MM-4302

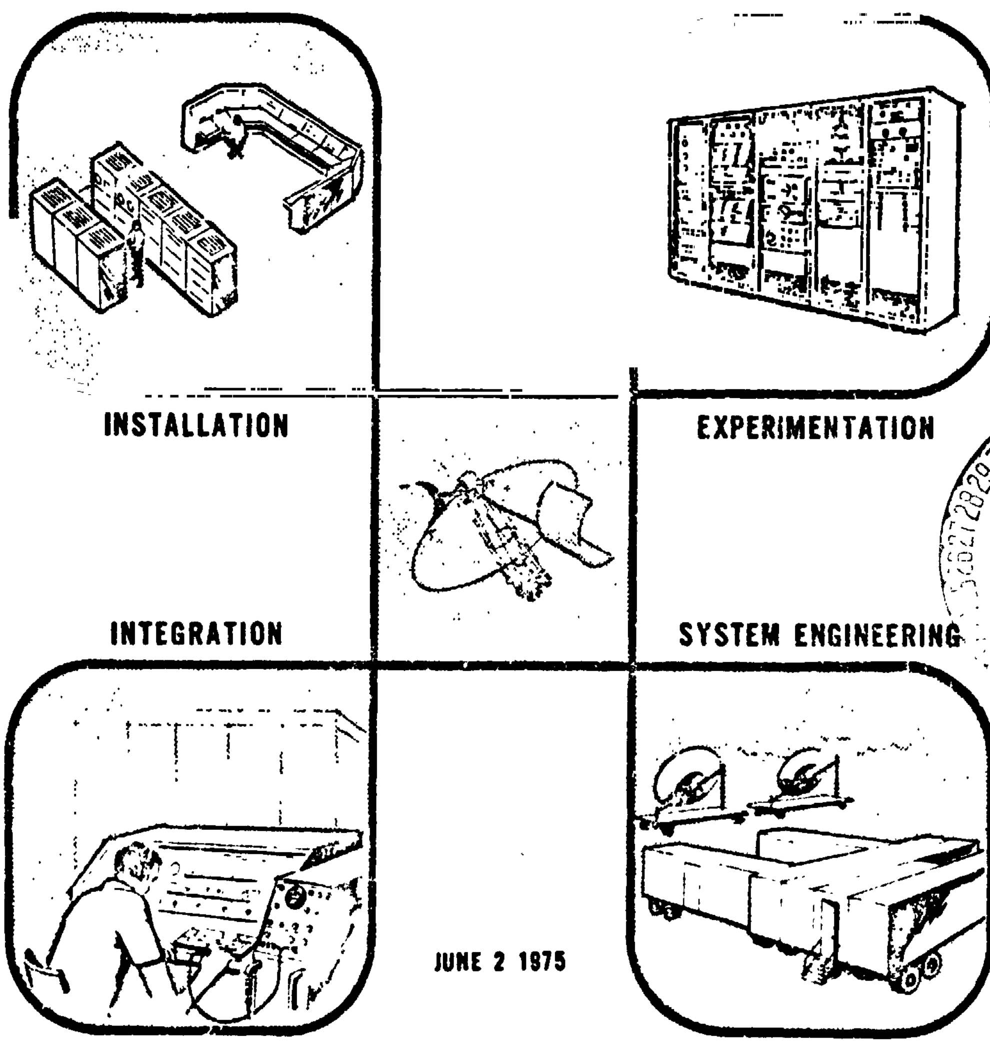
NASA CR-144735

ATS-F

GROUND STATION INTEGRATION

FINAL REPORT

(NASA-CR-144735) ATS-F GROUND STATION INTEGRATION Final Report (Westinghouse Defense and Electronic Systems) 183 p HC $7.50 CSCL 22D
N76-20174
Unclas
G3/14 22163



JUNE 2 1975

Westinghouse Electric Corporation
Defense and Electronic Systems Center
Baltimore, Maryland

FIS-75-0032

ATS-F

GROUND STATION INTEGRATION

FINAL REPORT

2 JUNE 1975

Contract NAS 5-21548

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Goddard Space Flight Center
Greenbelt, Maryland

WESTINGHOUSE ELECTRIC CORPORATION
Defense and Electronics System Center
Baltimore, Maryland

PREFACE

This report describes the activities performed by Ⓦ as part of the Ground Station Integration (GSI) Contract for the Applications Technology Satellite Program (ATS-F) at the Rosman, North Carolina, and Mojave, California, ground stations. The report covers the work performed for NASA/GSFC during the period ending with the completion of the Westinghouse on-site integration and test effort.

The objective of the GSI Contractor has been to provide the necessary engineering, design, materials, and services required to integrate the planned modifications to the ATS Ground Stations that were necessary to support the ATS-F spacecraft. The objective of the GSI has been to integrate the communications subsystems at the ATS Ground Stations, and to ensure the readiness of the ground stations to perform their assigned missions as data acquisition facilities for the ATS program.

A ground terminal system description, and a performance summary, is provided in Section I of this report. This discussion includes a brief introduction of background material leading to a description of the ATS Ground Terminals. The configuration of each station is described, and a performance summary of principal communication parameters, which considers measured values at each ground station is provided in chart form. A general description of the ATS-F experiment interfaces for which the GSI had some measure of responsibility, and an ADP Subsystem description including its operational capabilities and functions has also been included in Section 1.

The basic GSI contract, and its subsequent modifications divided the work effort into twelve (12) separate tasks, each of which are discussed in Section II of this report. The initial task required the study, analysis, and defination of interfaces of the proposed ground terminal network, systems and subsystems. As the integration contractor, Westinghouse was required to provide installation design; fabrication of interface cabling; wiring; and other material and equipment required to interconnect the subsystems. The GSI also provided liaison with GFE subsystem contractors;

test data review and analysis; witnessing of subsystem contractors acceptance tests; supervision of installation; and the integration, and testing of communications subsystems. Throughout the entire period of contract performance, documentation in the form of reports, drawings and test plans were submitted to NASA in conformance with an established schedule. Westinghouse was also expected to design, fabricate, and install selected display, monitoring equipment and test facilities necessary to maintain operational efficiency.

After completing the installation effort, a series of tests were performed, which included both subsystem and system integration tests. Basically, these integration tests utilized transmitter and receiver back-to-back loops, which provided a means of evaluating the communications system performance of the ground station prior to the launch of the spacecraft. A GSI training program was conducted which included both formal classroom training, and O. J. T..

The GSI provided program management control, which established and monitored schedules, assured timely deliveries of key items, assigned tasks and monitored manpower, controled costs and spending, and established and monitored management policies and procedures.

Westinghouse achieved its contract objective by completing the assigned tasks on schedule to meet the ATS-F launch date. As the program progressed many obstacles were overcome, with minimum program impact. Engineering analysis and reports were submitted as required, and where necessary recommendations were provided. The GSI rescheduled its program and manpower to accomodate the slip in launch date, late delivery of GFE equipment, loss of the antenna use at Rosman for six (6) months, and various problems with the GFE test equipment. Added scope efforts were accomplished within time and cost constraints, and experiment specifications and interface information was provided in a timely manner. Excellent communication channels were effected for a smooth flow of pertinent information, to all interested and affected parties. The GSI responded quickly and efficiently to all requests made of them, by GSFC, NASA site personnel, and the various involved GFE contractors.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I - FINAL REPORT
ATS-F GROUND TERMINAL
SYSTEM DESCRIPTION AND PERFORMANCE SUMMARY

1.0 INTRODUCTION

This section of the Final Report is intended to provide the reader with a description of the ground terminal systems and their performance, as tested by the GSI. Westinghouse was selected as the Ground Station Integration Contractor in 1970 and was awarded the GSI contract in November of that year. Under the terms of this contract, the GSI was required to integrate the various subsystems delivered by the involved industrial firms under contract to NASA/GSFC, into an operating system. These ground terminals were located at Rosman, North Carolina and at Goldstone Dry Lake near Barstow, California. Detailed integration test results have been provided to NASA by the GSI in seven (7) separate volumes (GSI Test Data Report); as referenced material to this report. (See Section 1.6 for compendium).

The ATS ground stations as described in this section include a system description, operational frequencies and bandwidth, and a discussion individual subsystems which comprise the system. Station configuration is described, and the floor plan for each station is provided. The station performance, as tested by the GSI, is displayed in chart form, providing a summary of the more important parameters tested. This chart provides a listing of test data, by site, for comparison purposes. Also included in this section is a description of the ATS-6 experiments, the equipment, and interfaces required to perform these experiments. The ADP subsystem and its role in the experiments is also described.

1.1 THE ATS GROUND STATIONS

This part of the Final Report presents a description of the three ground terminals integrated and tested by Westinghouse. Although these three ground stations are each of a different configuration, their characteristics remain similar. The following paragraphs will provide a system description, and discussions of the various subsystems which comprise the system.

1.1.1 SYSTEM DESCRIPTION

The ground communications systems described are those at Rosman, N. C., Mojave, California and the Hybrid Terminal. The stations at Rosman and Mojave are those which have been used for the ATS-1 through 5 programs and have been modified and updated for the ATS-F (6) program experiments. The Hybrid Terminal which is intended to be situated in Spain, near Madrid, was formed from selected parts of the earlier Transportable Ground Station (TGS) and the ATS-F Mobile Terminal. The Hybrid Terminal antennas, RF and frequency generation equipment was obtained from the Mobile Terminal; while its range and range rate subsystem, master control console, etc., was formally part of the TGS. The ADP equipment is a new addition.

The systems at Rosman and Mojave are basically similar with the exception of the larger size main antenna at the Rosman location. The equipments at the two locations have been designed and integrated to operate with the ATS-F (6) satellite to support all of the presently proposed experiments. These terminals can also support other experiments and future quasi-operational type activities. An example of a quasi-operational type of program would be the Apollo/Soyuz mission via ATS-F, if Rosman were selected as a participating station.

The relevant equipments at each site consist of the antenna and tracking systems; the RF equipment (transmitters and receivers); the Modems (modulators and demodulators); the IF interfaces; the baseband interfaces; the ATSR timing and ranging subsystem which also provides the station standards of frequency and time, as well as performing satellite ranging measurements; the CTEC subsystem consisting of test equipment which can be conveniently interfaced with the transmitters, receivers, etc.; the master control console; the recording equipments; and the automatic data processing subsystem. Telemetry and command equipments are also present at each station.

A block diagram showing the equipment and their interfaces is provided in Section 1.1.13. Floor plans for each station are presented in Section 1.2.4.

As a part of the integration testing, the important communication performance parameters were measured at the Rosman and Mojave Stations. Less complete tests were performed at the Hybrid Terminal. The test data recorded at each site is presented in Sections 2, Vol. 1, GSI Test Data Report. The more important performance communications systems parameters are summarized for Rosman, Mojave and the Hybrid Terminal in Section 1.3 of the Final Report. The performance values given in this section are those actually measured on-site at Rosman, Mojave and the Hybrid Terminal for the equipment as delivered to the GSI contractor, and as placed into service and adjusted according to the specifications of the equipment suppliers. In some cases the performance of the actual equipments falls short of their specifications; (Ref. Vol. 1, GSI Test Data Report).

As indicated, performance of some of the equipment is outside specification, but the measured parameters at Rosman and Mojave are adequate to perform the experiments planned for ATS-F (6). In some cases, performance values for the Hybrid Terminal appear to be far outside specification. It is believed that this is in most cases due to the use of the test transponders which had improper performance, rather than due to improper performance of the actual communications equipment. This is outside the responsibility of the GSI contractor.

1.1.2 OPERATIONAL FREQUENCIES

Transmission and reception is performed at C, S, and L-Bands. The specific frequencies (band centers) are presented in Section 1.3. It should be noted that simultaneous operation at S and L Bands is not possible, using the equipment in the S & L-Band shelter. In the S & L-Band modes, certain parts of the equipment are common to the two bands. The operational frequencies may be changed within the satellite transponder passbands by changing either the synthesizer frequency, or by changing the IF center frequency (within its passband).

1.1.3 OPERATIONAL BANDWIDTH

The ground terminal equipments are inherently wideband; a nominal 40 MHz bandwidth is provided in all the IF amplifiers, etc. Several narrower IF bandwidth filter are available (nominally 12 MHz). In the case of many of the experiments the bandwidths are tailored to the experimenter's equipment requirements. The RFI experiment is unique in that it has a full 500 MHz receive bandwidth and uses only the receiver low noise front end of the ground receiving equipment. The amplitude and delay characteristics of the transmitters and receivers for this experiment are such as to allow them to support wideband angle modulation signals (such as FM television) with only small degradation of performance. Section 1.4 describes the actual performance parameters for the RFI Experiment.

1.1.4 ANTENNA SUBSYSTEM

The antennas at each station consist of a large C-Band antenna, and a smaller (15 ft.) L and S-Band unit. The C-Band antenna size at Rosman is 85 ft. in diameter and at Mojave is 40 ft. in diameter. A 21 ft. diameter antenna is used at the Hybrid Terminal. The 85 ft. and 40 ft. diameter antennas are equipped with tracking facilities and can track a spacecraft either by utilizing a position program and/or the C-Band satellite beacon. The receiving subsystems attached to the antennas use low noise parametric amplifiers, that provide high values of G/T. The G/T values for the various antennas and frequencies are tabulated in Section 1.3 along with the gains of the antennas. The transmitter powers are nominally 8 KW at C-Band, and 1 KW and 200 W at L-Band and at S-Band, respectively. The actual measured powers, and effective radiated powers are presented in Section 1.3. The transmitter powers may be adjusted to lower values as required. This particular requirement is desirable in order to compensate for multiple carrier operation where intermodulation is a problem. This feature is also useful to simulate small transmitter installations, such as an aircraft. The intermodulation performance of the transmitters are given in summary form in Section 2, Vol. 1, of the GSI Test Data Report.

1.1.5 INTERFACES

As indicated above, there are IF interfaces for both the transmitters and receivers. The intermediate frequency is in each case 70 MHz with a nominal 40 MHz bandwidth. The interface at IF is at a standard 75 ohm impedance with levels in the order of -10 to 0 dBm. The exact levels will depend upon the received signal levels and the transmitter powers involved. The Rx/Tx IF may interface with external equipment (supplied by the experimenter); with the 70 MHz wideband modems, which are a part of the ground station and are capable of supporting wide-band signals such as FM video; or may also interface at IF with units such as the ATSR equipment utilized for satellite ranging measurements.

1.1.6 LOCAL OSCILLATOR

The local oscillators used in generating the transmitter and receiver conversion frequencies are all derived from the 5 MHz standard which is a part of the ATSR equipment. The oscillator long term stability is that of the station standard in each case; and is nominally ± one part in 10^{12}. The short-term stabilities (PM noise) are identified in Section 1.3 for each transmitter and each receiver, in combination with its performance monitor (see below). Except in the case of the C-Band receivers at Rosman and Mojave, the local oscillators are free-running units at the required frequency which are phase locked to harmonics of frequency synthesizers, which are themselves driven from the 5 MHz station standard. The C-Band receivers local oscillator use multipliers from the synthesizers.

