit was not the correct value. It measured 130 picofarads rather than the specified 27 picofarads. When the proper-value capacitor was installed, normal performance was restored.
					Transmitter Assembly, S/N 301
4500 2/8/64	Transistor Q2 (type 2N1493)	Shorted, base to collector	Vacuum	Workmanship	After 49 minutes of full-power operation, the RF output from the F-Channel was lost. An unsuccessful attempt was made to obtain full-power operation by operating the channel through a five-minute warmup cycle. Investigation of the loss of power revealed that the +100-volt supply was open. Two resistors (Refer to MR 4498 and 4499) were severely overstressed. Further investigation revealed that this overstress had been caused by a collector-to-base short in transistor Q2 of the X12 multiplier. This short is believed to have been caused by thermal runaway of the transistor caused by either an insufficient amount of silicone grease under the transistor or the failure of the transistor to be firmly attached to its heat sink. Quality Control has been instructed to closely inspect all transistors that use a wall-type mounting to ensure that sufficient silicone grease is present and that the transistor is firmly mounted. If any transistors are found not to be firmly mounted, they are to be removed, additional silicone grease is to be applied, a new beryllium wafer and teflon insulator are to be added, and the transistor is to be firmly supported so that no movement is allowed.
4498 4499 2/8/64	Resistors R12 and R13	Open	Thermal-vacuum	Secondary	During the investigation of the malfunction noted in Malfunction Report 4500, these resistors were found to be open. While the short remained on that transistor, these resistors tried to dissipate over six times their rated values and were destroyed.
4470 2/11/64	Capacitors C6 and C7	Cracked insulation	Ambient	Workmanship	Although the ceramic insulation on these feed-through capacitors was found to be cracked, this is not a true malfunction as defined in AED-708 because the equipment had not been operated. The components are believed to have been damaged during rework. Procedures, standards, and instructions were examined and found adequate to prevent this type of problem.
3999 4/2/64	Capacitor C11 Choke L5 Resistor R8	Chipped	Ambient	Accident	A cracked ceramic capacitor was noted during rework. Although the assembly operated normally during a brief electrical test, the capacitor was replaced. During the replacement, choke L5 and resistor R8 were broken. These components were also replaced.
3857 5/23/64	Capacitors C22 and C29	Parts damaged	Ambient	Nonconfirmed	While investigating the Transmitter Assembly (Serial No. 301) to evaluate rate-response distortion (See MR 3859), capacitors C22 and C29 required adjustment. These components are miniature trimmer capacitors that had to be bonded in a fixed position. Attempts to adjust the capacitors resulted in the rotor stripping from the adjustment screw. The epoxy bond was stronger than the bond of the rotor to the screw. All personnel have been informed of the damage that may occur to epoxied trimmer capacitors should readjustment be required.
3858 5/25/64	IPA tube, Serial No. 1415	Output power drop	Ambient	Random	The output power of the IPA dropped from 7 to 5 watts. The IPA tube, Serial No. NILB 1415, was replaced by Serial No. NILB 216 and normal operation was restored. The failed tube was tested and instability and low emission were verified. During this testing, the tube was operated without cooling and serious overheating resulted. The tube was returned to the vendor for analysis but no definite conclusions could be reached as to the cause of failure.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Transmitter Assembly, S/N 303		
3859 5/22/64		Excessive distortion	Ambient	Nonconfirmed	The excessive distortion reported in this FM modulator was found to be due to a subtle degradation in test equipment used for this measurement. The defective unit, a receiver, was replaced by one having a lower inherent distortion error and the FM modulator was then within the specified distortion requirements.
			PTM Transmitter Assembly		
2168 2180 2181 2183 5/2/64 5/5/64 5/12/64		Power fluctuations	Thermal-vacuum	Secondary	The power fluctuations associated with these malfunctions of the PTM Communications Group are believed to be attributed to the Transmitter Power Supply Assembly (Serial No. 007). This power supply was associated with a previous problem in the F-Channel on November 23, 1963. Transmitter Power Supply (Serial No. 007) was replaced in the PTM on May 27, 1964 and no indications of the power-fluctuation problem have been encountered since that time.
2164 6/3/64		Poor Power Profile	Ambient	Nonconfirmed	The Transmitter chains of the PTM were not retuned at AED after they had been reworked to the Ranger VII flight configuration. Several extended power runs contributed to the acceleration of the detuning. The F- and P-Channel Transmitter chains have now been retuned and the power profile is normal.
			FM III-2 Transmitter Assembly		
2169 6/8/64		RF interference	Ambient	Nonconfirmed	Prior to the closing of the chamber for a thermal-vacuum test, a TV reference test was performed, at ambient conditions, on the Flight Model III-2 TV Subsystem mated to the JPL Bus. This test is performed in accordance with JPL test procedure 3R320.01, dated June 8, 1964. For the TV reference test, no wires are connected to the Subsystem and no collimators are employed, however, the shrouds and batteries are installed. The TV Subsystem is mounted on the JPL Bus with the high-gain antenna folded and facing the floor of the 25-foot chamber. A microwave-absorbent material (Echosorb) was lined on the floor, however, structural metal members of the chamber were between the antenna and the absorbent material. During the test, the F_B and P_3 Camera Subassemblies encountered RF interference, and severe interference was noted in the telemetry. In new test configurations such as this, a prototype model should be employed to define interference problems and to avoid exposure of a flight model to an unknown environment. JPL was notified of this problem. During the initial set-up of the test, no precaution was taken by JPL to determine the effects of the antenna pattern bouncing within the chamber or to determine the effects of the chamber structural members. The antenna was not deployed in flight configuration during this test.
			High-Current Voltage Regulator Assembly, S/N 002		
1382 2/2/63	-	Poor regulation	Thermal (+5 to +60° C)	Workmanship	Unit was out of regulation with a 30.5-volt input and 5.6-amp. load. A visual inspection revealed corrosion around the base of the SCR (2N2025), Q6 and Q7. When the corrosion was removed, the unit operated correctly. This PTM regulator did not have a protective finish applied (iridite). All flight units are protectively coated.
1758 3/7/63	Transistor Q7 (type 2N1490)	Short	Room (integration)	Secondary	Regulator output voltage was -32 volts instead of -27.5 volts. This regulator has been subjected to many overloads during the life of the PTM, including shorts in the DCU (reported in MR 1759). It is believed that the parameters of one of the matched control transistors changed, under these conditions, resulting in an overstress of Q7.
5801 3/17/64	Transistors Q6 and Q7 (type 2N1490)	Reading out of specified limits	Ambient	Accident	A voltage reading taken during testing was 0.23 volt lower than the specified minimum of 27.0 volts. This reading, however, was taken at the end of a 5-foot cable that presented sufficient resistance to reduce the voltage level below the specified minimum. The transistors were replaced, before the real cause of the misreading was discovered, and were found to be fully operable.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
High-Current Voltage Regulator Assembly, S/N 002 (Continued)					
2197 5/24/64	SCR	Broken lead	Ambient (visual inspection)	Workmanship	This failure was detected during a visual inspection of the High-Current Voltage Regulator, Serial No. 002, and is not an electrical failure. Part of the SCR lug was protruding through the thermofit sleeving, and removal of the sleeving revealed the broken lead. The connecting welded part had been removed and was not available for analysis. The conclusion was that this failure was a random fault of workmanship. All High-Current Voltage Regulators, except Serial Nos. 002, 003 and QTM, were inspected and the weld points have been reinforced with a coating of conductive epoxy and covered with a coating of nonconductive spray.
High-Current Voltage Regulator Assembly, S/N 003					
1383 4/24/63	Silicon Control Rectifier	Battery short to heat sink of SCR	Thermal-vacuum	Design	Insulation was worn. (-) Battery lead was grounded to mounting screw of SCR heat sink. Corrective Action: Wire routing will be specified; Wires will be epoxied down; Mounting screws will be covered with epoxy; and additional insulation will be used.
2199	Transistor Q6 (type 2N1490)	Shorted	Ambient	Workmanship	An attempt to use the RTC-7 command to turn-on the P-Channel into warm-up resulted in the tripping of the P-Channel external-power-supply circuit breaker. Subsequent attempts gave the same results. The P-Channel High-Current Voltage Regulator (Serial No. 003) was removed from the Subsystem and investigation revealed that both the regulated and unregulated outputs were shorted to ground. The unit was returned to AED and tested. Transistors Q5, Q6, and Q7 were removed and replaced. Transistors Q5 and Q7 were found to be satisfactory; however, transistor Q6 was shorted base-to-emitter, and collector-to-base. The mica insulator appeared to be the basic cause of the failure. The transistor mounting screw abraded the mica when it was installed and caused cracking and flaking. Arcing at this point eventually led to a complete short. A teflon insulating washer, which has a tendency to cold flow, compounded the problem and may have resulted in a loss of secure mounting. Flight units have been modified to correct this situation, but the PTM was not corrected since it was at JPL.
3333 5/8/63	Transistor Q6 (type 2N1490)	Shorted collector-emitter	Room (ambient)	Nonassignable	An inspection of the failed part revealed a burned element due to an applied overstress. Failure Modes & Effects Analyses were performed but the cause of failure could not be determined or predicted. Transistors Q6 and A7 were replaced with a matched pair.
High-Current Voltage Regulator Assembly, S/N 005					
3355 6/28/63	Transistors Q6 and Q7 (type 2N1490)	Open emitter	Room (integration)	Accident, test error	The test console "turn off" voltage had been turned up to 150 volts when it should have been 70 volts.
3351	Transistors Q6 and Q7 (type 2N1490)	Short, collector to emitter	Room	Accident	A portion of this problem is apparently due to the same cause as that listed in MR 3355, i.e. extremely high "turn off" voltage in the test console. A further cause is due to operating the High-Current Voltage Regulators without sufficient load on their output. To correct this problem a change has been made in the SCR turn-off procedure. When there is no load on the output of the High-Current Voltage Regulators, the voltage is now turned down on the GSE using the variac on the Console Power Supply. All integration and ground station personnel have been warned not to tamper with the console SCR turn-off supply unless the procedure is closely monitored with a meter and the test director is notified.
High-Current Voltage Regulator Assembly, S/N 006					
1959 1/2/63	Ground wire	Shutter did not operate	System test (ambient)	Workmanship	Ground-return wire for P1 camera shutter missing. Wire was installed. ECN change not put into FM-2.
1661 3/11/63	Pyrofuse wire	Open	Room	Accident	Malfunction occurred at JPL. No battery voltage indicated on GSE during presystem test of TV. Accidental short of battery monitor cable opened the fuses in the High-Current Voltage Regulator.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
High-Current Voltage Regulator Assembly, S/N 007					
5833 4/18/64 5834 4/25/64		Output voltage out of specified limits	Ambient	Workmanship	The output of the HCVR during testing failed to meet the specified minimum requirement. Replacement of transistors Q5, Q6, and Q7 did not remedy the malfunction. Further investigation revealed that a wire connecting the emitter of transistor Q6 to resistor R11 was broken. Replacement of the wire restored normal operation of the HCVR. The replaced transistors were checked and found to be fully operational.
3751 5/12/64	Insulation	Leakage	Ambient	Workmanship	Investigation of the inability of this regulator to pass the insulation and leakage test following reassembly after vibration testing revealed that the cover had been improperly attached and had caused the printed circuit board to shift. The QTM was considered a nonflight unit, and, therefore, did not receive the latest ECN which relieved the sharp areas on the corner post of the right-side plate.
2170 6/11/64		Failed bench test	Ambient	Workmanship	Following the modification of the SCR gate levels to the Ranger VII flight configuration, the High-Current Voltage Regulator (Serial No. 097) failed the electrical bench check test. Investigation revealed that electrically conductive epoxy had been improperly applied to the SCR by the JPL Chem-istry Laboratory, and a short resulted between the gate and the anode of the SCR. The epoxy was removed and the SCR recoated in accordance with the procedure specified for flight units. This HCVR then successfully passed bench test.
High-Current Voltage Regulator Assembly, S/N 008					
4055 2/28/64	Transistors Q6 and Q7 (type 2N1490)	White deposit	Thermal-vacuum	Design	Investigation into white deposits found on the series regulator transistors Q6 and Q7 in the High-Current Voltage Regulator revealed the deposits to be composed of cadmium and, in minor amounts, cadmium hydroxide. The source of the cadmium was found to be the cadmium plating on the transis-tors. Although the two transistors were electrically undamaged, micro-scopic examination revealed signs of arcing on the sides of the transistors. Measurements across the deposits at the mica insulators revealed the de-posits to be conductive. All cadmium-plated transistors have been re-placed by the gold-plated type used on Flight Model III-2 and subsequent equipment.
4783 3/21/64	Resistor R9	No regu-lation	Ambient	Workmanship	Investigation into loss of regulation revealed the installation of a resistor of the wrong value for resistor R9. A 220-ohm resistor was incorrectly in-stalled for one of 1.2 k ohms. The correct value was installed and normal operation was obtained.
5814 3/30/64	Mica washer	Cracked	Ambient	Accident	Investigation of the inability of this High-Current Voltage Regulator to pass the electrical case leakage test disclosed a cracked mica washer under the SCR. Excessive tightening of the mounting screws probably caused the mica washer to crack. Another possibility could be that the surface on which the washer was mounted on was not thoroughly cleaned prior to mounting. A directive has been issued specifying the correct torque.
3962 8/18/64	SCR Type 1706820	Suspected bent SCR lead	Ambient	Nonconfirmed	The SCR gate lead of High-Current Voltage Regulator, Serial No. 008, appeared to be bent. This SCR was the new flag type. This was not an actual malfunction and was detected by visual inspection. The control lead of the SCR gave the appearance of a slight bend as a result of the swaging operation. This condition was normal. Because of past difficulties en-countered with SCR's, this malfunction report was generated to ensure that this condition was not abnormal in the new type SCR.
High-Current Voltage Regulator Assembly, S/N 009					
3352 6/23/63	Transistors Q6 and Q7 (type 2N1490)	Short C-E	Room (integration)	Accident test error	The test console "turn off" voltage had been turned up to 150 volts when it should have been 70 volts. To correct this problem a change has been made in the SCR turn-off procedure.
High-Current Voltage Regulator Assembly, S/N 010					
3929 4057 4/1/64		Reading not within spec-ified limits	Thermal-vacuum (+55° C)	Accident	Investigation of a reading not within specified limits disclosed that the test fixture was incorrectly wired. The battery was directly shorted by the switch, there was no possibility of damage to the Assembly. The test fix-ture was wired correctly and the test was completed satisfactorily.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			High-Current Voltage Regulator Assembly, S/N 011		
4237 2/7/64	Fuse F1	Open	Room	Accident (JPL)	During investigation of a malfunction of sequencer, the negative battery terminal was shorted to ground through fuse F1 by a grounded terminal on a digital voltmeter.
			High-Current Voltage Regulator Assembly, S/N 012		
4013 9/5/63	Potentiometer R3	Erratic operation	Ambient	Accidental	The trim potentiometer was damaged at the CW end and its wiper was burned during testing because of an accidental overstress.
4012 9/5/63	Resistor R1	-	Ambient	Nonconfirmed	Resistor R1 was replaced because the regulated voltage could not be adjusted. The resistor was then tested and found to be within specification limits.
4011 9/6/63	Transistor Q6 (type 2N1490)	Short, emitter to collector	Ambient	Accidental	Transistor Q6 was found to be shorted, emitter to collector. Investigation disclosed that this was caused by either an overstress in the test set-up or the shorting of a test probe.
4080 10/11/63		Short to ground	Room	Nonconfirmed	The chassis of the regulator was shorted to the ground. A check of the test set-up revealed a defective test lead. The lead was shorted internally between the shielding and conductor. This is the DC return on the digital voltmeter.
4238 2/7/64	HCVR S/N 012 (III-3)	Open	Room (JPL)	Accident	During an investigation, the negative battery terminal was shorted to ground through the fuse by a grounded terminal on a digital voltmeter.
2262 12/10/64	Resistor R24 (type RN65E2002E)	Output voltage not within specified limit	Thermal-vacuum	Design	During thermal-vacuum testing at JPL, High-Current Voltage Regulator, Serial No. 012, was not operating within specified limits. Telemetry data indicated an output voltage of -26.0 volts, with an indication of one momentary drop to -23.0 volts. However, at no time did the communications or video output indicate an insufficient input-power condition. The assembly was returned to RCA, where troubleshooting revealed that resistor R24 in the regulated output telemetry circuit was changing resistance value. The component varied from 20 kohms normal to 15 kohms when heated. The resistor was replaced in the HCVR. High- and low-temperature tests were performed with no measurable change in the telemetry voltage after 30 minutes of operation. The resistor was then permanently installed, and the HCVR was acceptance tested. X-rays of the failed resistor revealed that one of the internal leads had separated from the resistive element. In resistors of this type, the leads are attached to a talon insert, which is bonded to the resistive element by a conductive cement. The cement is a mixture of silver and an organic binder, in which unseen cracks or voids occasionally occur during the curing process. This failure mode has occurred before. The previous failure was reported in Malfunction Report No. 3593 and involved the same resistor R24 in HCVR, Serial No. 13. The vendor is aware of the failure mechanism and indicated that it is an unusual occurrence. In order to increase part reliability, construction of this type of resistor has been changed from the talon lead, which failed, to a capped-lead construction. New resistor procurements will be of the end-cap configuration. A review of the TV Subsystem design indicated that RN65-type resistors are also employed in the Video Combiner, Low-Current Voltage Regulator, and High-Current Voltage Regulator Circuits.
			High-Current Voltage Regulator Assembly, S/N 013		
1689 11/18/63	Transistor Q6 (type 2N1490)	Collector to emitter	Room	Accident	The regulator failed during initial turnon. An inspection of the regulator revealed a shorted transistor, Q6, and a foreign material spread over the transistor and heat sink. This material was found by the chemistry laboratory to be alkaline. This deposit was not a contributing factor to the malfunction. However, all replacement transistors were gold-plated. The malfunction was caused either by improper loading of the regulator or by an improper turn-off procedure.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					High-Current Voltage Regulator Assembly, S/N 013 (Continued)
4682 1/7/64	Capacitor C1 Bracket	Shorting to chassis	Room	Design	Upon turn-on of the assembly, no outputs were present. Investigation revealed that the chassis was shorted to the terminal of capacitor C1. Four other High-Current Voltage Regulators had been reworked to shorten the capacitor brackets for additional clearance, but Serial No. 013 had not been included for the rework. The capacitor bracket was cut down and the assembly operated normally. The mechanical drawings will be modified to reflect this change.
5835 4/26/64	Transistors Q6 and Q7 (type 2N1490)	Failures to regulate output	Ambient	Workmanship	Following replacement of the cadmium-plated transistors on this regulator, the assembly did not regulate properly when operated at an input of 30.5 volts and an output of 5 amperes. Although the malfunction was thought to have been caused by improperly matched transistors, it was found that the regulators operated properly when the transistor mounted lugs were cleaned and the transistors retightened to provide a good electrical contact.
3593 4/27/64	Resistor R24	Value changed	Ambient	Workmanship	The output telemetry of this regulator exceeded specified limits during bench testing. Investigation disclosed that the resistance value of resistor R24, a 20,000 ohm ± 1 percent type, had changed by 6 percent. The vendor has been changing his methods of manufacturing from a talon-lead type of construction to a secure-end-cap type. The date code of this component indicated the talon-lead type of construction. The vendor verified the out-of-specification resistance value (9.2 percent) above nominal value. The talon lead was loosened or was pulled slightly away from the ceramic core. The conductive cement that originally bonded the lead to the core separated. This condition has occurred previously with the talon-lead resistor and has been known to result in a positive change of resistance from 1 to 10 percent. A radiograph established the failure mode which was confirmed when the molded jacket and protective coating were removed. The resistive element was measured in a test clip and was found to be within tolerance. The manufacturer has changed from a talon-lead to a capped-lead construction.
3903 5/27/64		Output at low end of specified limit	Ambient (postvibration)	Nonconfirmed	The regulated output of the High-Current Voltage Regulator (Serial No. 013) measured -27.00 volts during the postvibration test with an input of -30.5 volts and a 5-ampere load. RTSP-1132A requires an output voltage of -27.5 ±0.5 volts. The voltage drop across the SCR was measured, and while it was not found to be excessive, it was slightly higher than normal. The High-Current Voltage Regulator (Serial No. 013) was sent to the Chemistry Laboratory for cleaning and remounting of the SCR. A hold was placed on the unit for replacement of 2N329A transistors. Since the High-Current Voltage Regulator was within the specified limits of output voltage (although at the very low end of the tolerance), this is technically not a malfunction. The recommendation has been made that the SCR be cleaned and the measurement repeated (-30.5 volt input, 5-ampere load) prior to replacement of the SCR. If this cannot be accomplished, testing of the High-Current Voltage Regulator to RTSP-1132A should be followed closely to determine if a problem still exists.
					High-Current Voltage Regulator Assembly, S/N 014
4083 10/13/63	Holddown Bracket	Short to ground	Room (bench)	Design	An improper output was found when the regulator was bench tested. This was caused by a short from the C1 mounting bracket to the cover of the unit. Two other new regulators were inspected and it was found that these brackets were also too close to the covers. The bracket was reworked, reducing the size of the bracket and relocating the mounting screws eliminating the short.
4475 12/7/63	SCR CR5 (type 2N2025)	Erratic turn-on and interim cut-off	Ambient (Manuf.)	Nonconfirmed	Following erratic operation during manufacturing test, the SCR was tested and found to meet all specifications. However, with only a small load present, the SCR will not fully turn-on nor will it stay in the conducting state during voltage variations.
4027 1/4/64 4724 1/16/64	SCR CR5 (type 2N2025)	Low cathode gate resistance	Room	Secondary	A continuity check of the Subsystem following a malfunction in the Distribution Control Unit revealed a change in the front-to-back SCR cathode-gate ratio. The ratio should have been 10 to 1, it measured 5 to 1, however. Although the High-Current Voltage Regulator still functioned properly, the component was replaced because of the ratio change.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					High-Current Voltage Regulator Assembly, S/N 014 (Continued)
4027 1/4/64 4724 1/16/64 (Continued)					When the Distribution Control Unit was shorted, 3.5 amperes passed through the cathode-gate junction of the SCR. The maximum allowable gate current is only 2 amperes. The gate current, therefore, was 1.5 amperes over the specified limit and resulted in damage to the junction of the SCR. In order to prevent a recurrence of this malfunction, a procedure has been issued which states that the chassis of each unit is to be grounded during bench testing. This will prevent "floating" shorts.
4707 1/24/64	Transistor Q4 (type 2N329A)	Open collector	Thermal-vacuum (+55° C)	Workmanship (vendor)	Investigation of intermittent operation of the High-Current Voltage Regulator during a thermal-vacuum test revealed a defective Q4 transistor. Opening of the transistor disclosed a defective bond between the collector lead and the transistor junction. A review of the previous Ranger malfunction indicated that no previous type 2N329A transistors had failed. However, subsequent problems were revealed with the Raytheon Transistor and they were replaced with Sperry and National units. No documentation change was required to implement this replacement.
4056 4/9/64		Poor regulator	Ambient	Workmanship	Investigation of a low output voltage from the HCVR (26.86 volts as opposed to 27 ±0.5 volts) revealed an excessive voltage drop across SCR CR5. The SCR was replaced; however, during the replacement, deposits of flux and oxidation were discovered on the sides of the heat sinks where the cable lugs are attached. This contamination was established as the cause of the malfunction after a check on the SCR (removed from the HCVR) proved it to be fully operational. Instructions for cleaning the heat-sink contact surfaces have been issued and are now in effect.