By changing the synthesizer frequencies in small steps it is possible to "pull" or change the local oscillator frequencies by a small amount. Use may be made of this possibility for removing oscillator errors and/or gross doppler shifts in cases where the ATS spacecraft is operating in conjunction with another low altitude satellite, such as a Nimbus-type satellite for the T&DRE experiment or Apollo/Soyuz.

1.1.7 PERFORMANCE MONITOR

As mentioned above, each transmitter and receiver at Rosman and Mojave is provided with a performance monitor. The transmitter performance monitor is in effect a receiver coupled into the transmitter output while the receiver performance monitor is effectively a very low power transmitter coupled to the receiver input. These performance monitors have an IF of 70 MHz and have performance in terms of amplitude flatness and delay variations which are as good as, or better than the units with which they are associated. They have separate local oscillators and synthesizers to prevent any cancellation of instability or PM noise. They permit the testing of a transmitter or a receiver (with its associated monitor) on a 70 MHz to 70 MHz basis or on baseband to baseband basis when used with the available modems. Many of the measurements which have been referenced are performed on a transmittter or receiver with its appropriate performance monitor. The performance of the transmitter or receiver alone (which cannot be readily measured in these cases) would be somewhat better than the quoted values.

1.1.8 RANGE AND RANGE RATE

The ATSR subsystem, in addition to performing the function of sidetone ranging and range rate determination through the satellite, also provides the station timing signals which are used in the data processing and recording equipments. This equipment supports certain of the experiments; and the station standard frequencies. The primary standard frequency is 5 MHz from which the transmitter and receiver local oscillators are derived.

1.1.9 ADP

The automatic data processing equipment is described in Section 1.5. Its purpose is to allow on-site processing and preliminary reduction of data obtained from the experiments. Wideband data tape recorders and video tape recorders are provided for recording of data from experiments. Strip chart recorders are also available plus cameras to make permanent records of oscilloscope type displays.

1.1.10 CTEC

The CTEC unit contains of a wide variety of test equipment, including level meters, noise measuring equipment, a microwave link analyzer, television pattern generators and monitors. The CTEC is provided with convenient means of connection of the IF and baseband interfaces, and to the experimenters' equipments in order to allow these test instruments to be readily available for station evaluation and experiments.

1.1.11 MCC

The Master Control Console is a convenient central facility from which the overall station status can be monitored, and from which station personnel in charge of operations can control the station by means of a voice intercom system.

1.1.12 COLLIMATION TOWER

The Collimation Tower System consists of a test facility remoted from the operational stations that can be used to calibrate and evaluate the Rosman and Mojave ground terminals. This test facility utilizes a tower structure that is within a line-of-sight of the ground terminal antenna and has been instrumented with electronic equipment and suitable antennas that can simulate a spacecraft at some distance from the operational stations. The tower equipment is remotely controlled to allow the configuration of various test modes without the need for operational personnel being present at that facility.

The Rosman ground terminal has both a near and far field collimation tower. The near field tower is 2800 ft. from the Ros. II 85 ft. diameter antenna and has been instrumented with a T&C spacecraft simulator and the ATS-F spacecraft simulator. The far field tower is several miles from the station and has been instrumented with: a C-S-L band Tx/Rx frequency translator, C-band and MMW (20/30 GHz) frequency sources, the ATS-A/E satellite simulator, the RFI test translator and an optical target lamp.

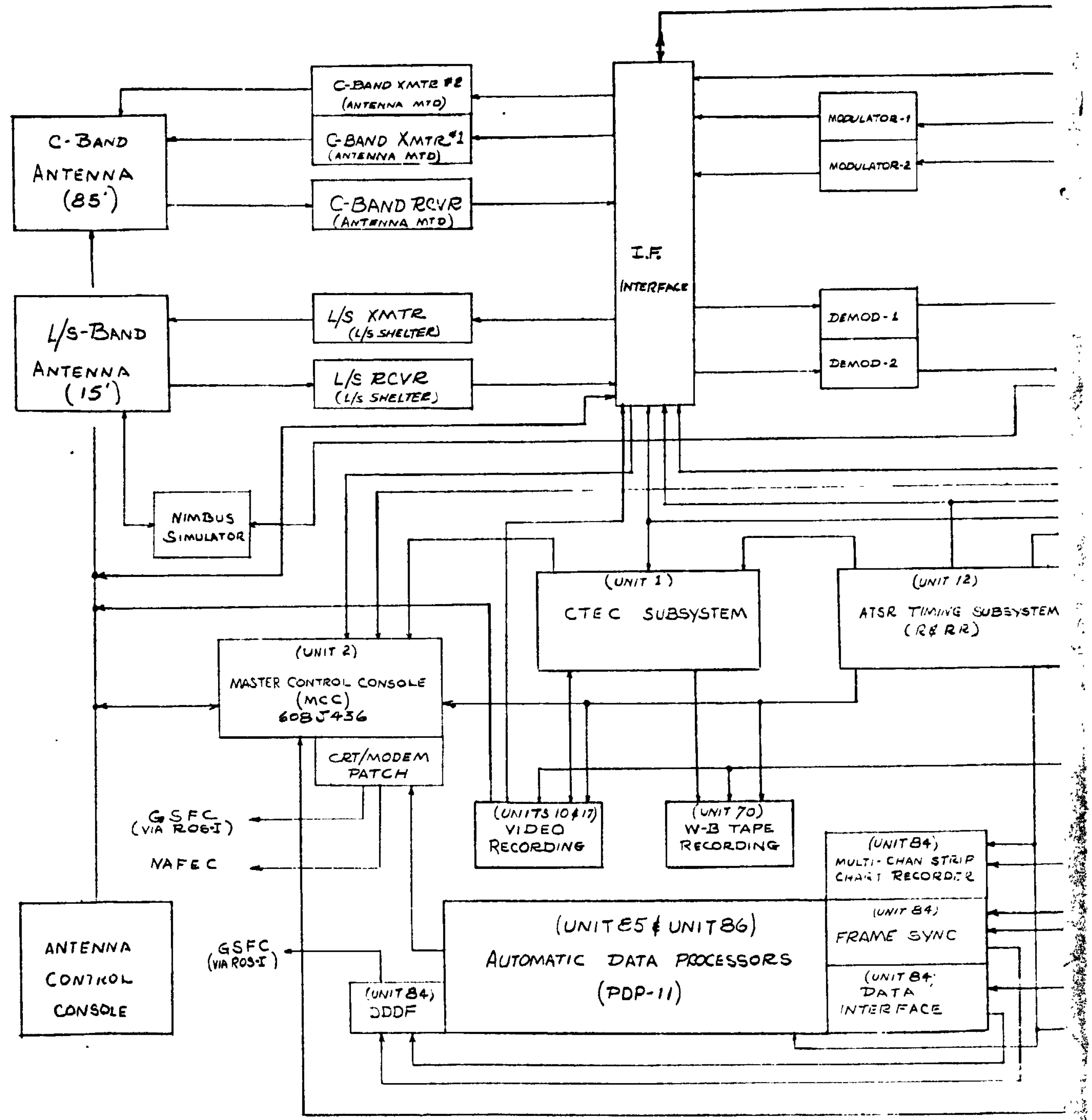
The Mojave ground terminal has only one collimation tower in the far field and has been instrumented with: a C-S-L Rx frequency source, a C-S-L Tx/Rx frequency translator, the ATS-A/E satellite simulator and an optical target lamp.

A more detailed description of the collimation tower facilities can be obtained from the Operation and Maintenance Manual for the ATS-F Collimation Tower Control Equipment, Rosman/Mojave.

1.1.13 STATION BLOCK DIAGRAM

Station block diagrams were developed early in the program to maintain an awareness of station configuration and capability. These drawings were first prepared on the basis of existing and available data, and were updated as new data was obtained or developed. To assist the reader in visualizing the station, in its final "As-Built" configuration, the block diagram for the Rosman Ground Terminal, ATS-F has been included in this section as Figure 1.1 ; the block diagram for the Mojave Ground Terminal as Figure 1.2 ; and the block diagram for the Hybrid Ground Terminal as Figure 1.3 .

FOLDOUT FRAME 1



FOLDOUT FRAME 2

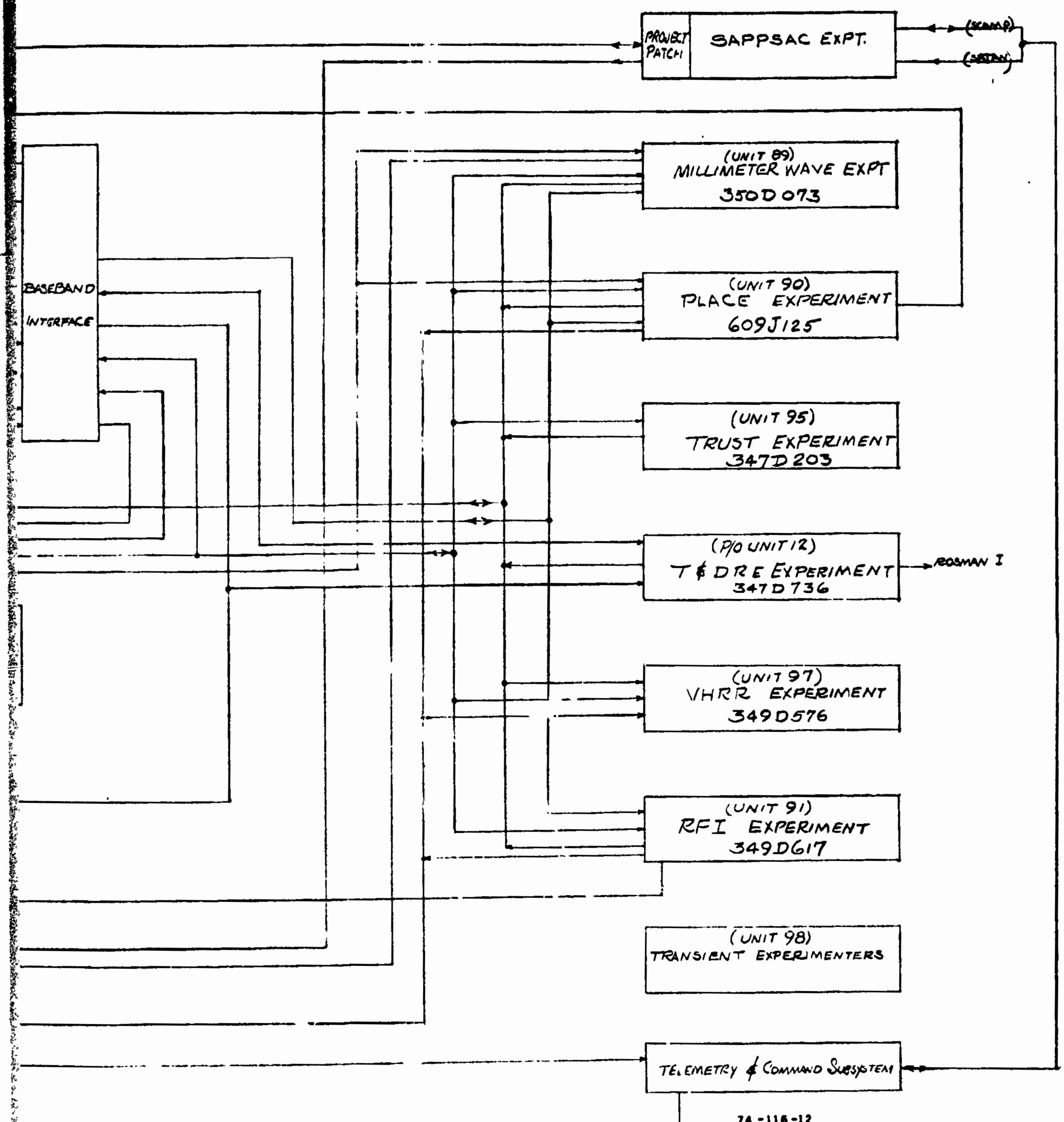
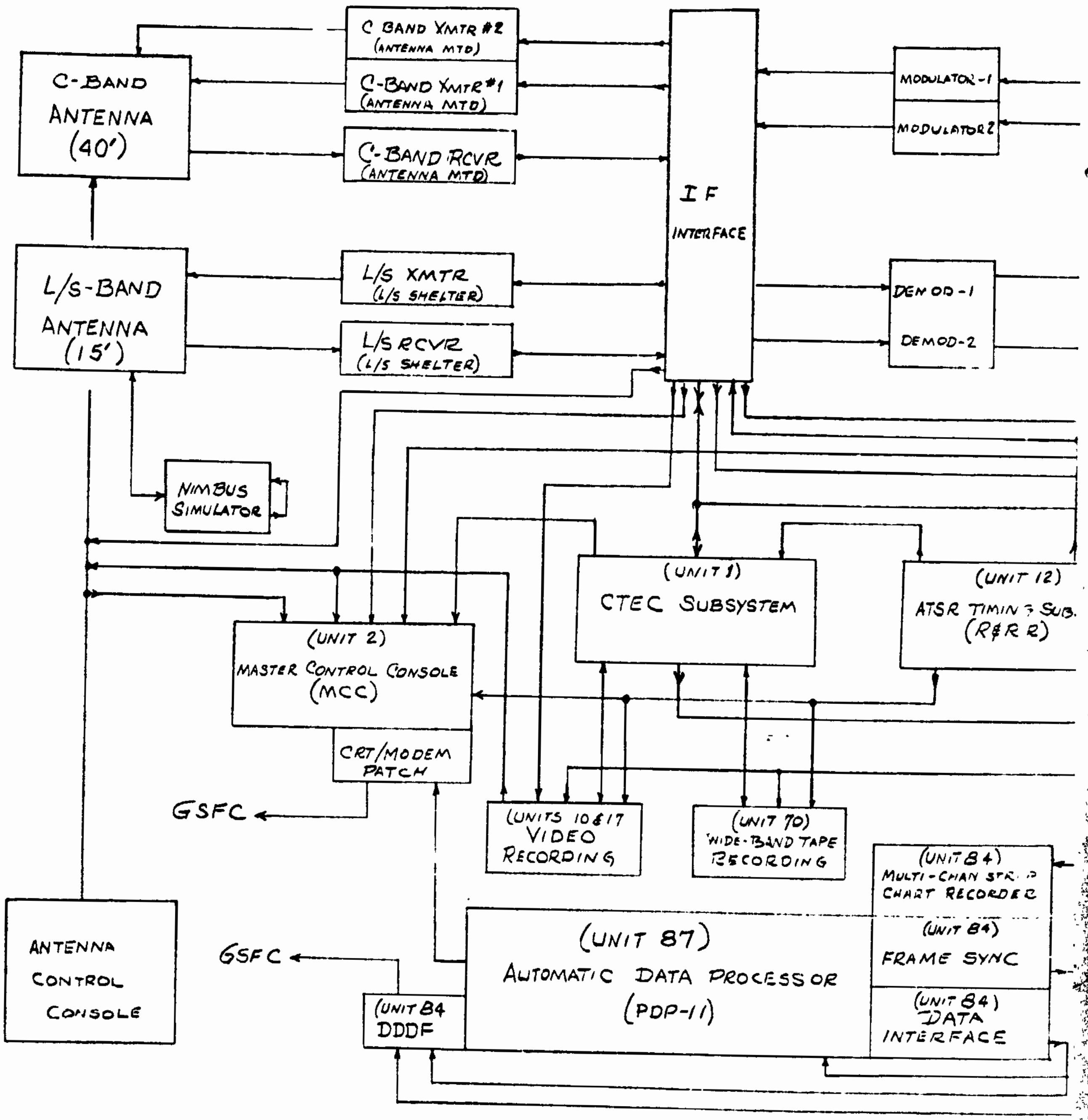