4797 4/12/64		SCR would not trigger	Ambient	Workmanship	Investigation into the inability of SCR to trigger revealed the installation of a resistor of the wrong value in the test set-up. The correct value resistor was installed but the SCR still would not trigger. Further investigation revealed a 600-ohm short from the junction of C3, R27, and CR8 to ground. This malfunction was caused by a pinched wire that was improperly routed. Replacement of the wire in its correct route restored normal operation of the SCR.
					High-Current Voltage Regulator Assembly, S/N 015
3559 9/17/63	Potentiometer R3 (type 22UL 500-501)	Potentiometer open	Ambient	Accidental	Potentiometer was open at the lower end. Vendor analysis indicated that the element at the CW end over the termination-tab area and the wiper were burned because of an overstress due to a test error.
4082 10/12/63	Hold-Down Bracket	Short to ground	Room	Design	An improper output was found when the regulator was bench tested. This was caused by a short from the C1 hold-down bracket touching the cover of the unit. Two other new regulators were inspected and it was found that these brackets were also too close to the cover. The hold-down bracket was reworked, reducing the size of the bracket and relocating the mounting screws eliminating the problem.
4685 4702 1/8/64	Transistor Q6 (type 2N1490)	Shorted, collector-to-emitter	Room	Secondary	Following the repairs necessitated by Malfunction Report No. 4683, it was found that the output from the High-Current Voltage Regulator was 32.3 volts. This indicated a shorted series transistor. Transistors Q6 and Q7 were both replaced because they are a matched pair. It is believed that the shorted input noted in MR 4683 on transmitter power supply 019 caused this malfunction.
4798 4/16/64	Wires	Shorted	Ambient	Workmanship	Investigation of shorting which appeared during testing of the High-Current Voltage Regulator disclosed four wires within the Assembly that were either pinched or chafed and were shorted to the chassis. The wiring errors were corrected. Cable rerouting and modified wiring information are being issued that will prevent a recurrence of this malfunction.
					High-Current Voltage Regulator Assembly, S/N 016
4477 4478 12/13/63	Lead	Poor regulation	Room	Workmanship	The High-Current Voltage Regulator exhibited poor regulation during the six-camera bench test. Investigation disclosed that the lead used to connect the emitter of transistor Q5 to resistor R12 had been pinched and severed during assembly. The damaged wire and several other leads were replaced.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Four-Port Hybrid Assembly, S/N 004		
4497 1/12/64		Power fluctuation	Partial vacuum	Workmanship	Investigation into a power fluctuation of 0.2 db during the high-power, ionization-breakdown acceptance test of this stripline hybrid revealed a severe scratch extending across the copper center-conductor strip on the J-connector strip. This scratch had almost completely severed the strip. This scratch had occurred prior to the plating process because gold plating was noted along the edge of the scratch. All contact strips will be examined under a magnifying glass to prevent future failures of this type.
			Four-Port Hybrid Assembly, S/N 006		
4491 1/3/64	Cable 30W28, Serial No. 012	Power fluctuation	Partial vacuum	Workmanship	A power fluctuation of 0.3 db occurred during high-power ionization-breakdown acceptance tests. The fluctuations appeared to depend more on temperature than on the partial vacuum and were not affected at all by the presence of Cobalt 60. After replacement of the Hybrid with Serial No. 004 did not cure the malfunction, the cable was replaced and the malfunction disappeared. An X-ray examination of the cable revealed that a solder void of 45 percent existed between the center conductor and the connector pin at A24P4. It should be noted that the high-power ionization test will always reveal this type of malfunction in an RF cable.
			Dummy Load Assembly, S/N 004		
3932 3970 5881 3/24/64		High leak rate	Ambient	Design	The malfunction reports recorded three consecutive times that the assembly did not pass the leak test. One malfunction was attributed to the cutting of the silicon-rubber spacing pads. However, all malfunctions occurred prior to the issuance of a requirement for increased torquing of the screws used to fasten the cover of the pressure vessel. Following retorquing, the assembly passed the leak test.
			Dummy Load Assembly, S/N 009		
3423 10/3/63	Valve Core	Gas leak	Room (JPL)	Workmanship	Two failures were discovered on this unit. First the unit was leaking pressure and second it had a high VSWR. Preliminary analysis indicated that tapping the unit would change the VSWR. The problem was investigated by AED mechanical engineers, and it is believed to be a fabrication weakness. The responsible personnel have issued revisions to manufacturing and fabrication control drawings.
3966 10/10/63	Dummy Load (RCA Dwg. 8483238)	High VSWR	Room	Random	When tested the Dummy Load was found to be tap-sensitive. (Tapping would cause the VSWR to increase.) The unit was disassembled for examination and then reassembled so additional tests could be performed. The unit was no longer tap-sensitive and had an acceptable VSWR. The failure could not be duplicated and the vendor was unable to furnish any possible reason for this failure.
			Dummy Load Assembly, S/N 011		
4267 1/15/64	Valve Core	Leaky	Room (AMR)	Accident	Investigation into the drop in pressure of the pressure vessel for the Dummy Load from 15 to 5 psig revealed that the valve core had been crushed allowing it to leak. The pressure gage and tank filler can be tightened so that the valve core is crushed. Only the individuals who have been properly instructed in the proper use of the filler and pressure gage should make the pressure measurements. Also, all valve cores which have not been changed since December 13, 1963 should be replaced because prior to that date, all pressure checks were made without the realization that the core could be damaged.
			Dummy Load Assembly, S/N 012		
2784 8/28/63	Pressure Valve	Sheared off	Room (engineering test)	Accident (test error)	The pressure valve was sheared off at the threaded end when the valve cap was torqued on without using the proper tools (torque wrench).

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Dummy Load Assembly, S/N 012 (Continued)		
5880 4/16/64	Cable RG 142 A/U	Broken fiber jacket	Ambient	Workmanship	It is believed that during the installation of the Dummy Load in its housing, the proper procedures were not followed, attempts were made to force-fit the cable into the housing, and the fiberglass jacket of the RG 142 A/U cable was ruptured. The proper procedure has again been brought to the attention of manufacturing and quality control personnel.
			Dummy Load Assembly, S/N 026		
4024 12/13/63	Pressure Valve, (Model 300-1)	Loss of pressure	Thermal-vacuum (integration)	Accident	During the thermal-balance testing when the malfunction of Malfunction Report A4045 occurred, the output power was noticed to drop below normal. Following the replacement of the Sequencer Assembly, a power profile on the P-Channel was performed. The power profile revealed excessive reflected power. A check of the pressure vessels revealed that the pressure in the Dummy Load Assembly was zero psi. It was determined that the pressure valve core had been deformed by the pressure gauge. The "O" ring, pressure valve, valve core, and RF connector were all replaced. All personnel have been informed to use care when pressurizing the Dummy Load pressure vessel.
3375 7/13/64	Coaxial Connector	Damaged	Ambient	Accident	The Voltage Standing-Wave Ratio (VSWR) was measured as 1.52. The maximum allowable value is 1.30. The unit was disassembled and found to have a damaged coaxial connector. One of the contact leaves of the center conductor was broken. The unit was returned to the manufacturer for repair; however, it was decided to procure a new load and scrap Serial No. 026. The new load, Serial No. 031, has been installed in the pressure housing, Serial No. 006, and has satisfactorily passed its acceptance test.
			Dummy Load Assembly, S/N 027		
1544 11/30/64		Decrease in internal pressure	Post-thermal-vacuum	Nonassignable	During the post-thermal-vacuum pressure check of the dummy load, it was found that the pressure dropped from 13 psig to 7 psig. The core valve and the purged valve gasket were replaced. The unit was pressurized to 15 psig, and the valve was torqued to 30 inch-pounds. The core and cap were checked and found to be good. Leak rate was within specification limits.
			Dummy Load Assembly, S/N 031		
3575 1/6/65	Cable Serial No. 034A	High VSWR	Ambient	Workmanship	During acceptance testing of spare Dummy Load, Serial No. 031, the initial VSWR measurement read entirely off the meter scale. Troubleshooting isolated the problem to an RF cable, Serial No. 034A, in the pressure vessel, Serial No. 006. The cable, when checked with an ohmmeter, was found to have a short from the center conductor to the shield. Examination of the cable revealed that the female contact of the cable connector was bent to one side, and in this position, the male contact of the feedthrough connector shell on the bulkhead would not mate properly. This would indicate that the female contact of the cable had slipped down along the side of the feedthrough male contact instead of over it, thus making a connection from the center conductor to the outer shell. This short would not have occurred if the connector at the pressure-vessel end of the cable had been properly assembled. Inspection of the connector revealed that the front teflon insulator had not been installed. This insulation is a detached part and must be installed as the final step prior to installation of the connector outer shell and potting of the cable. The cable was replaced.
1504 1/21/65 1548 1/22/65 1549 1/26/65	Purge Screw, Purge-Screw Gasket, "O" Ring	Excessive leak rate	Vacuum	Wearout	Following installation of the internal RF cable (MR 3575), Pressure Vessel and Dummy Load, Serial Nos. 006/031, were retested and failed the leak test. The leak rate was measured as 1.95 x 10^{-5} cc per second, while the maximum specified value is 1 x 10^{-5} cc per second. The excessive leak rate was thought to be due to a worn purge screw. The purge screw, purge-screw gasket, and "O" ring were replaced. The unit was repressurized and again failed the leak test with a measured leak rate of 2.95 x 10^{-5} cc per second. The unit was disassembled, carefully examined for nicks or burrs, cleaned, and reassembled with a new "O" ring. The unit again failed the leak test with a measured leak rate of 1.5 x 10^{-5} cc per second. At this time, it was discovered that the wrong-sized "O" ring had

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Dummy Load Assembly, S/N 031 (Continued)		
1504 1/21/65 1548 1/22/65 1549 1/26/65 (Continued)					been used. The unit was assembled with the proper size "O" ring, pressurized, and successfully completed the leak test. The initial failure was attributed to the worn purge screw. All wrong-sized "O" rings were removed from stock.
			Dummy Load Assembly, S/N 301		
2109 3882 6/20/64		Excessive leak rate	Ambient (leak test)	Accident	Dummy Load Assembly, Serial No. 301, was found to have an excessive leak rate. The unit was disassembled, resealed, and retested. The excessive leak rate was still present. The unit was again disassembled and examined. Several scratches were found across the seal area of the "O" ring mating area. Most of the scratches were inflicted after iriditing and appear to be caused by handling. The scratches were polished, and the mating surfaces refinished. When the unit was reassembled and tested, the leak rate measured within the specified value (8.8 x 10^{-6} std ccHe per second).
			Low-Current Voltage Regulator Assembly, S/N 004		
3926 3/25/64		Measurements not within specified limits	Ambient	Accident	Investigation of the inability of this Assembly to pass the acceptance test indicated the possibility of operator error. Therefore, the test was repeated with satisfactory results.
			Low-Current Voltage Regulator Assembly, S/N 005		
5815 3/31/64	Mica Washer	Cracked	Ambient	Accident	Investigation of the inability of this Assembly to pass the electrical leakage test revealed that the mica washer was cracked. The washer was replaced and the Assembly passed the test. It is believed that either excessive tightening, foreign material under the washer, or surface irregularities were the cause of the washer cracking. The proper torque to be used has been disseminated and all mounting surfaces will be carefully cleaned and inspected in order to prevent recurrence of this malfunction.
			Low-Current Voltage Regulator Assembly, S/N 007		
3783 8/28/64	Resistor R4		Ambient	Design	This is not a true malfunction, but is a design modification required by the replacement of the Instrument Development Laboratories, Commutators with units manufactured by the Fifth Dimension, Inc., on Flight Models III-3 and III-4 and the Spare TV Subsystem. This change of Commutators reduced the load requirements on the Low-Current Voltage Regulator from 250 ma to 150 ma. In order to maintain an output voltage of exactly -27.5 volts at 150 ma, it is required that resistor R4 of the Low-Current Voltage Regulator be selected very close to its nominal value. Low-Current Voltage Regulator, Serial No. 007, has not deviated from its voltage tolerances during any tests.
3842 9/26/64		Leakage to chassis out of specification	Ambient	Nonconfirmed	During a leakage test on Low-Current Voltage Regulator, Serial No. 007, a measurement of -0.145 volt was read on a digital voltmeter. This exceeded the specified limit of -0.1 volt. The measurement was repeated with two different digital voltmeters and the leakage was found to be within the specified limit, indicating the original voltmeter employed was defective. However, a calibration procedure was performed and the voltmeter was found to be within specification. A leakage measurement was again taken with this voltmeter and this time a normal value was obtained. The digital voltmeter is still considered to be the probable source of this malfunction. If a malfunction of this nature recurs, the test equipment will be thoroughly investigated internally to determine the cause of the failure.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Low-Current Voltage Regulator Assembly, S/N 009		
4775 4/14/64		Monitored voltage not within specified limits	Ambient	Accident	Investigation of a monitored voltage not being within specified limits disclosed that a resistor of the wrong value had been installed in the circuit. The drawing had been accidentally changed to call for this resistor. Both the Assembly and the drawing were corrected.
			Telemetry Power Supply and Regulator		
5883 5884 3/24/64	Transistor Q2 (type 2N1490A) Diode CR2 (type 1N935)	Stressed Shorted	Ambient	Design	Investigation into the tripping of the circuit breaker at initial turn-on revealed that excessive current had been drawn by the shorting of diode CR5 and the resultant overstressing of transistor Q2. This had been caused by the interchanging of two wires and the nicking of the teflon sleeving in the base of transistor Q2. The nicking was caused by the hat of the diode being pressed into the base of the transistor. Both the diode and the transistor were replaced and the base leads of the transistor were rerouted. Normal operation was obtained.
5888 3/26/64	-	Voltage out of specified limits	(-10° C)	Accident	An insulation diode had been added in series with the input to the Telemetry Power Supply and resulted in an input of only -26.6 volts rather than -27.0 ±0.3 volts. The specification is being changed to permit -26.5 ±0.5 volts. In addition, the output voltage varied from 26.0 to 26.9 volts although the specification called for 28 ±1.4 volts. Because the reference voltage may vary 1.5 volts, the specification is being changed to permit an output voltage of 27 ±2 volts. The frequency of the VCO was found to be 6 cycles low at -10° C because of the lower voltages. It should be noted that although the specified maximum variation is 5 cycles, this is at 0° C and allowances should be made for lower operating temperatures.
5871 3/27/64	-	Low input voltage	Ambient	Design	The addition of a diode (type 1N538) in series with the input from the power supply resulted in a voltage drop of 0.5 to 1.0 volt which provided an input voltage below the specified minimum. The specification was revised to indicate a lower specified minimum. The operation of the assembly is satisfactory.
5889 3/27/64	-	Frequency out of specified limits	Thermal-vacuum (0° C)	Accident	The measurements made on the assembly while undergoing testing at 0° C were compared to the limits specified for ambient operation. The measured values were not within these limits and the assembly was, at first, considered to have failed the testing. However, the measured values did compare favorably with the limits specified for operation at 0° C in RSP 1140A. A new data sheet is being prepared that will specify the limits during operation at 0° C, -10° C, and +45° C (Refer to MR 5890).
5890 3/27/64	-	Frequency out of specified limits	Thermal-vacuum (+45° C)	Accident	The same problem as noted in MR 5889 occurred on this malfunction except that the values measured during operation at +45° C were being compared to the limits specified for operation at ambient.
5873 4/1/64	-	Corrosion on printed board trace	Ambient	Workmanship	Green surface corrosion was found on the printed circuit wiring. Further examination revealed incomplete removal of the solder flux and bare copper streaks on some of the printed traces. These problems are believed to have been caused by an inadequate rinse after removal of the board from the plating bath. All corrosion was removed and the printed wiring was covered with a heavy, smooth solder coating. This is the only occurrence of this type of problem and it in no way affected the electrical operation of the circuit.
3826 4/20/64	Filter Capacitor	Shorted	Ambient	Design	Investigation of the shorting of the filter capacitor revealed that this type of capacitor is manufactured using the case-within-a-case type of construction. This type of construction is prone to shorting between lead to case on both ends of the capacitor thus resulting in a shorting of the capacitor. All capacitors of this type will be replaced with type 6K105AA or, in one instance, with type 29F1563.
3829 4/24/64	-	Power supply input below specified limits	Ambient	Design	The input to the Telemetry Assembly power supply was below the minimum specified voltage; however, operation of the Telemetry Assembly was normal and within other specification conditions. Data from the test were reviewed by JPL and operation of the telemetry chassis was considered acceptable.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Telemetry Power Supply and Regulator (Continued)		
3987 4/27/64	Capacitor	Mylar insulation cut	Thermal-vacuum	Accident	A heavy load on the negative voltage supply was found to have been caused by the cutting of the mylar insulation sleeve during the mounting of the capacitor into the supporting clip. The damage was repaired and normal operation restored.
3878 5/6/64	Transformer	Open winding	Qualification (vibration)	Wearout	Investigation of the loss of pedestal reference levels during the second qualification level vibration test for the commutators (5D Inc.) revealed an open primary in the transformer. The leads had broken at the terminal end of the toroid. This Telemetry Assembly and Power Supply has undergone at least six vibration tests at qualification levels. Therefore, the malfunction is considered to have been caused by vibration fatigue.
3765 6/23/64	-	Input voltage below specified value	Thermal (at 0°C)	Nonconfirmed	The telemetry power-supply input voltage read -25.74 and -25.77 volts at 0°C. The specified value is -27.5 ±1.5 volts. MRA 100-64-130 has been approved by JPL indicating acceptability of this condition. This reduction in input voltage will not affect the operation of Voltage Controlled Oscillator or the telemetry power-supply output.
			90-Point Commutator, S/N 1002		
2898 5/3/63	-	Incorrect data point	Room (ambient)	Design	Incorrect data read from point No. 85. The commutator was returned to the vendor to increase brush pressure and add lubricant to switch contacts to prevent build-up of film.
4264 11/26/63	-	Telemetry points erratic	Ambient (JPL)	Nonconfirmed	Following erratic indications from telemetry points Nos. 46, 41, and 66, the commutator was replaced with a spare. The malfunctioning commutator was returned to RCA for tests and was found to be good. It is possible that a connector was responsible for the missing telemetry points.
			90-Point Commutator, S/N 1003		
A2836 4/9/63	-	Data point missing	(0°C)	Design	Data point missing. Returned to vendor to increase brush pressure to approximately 15% and add lubricant to switch contacts to prevent build-up of film.
			90-Point Commutator, S/N 1005		
2983 4/12/63	-	Data point missing	Thermal-vacuum	Design	Data points missing. Returned to vendor. Vendor will increase brush pressure to approximately 15% and add lubrication to switch contacts to prevent build-up of film.
4236 1/5/64	-	Open points	Room (JPL)	Workmanship	The 90-point commutator was returned to the vendor for analysis because it was reading open on point Nos. 3, 5, 7, 9, 11, and 13. During the leak tests to which all returned commutators are subjected, this commutator exhibited excessive leakage around the speed-adjust potentiometer. The capsule that contained the air-conditioning agent was found to be empty. This resulted in contamination to the contacts.
			90-Point Commutator, S/N 1006		
1671 4/19/63 1669 4/12/63	-	Data point missing	Thermal-vacuum	Design	Data point missing. Returned to the vendor to increase brush pressure by approximately 15% and add lubricant to switch contacts to prevent build-up of film.
			90-Point Commutator, S/N 1008		
2899 5/3/63	-	Incorrect telemetry voltage	Room (ambient)	Design	Point No. 88 read a positive instead of a negative voltage value. Believed to be due to an incorrect switch wiring. The commutator was returned to the vendor (IDL) for repair, modification, and analysis. The opinion of the vendor was that contact bounce was responsible for the erratic data on this point. The increased brush contact pressure and the lubrication of the contact corrected this malfunction. All flight commutators will receive the same modification.
3309 3359 7/11/63	-	Short	Room (integration)	Workmanship (vendor)	Erratic operation of the Telemetry Assembly on the Subsystem was verified on the bench. The 90-point commutator was faulty at every other data point. This commutator was returned to the vendor for analysis.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					90-Point Commutator, S/N 1008 (Continued)
3309 3359 7/11/63 (Continued)					It was discovered that a plastic bag, containing a conditioner, had developed a leak. This fluid is a conductor and formed parallel conductive paths, allowing the switch to contact. The vendor considers the makeup of this conditioner and its need in the switch to be proprietary and will not reveal this information. They state that they have had very few failures, if any, of this type and several of their bags of conditioners are used in all of the switches that they make.
					90-Point Commutator, S/N 1012
3977 4/18/64	-	Loss of data points	Ambient	Workmanship	The voltage output from point Nos. 64, 66, 68, and 70 of the 90-point commutator were positive with respect to the zero reference. Investigation revealed that this was caused by contact contamination resulting from a loss of air conditioning fluid caused by air leaks in the sealed unit. All IDL commutators are being reworked and in addition, a second source from Fifth-Dimension, Inc. is being tested for qualification and, if approved, all IDL commutators will be replaced.
					90-Point Commutator, S/N 4986
3958 5/5/64	-	Telemetry noise	Vibration	Secondary	The commutator (Serial No. 4986) was returned to the vendor after noise was detected during the operating vibration test. The unit had failed initially (See MR 4000) and it was discovered that the brushes had been damaged but not replaced after the failure. The brushes were replaced and the unit successfully completed the operating vibration test.
4000 5/5/64	-	Noisy operation	Qualification (vibration)	Workmanship	The output from the 90-point commutator became noisy during the qualification vibration testing. The noise was only on the leading edge of the data points and all information could be interpreted. Operation of the unit without vibration was normal, but when subjected to flight vibration, again became noisy. An examination of the unit by the vendor revealed that an insufficient amount of epoxy has been applied to the "C" clamp and rotor resulting in the "C" clamp loosening and allowing some slight movement of the rotor about its shaft. The amount of bonding material has been increased so that the epoxy is now applied to the entire "C" clamp.
					90-Point Commutator, S/N 4987
2140 7/12/64	-	Data points No. 75 and 80 reversed	Ambient (camera calibration verification)	Design	Improper data were received from data points Nos. 75 and 80 during the camera calibration verification. This situation occurred after the thermal-vacuum test performed on April 26, 1964. Confirmation of the failure was not possible until recently when both channels of the commutator were operated independently. Examination of the commutator revealed that the wiring of data points No. 75 and 80 was interchanged. These points are for the heat-sink telemetry; the correct notation is as follows. Data Point No. 75: P-channel PA heat-sink temperature (Sensor No. 6) Data Point No. 80: F-channel PA heat-sink temperature (Sensor No. 7) The applicable data sheets were corrected and the cognizant RCA representative (SDAT) was notified of the condition. Specifications are being revised to reflect the change.
					15-Point Commutator, S/N 1001
1664 3/28/63	-	Loss of data points	Thermal-vacuum	Design	Loss of points 8, 9, 10, 11 data. Returned to vendor. Vendor will increase brush pressure approximately 15% and apply lubricant to the switch contacts to prevent build-up of film.
					15-Point Commutator, S/N 1003
5875 4/2/64	-	High and erratic current drains, grinding noise	Ambient	Workmanship	During a bench test, the 15-point commutator was reported as making a grinding noise. High and erratic current drains were also noted. Replacement of the unit resulted in normal operation of the telemetry chassis. The malfunctioning unit was returned to the vendor for analysis and repair. An initial electrical inspection indicated an intermittent open circuit. In addition, the motor was drawing excessive current. After disassembly, the wear on the carbon brushes was found to be less than normal, which indicated low brush pressure. The pressure was increased, and the latest modifications were incorporated. The commutator was assembled, tested, and returned.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					15-Point Commutator, S/N 1010
4241 4/20/64	-	Noisy data points	Ambient (JPL)	Workmanship	Following the x-axis noise bursts of the vibration test, the 15-point telemetry became noisy and information from several of the data points was lost. The operation of the commutator throughout the vibrationtesting had been noisier than normal. Replacement of commutator Serial No. 1010 with Serial No. 1011 restored normal operation. It is planned to replace the IDL commutators on the PTM, the only Subsystem to still use the IDL types of commutators, with 5-D Inc. types when they become available.