Figure 1.1. Rosman Ground Terminal Block Diagram

FOLDOUT FRAME



FOLDOUT FRAME 2

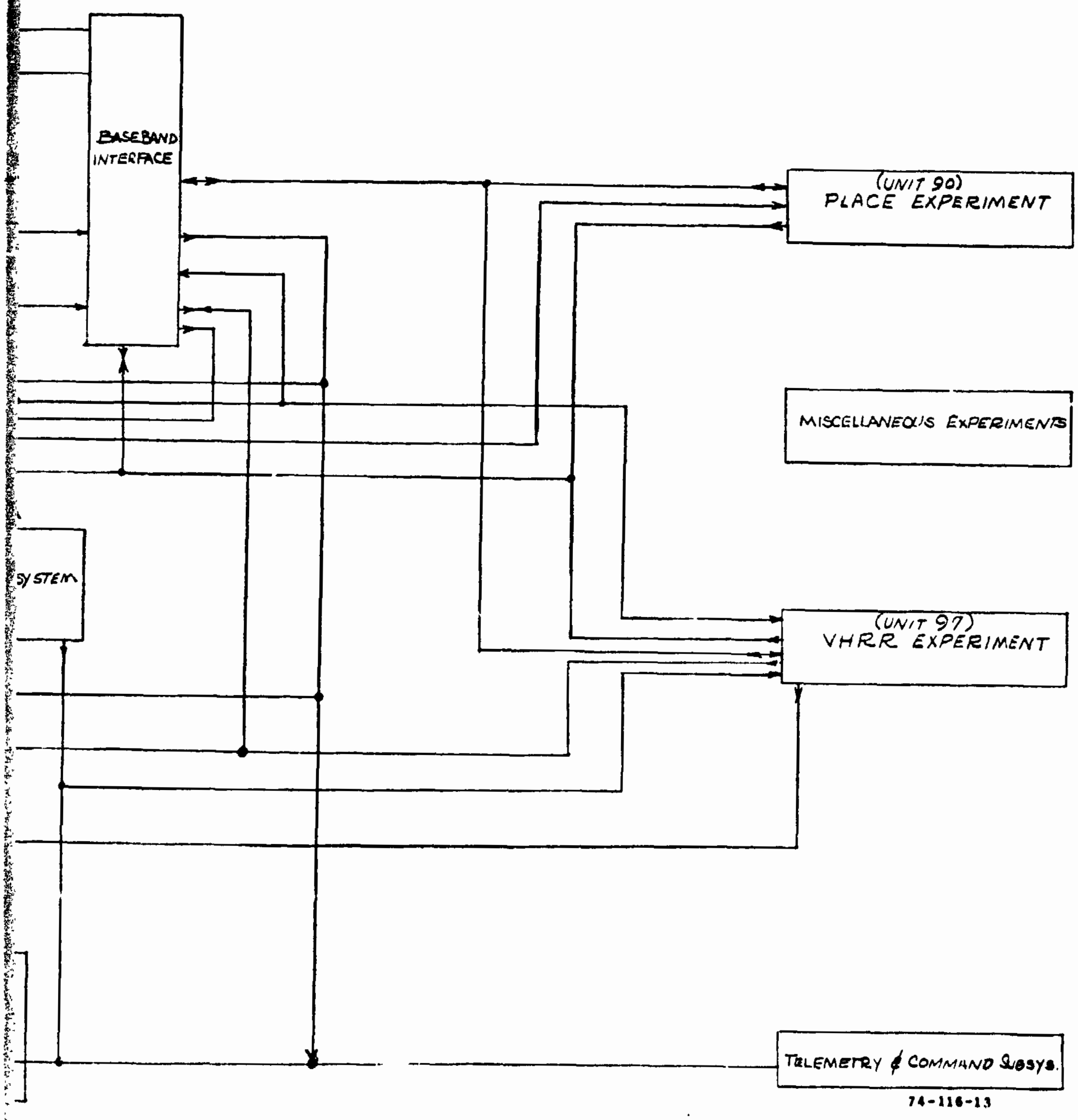
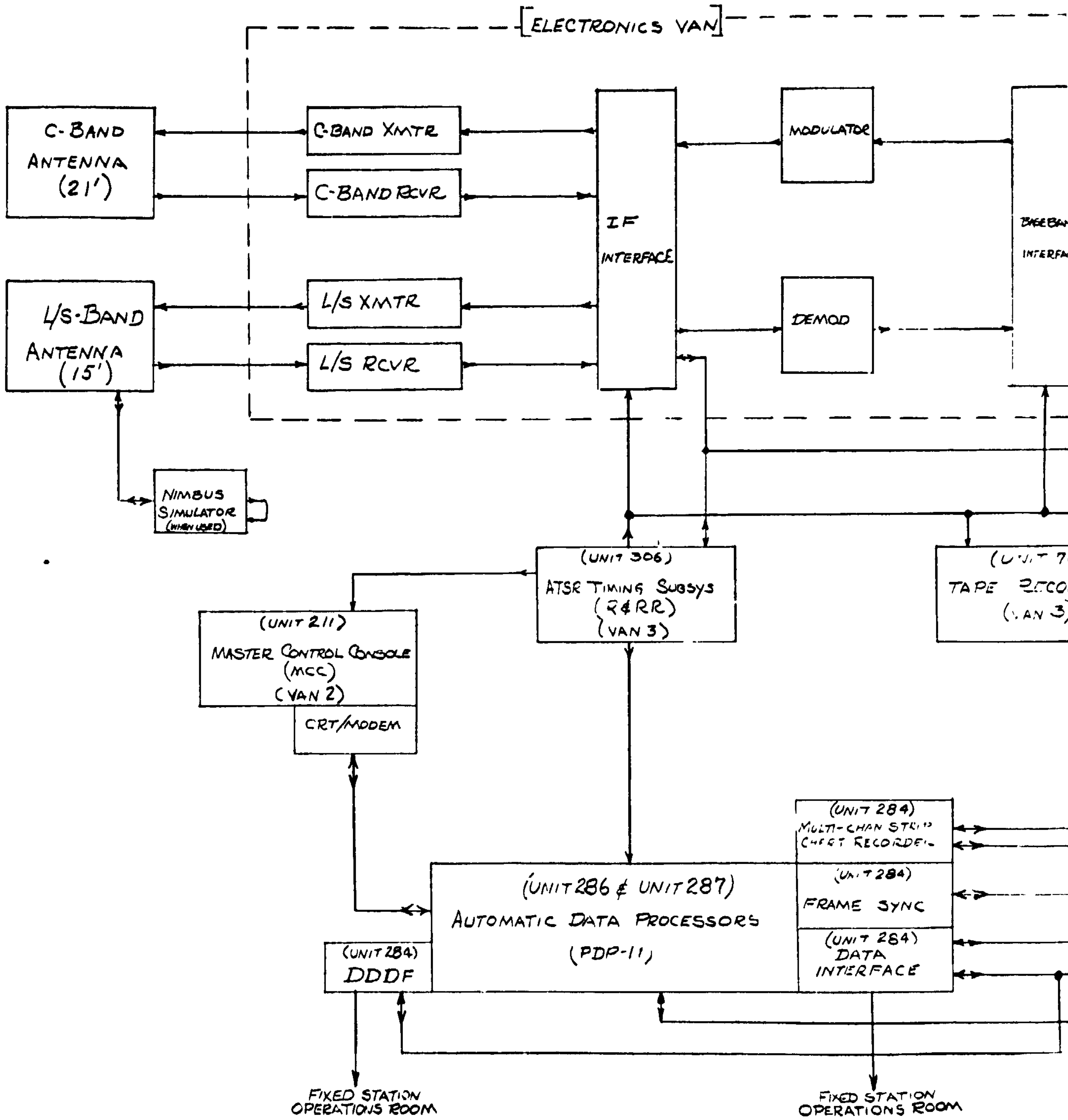


Figure 1.2. Mojave Ground Terminal Block Diagram

FOLDOUT FRAME 1



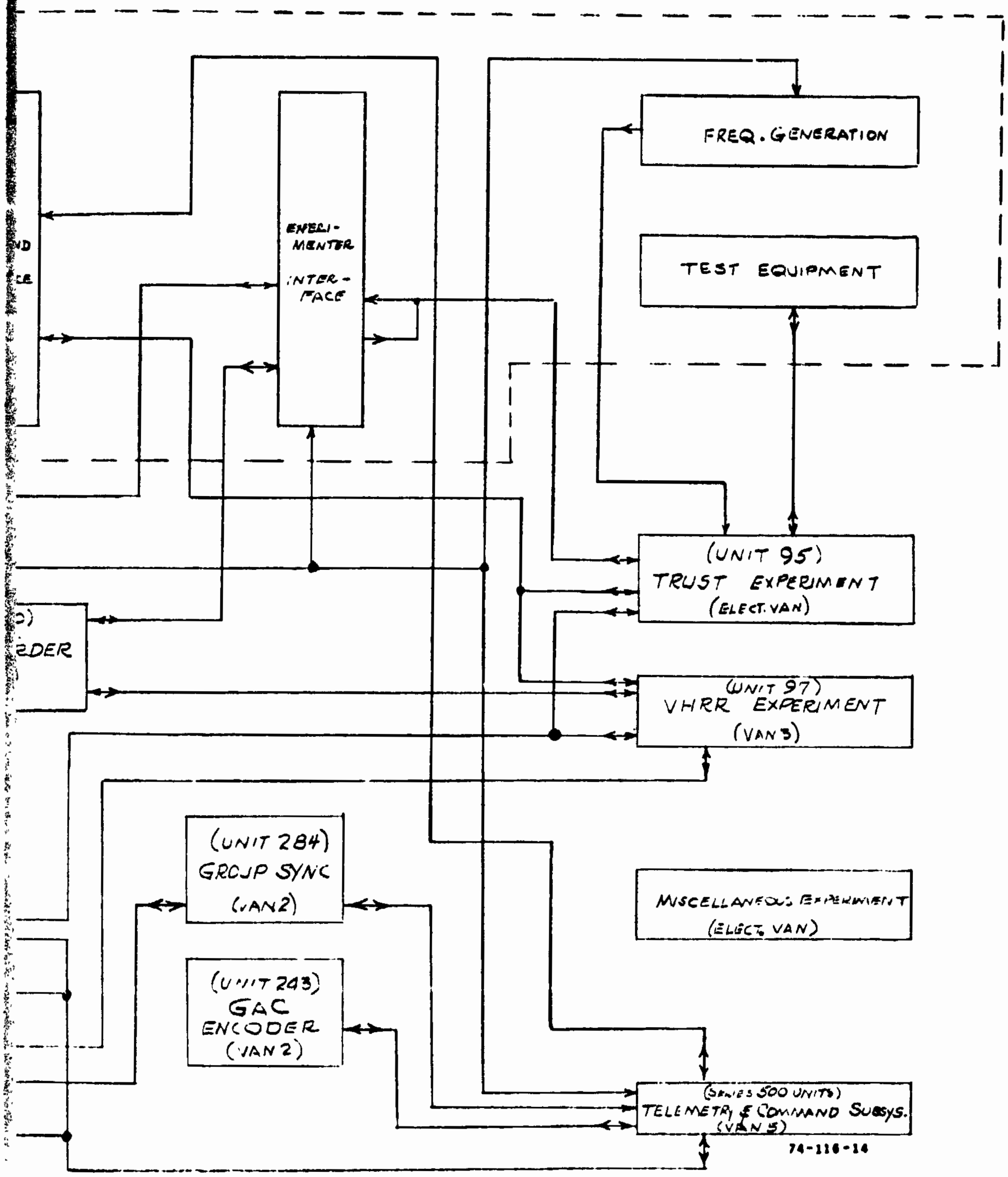


Figure 1.3. Hybrid Ground Terminal Block Diagram

1.2 STATION CONFIGURATION

This part of the Final Report is intended to describe the ATS-F station configuration and the events leading up to the final "As-Built" configuration. Initially the configuration plans were a portion of a three-part contract item. It was entitled the Configuration, Interface and Display Plan. A draft plan was submitted per schedule on 25 March 1971 which was preliminary in nature due to lack of specific vendor data, and experimenter requirements.

The configuration section of this plan presented floor plan layouts consistent with the philosophy at that time, which reflected minimum rework of existing station equipment on a cost effective basis. Surplus or superceeded equipments were removed and the then known new equipments were integrated.

The plan was reviewed on 31 March 1971 and a decision was made to treat the overall plan as three separate entities, to be issued as data became available. A philosophy change was decided upon, whereby subsystem equipments would be regrouped into functional areas and thereby facilitate like operations. In accordance with this decision, the floor plans were reworked to optimize the station operations aspect.

1.2.1 ROSMAN CONFIGURATION

In the new Rosman configuration, experimenter equipments were consolidated as much as reasonably practical. The frequency generation, modulation and control cabinets were aligned together in one row with baseband, receiver, test and control equipment racks. Resubmission of the plan was accomplished in July 1971.

Since this was a "living document", changes were made as the program progressed and requirements were defined. Some of the changes which were incorporated included the removal of the FM Transmitter, and the removal of the glass enclosure (visitors viewing area) at the entrance to the operations room, for emplacement of the computer complex. By aligning the experimenter and recording equipment in two rows in the area previously occupied by the multiplex and video units, consolidation was accomplished. The MCC and computer complex were interchanged to provide improved visibility for the MCC operator, and to bring the computer closer to the experimenter group.

Although additional minor changes were made as the occasion arose, the Rosman configuration established by Dec. 1971 remained basically unchanged. Final approval of the Rosman floor plan was received from NASA in Feb. 1973.

1.2.2 MOJAVE CONFIGURATION

The Mojave floor plans also involved several resubmissions, however, the changes were accomplished more easily because fewer new cabinets were involved. The major changes involved the rotation of the MCC 90 degrees to improve operator supervision, and the realignment of three CTEC racks to reduce congestion in the Transmitter-Receiver area.