					15-Point Commutator, S/N 1012
3979 4/19/64	-	Loss of data points	Ambient	Workmanship	Investigation into the loss of output from point Nos. 7 through 13 revealed a condition similar to that discussed under MR 3977. In addition, it was found that epoxy was flaking off the brushes and was reacting with the cramaline used to lubricate the contact surfaces. Refer to MR 3977 for recommendations.
					15-Point Commutator, S/N 5948
2307 2/4/65	-	Telemetry out of specification	Ambient (ETR)	Nonassignable	A review of telemetry data during Ranger VIII collimator alignment indicated that the output from data point No. 12 (full-scale reference) of the 15-point telemetry Commutator, Serial No. 5948, was only half its normal width and normal amplitude. On the next telemetry frame, the amplitude was reduced to a small spike. All subsequent telemetry frames indicated an output of +0.2 volt for data point 12 which is an indication of open-circuit condition. The unit was replaced by spare Commutator, Serial No. 5949, and normal operation for all data points, including data point No. 12, was restored. All pins of the disconnected cables were given a pin-retention check and were normal. The failed unit was installed on the Spare TV Subsystem and operation of all data points including data point No. 12 was normal. The Commutator was returned to the vendor where a contact-resistance test indicated that all data points were normal (0.2 ohm). The specification value is less than 1 ohm. This test indicated good contact and good connection for all circuits of data point No. 12. The following items were then examined under a microscope with no indications of abnormalities: the pins of the commutator connector, wire side of the connector with the commutator disassembled, the wires, brushes, and commutator segments. The vendor could not conceive of any failure mode, which would affect only one data point, that was not checked in these tests. Two connectors and a cable, the telemetry unit, and the commutator complete the circuit. The reference voltages for the 15- and 90-point Commutators are obtained from the same source. The full-scale reference voltage for the 90-point Commutator was normal during the time that the full-scale reference voltage for the 15-point Commutator indicated the abnormal +0.2 volt. The Commutator will undergo further tests at RCA if required to support the Ranger IX Subsystem.
					Channel-8 VCO, S/N 037
3757 5/22/64	-	Center frequency out of specified limits	Thermal-vacuum (qualification level)	Accident	The center frequency of the Channel-8 VCO was out of specification limits when tested at 45°C under thermal-vacuum qualification-level conditions. The center frequency measured 2993.7 cps, while the specified limit is 3000 ±5 cps. The Channel-8 VCO was then tested at ambient conditions and the center frequency was still out of specified limits. The center frequency was readjusted at ambient and subjected to temperature extremes. The center frequency then remained within specified limits. The malfunction was attributed to parts not screened at high-temperature, and as a result of operation at +65° C, these parts assumed a permanent set. This Channel-8 VCO was retested under thermal-vacuum conditions.
3758 3759 5/22/54	-	Apparently out of specified limits	Ambient	Nonconfirmed	The Telemetry Assembly was inadvertently tested to the unrevised RTSP-1140, Appendix B, and the Channel-8 VCO and Channel-P VCO were considered out of specification. When tested to the revised RTSP-1140, Appendix B (revised May 5, 1964), the Channel-8 VCO and Channel-P VCO were considered with the specification limits.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
Channel-8 VCO, S/N 3403					
2885 2/20/63	-	Excessive frequency change	Thermal-vacuum (+55° C)	Workmanship (vendor)	Center frequency changed by 60 cps at +55° C during thermal-vacuum test. The allowable change is ±5 cps. Unit was returned to the vendor for analysis. The vendor found an intermittent lead connection between R12 and R18. The vendor will institute tighter assembly and quality control inspection procedures.
3934 4/7/64	-	Frequency not within specified limits	(-10° C)	Workmanship	This malfunction was previously analyzed under MR 5874. This is the second malfunction report written on the same problem.
5872 4/3/64 5874 4/7/64	-	Frequency out of specified limits	Ambient and -10° C	Workmanship	At -10° C the frequency output of the VCO was 3.2 cycles below the specified limit of 2995 cps. During subsequent testing under ambient conditions, the VCO could not be modulated. Following replacement with VCO Serial No. 3431, the malfunctioning VCO was microscopically examined. This disclosed considerable flaking and wear of the gold plate on the contacts. The malfunctioning was believed to have been caused by either shorting between the contacts because of loose gold flakes or by an open circuit because of foreign matter being trapped at discontinuities of the plating. The cleaning of the contacts restored proper operation.
Channel-8 VCO, S/N 3431					
3761 6/1/64	-	Center frequency out of specified limits	Thermal-vacuum (+45° C)	Accident	When tested under thermal-vacuum conditions at +45° C, the center frequency of the Channel-8 VCO was measured at 3005.1 cps, while the specified limits for the center frequency are 3000 ±5 cps. It was concluded that the Channel-8 VCO has assumed a permanent set due to temperature bake in thermal-vacuum. The center frequency can be brought into specified limits by retuning. This deviation was reviewed by Material Review Action and approved by JPL.
Channel-8 VCO, S/N 3433					
3955 5/8/64	-	Variation in output	Ambient	Workmanship	The output of the Channel-8 VCO varied during a check-out test following vibration testing. Examination of the unit revealed a poor solder connection on the chassis connector. Proper soldering of the connector restored normal operation.
Channel-8 VCO, S/N 3435					
3767 6/29/64	-	Center-frequency reported out of specification	Thermal-vacuum (at +45° C)	Nonconfirmed	The center-frequency of the Channel-8 VCO drifted from 3001.8 cps (the original frequency) to 3009.6 cps after 64 hours of a thermal-vacuum test. (The tolerance specified for the VCO is ±5 cps.) The excessive drift is attributed to a malfunction of the HP counter used for frequency monitoring.
Channel-8 VCO, S/N 4007					
5876 4/2/64	-	Loss of output	Ambient	Random	After attempts to alter the output amplitude only resulted in a loss in amplitude, the assembly was returned to the vendor for analysis because it is sealed and proprietary. The vendor removed the potentiometer, measured the resistance, discovered an open circuit, and then inadvertently discarded the failed potentiometer. Therefore, the reason for this part failure could not be established. No previous open-potentiometer failures have been encountered on this VCO.
3771 7/6/64	-	Low output voltage	Thermal (at 0° C)	Nonconfirmed	During thermal test at 0° C, the output voltage of the Channel-8 VCO, Serial No. 4007, was measured at 5.8 volts, peak-to-peak. The specified minimum output voltage is 6.0 volts. Channel-8 VCO, Serial No. 4007, is an early design which incorporates a series resistor and a tapped potentiometer for a variable output. Later designs employ a single fixed resistor. The output voltage at 25° C measured 6.5 volts, peak-to-peak; at 0° C in vacuum, measured 6.2 volts; and at 45° C was 7.1 volts. The performance of the TV Subsystem will not be affected by this condition. MR 100-64-134 has been approved by JPL, indicating acceptability of this condition.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Channel-8 VCO, S/N 4007 (Continued)		
3787 8/31/64	-	Frequency shift	Ambient	Accident	During a recheck of the F-Channel of Flight Model III-3 TV Subsystem, the frequency of the Channel-8 VCO shifted as the F-Channel current was increased. The actual frequency appeared normal when viewed on an oscilloscope. Further testing revealed that high-frequency noise on the 3-kc input to the counter was causing the counter to be falsely triggered. When the gain on the counter was reduced, the frequency of the Channel-8 VCO became stable and within specification.
			Channel-8 VCO, S/N 4010		
2897 5/2/63	-	Unstable center frequency	Vibration	Workmanship (vendor)	Center frequency was unstable and could be shifted by tapping the case. The VCO was returned to the vendor for analysis. The vendor found that capacitors C1 and C2 were intermittent, transistor Q3 had low gain, and Q4 was open. The VCO was repaired and the vendor instituted tighter receiving and quality control test procedures.
			225-kc, VCO, S/N 002		
2264 12/17/64	-	High output level	Ambient	Accident	During testing of Flight Model III-4 at JPL, the output of F-Channel VCO, Serial No. 002, was 3 db higher than nominal. This unit, manufactured by Datatronics, had replaced VCO, Serial No. 1034, manufactured by Vector, on this Flight Model. Specification requires that the output of the VCO is to be adjusted for 1.5 volts, peak-to-peak, measured across a 10-kilohm load at the end of flight-length subminiature cable. Resistor R5 in the modulator circuit must be adjusted to provide the proper telemetry deviation for a 1.5-volt input to the IF modulator. The encountered problem occurred because the Vector VCO is not an emitter-follower output-type (output impedance is 20kilohms) as the Datatronics unit, and is affected by modulator input impedance which varies from unit to unit. Therefore, the Datatronics VCO is not a direct replacement for the Vector unit without adjustment. Resistor R5 in the modulator has been adjusted so that the telemetry sidebands are 0 db below peak carrier amplitude.
			225-kc VCO, S/N 004		
3766 3768 6/23/64 6/29/64	-	Center-frequency out of specification	Thermal-vacuum (at +0° C +45° C	Nonconfirmed	The center-frequency of the F-channel VCO was 224.324 kc during the 0° C test and was 225.760 kc during the +45° C test (the specification tolerance is 225 ±0.5 kc). Furthermore, the VCO was slow in stabilizing when it was turned on. The trouble was traced to an HP counter which was found to be reading 1% low (by 2.25 kc at the VCO center-frequency). The VCO was adjusted to 1% high in frequency and then subjected to electrical acceptance tests. The center-frequency was readjusted, using a calibrated counter, and normal operation was restored.
4039 10/2/63	-	No output	Room (engineering)	Workmanship (vendor)	The VCO was removed and sent to the vendor for analysis because of no output. The vendor reported that the decoupling capacitor was defective. This capacitor is a mylar, polycarbonite sheet inside the case of the VCO. The vendor further reported that this sheet had yellowed, probably because of subjection to an excessive amount of heat that resulted in the lessening of the dielectric strength and thus allowing the capacitor to short.
			225-kc VCO, S/N 005		
2108 6/18/64	-	Unstable	Ambient	Workmanship (vendor)	The P-Channel output of the 225-kc VCO was unstable. The output frequency varied for a fixed-voltage input after a warm-up period of approximately 15 minutes. This VCO was replaced by Serial No. 009. Examination of the faulty VCO revealed potting compound on pins 4, 5, 8, and 9 of its connector. The connector was cleaned and retested. Operation was still unstable, so the unit was returned to the vendor for analysis. The vendor confirmed the failure. Some foreign material was found between the collector-resistor and emitter-resistor leads of the input transistor on the printed circuit board. The foreign material was removed, the board cleaned, and operation was normal. The material was not analyzed.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					225-kc VCO, S/N 015
4653 2/8/65	-	Frequency deviation Out of specification	Thermal-vacuum	Accident	During thermal-vacuum testing, at 45° C, of the 225-kc VCO, Serial No. 015, the frequency deviation was higher (10.544 kc) than the specified upper limit of 10.5000 kc. In addition, the output level for a +1.25-volt input was lower (1.28 volts) than the specified minimum value of 1.30 volts. However, the frequency deviation was linear throughout the entire range. Review of the history of this unit revealed that the center frequency was adjusted at ambient condition, and that the input-voltage extremes (+1.25 to -5.0 volts, DC) were checked for conformance to the frequency specification. The unit had not been checked for frequency deviation at +45° C, which would include the +1.25-volt input. This check is not required, but is usually performed as a precaution before flight acceptance testing. The VCO was checked in a Tenny chamber at +45° C for frequency deviation, and the sensitivity, center frequency, and pulse amplitude were adjusted for optimum operation. The VCO performed normally during this test. This out-of-specification condition has been referred to JPL on MRA No. 100-65-002 and has JPL concurrence.
					225-kc VCO, S/N 1023P
2800 1/25/63	-	Adjustment	Bench test after commutator burn-in	Random	Could not set peak-to-peak deviation to 10 kc. Unit functioned properly during initial tests. Returned to vendor for analysis. The vendor has reported that this is the first failure of the type encountered. It was random in nature and not due to design, operations, or processes. The subcontractor was requested to furnish more detailed failure analyses, as a matter of record, in the event additional malfunctions are reported.
					225-kc VCO, S/N 1026P
2863 7/25/63	-	Loose potentiometer	Room (engineering)	Workmanship (vendor)	The output potentiometer on the VCO was found to be loosely mounted. While no changes in the unit's electrical characteristics could be attributed to this mechanical problem, the loose potentiometer prevents the VCO from being used on a spacecraft. The VCO, Serial No. 1026P was replaced.
					225-kc VCO, S/N 1047P
3595 5/1/64	-		Ambient	Accident	The apparent failure of the F-Channel, 225-kc VCO to operate was caused by the failure of the operator to perform the test in accordance with the latest revision of RTSP-1140A. During a test in accordance with this specification, the unit did operate although not correctly. However, this component was utilized only to complete telemetry change for Qual testing other components. These VCO's are being replaced by Datatronics.
3996 5/1/64	-	Output not within specified limits	(0° C)	Secondary	During a new series of re-qualification tests performed because of changes in the Telemetry Assembly for Flight Model III-2, the output of this VCO was noted to be out of specified limits. This VCO was included only to provide proper power supply loading and was known to be operating improperly. (Refer to MR 3595)
					225-kc VCO, S/N 1468
3773 7/11/64	-	Center frequency not within specified limits	Thermal-vacuum (at 45° C)	Nonconfirmed	The center frequency of Channel-F VCO, Serial No. 006, measured 224.43 kc during flight acceptance subassembly testing under thermal-vacuum conditions at 45° C. The specified limit for the center frequency is 225 ±0.5 kc. Allowable center frequency and deviation are governed by the band-width of the ground-receiver discriminator. The 70-cycle shift encountered is well within the capability of the ground-receiver discriminator and will have no effect on receiver operation or telemetry received.
2148 10/28/64	-	Center frequency out of specification	Explosive safe (JPL)	Workmanship	During an Explosive Safe Area TV full-power test, the F-Channel 15-point Telemetry was erratic. The frequency of the F-Channel, 225-kc Voltage Controlled Oscillator was measured as a function of input bias, using telemetry calibration chassis A-100. The frequency deviation was normal, approximately 10 kc; however, the center frequency was approximately 8 kc high, which made the recovery of telemetry impossible. This VCO, manufactured by Vector, was removed and replaced with an equivalent unit manufactured by Datatronics. A linearity plot of the VCO was performed and no adjustments were required. Operation of the TV Subsystem was normal. The failed unit was scrapped. Only Datatronics 225-kc VCO's will be used on Flight Units.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			225-kc VCO, S/N 1469		
2878 2/5/63	-	Excessive drift	Thermal-vacuum (0° C)	Design (vendor)	Unit drifted by 1 kc during thermal-vacuum exposure at 0° C. The limit is ±500 cps. The VCO was returned to the vendor for further analysis. The vendor has changed several parts and modified the design. However, for proprietary reasons, detailed changes were not disclosed.
			225-kc VCO, S/N 1471		
3879 5/9/64	-	Drift in output frequency	Thermal-vacuum	Accident	Investigation of why the output frequencies differed from the specified values in RTSP-1140 revealed that these specified values were incorrect. The RTSP has been corrected.
			225-kc VCO, Miscellaneous		
2158	-	Noisy 90-point telemetry	Ambient	Nonconfirmed	The 90-point P-Channel telemetry was very noisy. The telemetry deviation for the P-Channel 225-kc VCO was found to be low. While the specified amplitude of the first sideband is -20.8 db below the carrier amplitude, it was measured at -22 db. The frequency of the 225-kc VCO was found to be approximately 0.5 kc off center frequency. This would be a contributing factor to the noise experienced on the 90-point telemetry. The discriminators were replaced and the noise was decreased. The reason that changing the discriminators decreased the noise is that the second discriminator limits at a lower input-signal level (225 kc) and therefore results in less noise on the detected output signal. The deviation was increased by retuning the 225-kc VCO.
2877 2/6/63	-	Low voltage output	Pre-thermal-vacuum	Workmanship (vendor)	On VCO's, S/N 1038P, 1034, and 1468, vendor used a 47-k instead of a 20-k reactor, which reduced the voltage to less than 1 volt p-p. The units will be repaired. The vendor attributed the low output to the use of an incorrect resistance value. Resistance values used for the Ranger assemblies are different from those used for the vendor's standard design and specified output voltages of the units were accidentally checked against the wrong specification.
5887 3/26/64	-	Frequency not within specified limits	(-10° C)	Accident	Investigation into the frequency output of the VCO not being within specified limits during a -10° C test revealed that although the thermocouple did record a temperature of -10° C, the air that was blowing directly on the VCO was at -20° C resulting in the VCO being at approximately -20° C. A baffle was added and the temperature of the VCO was stabilized at -10° C. The test was rerun successfully. The test specification has been modified to include the baffle.
			Telemetry Malfunctions, Miscellaneous		
4699 4/14/64	-	Wire reversed	Ambient	Accident	The input wiring for F and P Channel at the input jacks on the Telemetry Assembly was reversed. The drawings are being changed so that the assemblies will reflect this configuration rather than re-work the wiring of the Assemblies.
3827 4/21/64	-	Broken wire	Pre-vibration test (0° C)	Workmanship	Investigation of a reading of zero at test point 4 instead of 27 ±1.4 volts revealed that one end of the lead from test point 4 to capacitor C5 was broken at lug C5. The lead was resoldered and normal operation was obtained.
3944 5/2/64	JPL Test Equipment	Cruise mode did not operate	Thermal-vacuum (JPL)	Nonconfirmed	The cruise mode did not turn on when activated during the 16-hour simulated mission performed in thermal-vacuum. The cruise mode had previously been turned off by the unit 18 console but the JPL hydraulic time switch had not been de-energized. This caused the integrating circuit on the cruise-mode relay to remain charged resulting in the inability to reactivate cruise mode by the unit 18 console. Cruise mode could be activated, however, by switching the power select relay off, then on again. This gave the appearance that the power control relay was defective; later proved not to be true. The JPL procedure has been reviewed and suggestions have been made to ensure that this type of problem does not recur.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Telemetry Malfunctions, Miscellaneous (Continued)
3942 5/5/64	-	Cruise mode did not operate	Thermal-vacuum (JPL)	Nonconfirmed	During MVT No. 2, the JPL test director requested turn on of the cruise mode by the "Solar Panel Deployment" command. The cruise mode did not respond because the hydraulic timer switch had not been opened. (Refer to MR 3944.) Cruise mode was initiated by opening the hydraulic timer switch and providing the "Solar Panel Deployment" command. The recommendation has been made to include into the test the "Solar Panel Deployment" command for enabling of the Subsystem.
2185 5/14/64	-	Cruise mode turned on too early	Ambient (JPL)	Nonconfirmed	Cruise mode turned on when power was applied to the Subsystem although no cruise-on command had been initiated. The Subsystem was turned off and several attempts were made to cause a repeat of the problem; all without success. Investigation disclosed that during center-of-gravity and weight measurements, the solar panels had been deployed by using a jumper plug which had inadvertently activated the cruise-on relay resulting in the initiation of cruise mode as soon as power was applied.
1542 11/27/64	-	Erratic telemetry reading	Thermal-vacuum	Accident	During thermal-vacuum testing of Flight Model III-4, Telemetry Point No. 10 of the 15-point, channel 8 telemetry indicated 2.25 volts during one frame and returned to its normal level of 0.5 telemetry volt during the next frame. A check of the battery voltage indicated that a very slight voltage drop had occurred; but if the magnitude of the current indicated by the telemetry were drawn across the entire battery, the battery voltage drop would have been four times the drop that was indicated. Review of the battery cell-monitoring circuit showed that a voltmeter in parallel with a digital voltmeter is used for cell monitoring. The circuit employs a current-limiting resistor in series with the meters to protect the battery from unusual current surges should a short occur in the voltmeter or digital voltmeter. While the value of this current-limiting resistor is normally 1200 ohms, the resistor in use at the time of the problem was only 12 ohms. The only explanation for this problem is that a momentary short occurred between signal ground and chassis ground of the digital voltmeter. Since the operator was approximately one-third to one-half way through the cell monitoring procedure, the voltage was approximately 12 to 14 volts dropped across the 12-ohm resistor. This would give a current indication of 1.2 amperes through the Current Sensing Unit. This value compares very closely to the current monitored at that test point during short intervals. Although this is the only possible conclusion, momentary shorts in any of the digital voltmeters in the Ranger Program have not been confirmed.
					Power Amplifier Assembly, S/N 003
2896 5/6/63	RF Connector (J2) Rings KA-19-d	Broken pin	Room (Ambient)	Wearout	During integration of the power amplifier on the structure, the coaxial female contact was seen to have a broken spring quadrant. The cable was replaced. Failure was attributed to wearout due to numerous insertions and manipulations.
3422 9/28/63		Leaky	Room (JPL)	Workmanship (vendor)	During initial testing at JPL, the pressure in the vessel was measured at only 10 psig. Several days later, a remeasurement was made and only 8 psig was recorded. The vessel was repressurized to 15 psig and a leak detector was utilized. It was found that all jacks in the vessel were leaking. The malfunction report was not immediately written because the leak rate at which a failure occurred was not defined. Because extensive rework would have been necessary to replace the pressure vessel, all jacks on the Serial No. 003 vessel were replaced with those from the Serial No. 015 vessel. AED engineering investigation into the leakage around the RF connectors from these pressure vessels revealed that the pressurized RF conductor with a standard type 2022C RF fitting was designed incorrectly. The groove of the 2022 C connector is such that none of the available O-rings would provide a proper fill. The thickness of the O-ring groove was 125 percent of the width of the O-ring groove. This resulted in a very poor seal at the connector and a high leakage rate that is greatly accelerated through rapid temperature changes. All of the pressure vessels are to have the standard RF 2022C type fittings removed and replaced with Automatic Connector type 101-T3101-75 fittings.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Power Amplifier Assembly, S/N 006		
4035 9/20/63	RF Cable	Loose Connector	Room (engineering)	Workmanship	The connector on the RF input cable which connects the pressurized housing to the Power Amplifier broke off. Because of a loop in the cable, a twisting force is always present on this connector. The excess cable is required for installation and removal of the Power Amplifier.
4036 9/22/63	Resdel Amplifier	Low power output	Bench	Workmanship (vendor)	The Resdel Amplifier was replaced because the power output was only 20 watts after 2 to 5 minutes of 8 watts of input. The unit was returned to the vendor. The vendor discovered several of the metal contact fingers between the tube housing and active cavity were bent out of position. These fingers were bent during manufacturing when the tube cavity was joined to the cavity. The loss of these contacts would cause a decrease in RF power output.
			Power Amplifier Assembly, S/N 013		
4463 1/6/64 Amplifier S/N	Vacuum Tube (Type ML-7855)	Open filament	Room (post vibration)	Workmanship	Investigation into the opening of the filament of the tube during vibration revealed that the interior elements of the tube, i.e., plates, grids, and cathode emmisive coating, showed no evidence of overheating or discoloration. The filaments were found to have broken at the point the helix is welded to the terminal. It appeared that the filaments were crushed when welded, thus breaking when vibrated.
			Power Amplifier Assembly, S/N 015		
4690 1/27/64	Connector	Binding	Room	Accident	The P2 connector was binding when removed from the Resdel amplifier. Visual inspection of the connector failed to reveal any reason for this. After the connector shell was cut open, the binding disappeared. It is believed that the shell had been deformed because of being tightened or removed by use of an adjustable wrench or a wrench of the wrong size. The connector was replaced. A new procedure, delineating torque requirements, has been implemented.
			Power Amplifier Assembly, S/N 018		
2842 3/29/63	Pressure Valve (Shraeder)	Loss of pressure	Thermal-vacuum	Design	Pressure could not be stabilized in test chamber. When removed from chamber, a pressure check of Power Amplifier housing revealed zero psig. A leak test was made and leakage was detected at pressure valve. Engineering is going to a Shraeder-type 300 tank valve which has been used on TIROS.