The configuration established by Dec. 1971 remained basically unchanged. Final approval of the Mojave floor plan was received from NASA in Feb. 1973.

1.2.3 HYBRID CONFIGURATION

Initially, this system was scheduled to be configured as the TGS. Space problem restrictions created numerous problems. The floor plan submitted in Nov. 1971 grouped all basic communication equipments in the TGS Van 1. Vans 2 and 3 were reserved for experimenter and computer equipment, except for the R&RR subsystem which remained in Van 3. The floor plan as submitted was acceptable to NASA, however formal approval was withheld pending resolution of the TGS F&G concept. This configuration effort was terminated in Jan. 1972.

Contract Mod. 8, dated 6 July 1971, formally established the marriage of the TGS with the ATS Mobile Terminal into the Hybrid system. A configuration plan was submitted in June 1973 which provided details of site layout for both Mojave and Madrid. Site configuration was complicated by several conditions such as the two different site locations, the marriage of two independent systems into one, antenna orientation, and the selection of those TGS vans which could be considered dispensable.

1.2.4 FLOOR PLANS

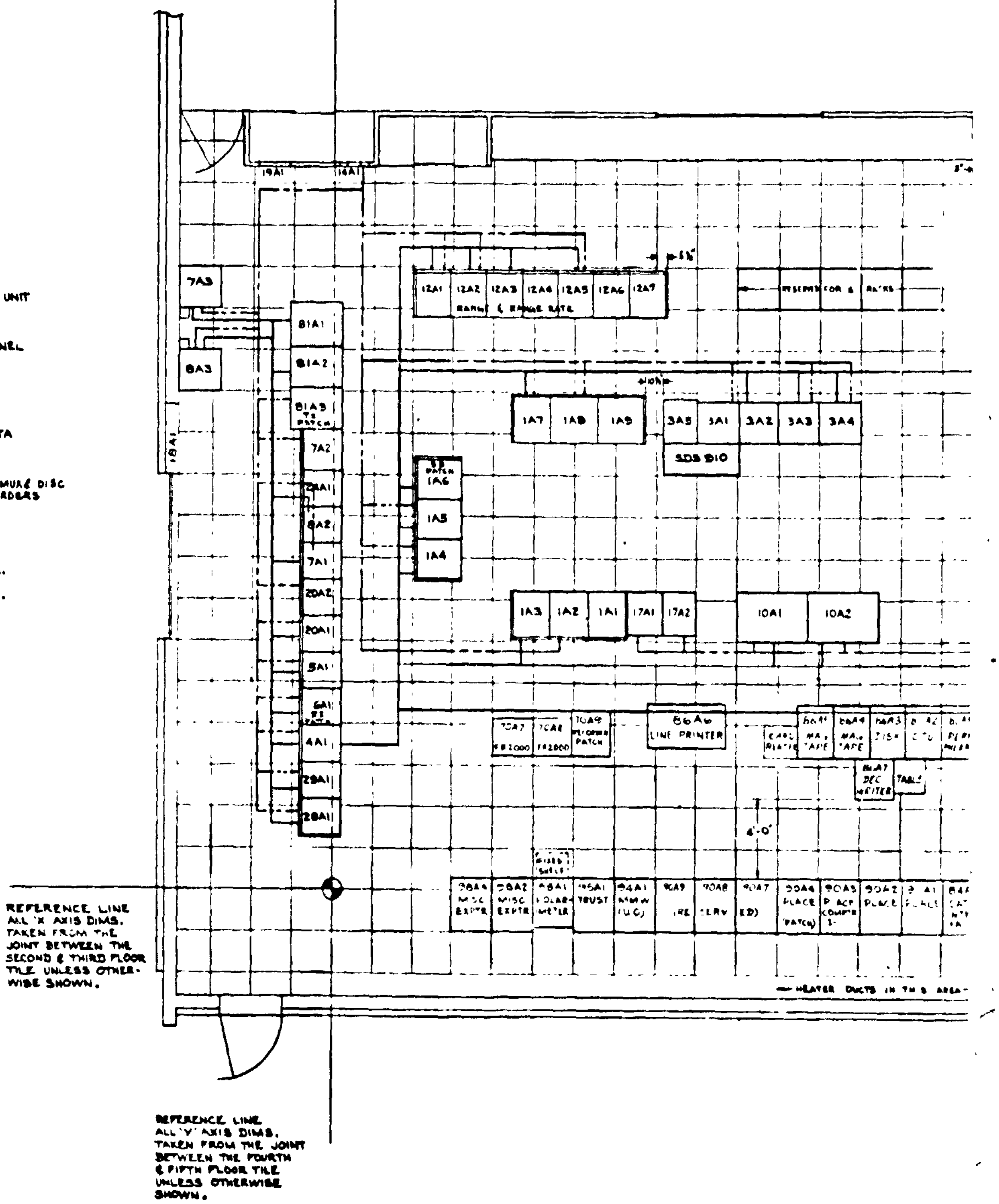
Floor plans of each station are provided to assist the reader in visualizing the station layout at the completion of the GSI effort. The detailed floor plan for the Rosman II Ground Terminal is provided as Figure 1.4. The detailed floor plan for the Mojave Terminal is Figure 1.5, and the detailed floor plan for the Hybrid Terminal is Figure 1.6. The reader can readily visualize the many iterations involved throughout the life of the program prior to the development of these "As-Built" drawings. The GSI believes that these drawings will prove to be of great value to the reader of this report, as he progresses through the various phases of the program, including the test effort.

FOLDOUT FRAME

LEGEND

- — - - — - - — POWER CABLES
- ———————— SIGNAL & CONTROL CABLES

UNIT	NOMENCLATURE
1	CTEC (COMM. TEST & EVALUATION CONSOLE)
2	MCC (MASTER CONTROL CONSOLE)
3	DPS (DATA PROCESSING SYSTEM)
4	C-BAND RCVRS, SYNTH & CONTROLS
5	IF AMP & DISCRIMINATORS; & SIGNAL PROCESSING
6	L/S Rx CONTROL & P.P.
7	C-BAND Tx PRIME
8	C-BAND PLACE Tx
9	DELETED
10	VIDEO TAPE RECORDER
11	DELETED
12	R & RR (RANGE & RANGE RATE)
13	DELETED
14	TECHNICAL POWER
15	DELETED
16	DELETED
17	TV BASEBAND EQUIPMENT
18	CABLE ENTRY
19	UTILITY POWER
20	TRANSMITTER/RECEIVER TEST EQUIPMENT UNIT
21	UNASSIGNED
22	DELETED
23	TELETYPE EQUIPMENT
24	TRANSMITTER TEST EQUIPMENT & PATCH PANEL
25	DELETED
26	DELETED
27	UNASSIGNED
28	COLL TOWER CONTROL
29	POLARIZATION UNIT
30 THRU 35	UNASSIGNED
36	PCM/DHE (PULSE CODE MODULATION DATA HANDLING EQUIPMENT)
37	RECORDERS (T&C)
38	MULTIPLEX & DISCRIMINATOR
39	TEST EQUIPMENT & VIDEO PATCH PANELS, MUX & DISC
40	T&C RECEIVERS & PATCH PANELS & RECORDERS
41	VHF MUX & PATCH PANEL
42	T&C ANTENNA CONTROL
43	SYNCHRONOUS CONTROLLER
44	T&C REMOTE TRANSMITTER CONTROL
45	T&C COMMAND CONSOLE
46 THRU 48	NOT IN INSTRUMENTATION BLDG.
49	UNASSIGNED
50 THRU 69	NOT IN INSTRUMENTATION BLDG.
70	RECORDERS & PATCH PANELS
71 THRU 74	UNASSIGNED
75 THRU 77	NOT IN INSTRUMENTATION BLDG
78 THRU 80	UNASSIGNED
81	C, L/S Tx & Tx CONTROL
82 & 83	UNASSIGNED
84 THRU 86	COMPUTER COMPLEX (PDP 11)
87	UNASSIGNED
88	MMW COMPUTER COMPLEX
89	MMW EXPERIMENT
90	PLACE
91	RFI
92	UNASSIGNED
93	UNASSIGNED
94	MMW (UNIV of OHIO)
95	ITV/TRUST
96	DRE (MOUNTED IN 12A5 & 12A6)
97	VHRR
98	MISC EXPERIMENTS
99	85-2 ANT. AXIS



FOLDOUT FRAME 2

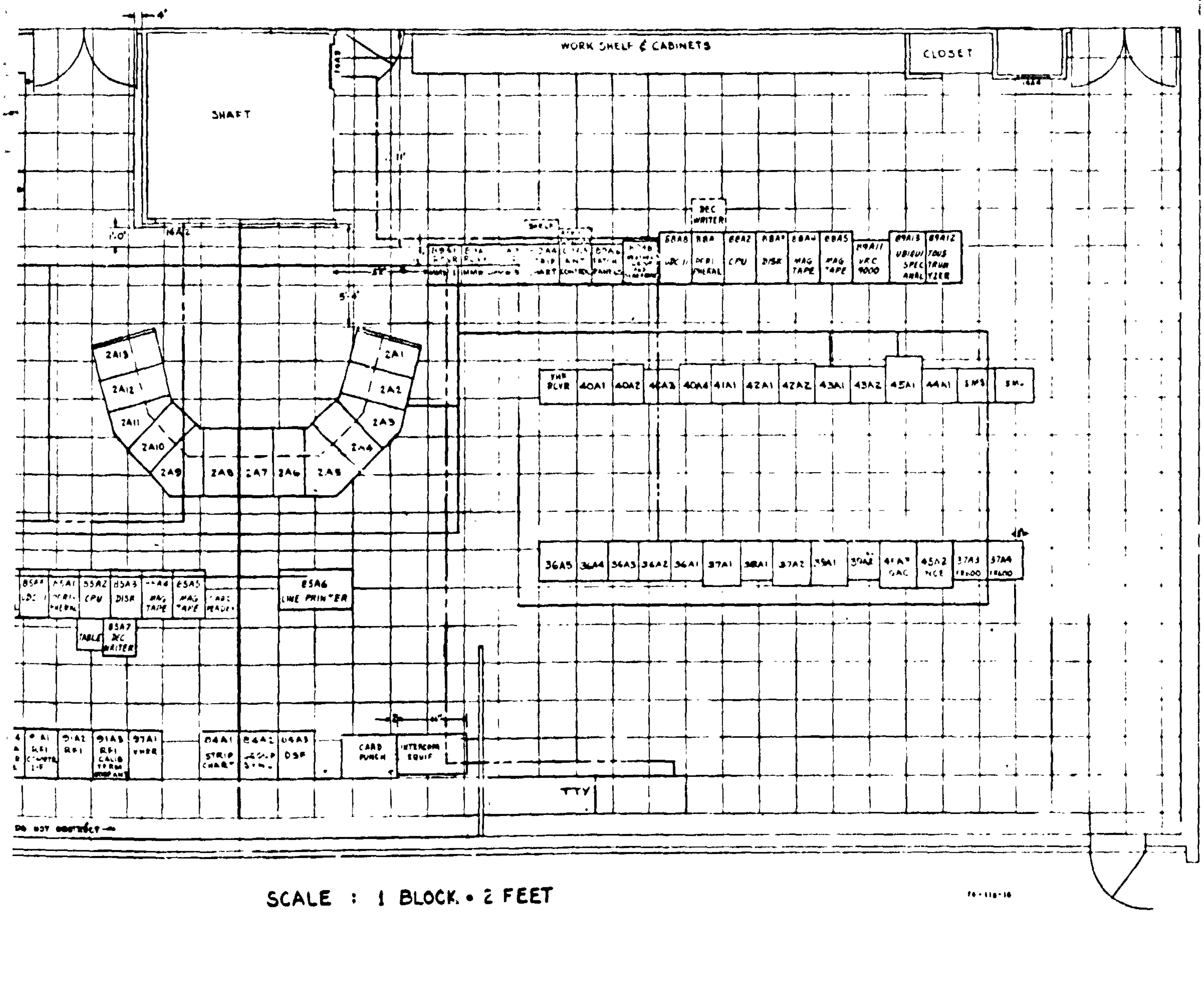
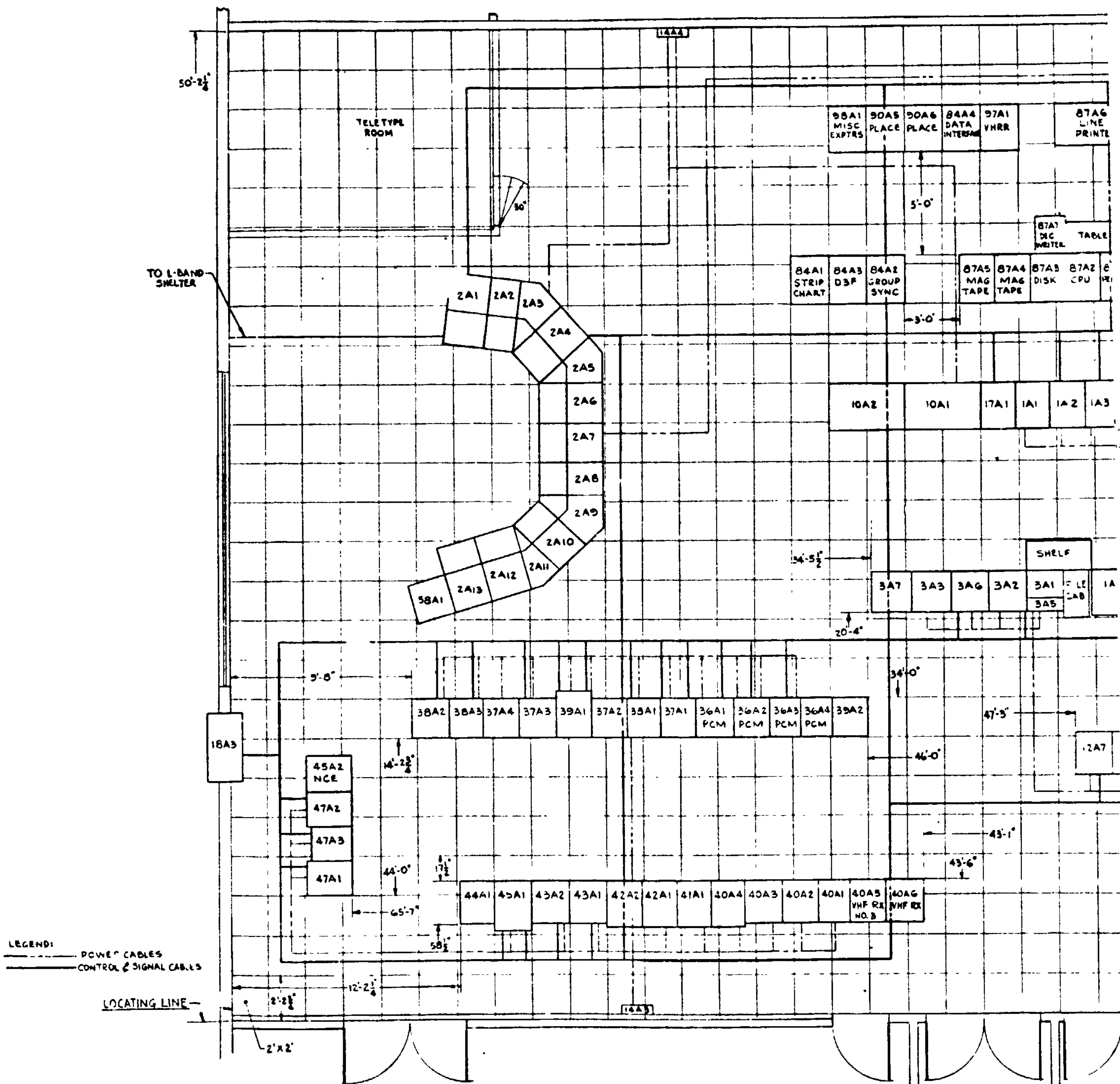


Figure 1.4. Rosman Ground Terminal Floor Plan


14A4
50'-2¼"
TELETYPE ROOM
30°
98A1 MISC EXPTRS
90A5 PLACE
90A6 PLACE
84A4 DATA INTERFACE
97A1 VHRR
87A6 LINE PRINTER
5'-0"
87A7 DEC WRITER
TABLE
TO L-BAND SHELTER
84A1 STRIP CHART
84A3 DSF
84A2 GROUP SYNC
87A5 MAG TAPE
87A4 MAG TAPE
87A3 DISK
87A2 CPU
3'-0"
2A1
2A2
2A3
2A4
2A5
2A6
2A7
2A8
2A9
2A10
2A11
2A12
2A13
58A1
10A2
10A1
17A1
1A1
1A2
1A3
SHELF
34'-5½"
3A7
3A3
3A6
3A2
3A1
3A5
20'-4"
5'-8"
34'-0"
38A2
38A3
37A4
37A3
39A1
37A2
38A1
37A1
36A1 PCM
36A2 PCM
36A3 PCM
36A4 PCM
39A2
47'-5"
18A3
45A2 NCE
16'-2¾"
46'-0"
2A7
47A2
47A3
43'-1"
43'-6"
47A1
44'-0"
17½"
44A1
45A1
43A2
43A1
42A2
42A1
41A1
40A4
40A3
40A2
40A1
40A5 VHF RX NO. 3
40A6 VHF RX
65'-7"
58½"
LEGEND:
POWER CABLES
CONTROL & SIGNAL CABLES
12'-2¼"
LOCATING LINE
2'-2¾"
14A3
2'x2'

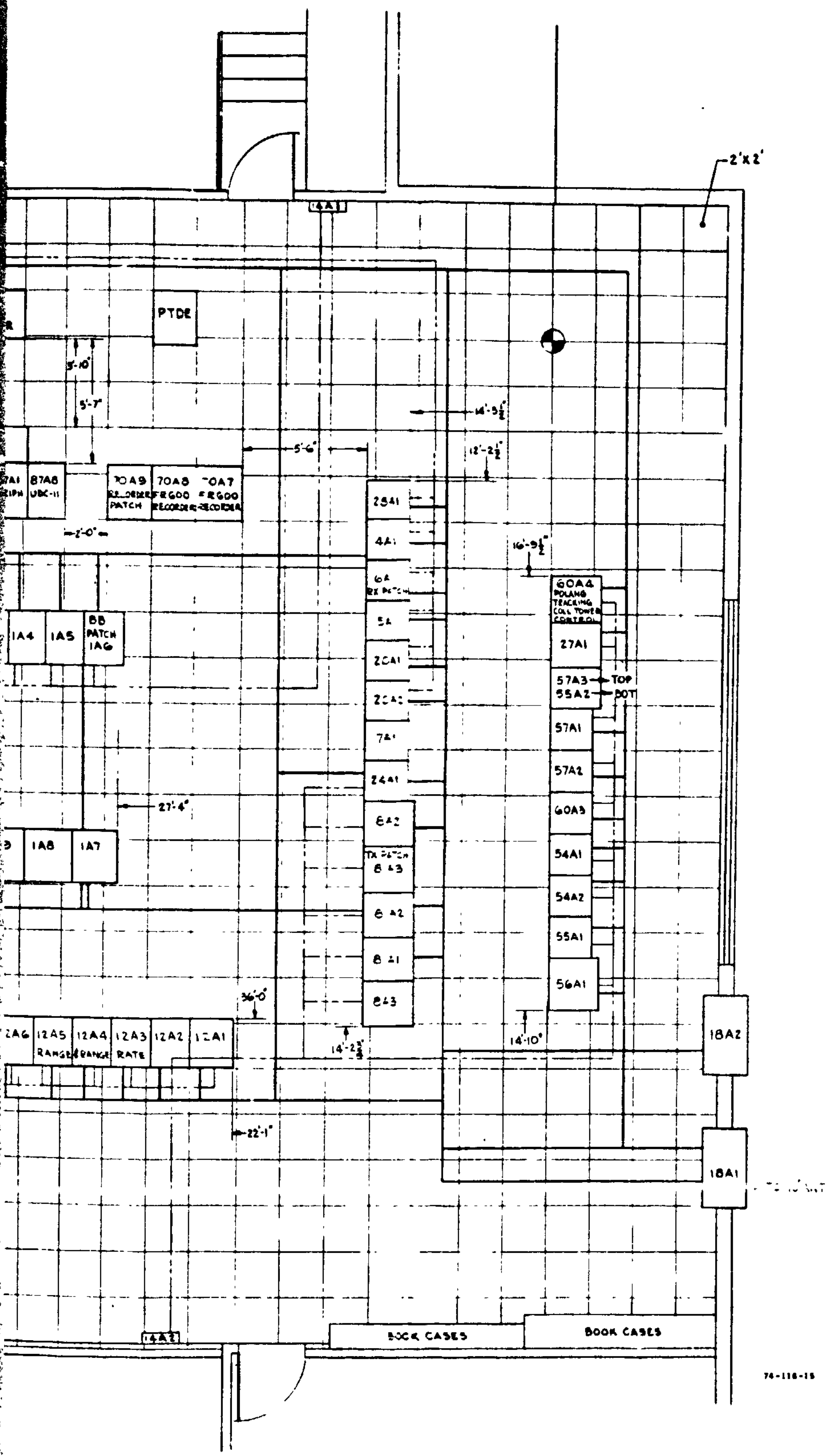
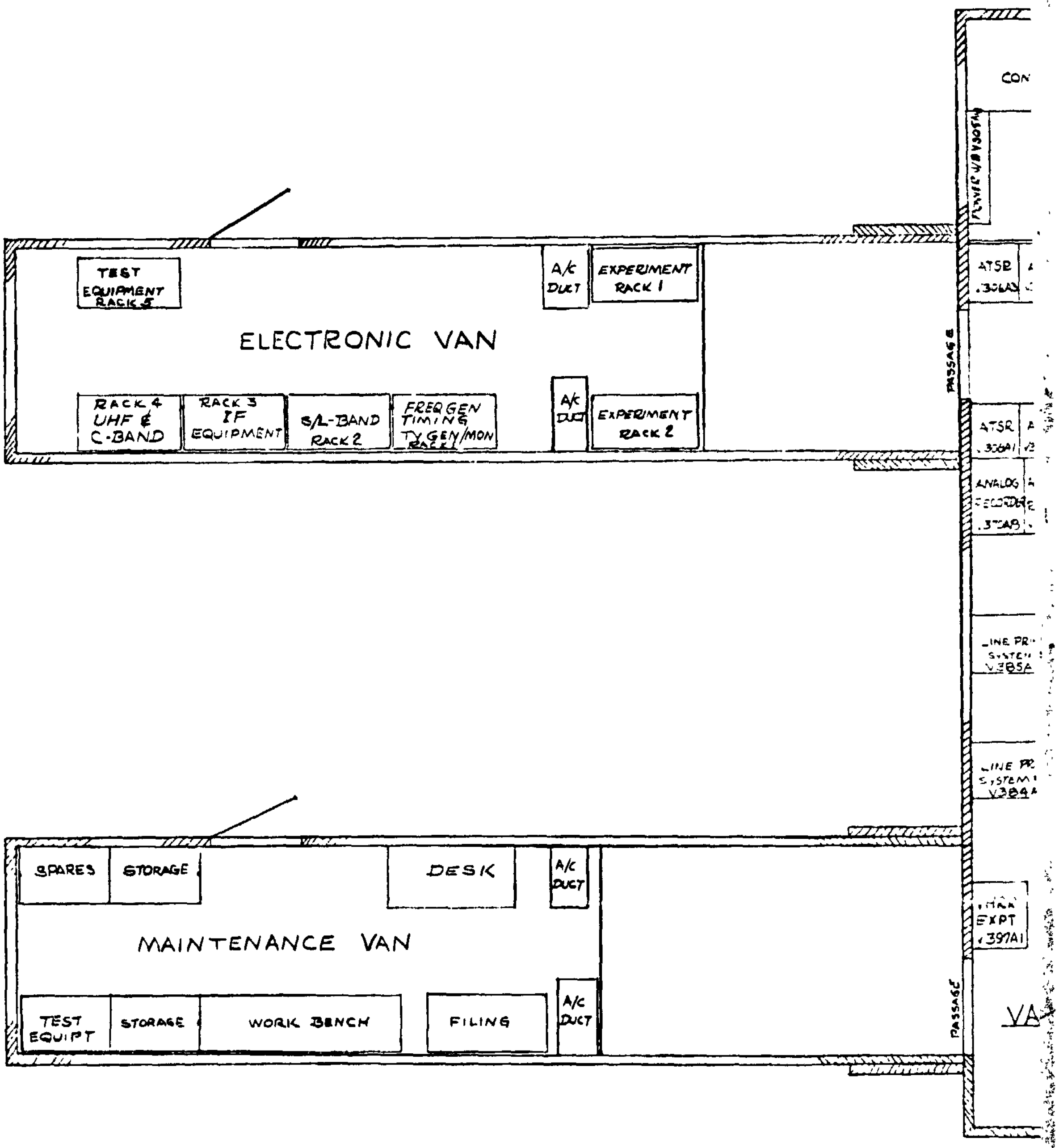


Figure 1.5. Mojave Ground Terminal Floor Plan

UNIT	NOMENCLATURE
1	CTEC (COMM TEST & EVALUATION CONSOLE)
2	MCC (MASTER CONTROL CONSOLE)
3	DPS (DATA PROCESSING SYSTEM)
4	PARAMP CONTROL & SYNTHESIZER
5	Rx IF & BASE BAND
6	RECEIVER PATCH PANELS & L/S RCVR CONTROL
7	SSB TRANSMITTER
8	FM TRANSMITTER
9	
10	VIDEO TAPE RECORDER
11	AUDIO TAPE RECORDER
12	R & RR (RANGE & RANGE RATE)
13	UNASSIGNED
14	TECHNICAL POWER
15, 16	UNASSIGNED
17	TV BASEBAND EQUIPMENT
18	CABLE ENTRY CABINET
19	UNASSIGNED
20	TRANSMITTER/RECEIVER TEST EQUIP UNIT
21, 22, 23	UNASSIGNED
24	TRANSMITTER TEST EQUIPMENT & PATCH PANEL
25	UNASSIGNED
26	UNASSIGNED
27	POLARIZATION UNIT
28	TDA & NOISE CONTROL
29	PARAMETRIC AMPLIFIER
30	THRU 35 UNASSIGNED
36	PCM/DHE (PULSE CODE MODULATION DATA HANDLING EQUIPMENT)
37	RECORDERS
38	MULTIPLEX & DISCRIMINATOR #1
39	MULTIPLEX & DISCRIMINATOR #2
40	T & C RECEIVERS & PATCH PANELS
41	CHART RECORDER
42	STATION T & C
43	SYNCHRONOUS CONTROL
44	T & C TRANSMITTER REMOTE CONTROL
45	T & C COMMAND CONSOLE
46	UNASSIGNED
47	T & C TRANSMITTER
48, 49	UNASSIGNED
50	THRU 53 NOT IN INSTRUMENTATION BLDG
54	40FT ANTENNA PROGRAMMER
55	40FT ANTENNA PUNCH
56	40FT ANTENNA COMPUTER
57	40FT ANTENNA CONTROL CONSOLE
58	15FT ANTENNA CONTROL RACK
59	UNASSIGNED
60	COLLIMATION TOWER EQUIPMENT
61	L-BAND SYNCHRONIZES
62	THRU 69 UNASSIGNED
70	RECORDERS
71	COMMUNICATIONS
72	THRU 74 UNASSIGNED
75	THRU 77 NOT IN INSTRUMENTATION BLDG
78	THRU 80 UNASSIGNED
81	C, L/S TX & TX CONTROL
82, 83	UNASSIGNED
84,86	COMPUTER COMPLEX
[illegible]	[illegible]
90	PLACE
91	THRU 96 UNASSIGNED
97	VHRR
98	UNASSIGNED
99	CABLE TRANSITIONS
*	EXISTING PLACE EXPMT, TEMPORARY