			Power Amplifier Assembly, S/N 020		
4048 11/5/63	High Voltage Connector, J4 DC4-504000	Shorted	Thermal-vacuum	Workmanship	All RF output was lost and the line current dropped to 4.5 amps (normal valve is 10 amps at operational levels). It was believed a short had occurred in the 1000-volt jacks. The resistance between J4 and ground was found to be 1.9k. When the connector was opened by engineering personnel, a large dark deposit was noted on the teflon insulator. This connector was returned for analysis. Unfortunately the connector had been cut open so that when it was examined there were excessive amounts of metal around the insulation. This prevented an accurate analysis. In addition to the metal, there was also silicone grease around the burn mark. In the future the failed parts will not be disassembled by engineering personnel. Secondly, at no time will silicone grease be used on these connectors, and care will be exercised to see that no grease is picked up from the pressure vessel.
			Power Amplifier Assembly, S/N 021		
2188 5/19/64		Not safety-wired	Post-vibration	Workmanship	The cover was removed from the Power Amplifier Assembly (Serial No. 021) and it was discovered that the coaxial connectors on the Resdel cavity were not safety-wired. This Power Amplifier Assembly was originally a spare that replaced Serial No. 018 on Flight Model III-2. The unit had been final tuned and sealed without safety wiring because of the lack of documented procedure on this function. Normally, all units designated for flight are final tuned, safety-wired, and sealed; however, spares are usually not safety-wired or sealed. All spares will be tagged to indicate that they

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Power Amplifier Assembly, S/N 021 (Continued)
2188 5/19/64 (Continued)					have not been safety-wired and special quality-control procedure will be followed to ensure they are safety-wired when designated for flight operation.
					Power Amplifier Assembly, S/N 039
2910 3/2/63	Mylar gasket capacitor (C3)	Arc-over	Thermal-vacuum	Secondary	It was not possible to stabilize test chamber pressure. Also, line current fluctuated from 6.5 to 14 amperes. Power amplifier housing lost pressure, causing arc-over around mylar gasket.
					Power Amplifier Assembly, S/N 120
3223 5/15/63		Increase in reflected power	Room (bench)	Nonconfirmed	The reflected power at the PA input increased from 0.2 watt to approximately 1 watt when the PA was being tuned. C1 and C2 were retuned for maximum power output and minimum reflected power. C2 was lightly tapped and the reflected power again increased to approximately 1 watt. This amplifier was checked by the vendor and found to operate properly. Difficulties may have been encountered in tuning this particular amplifier in a transmitting channel. The tuning of capacitor C2 was very critical.
4047 10/31/63	Resdel Power Amplifier	High reflected power	Ambient (engineering)	Accident	The solder-lug washer on Capacitor C2 was believed loosened during test. The solder-lug washer was re-epoxyed and the unit was returned to service after a satisfactory electrical check.
					Power Amplifier Assembly, S/N 121
4037 9/24/63	Resdel Amplifier	Drop in output power	Bench	Nonconfirmed	After 30 seconds of full power, the power output level dropped from 60 to 40 watts. The power amplifier was retuned by turning capacitor C2 approximately 1/8-turn and the output level rose to 60 watts. The setting of capacitor C2 was critical.
					Power Amplifier Assembly, S/N 122
1676	Resdel Power Amplifier	Low output power	Thermal-vacuum	Workmanship	The power amplifier was returned to vendor for analysis. The results of the analysis indicated that the finger contacts at the bottom of the cavity were not making good contact. This would result in an effective change of the size of the cavity.
					Power Amplifier Assembly, S/N 124
1365 10/14/64	Transmitter Serial No. 210 (Flight Model III-4)	Low power output	Room (ambient)	Accident	During initial RF operation of the P-Channel, only 18 watts of power was obtained at the Four-Port Hybrid. Inspection of the transmitter revealed that the capacitor C2 on the Resdel IPA (Intermediate Power Amplifier) was adjusted so that only 1.5 watts could be obtained from the IPA. With the capacitor in the normal position, the power output was 8 watts (normal). Inspection of photographs taken when the transmitter was released to integration, showed the capacitor in the normal position. It could not be determined when the capacitor was reset. A Quality Control seal will cover the adjustment hole for capacitor C2 to prevent a resetting of this capacitor.
					Power Amplifier Assembly, S/N 125
4042 9/13/63	Anode Ring of Power Amplifier	Anode ring loose	Bench	Accident	Investigation of why power decreased from 60 watts to 20 watts disclosed that the anode ring was loose. Vendor analysis showed that undue pressure from the tuning slug exerted pressure on the anode plate that is mechanically attached to the tube. Care should be exercised in the adjustment of the tuning slug.
					Power Amplifier Assembly, S/N 137
4693 1/28/64	Connector J2	Binding	Room	Accident	During electrical checkout of Flight Model III-4, a slight fluctuation in output power was observed. The cable between the Power Amplifier and the pressure vessel was suspected to be the cause. During the replacement of the cable, it was found that the cable was binding. It is believed that the connector was damaged during either assembly or disassembly by the

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
					Power Amplifier Assembly, S/N 137 (Continued)
4693 1/28/64 (Continued)					use of either an adjustable wrench or a wrench of the wrong size. A new procedure which delineates the proper torque to be applied has been recommended.
4752 2/11/64	Resdel Amplifier	Arcing	Room	Nonassignable	During the Subsystem test of Flight Model III-4, power fluctuations of 1 to 5 watts were observed. The investigation of these malfunctions lead to the replacement of the Resdel Amplifier Serial No. 137 with Serial No. 158. The replaced amplifier had had a previous mechanical failure (MR 4693). A close inspection revealed indications of arcing in the vicinity of the anode-spring contact and the cavity wall. The Power Amplifier was then returned to the vendor for an analysis which indicated that the assembly had been operated in a partial vacuum. However, a review of the past history of the assembly by AED did not reveal any evidence of the existence of a pressure problem. The actual cause of the arcing, therefore, could not be established. Another failure mode, other than the partial-pressure mode advanced by the vendor, could be a tolerance or machining error in the parts of the amplifier.
					Power Amplifier Assembly, S/N 140
5877 5878 5879 4/3/64	Pressure Vessel	Excessive leak rate	Ambient	Design	Replacing of the O rings, purge valves, seals, and valve caps did not lessen the excessive leak rate exhibited by this assembly. As a result, a directive was issued for requiring an increased torquing of the screws used to fasten the cover of the pressure vessel. In addition, a higher leak rate was established because the previously specified maximum of 9×10^{-7} cc per second was unrealistic. The assembly now passes the leak test.
					Power Amplifier Assembly, S/N 144
3886 9/3/64	DC Connector "O" Ring	High leak rate	Ambient	Nonassignable	A leak in the pressure vessel of Power Amplifier Assembly, Serial No. 144, was traced to a defective "O" ring on DC connector J3. Inspection of the "O" ring groove, mating surfaces, and the rubber "O" ring indicated that the "O" ring had to be replaced. A new ring was installed and the leak test was successfully performed. The replaced "O" ring was not retained for examination; thus, it could not be determined whether the "O" ring had been pinched or twisted, or just dried out.
					Power Amplifier Assembly, S/N 145
10452 5/3/63	Tube (type MIL-7855)	Low perform-ance	Thermal (manufacturing)	Accident	The heater and plate voltages were applied at the same time without the five-minute warm-up.
					Power Amplifier Assembly, S/N 147
3334 5/10/63	Tube Machlett 3CX100A5	No power output	Room (ambient)	Accident (test error)	During checkout, there was no power output from the Resdel amplifier. Tube replacement corrected the fault. The replaced tube was returned to the vendor who found a small leak around the grid insulator. Apparently this leak was present during the last successful run, but was not immediately detected because the leak rate was low. Possible cause of the leak was an excessively hot ambient condition.
					Power Amplifier Assembly, S/N 155
5882 3/23/64	Power Amplifier, Serial No. 155 Pressure Vessel	Arcing during turn-on	Ambient	Accident	Investigation of arcing inside the assembly at turn-on revealed that all the helium had not been removed from the assembly. This had resulted in a partial-pressure condition caused by a mixture of air and helium. The breakdown voltages for equal spacing are 1,200 volts for helium as opposed to 11,000 volts for air. The manufacturing procedure for purging the pressure vessel for the Power Amplifier is being revised to ensure that this failure mode will not recur.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Power Amplifier Assembly, S/N 158		
2114 6/30/64	Tube MA7855	High-voltage puncture of mylar wafer capacitor	Ambient	Accident	During bench test, the output of the IPA was being checked. Normally, the high voltage (+1000 volts) and filaments of the Power Amplifier Assembly are off during this check. However, power was applied to the Power Amplifier Assembly, and the plate dissipation of the power amplifier went to 125 volts (normally 65 volts) for 2 minutes. It was found that a roughness in the casting caused the puncture of the mylar insulator. The housing was made smooth and was replated. The insulator was replaced. The vendor also repaired a cracked solder joint in the output coupling loop and removed the shim stock found inside the housing near the input matching capacitor.
			Current Transformer Units		
3836 5/4/64	Current Transformer Units, Serial Nos. 011 and 012	Exuded potting	Thermal-vacuum	Design	Investigation of the potting compound exuding from the case of the Current Transformer Units during thermal-vacuum testing revealed that the plasticizer was being pulled from the transformer coil by the vacuum. The plasticizer, if not retained by the urethane barrier applied over the coil, will react with the potting compound. Final analysis indicated that both CTU assemblies were potted before the conformal coating on the coils was completely cured. This resulted in the entrapment of toluene within the potting material. The solethane conformal coating and the potting material in contact with the toluene remained in a solvated condition. It is believed that when the units were subjected to thermal-vacuum tests, the solvated resins surrounding the coil exuded through the relatively porous potting material and foamed at the surface. The cure procedure has been changed to incorporate a vacuum cycle before the final cure during the final potting.
3852 5/12/64	Current Transformer Unit, Serial No. 015 (Spare)	Open connection	Ambient	Workmanship	During a continuity check following assembly and potting, no continuity, as required by specification, was measured between pins 1 and 4 and 3 and 4. An X-ray photograph of the unit revealed that the leads were open.
			Current Sensing Unit S/N 001		
5823 3/25/64		Telemetry voltage Positive	Ambient	Design	Investigation into the wrong polarity of telemetry voltage from the Current Sensing Unit resulted in a design change which corrected the situation. The necessary Engineering Change Notices have been distributed and have effected manufacturing changes and Revision A to Drawing No. 1758384 on March 27, 1964. The PTM assembly has been modified.
1324 9/24/64		Telemetry reading not within specified values	Ambient	Nonconfirmed	During final acceptance testing, Current Sensing Unit, Serial No. 001, was rejected because of an out-of-specification telemetry voltage reading. The unit was checked and found to exhibit a telemetry voltage reading that was 7 millivolts out of specification at 27.0 volts and 1 millivolt out of specification at 27.5 volts. This condition was the result of a higher-than-normal breakdown voltage in diode 1N746A of the telemetry output circuit. This telemetry variation from its specified value will not affect the operation of the Current Sensing Unit, nor will it affect the overall performance of the telemetry. MRA 100-64-161 has been written to cover this deviation from specification. Based on the MRA, the unit has been accepted by RCA Product Assurance and JPL.
			Current Sensing Unit S/N 002		
3928 3/31/64		Output not within specified limits	(0°C)	Design	During the calibration test, two of the recorded readings were not within the specified limits. Examination of these limits revealed that they should be revised to a graphical rather than specific limit. The test specification has been revised.
			Current Sensing Unit S/N 003		
3893 10/24/64		Premature turn-on	Thermal-vacuum	Accident	The calibration test of Current Sensing Unit, Serial No. 003, was initiated before the thermal-vacuum chamber had stabilized to the prescribed pressure of 1.0×10^{-5} mm Hg. The pressure at the start of test was 1.1×10^{-5} mm Hg. MRA-100-64-193 was initiated to cover this occurrence. Test

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
				Current Sensing Unit S/N 003 (Continued)		
3893 10/24/64 (Continued)						personnel have been cautioned as to the problems of premature turn-on during thermal-vacuum testing, and have been instructed to double-check the accuracy of all test conditions prior to initiation of testing.