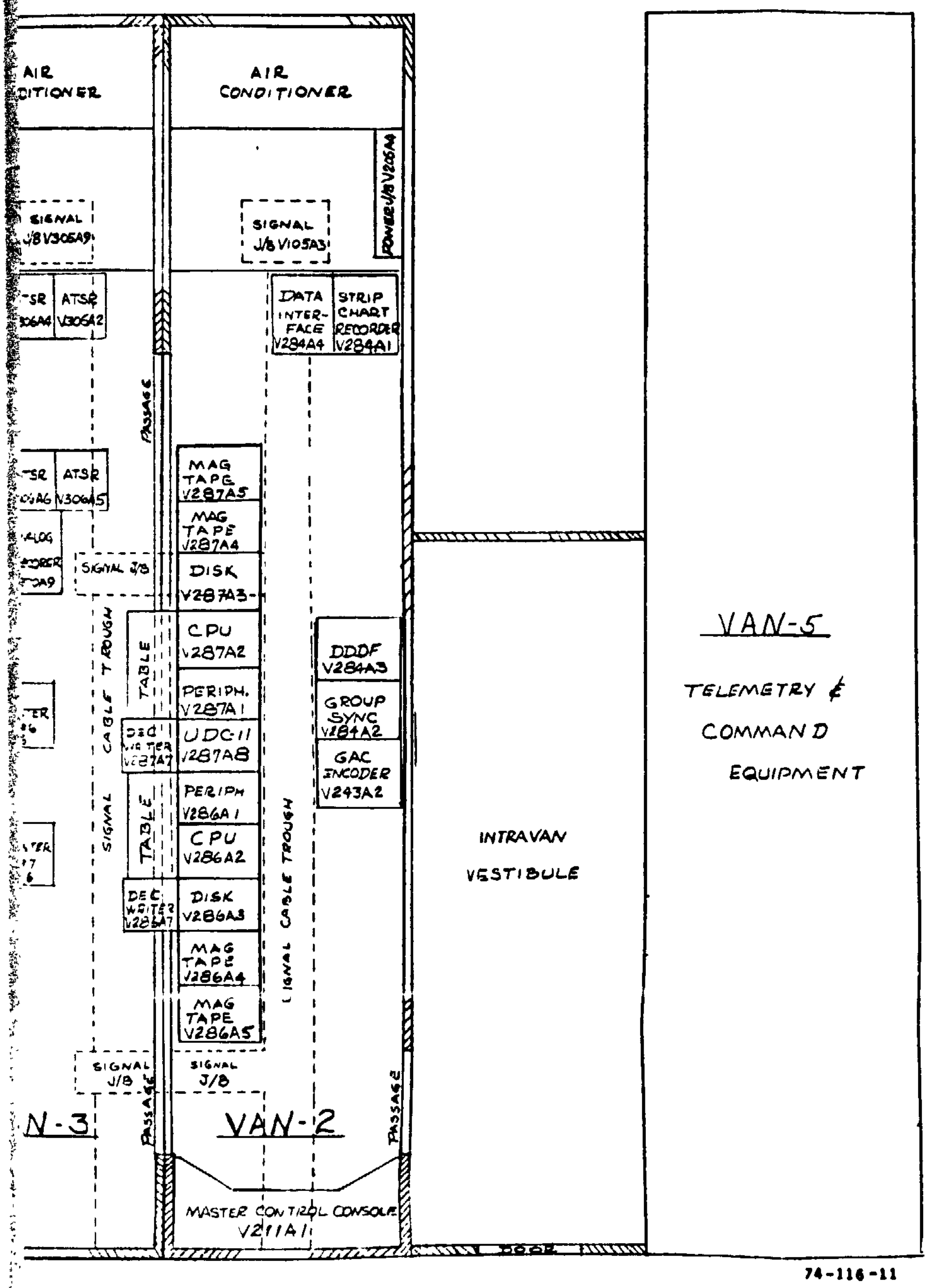
FOLDOUT FRAME 2

FOLDOUT FRAME 1



Figu

...DOUT FRAME



...re 1.6. Hybrid Ground Terminal Floor Plan

1.3 STATION PERFORMANCE

The GSI test program was developed subsequent to an analysis of the ATS-F mission performance requirements. The selection of tests performed was designed to reveal the measure to which those requirements were met. Analysis of test results provided a working knowledge of system capabilities, and in some instances resulted in recommendations and conclusions for modifications and/or limitations of these systems. The following paragraphs will provide the reader with a working knowledge of the performance of each ground terminal. Detailed test data analysis, and data sheets for each test performed at each station, has been provided as reference material and is located in seven volumes entitled "GSI Test Data Report".

1.3.1 ROSMAN GROUND TERMINAL PERFORMANCE

The Rosman Satellite Ground Terminal can provide an interface between a space segment and a variety of communication applications. In the case of the ATS-F (6) program, the space segment is the ATS-6 spacecraft and the communication applications are those specified by the various experimenters associated with this project. The performance of this system configuration, in support of the various experiments, is presented in Section 1.4. The following parameters cover that criteria that deals with the overall suitability of the Rosman Ground Terminal to perform communication functions in general, and the ATS-F (6) program specifically. Detailed performance data has been presented in Section 1.3.4 of this report and in Vol. 1 of the GSI Test Data Report.

- Antenna Subsystem

It is necessary to interface the ground terminal with the space segment utilizing an antenna subsystem. At Rosman N.C., the communication base station utilizes an 85 ft. diameter C-Band antenna and a 15 ft. diameter L/S band antenna, to perform this function.

The 85 ft. diameter C-Band antenna has been designed to operate over a Rx band of 3.7 to 4.2 GHz and a Tx band of 5.925 to 6.425 GHz. The gain of this antenna is 58.3 dB at 3.95 GHz and 59.1 dB at 5.95 GHz. The feed equipment provides rotatable linear polarization that can either present Rx/Tx orthogonal or parallel polarization. A closed loop tracking system provided the real-time rotatable polarization alignment. The antenna noise temperature is 57.8°K, as measured at 3.95 GHz. With the receiver subsystem interfaced with the antenna, this system provides a G/T of 38.2 dB at 3.95 GHz. The EIRP of the antenna subsystem is +128.7 dBm utilizing the Tx subsystem as a source of communication power. The antenna is pointed at the space segment utilizing an X-Y mount, activated by a hydraulic drive system. Pointing is accomplished either manually, via an open loop program, or utilizing a monopulse closed loop auto track system. The pointing accuracy of this antenna will allow the RF pattern main lobe to be maintained within 1 dB of the peak of the beam at its highest operational frequency. The rate of axis movement will allow the tracking of either a synchronous or lower orbital satellite.

The 85 ft. diameter antenna has been modified to support S-Band Rx operations using a prime focus feed through a dichroic lens that acts as a C-Band subreflector. The gain of this antenna mode, at S-Band, is 50.9 dB (LP) as measured at 2.61 GHz. The Rx S-Band antenna system noise temperature is 1190°K.

The 15 ft. diameter L/S band antenna has been designed to operate at <u>either</u> L-Band or S-Band. The L-Band operational Rx band is 1.5 to 1.58 GHz and the Tx operational band is 1.62 to 1.7 GHz. The L-Band gain of this antenna is 33.7 dB for Rx and 32.6 dB for Tx. The feed equipment will provide either LCP or RCP polarization which is manually changeable. The L-Band antenna noise temperature was measured and found to be 84°K. With the receiver subsystem interfaced with the antenna, this system provides a G/T of 11.4 dB. The EIRP of the L-Band antenna subsystem configuration is +94.3 dBm utilizing the Tx subsystem as a source of communication power. The antenna is pointed at the space segment utilizing a El/Az mount that supports both the L & S band antenna equipment. Pointing is accomplished manually utilizing an electric drive open loop system. The pointing accuracy of this antenna system is dependent upon the skill of the antenna operator as he utilizes a Rx signal strength indicator to point the antenna. Only synchronous satellite operation is feasible with this equipment.

The S-Band section of the 15 ft. diameter antenna will support a Rx bandwidth of 2.05 to 2.1 GHz and a Tx bandwidth of 2.2 to 2.3 GHz. The S-Band Rx gain is 35 dB and the Tx gain is 33.7 dB. The feed equipment will support the same polarization characteristics as that of the L-Band equipment (RCP & LCP). The S-Band antenna noise temperature is 116°K and provides a G/T of 11.4 dB when interfaced with the receiver subsystem. The S-Band EIRP is +83.7 dBm utilizing the Tx subsystem as a source of communication power.

- Receiver Subsystem

The receiving subsystem performance is principally a function of the carrier to noise ratio. This parameter is a function of the field strength of the Rx signal, the capability of the antenna to collect this energy, and the system noise temperature, as well as the communication bandwidth parameters. This is why the antenna gain efficiency and noise temperature affect the receiver performance. At the Rosman Terminal, the C-Band system utilizes a wideband low noise RF amplifier that provides a Rx noise temperature of 16.4°K. This equipment, along with the antenna contribution developes a Rx system noise temperature of 57.8°K that relates to a G/T of 38.2 dB. The S and L-Band Rx amplifiers develope noise temperatures over the operational bands of 115°K and 111°K that relate to an S-Band G/T of 11.4 dB and a L-Band G/T of 10.8 dB. These parameters are the key items that effect the C/N for each operational bandwidth.

The RF to IF frequency down converter (C, S or L-Band) equipments are nominally wideband devices. Their operational frequencies and bandwidths are as presented in Section 1.3.4. The IF amplifiers of the receiving equipment have flat bandwidths of approximately 40 MHz. The RF bandwidths are at least this wide with the exception of L and S-Bands. Operational band pass IF filters are provided, that tailor the communication bandwidths to the experiment requirements. These bandwidths have flat responses in order to maintain group delay variations within the specification limits. The C-Band Rx group delay measured over a ±20 MHz band is approximately 4 nsec P-P and has a ripple component of 2 nsec P-P. The S-Band Rx group delay also measured over a ±20 MHz bandwidth is 1.5 nsec P-P and has a ripple component of 1.5 nsec P-P. The L-Band Rx group delay was measured over an IF band of ±5 MHz and is 3 nsec P-P with a ripple component of 1 nsec P-P. In order to maintain these values of phase linearity, the 1 dB IF bandwidth for the C-Band and S-Band equipment is 50 MHz. The L-Band 1 dB bandwidth is ±18 MHz. These characteristics are required to support wideband television, multiple channel FMDSSB/FM telephone signals and other applications.

This station is equipped with 70 MHz modems, which permit demodulation of IF signals to be accomplished. These wideband units are capable of supporting NTSC television, 1200 telephone channels in FDM multiplex as well as other applications. The performance of this equipment meets CCIR and Intelsat specifications. The output video frequency response is from 30 Hz to 4.2 MHz while the multichannel mode response is from 60 Hz to 5.2 MHz.

All RF to IF translation oscillator frequencies in the receivers are derived from the station standard which has a long term stability of ± 1 part in 10^{12}. Therefore, on a long term basis the ground station introduces essentially no frequency error. This is important in many experiments since it allows precise measurements of such things as doppler frequency, and permits the spacecraft oscillators to be locked to this stable known frequency from the ground in the satellite coherent mode. When using the wideband FM modulator, lesser stability is obtained with the oscillator AFC. Timing signals with the same stability are available, and may be used for such purposes as measuring the satellite range (this is done indirectly in the ATSR equipment by measuring relative phase of tones derived from the station standard; however this is in effect a time measurement). The short term stability is not a function directly of the station standard, but is a function of the quality of the synthesizers, phase lock oscillators etc. used to derive the receiver local oscillators. Short term instability shows up as PM noise on the translation oscillators and hence on the RF signals. It sets an ultimate limit to the S/N of television pictures, voice channels etc., transmitted or received as FM or PM, and in the case of these stations the noise on certain of the oscillators is marginal for the intended use. The following C-Band phase noise was measured: 1 Hz BW below 1 KHz is -40 dB, 3 KHz BW measured from 1 KHz to 5 MHz was -55 dB. At S-Band the 1 Hz BW phase noise was -48 dB at 10 Hz and -80 dB at 1 KHz, while the 3 KHz BW noise was -55 dB from 1 KHz to 5 MHz. The L-Band phase noise measured in a 10 Hz BW was less than -70 dB at 1 KHz and in a 3 KHz BW was -55 dB up to 5 MHz. These values of phase noise do not meet CCIR or Intelsat requirements.

- Transmitter Subsystem

The transmitting subsystem performance is principally a function of output power that can be turned in to EIRP and quality of sideband information developed by the Tx modulator and IF to RF upconverter. At the Rosman Terminal, the

C-Band Tx subsystem can develop a station EIRP of +128.7 dBm in a 50 MHz BW. The operational carrier frequencies that are utilized have been presented in Section 1.3.4. The same communication parameters that affect the Rx subsystem frequency down converter and IF amplifiers apply to the transmitter subsystem. Parameters such as phase noise, frequency response, and phase linearity are also key items that can affect the performance of the transmitter. In the case of the C-Band Tx, group delay measured over a BW of ±20 MHz is approximately 6 nsec P-P and has a ripple component of 4 nsec on the average. The 1 dB bandwidth is >50 MHz. Phase noise as measured in a 10 Hz BW was -50 dB at 100 Hz to -60 dB at 500 Hz. In a 300 Hz BW the phase noise is -45 dB at 10 KHz to -70 dB at 100 KHz and in a 3 KHz BW this parameter is -63 dB from 0.2 MHz to 5.0 MHz. These communication performance values are representive of the Rosman station.

The S-Band Transmitter subsystem developes an average power that will allow the Antenna Subsystem to radiate an EIRP of +85.7 dBm. The variation in group delay is 1.5 nsec P-P measured over a ±20 MHz B.W. and has a ripple component of 1.5 nsec. The 1 dB BW frequency response is >50 MHz. Phase noise characteristics indicate that the 1 Hz BW is -48 dB at 10 Hz to -80 dB at 1 KHz and that the 3 KHz BW phase noise is -55 dB out to 5 MHz.

The L-Band transmitter subsystem developes an average power that will allow the Antenna Subsystem to radiate an EIRP of +92.6 dBm. The variation in group delay is 3 nsec P-P as measured over ±5 MHz and has a ripple component of 1 nsec P-P. The 1 dB frequency response BW is ±5 MHz. Phase noise as measured in a 300 Hz BW is >-65 dB up to 60 KHz and in a 3 KHz BW is >-55 dB to 5 MHz.

The modulators and baseband circuits for all frequency bands are wideband devices that can support NTSC television and 1200 channel FDM multiplex telephone signals. This equipment meets CCIR and Intelsat requirements. The input video frequency response is from 30 Hz to 4.2 MHz while the multichannel mode response is from 60 Hz to 5.2 MHz.

1.3.2 MOJAVE GROUND TERMINAL PERFORMANCE

The Mojave Satellite Ground Terminal can provide an interface between a space segment and a variety of communication applications. In the case of the ATS-F (6) program, the space segment is the ATS-6 spacecraft and the communication applications are those specified by the various experimenters associated with this project. The performance of this system configuration in support of the various experiments is presented in section 1.4. The following parameters cover that criteria that deal with the over all suitability of the Mojave Ground Terminal to perform communication functions in general and the ATS-F (6) program specifically. Detailed performance data has been presented in section 1.3.4 of this report and in Vol. 1 of the GSI Test Data Report.

- Antenna Subsystem

It is necessary to interface the ground terminal with the space segment utilizing an antenna subsystem. At the Mojave Station near Barstow Cal., the communication base station utilizes a 40 ft. diameter C-Band antenna and a 15 ft. diameter L/S band antenna to perform this function.

The 40 ft. diameter C-Band antenna has been designed to operate over a Rx band of 3.7 to 4.2 GHz and a Tx band of 5.925 to 6.425 GHz. The gain of this antenna is 51.5 dB at 3.95 GHz and 53.6 dB at 5.95 GHz. The feed equipment provides rotatable linear polarization that can present Rx/Tx orthogonal polarization. A closed loop tracking system provided the real time rotatable polarization alignment. The antenna noise temperature is 13.8°K as measured at 3.90 GHz. With the receiver subsystem interfaced with the antenna, this system provides a G/T of 35.1 dB at 3.95 GHz. The EIRP of the antenna subsystem is +122.6 dBm utilizing the Tx subsystem as a source of communication power. The antenna is pointed at the space segment utilizing a X-Y mount, activated by a hydraulic drive system. Pointing is accomplished either manually, via an open loop program, or utilizing a monopulse closed loop auto track system. The pointing accuracy of this antenna will allow the RF pattern main lobe to be maintained within 1 dB of the peak of the beam at its highest operational frequency. The rate of axis movement will allow the tracking of either a synchronous or lower orbital satellite.

The 15 ft. diameter L/S band antenna has been designed to operate at either L-Band or S-Band. The L-Band operational Rx band is 1.5 to 1.58 GHz and the Tx operational band is 1.62 to 1.7 GHz. The L-Band gain of this antenna is 33.7 dB for Rx and 31.9 dB for Tx. The feed equipment will provide either LCP or RCP polarization which is manually changeable. The L-Band antenna noise temperature was measured and found to be 166°K. With the receiver system interfaced with the antenna, this system provides a G/T of 9.4 dB. The EIRP of the L-Band antenna subsystem configuration is +91.9 dBm utilizing the Tx subsystem as a source of communication power. The antenna is pointed at the space segment utilizing a El/Az mount that support both the L & S Band antenna equipment. Pointing is accomplished manually utilizing an electric drive open loop system. The pointing accuracy of this antenna system is dependent upon the skill of the antenna operator as he utilizes a Rx signal strength indicator to point the antenna. Only snchronous satellite operation is feasible with this equipment.

The S-Band section of the 15 ft. diameter antenna will support a Rx bandwidth of 2.05 to 2.1 GHz and a Tx bandwidth of 2.2 to 2.3 GHz. The S-Band Rx gain is 35 dB and the Tx gain is 33.7 dB. The feed equipment will support the same polarization characteristics as that of the L-Band equipment (RCP & LCP). The S-Band antenna noise temperature is 196°K and provides a G/T of 10 dB when interfaced with the receiver subsystem. The S-Band EIRP is +83.7 dBm utilizing the Tx subsystem as a source of communication power.

- Receiver Subsystem

The receiving subsystem performance is principally a function of the carrier to noise ratio. This parameter is a function of the field strength of the Rx signal, the capability of the antenna to collect this energy, and the system noise temperature, as well as the communication bandwidth parameters. This is why the antenna gain efficiency and noise temperature effect the receiver performance. At the Mojave Terminal, the C-Band system utilizes a wideband low noise RF amplifier that provides a Rx noise temperature of 15.3°K. This equipment, along with the antenna contribution developes a Rx system noise temperature of 43.3°K that relates to a G/T of 35.1 dB. The S and L-Band Rx amplifiers develope noise temperature over the operational bands of 110°K and 99°K that relate to an S-Band G/T of 10 dB and a L-Band G/T of 9.4 dB. These parameters are the key items that effect the C/N for each operational bandwidth.

The RF to IF frequency down converter (C, S or L-Band) equipments are nominally wideband devices. Their operational frequencies and bandwidths are as presented in section 1.3.4. The IF amplifiers of the receiving equipment have flat bandwidths of approximately 40 MHz. The RF bandwidths are at least this wide with the exception of L and S-Bands. Operational bandpass IF filters are provided that tailor the communication bandwidths to the experiment requirements. These bandwidths have flat responses in order to maintain group delay variations within the specification limits. The C-Band Rx group delay measured over a ±20 MHz band is approximately 5 nsec P-P and has a ripple component of 2 nsec P-P. The S-Band Rx group delay also measured over a ±20 MHz bandwidth is 0.8 nsec P-P and has a ripple component of 1.5 nsec P-P. The L-Band Rx group delay was measured over an IF band of ±5 MHz and is 3.6 nsec P-P with a ripple component of 2 nsec P-P. In order to maintain these values of phase linearity, the 1 dB IF bandwidth for the C-Band and S-Band equipment is >50 MHz. The L-Band 1 dB bandwidth is ±20 MHz. These characteristics are required to support wideband television, multiple channel FMDSSB/FM telephony signals and other applications.

This station is equipped with 70 MHz modems, which permit demodulation of IF signals to be accomplished. These wideband units are capable of supporting NTSC television, 1200 telephone channels of FDM multiplex as well as other applications. The performance of this equipment meets CCIR and Intelsat specifications. The output video frequency response is from 30 Hz to 4.2 MHz while the multichannel mode response is from 60 Hz to 5.2 MHz.

All RF to IF translation oscillator frequencies in the receivers are derived from the station standard which has a long term stability of ±1 part in 10^{12}. Therefore on a long term basis the ground station introduces essentially no frequency error. This is important in many experiments since it allows precise measurements of such things as doppler frequency, and permits the spacecraft oscillators to be locked to this stable known frequency from the ground in the satellite coherent mode. When using the wideband FM modulator, lesser stability is obtained with the oscillator AFC. Timing signals with the same stability are available, and may be used for such purposes as measuring the satellite range (this is done indirectly in the ATSR equipment by measuring relative phase of tones derived from the station standard; however this is in effect a time measurement). The short term stability is not a function directly of the station standard, but is a function of the quality of the synthesizers, phase lock oscillators etc. used to derive the receiver local oscillators. Short term instability shows up as PM noise on the translation oscillators and hence on the RF signals. It sets an ultimate limit to the S/N of television pictures, voice channels etc., transmitted or received as FM or PM and in the case of this station the noise on certain of the oscillators is marginal for the intended use. The following

C-Band phase noise was measured: 1 Hz BW below 1 KHz is -42 dB, 3 KHz BW measured from 1 KHz to 5 MHz was -55 dB. At S-Band the 1 Hz BW phase noise was -60 dB to -80 dB from 50 Hz to 500 Hz, while the 3 KHz BW noise was -48 dB from 50 KHz to -61 dB at 5 MHz. The L-Band phase noise measured in a 300 Hz BW was less than -62 dB up to 90 KHz and in a 3 KHz BW was -55 dB up to 5 MHz. These values of phase noise do not meet CCIR or Intelsat requirements.

- Transmitter Subsystem

The transmitting subsystem performance is principally a function of output power that can be turned in to EIRP and quality of sideband information developed by the Tx modulator and IF to RF upconverter. At the Mojave Terminal, the C-Band Tx subsystem can develop a station EIRP of +122.6 dBm in a 50 MHz BW. The operational carrier frequencies that are utilized have been presented in section 1.3.4. The same communication parameters that affect the Rx subsystem frequency down converter and IF amplifiers apply to the transmitter subsystem Parameters such as phase noise, frequency response, and phase linearity are also key items that can affect the performance of the transmitter. In the case of the C-Band Tx, group delay measured over a BW of ±20 MHz is approximately 7 nsec P-P and has a ripple component of 4 nsec on the average. The 1 dB bandwidth is >50 MHz. Phase noise as measured in a 300 Hz BW was -55 dB below 50 KHz and in a 3 KHz BW this parameter is -55 dB from 0.2 MHz to 5.0 MHz. These communication performance values are representive of the Mojave station.

The S-Band Transmitter subsystem developes an average power that will allow the Antenna Subsystem to radiate an EIRP of +83.7 dBm. The variation in group delay is 2.5 nsec P-P measured over a ±20 MHz B.W. and has a ripple component of 1.5 nsec. The 1 dB BW frequency response is >50 MHz. Phase noise characteristics indicate that the 1 Hz BW is -60 dB at 50 Hz to -85 dB at 0.5 KHz and that the 3 KHz BW phase noise is -48 dB to -61 dB out to 5 MHz.

The L-Band transmitter subsystem developed an average power that will allow the Antenna Subsystem to radiate an EIRP of +91.9 dBm. The variation in group delay is 3.6 nsec P-P as measured over a ±5 MHz and has a ripple component of 1.7 nsec P-P. The 1 dB frequency response BW is ±5 MHz. Phase noise as measured in a 300 Hz BW is >-55 dB up to 35 KHz and in a 3 KHz BW is >-55 dB to 5 MHz.

The modulators and baseband circuits for all frequency bands are wide band devices that can support NTSC television and 1200 channel FDM multiplex telephone signals. This equipment meets CCIR and Intelsat requirements. The input video frequency response is from 30 Hz to 4.2 MHz while the multichannel made response is from 60 Hz to 5.2 MHz.

1.3.3 HYBRID TERMINAL

Testing of the Hybrid Terminal began in mid - April 1974. This date was dictated by the return of the two mobile antennas to the Mojave site that had been undergoing repair at the vendors plant. Testing was completed in May 1974, except for two tests which required delivery of two GFE items (the PCM and NCE units). Seven antenna tests involving the Collimation Tower were not performed by direction of GSFC because of the difficulty of repositioning the mobile terminal antennas.

Test data was submitted directly from the Mojave site to GSFC as directed by NASA and data analysis was not performed by the GSI. For this reason, the Hybrid Terminal performance description has not been included in this report.

1.3.4 PERFORMANCE PARAMETERS

The GSI has selected certain critical Communication Parameters, and has placed the test results data for the Rosman, Mojave and Hybrid Terminals in Tabular form where they may be reviewed and compared on a station by station basis. This data is the actual test results obtained, and does not necessarily conform to specification requirements. The reader may refer to the test plans and/or the Test Data provided elsewhere, as reference material, to ascertain the methods of testing, specification limits, and specific conditions which may have existed. The Basic Performance Parameters shown in Table 1, reflect the actual test results obtained and indicates integrated equipment and/or station characteristics.

Table 1

BASIC PERFORMANCE PARAMETERS

	PARAMETER	ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
C-BAND				
1.0	Antenna Type	Parabolic reflector with cassegrain feed for C-Band operation and a prime focus feed through a dichroic lens for S-Band operation. Prime focus feed for C-Band, 15 Ft. Tx only operation.	Parabolic reflector with cassegrain feed.	Parabolic reflector with cassegrain feed.
2.0	Dish Diameter	85 Ft. 15 Ft. (Tx only)	40 Ft.	21 Ft.
3.0	Polarization and Method of Alignment	Rotatable linear, auto track and remote control at C-Band for the 85 Ft. antenna, fixed linear at S-Band. Manual rotatable linear at C-Band for the 15 Ft. Tx only antenna.	(a) Rotatable linear, auto track, and remote control.	(a) Rotating linear, manual remote control
4.0	Antenna Axis Tracking Methods	(a.) Monopulse auto track (b.) Program track (c.) Manual, remote control	(a.) Monopulse auto track (b.) Program track (c.) Manual, remote control	(a.) Manual, remote control
5.0	Mount Type and Drive	(a.) X-Y, hydraulic drive (85 Ft.) (b.) El/Az, manual drive (15 Ft.)	(a.) X-Y hydraulic drive	(a.) Hour angle/dec. electric drive
6.0	Rx Frequency Bands	(a.) 3.7 to 4.2 GHz (b.) 2.2 to 2.3 GHz	(a.) 3.7 to 4.2 GHz	(a.) 3.7 to 4.2 GHz
7.0	Tx Frequency Band	5.925 to 6.425 GHz	5.925 to 6.425 GHz	5.925 to 6.425 GHz
8.0	Antenna Rx Gain 3.75 GHz 3.95 GHz 4.15 GHz 4.78 GHz 2.61 GHz	 57.5 dB 58.3 dB 58.2 dB 58.1 dB 50.9 dB (L.P.)	51.5 dB	44.8 dB
9.0	Antenna Tx Gain 5.925 GHz 5.95 GHz 6.15 GHz 6.35 GHz 6.00 GHz 15 Ft. Tx only antenna	 59.1 dB 59.7 dB 59.9 dB 43.1 dB	53.6 dB	48.9 dB
10.0	Rx Noise Temperature			
10.1	Measured at 3.70 GHz		(a.) Ant. Temp. 28.0°K (b.) Rx Temp. 15.3°K (c.) System Temp. 43.3°K	
10.2	Measured at 3.75 GHz	(a.) Ant. Temp. 57.4°K (b.) Rx Temp. 14.3°K (c.) System Temp. 71.7°K		(a.) Ant. Temp. 39.5°K (b.) Rx Temp. 24.6°K (c.) System Temp. 64.1°K
10.3	Measured at 3.90 GHz		(a.) Ant. Temp. 13.8°K (b.) Rx Temp. 30.7°K (c.) System Temp. 44.5°K	
10.4	Measured at 3.95 GHz	(a.) Ant. Temp. 57.8°K (b.) Rx Temp. 16.4°K (c.) System Temp. 74.2°K		(a.) Ant. Temp. 39.3°K (b.) Rx Temp. 23.9°K (c.) System Temp. 63.2°K

Table 1
BASIC PERFORMANCE PARAMETERS (Continued)

PARAMETER		ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
C-BAND				
10.5	Measured at 4.10 GHz		(a.) Ant. Temp. 29.2°K (b.) Rx Temp. 13.8°K (c.) System Temp. 43.0°K	
10.6	Measured at 4.15 GHz	(a.) Ant. Temp. 52.4°K (b.) Rx Temp. 17.2°K (c.) System Temp. 69.6°K		(a.) Ant. Temp. 48.7°K (b.) Rx Temp. 35.7°K (c.) System Temp. 84.4°K
10.7	Measured at 2.67 GHz (85 Ft. antenna only)	(a.) System Temp. 1190°K		
11.0	G/T (3.95 GHz)	38.2 dB	35.1 dB	25.2 dB
12.0	Tx, EIRP (6.15 GHz)	+128.7 dBm	+122.6 dBm	+111.9 dBm
13.0	RF Operational Bandwidths			
13.1	Tx Operational Frequencies (RF) 45 MHz, Bandwidth			5.950 GHz 6.150 GHz 6.212 GHz 6.301 GHz 6.350 GHz
	Tx Operational Frequencies (RF) 50 MHz, Bandwidth	5.950 GHz 6.150 GHz 6.212 GHz 6.301 GHz 6.350 GHz	5.950 GHz 6.150 GHz 6.212 GHz 6.301 GHz 6.350 GHz	
13.2	Rx Operational Frequencies (RF) 50 MHz, Bandwidth	3.750 GHz 3.950 GHz 4.150 GHz 4.178 GHz 4.119 GHz	3.750 GHz 3.950 GHz 4.150 GHz 4.178 GHz 4.119 GHz	3.750 GHz 3.950 GHz 4.150 GHz 4.178 GHz 4.119 GHz
14.0	Rx and Tx Phase Linearity			
14.1.1	Delay Variations, measured over a ±15 MHz B.W. at:	(a.) 5.950 GHz 3 nsec P-P (b.) 6.150 GHz 5 nsec P-P (c.) 6.350 GHz 3 nsec P-P	(a.) 5.950 GHz 5 nsec P-P (b.) 6.150 GHz 3.6 nsec P-P (c.) 6.350 GHz 5 nsec P-P	
14.1.2	Delay Variations, measured over a ±20 MHz B.W. at:	(a.) 5.950 GHz 3 nsec P-P (b.) 6.150 GHz 8 nsec P-P (c.) 6.350 GHz 6 nsec P-P	(a.) 5.950 GHz 9.5 nsec P-P (b.) 6.150 GHz 5.1 nsec P-P (c.) 6.350 GHz 9 nsec P-P	
14.1.3	Ripple, measured over a ±20	(a.) 5.950 GHz 2 nsec P-P (b.) 6.150 GHz 5 nsec P-P (c.) 6.350 GHz 1 nsec P-P	(a.) 5.950 GHz 4 nsec P-P (b.) 6.150 GHz 2 nsec P-P (c.) 6.350 GHz 5 nsec P-P	