3894 10/28/64 3895 10/26/64			Telemetry out of specification	Thermal-vacuum	Secondary	These malfunctions involved two slightly out-of-specification telemetry readings in the Current Sensing Unit, Serial No. 003, which occurred during thermal-vacuum testing at high temperature. Investigation revealed that this P-Channel Current Sensing Un t is slightly more temperature-sensitive, and the out-of-specification readings will not affect the operation of the unit. The telemetry deviations have been approved by MRA-100-64-194 and MRA-100-64-195.
				Current Sensing Unit S/N 004		
4799 4/17/64			Output not within specified limits	Thermal-vacuum (+55°C)	Accident	During the +55°C thermal-vacuum testing, the readings of the output from the Current Sensing Unit were not within specified limits. It was found that the digital voltmeter used to measure the output had been sitting on top of a power supply and had been overheating. Retesting of the Unit a few hours later provided satisfactory results.
				Current Sensing Unit S/N 005		
3791 9/18/64	Current Sensing Unit Serial No. 005 Cable 30W29 (QTM)		Excessive ripple	Ambient	Accident	An out-of-specification ripple voltage was encountered during electrical checkout of current Sensing Unit, Serial No. 005. Investigation revealed that a design change had been made in the direction of current flow through the Current Sensing Transformer. The cable used to connect the Current Sensing Unit, Cable 30W29, was an older type. When the current was revised, the unit performed satisfactorily. Engineering Notice EN 92261-009 has been issued to specify the direction of current flow for testing the QTM with the old cable (30W29). All flight units have been checked with new cables with the current direction specified by Test Method TM 1-1758390, Revision C.
3574 10/6/64		Diode CR1 (zener type 1N746)	Telemetry reading not within specified limits	Ambient	Design	Current Sensing Unit, Serial No. 005, was removed from its normal test cycle for evaluation of the telemetry-output problem experienced with CSU, Serial Nos. 007 (See MR 1359). Substitution of zener diode CR1 (type 1N746) was performed on this unit in order to obtain an optimum output slope of the transfer curve between 14 and 17 amperes of control current. This, therefore, did not constitute an actual failure, but the problem was anticipated, based on experience with CSU, Serial No. 007.
2069 11/5/64			No current drawn from power supply	Ambient	Accident	When the unit was turned on, no current was drawn from the power supply. This was found to be caused by an improperly connected cable in the external test harness. The inside retaining ring became loose and allowed the connector block portion of the Amphenol adapter to turn within its stops. The connector can mate in a correct or incorrect way. In an incorrect mating, a short ciruit occurs across the external power supply. The failure report shows no current was drawn from the power supply indicating that an incorrect mating did not occur. Thus, no undue stress was applied to the unit under test. The unit functioned properly when the connector pins were oriented properly.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
				Current Sensing Unit S/N 005 (Continued)		
1532 11/6/64			Calibration data out of specification	Ambient	Workmanship	A discrepancy was noted between the pre-thermal-vacuum and postacceleration calibration data. The data in question were obtained during post-acceleration testing. It was decided after a review of the data that the discrepancy was due to operator error. It was also discovered that the post-thermal-humidity test was performed with the test harness between the CSU and the CTU improperly connected. The test was rerun with a properly connected harness. Calibration data then met all specifications.
				Current Sensing Unit S/N 006		
3789 and 3790 9/13/64			Telemetry reading not within specified values	Ambient (post-vibration	Accident	During the postvibration electrical test of the Current Sensing Unit, Serial No. 006, telemetry readings were not within specified values. The unit indicated proper values for the low ranges (0 to 500 ma), but was out of specification for the high range (14 to 17 amps). In all subsequent tests, the telemetry readings were within specified values for both the low and high ranges. The postvibration electrical test was repeated and the telemetry readings were normal. It was therefore concluded that the out-of-specification condition during the first postvibration test was due to faulty readings.
				Current Sensing Unit S/N 007		
3573 10/5/64		Diode CR1 (Zener type 1N746)	Telemetry reading not within specified limits	Ambient	Design	During calibration tests of Current Sensing Unit, Serial No. 007, the minimum slope of the F-Channel transfer function between 14 and 17 amperes of control current was not within the specified limit, for input voltages of -27.0, -27.5 and -28.0 volts. Investigation revealed that the slope of the transfer curve is a function of zener diode CR1 in the telemetry output circuit and the magnetic coupling in the Current Transformer Unit. It is difficult to determine which zener diode (all with same characteristics) will provide a correct transfer-slope. A compatibility check must be made by substituting zener diodes into the circuit until optimum slope of the transfer function is obtained. The particular Current Sensing Unit and 30W29 Harness that are acceptance-tested together will remain as a single unit, in order to maintain similar characteristics of magnetic coupling which could affect the slope of transfer function. A drawing change has been initiated to reflect the necessity of selecting the proper 1N746 zener diode for each Current Sensing Unit.
1359 10/10/64			Telemetry reading not within specified limits	Ambient	Design	Following the initial malfunction of CSU, Serial No. 007, (see MR 3573) calibration tests were rerun and the slope of the transfer curve was inconsistent over a number of runs. This resulted from the difficulty in reading exactly the same current each time. The average slope reading was 81.5 millivolts per ampere between 14 and 17 amperes of control current with an input of -27.0 volts. The specified minimum value of 85 millivolts per ampere (100 mv/amp ± 15%) at -27.0 volts input to the CSU is too close to the design capabilities of the CSU. The specification limits have been revised to 100 mv ± 25% to correct the situation.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Teamperature Sensor			
3439 10/9/63	Temperature Sensor Assembly Serial No. 004 (Block III-1)	Diode CR1 (types MZ11.2V25 and MZ18V05)	Shorted	Room (JPL)	Accident(test error)	The Channel-8 telemetry points Nos. 3 and 4 read zero volts following the application of both GSE and battery power during thermal-vacuum testing. The 2 diodes were found to be shorted when the Temperature Sensor Assembly was inspected. In addition, it was noted that all the inked markings on the terminal boards were blistered and smeared. Further investigation revealed that the wrong lacquer had been applied and the blistering and smearing had occurred during sterilization. Future units will utilize the proper ink and lacquer although these units will not be subjected to sterilization.
3824 5/12/64	Temperature Sensor, Serial No. 006 (Flight Model III-2)	Mounting Flange	Shorted to structure	Vibration (JPL)	Workmanship	Investigation of why the output of temperature sensor No, 11, the Shroud Temperature, was reading low during vibration testing revealed that the resistance from pin 34 of the Temperature Sensor to the chassis was 10,000 ohms. Opening of the Temperature Sensor revealed that the board mounting flange overlapped a terminal on the board, resulting in the shorting of the terminal to the structure. Revision E of Drawing No. 1706223 caused eight insulating washers to be added to the Temperature Sensors.
4268 1/16/64	Temperature Sensor Assembly, Serial No. 007 (Flight Model III-1)	Diodes CR1 and CR2 (Types MZ11.2 V25 and MZ18V05)	Shorted	Room (ETR)	Random	Investigation into the inability to obtain battery temperatures revealed that diodes CR1 and CR2 in the Temperature Sensor Assembly were shorted. Both diodes showed evidence of extreme heat, believed caused by an overvoltage. The exact cause of the failure was not established.
3373 7/23/63	Temperature Sensor S/N 008	Diode CR3 (type MZ18V05)	Short	Room (bench)	Accidental	Unable to obtain any voltage due to zener diode CR3 being shorted. This occurred when the connector cable was shorted while the unit was undergoing thermal-vacuum testing.
2273 2/2/65	Temperature Sensor, S/N 009 (Flight Model III-4)	Reistor R7	Low telemetry indication	Ambient	Random	In a special Subsystem check, telemetry point 90-86, camera bracket temperature sensor No. 3, indicated 6 instead of 2.7 volts. This reading was traced to resistor R7 in the temperature sensor and the resistor was replaced. After extensive testing at JPL, the defective resistor was X-rayed, checked electrically, and found to be open.
			Miscellaneous			
2981 4/9/63	Structure (PTM)	Shrouds	Deposition of a light oily film	Thermal-vacuum	Nonassignable	Film was too thin for chemical analysis. Did not repeat in later thermal-vacuum test.
4676 6/11/64	Battery Positioning Bar (PTM)		Large clearances	Ambient	Nonconfirmed	Following dynamic testing at JPL, the Battery Positioning Bar had large clearances surrounding the shear pins. These clearances were probably the result of initial manufacturing and would have no effect on the Battery during environmental testing (vibration and acceleration). No action is required for Flight Model III-2. The Battery Positioning Bar for Flight Models III-3 and III-4 will be constructed of stainless steel rather than aluminum.
2127 6/22/64	(Flight Model III-2)	Impactograph Battery	Leaky battery	Ambient	Accident	When Flight Model III-2 was removed from its shipping container at AMR some liquid was observed on the lower thermal shield. The liquid was traced to a battery installed in the impactograph that had developed a leak during transit from JPL. Further investigation revealed that no other portion of the TV Subsystem was exposed to this liquid.

TABULATION OF MALFUNCTIONS ON FLIGHT EQUIPMENT (Continued)

MR Number and Date	Subassembly Serial Number	Component Part	Failure Mode	Test Environment	Cause of Failure	Analysis and Corrective Action
			Miscellaneous (Continued)			
2127 6/22/64 (Continued)						During transit the air conditioning unit in the van broke down and the temperature in the van rose from the 80°F level, for which the air conditioner was set to 98°F. The batteries for the impactograph were supplied from JPL stock and were considered to be fresh.
2126 6/22/64	(Flight Model III-2)		Dropped shipping container	Ambient	Accident	Upon the receipt of Flight Model III-2 at AMR no attempt was made to remove the Subsystem from the shipping container. The bolts holding down the cover were removed and the cover was raised; the cover, however, did not separate from the shipping container base and the entire container was raised between 1/8 and 1/4 inch from the floor. While in this position the base of the shipping container containing Flight Model III-2 separated from the cover and dropped to the floor. As the container base separated a rush of air was evident indicating that the pressure within the container was other than ambient. This failure was attributed to this pressure differential. Flight Model III-2 was removed from the shipping container, visually inspected and electrically checked. The drop was evaluated and the resulting g-loading on the Subsystem was determined to be insignificant. RCA specification RSP 1170A is being modified to ensure that the existing pipe plug in the cover of the shipping container will be removed prior to unpacking to ensure an equalization of pressure.
2275 2/26/65	Thermal Shroud (Flight Model III-4)	Fin B	Fin B of the -Y shroud had non-uniform alpha	Ambient (ETR)	Workmanship	The alpha of fin B of the -Y shroud varied between 0.37 and 0.49. A computer program analysis indicated that under the worst possible case, i.e., the complete fin B with an a_s, of 0.37, the lower portion of the TV Subsystem would run 9°F cooler than Ranger VIII and the camera area 3°F cooler than Ranger VIII (including the anticipated cooling of 2°F due to the lower solar constant in March). Because only one-fourth of the fin area was nonuniform, the most probable case is that the Subsystem will run 3 to 4°F cooler than Ranger VIII. The Ranger VIII Spacecraft was 4 to 5°F warmer than nominal, therefore, no change was needed on Ranger IX since the effect of a varying alpha tends to bring the temperatures closer to the design nominal.
2312 2/27/65	Lower Thermal Shield (Flight Model III-4)	---	Improper fit	Ambient (ETR)	Workmanship	The flight lower thermal shield did not fit properly because of interference with the Four-Port RF coaxial cable clamp. The spare unit did not fit either. An investigation disclosed that the side panel in the battery monitor connector area did not fit becasue it either had been sewn in upside down during initial assembly or too large a seam allowance had been used during final assembly. The side panel seam was opened and the panel repositioned and resewn to fit properly.