Table 1

BASIC PERFORMANCE PARAMETERS (Continued)

PARAMETER		ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
C-BAND				
14.2	Rx (3.950 GHz)			
14.2.1	Delay Variations, measured over a ±20 MHz B.W., utilizing:	(a.) Down Converter No. 1 5 nsec P-P (b.) Down Converter No. 2 4 nsec P-P	(a.) Down Converter No. 1 5 nsec P-P (b.) Down Converter No. 2 3 nsec P-P	
14.2.2	Ripple, measured over a ±20 MHz B.W., utilizing:	(a.) Down Converter No. 1 2 nsec P-P (b.) Down Converter No. 2 2 nsec P-P	(a.) Down Converter No. 1 1 nsec P-P (b.) Down Converter No. 2 1 nsec P-P	
14.3	Tx/Rx (IF to IF loop performance)			
14.3.1	Delay Variations, measured over a ±15 MHz B.W. (with filter) at:			(a.) 3.75 GHz 15 nsec P-P (b.) 3.95 GHz 8 nsec P-P (c.) 4.15 GHz 18 nsec P-P
14.3.2	Delay Variations, measured over a ±20 MHz B.W. (with filter) at:			(a.) 3.75 GHz 30 nsec P-P (b.) 3.95 GHz 28 nsec P-P (c.) 4.15 GHz 62 nsec P-P
14.3.3	Ripple, measured over ±20 MHz B.W. (with filter) at:			(a.) 3.75 GHz 4 nsec P-P (b.) 3.95 GHz 2 nsec P-P (c.) 4.15 GHz 5 nsec P-P
15.0	Rx and Tx Amplitude Response (flatness)			
15.1	Rx			
15.1.1	Down Converter No. 1			
15.1.1.1	1 dB B.W.	≥ 50 MHz	≥ 50 MHz	
15.1.1.2	±20 MHz B.W.	+0.5 dB -1.2 dB	±0.3 dB	
15.1.2	Down Converter No. 2			
15.1.2.1	1 dB B.W.	< 50 MHz	≥ 50 MHz	
15.1.2.2	±20 MHz B.W.	+0.7 dB -1.8 dB	+0.3 dB	
15.2	Tx			
15.2.1	Full Power			
15.2.1.1	1 dB B.W.	≥ 50 MHz	≥ 50 MHz	
15.2.1.2	±20 MHz B.W.	±0.5 dB	±0.3 dB	
15.2.2	-10 dB0 Power			
15.2.2.1	1 dB B.W.	≥ 50 MHz	≤ 50 MHz	
15.2.2.2	±20 MHz B.W.	±0.5 dB	±0.3 dB	
15.3	Tx/Rx (IF to IF) loop response			
15.3.1	1 dB B.W.			≥ 44 MHz
15.3.2	±20 MHz B.W.			±0.6 dB
16.0	Rx and Tx Oscillator Stability			
16.1	Rx			
16.1.1	Long Term	±1 parts in 10^{12}/day	±1 part in 10^{12}/day	

Table 1

BASIC PERFORMANCE PARAMETERS (Continued)

PARAMETER		ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
C-BAND				
16.1.2	Short Term			
16.1.2.1	Measured at a Rx frequency of 3.75 GHz	(a.) 1 Hz B.W. -40 dB @ 60 Hz (b.) 3 KHz B.W. -45 dB from 1 KHz to 5.0 MHz	(a.) 1 Hz B.W. below 1 KHz -42 dB (b.) 3 KHz B.W. 1 KHz to 5 MHz -55 dB	
16.1.2.2	Measured at a Rx frequency of 3.950 GHz	(a.) 1 Hz B.W. -42 dB @ 60 Hz (b.) 3 KHz B.W. -55 dB from 1 KHz to 5.0 MHz	(a.) 1 Hz BW below 1 KHz -45 dB (b.) 3 KHz B.W. 1 KHz to 5 MHz -52 dB	
16.1.2.3	Measured at a Rx frequency of 4.150 GHz	(a.) 1 Hz B.W. 42 dB @ 60 Hz (b.) 3 KHz B.W. -50 dB from 1 KHz to 5.0 MHz.	(a.) 1 Hz, BW below 1 KHz -46 dB (b.) 3 KHz PW, 1 KHz to 5.0 MHz -55 dB.	
16.2	Tx			
16.2.1	Long Term	±1 part in 10^{12}/day	±1 part in 10^{12}/day	
16.2.2	Short Term	(a.) 10 Hz B.W. -50 dB at 100 Hz to 60 dB at 500 Hz. (b.) 300 Hz B.W. -45 dB at 10 KHz to -70 dB at 100 KHz (c.) 3 KHz B.W. -63 dB from 0.2 to 5.0 MHz. (d.) Hum; -42 dB at 60 Hz -43 dB at 180 Hz.	(a.) 300 Hz BW -55 dB below 50 KHz. (b.) 3 KHz B.W. -55 dB from 0.2 to 5.0 MHz. (c.) Hum; +3 dB at 60 Hz -42 dB at 180 Hz.	
16.3	Tx/Rx (IF to IF) loop performance			
16.3.1	Long Term			±1 part in 10^{12}/day
16.3.2	Short Term			
16.3.2.1	Measured at a Tx/Rx frequency of 6.15/3.95 GHz			(a.) 1 Hz B.W. below 1 KHz, -44 dB (b.) 3 KHz B.W., 1 KHz to 5 MHz, -55 dB
16.3.2.2	Measured at a Tx/Rx frequency of 6.35/4.15 GHz			(a.) 1 Hz B.W. below 1 KHz, -46 dB (b.) 3 KHz B.W. 1 KHz to 5 MHz, -52 dB
16.3.2.3	Measured at a Tx/Rx frequency of 5.95/3.75 GHz			(a.) 1 Hz B.W. below 1 KHz, -47 dB (b.) 3 KHz B.W. 1 KHz to 5 MHz, -55 dB
17.0	Modulator and Demodulator			
17.1	Type (Tx & Rx)	FM	FM	FM
17.2	Deviation			
17.2.1	Tx Mod	±20 MHz P-P	±20 MHz P-P	±20 MHz P-P
17.2.2	Rx Demod.	±15 MHz P-P	±15 MHz P-P	±15 MHz P-P
17.3	Linearity			
17.3.1	Tx Mod.	2%	2%	2%
17.3.2	Rx Demod.	2%	2%	2%
17.4	Pre emphasis (Tx)	Video Standard CCIR (525 lines)	Video flat, CCIR standard Video (525 lines)	Video flat, CCIR Stand Video & Audio
17.5	De emphasis (Rx)	Video Standard CCIR (525 lines)	Video flat, CCIR standard Video (525 lines)	Video flat, CCIR Standard Video & Audio
17.6	Baseband Frequency Response			
17.6.1	Tx	30 Hz to 8 MHz	30 Hz to 8 MHz	30 Hz to 8 MHz

Table 1
BASIC PERFORMANCE PARAMETERS (Continued)

	PARAMETER	ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
C-BAND				
17.6.2	Rx	30 Hz to 4.2 MHz	30 Hz to 4.2 MHz	30 Hz to 4.2 MHz
17.7	Input/Output Characteristics			
17.7.1	Tx Mod.	75 ohm input 1 Volt P-P	75 ohm input 1 Volt P-P	75 ohm input 1 Volt P-P
17.7.2	Rx Demod.	75 ohm output 1 Volt P-P	75 ohm output 1 Volt P-P	75 ohm output 1 Volt P-P
S-BAND				
1.0	Antenna Type	Parabolic reflector with prime focus feed.	Parabolic reflector with prime focus feed.	Parabolic reflector with prime focus feed.
2.0	Dish Diameter	15 Ft.	15 Ft.	15 Ft.
3.0	Polarization and Method of Alignment	LCP/RCP manually changeable.	LCP/RCD Manually changeable.	LCP/RCD Manually changeable.
4.0	Antenna Axis Tracking Methods	Manual, remote control	Manual, remote control.	Manual, remote control.
5.0	Mount Type and Drive	El/Az, electric drive.	El/Az, electric drive.	El/Az, electric drive.
6.0	Rx Frequency Band	2.05 to 2.1 GHz	2.05 to 2.1 GHz	2.05 to 2.10 GHz
7.0	Tx Frequency Band	2.2 to 2.3 GHz	2.2 to 2.3 GHz	2.2 to 2.3 GHz
8.0	Antenna Rx Gain (2.075 GHz)	35 dB	35 dB	35 dB
9.0	Antenna Tx Gain (2.25 GHz)	33.7 dB	33.7 dB	33.7 dB
10.0	Rx Noise Temperature (2.075 GHz)	(a.) Ant. Temp 116°K (b.) Rx Temp. 115°K (c.) System Temp. 231°K	(a.) Ant. Temp. 196°K (b.) Rx Temp. 110°K (c.) System Temp. 306°K	(a.) System Temp. (Tx off) 274°K (b.) System Temp. (Tx on) 487.9°K
11.0	G/T (2.075 GHz)	11.4 dB	10.0 dB	8.2 dB
12.0	Tx, EIRP (2.25 GHz)	+83.7 dB	+83.7 dB	+83.7 dB
13.0	RF/IF Operational Bandwidths			
13.1	Tx Operational Frequencies, 50 MHz, Bandwidth	2.247 GHz 2.253 GHz	2.247 GHz 2.253 GHz	2.247 GHz 2.253 GHz
13.2	Rx Operational Frequencies, 50 MHz, Bandwidth	2.075 GHz	2.075 GHz	2.075 GHz
14.0	Rx and Tx Phase Linearity			
14.1	Tx			
14.1.1	Delay Variations, measured over: ±15 MHz	1.3 nsec P-P	0.6 nsec P-P	

Table 1

BASIC PERFORMANCE PARAMETERS (Continued)

PARAMETER		ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
S-BAND				
14.1.1	±20 MHz ±25 MHz	1.5 nsec P-P 2.6 nsec P-P	0.8 nsec P-P 2.5 nsec P-P	
14.1.2	Ripple, measured over a ±20 MHz B.W.	1.5 nsec P-P	1.5 nsec P-P	
14.2	Rx			
14.2.1	Delay Variations, measured over a ±20 MHz B.W. (a.) Down Converter No. 1 (b.) Down Converter No. 2	 5 nsec P-P 4 nsec P-P	6 nsec P-P	
14.3	Tx/Rx (IF to IF) loop performance			
14.3.1	Delay Variations, measured over: ±15 MHz B.W. ±20 MHz B.W.			 14 nsec P-P 28 nsec P-P
14.3.2	Ripple, measured over a ±20 MHz B.W.			4 nsec P-P
15.0	Rx and Tx Amplitude Response (flatness)			
15.1	Rx			
15.1.1	Down Converter No. 1			
15.1.1.1	1 dB B.W.	≥ 50 MHz +0.5 dB	≥ 50 MHz	
15.1.1.2	±20 MHz B.W.	-1.2 dB	±0.5 dB	
15.2	Tx			
15.2.1	1 dB B.W.	≥ 50 MHz +0.6 dB	≥ 50 MHz	
15.2.2	±20 MHz B.W. ±25 MHz B.W.	-0.3 dB	 +0.75 dB	
15.3	Tx/Rx (IF to IF) loop performance			
15.3.1	1 dB B.W.			≥ 40 MHz
15.3.2	±20 MHz B.W.			±0.5 dB
16.0	Rx and Tx Oscillator Stability			
16.1	Rx			
16.1.1	Long Term	±1 parts in 10^{12}/day	±1 parts in 10^{12}/day	
16.1.2	Short Term	(a.) 1 Hz B.W. -48 dB at 10 Hz to -80 dB at 1 KHz. (b.) 3 KHz B.W. -55 dB out to 5 MHz.	(a.) 1 Hz B.W., -60 to -85 dB, 50 Hz to 500 Hz. (b.) 3 KHz B.W., -48 dB at 50 KHz to -61 dB from 300 KHz to 5.0 MHz.	
16.2	Tx			
16.2.1	Long Term	±1 parts in 10^{12}/day	±1 part in 10^{12}/day	

Table 1

BASIC PERFORMANCE PARAMETERS (Continued)

	PARAMETER	ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
S-BAND				
16.2.2	Short Term	(a.) 1 Hz B.W. 59 dB at 100 Hz to 72 dB at 500 Hz. (b.) 60 dB out to 5 MHz.	(a.) 1 Hz B.W.; 10 Hz to 1 KHz -48 dB with -30 dB at 22 KHz. (b.) 3 KHz B.W., 1 KHz to 5.0 MHz -68 dB to -72 dB.	
16.3	Tx/Rx (IF to IF) loop performance			
16.3.1	Long Term			±1 part in 10^{12}/day
16.3.2	Short Term			(a.) 1 Hz, B.W. -30 dB to 52 dB, 100 Hz to 500 Hz. (b.) 3 KHz B.W. -76 dB, 500 KHz to 5.0 MHz.
17.0	Modulator and Demodulator			
17.1	Type (Tx & Rx)	FM	FM	FM
17.2	Deviation			
17.2.1	Tx mod	±20 MHz	±20 MHz	±20 MHz
17.2.2	Rx demod	±15 MHz	±25 MHz	±25 MHz
17.3	Linearity			
17.3.1	Tx mod	<2%	<2%	<2%
17.3.2	Rx demod	<2%	<2%	<2%
17.4	Pre emphasis (Tx)	Video Standard CCIR (525 lines)	Video Standard CCIR (525 lines)	Video flat CCIR Standard Video and Audio
17.5	De emphasis (Tx)	Video Standard CCIR (525 lines)	Video Standard CCIR (525 lines)	Video flat CCIR Standard
17.6	Baseband Frequency Response			
17.6.1	Tx mod	30 Hz to 8 MHz	30 Hz to 8 MHz	30 Hz to 8 MHz
17.6.2	Rx demod	30 Hz to 4.2 MHz	30 Hz to 4.2 MHz	30 Hz to 4.2 MHz
17.7	Input/Output Characteristics			
17.7.1	Tx mod	75 ohms input 1 Volt P-P	75 ohms input 1 Volt P-P	75 ohms input 1 Volt P-P
17.7.2	Rx demod	75 ohms output 1 Volt P-P	75 ohms output +5 dBm	75 ohms output 1 Volt P-P
L-BAND				
1.0	Antenna Type	Parabolic reflector with prime focus feed.	Parabolic reflector will focus feed.	Parabolic reflector with prime focus feed.
2.0	Dish Diameter	15 Ft.	15 Ft.	15 Ft.
3.0	Polarization and Method of Alignment	LCP/RCP manually changeable.	LCP/RCP manually changeable.	LCP/RCP manually changeable.
4.0	Antenna Axis Tracking Methods	Manual, remote control.	Manual, remote control.	Manual, remote control.
5.0	Mount Type and Drive	El/Az, electric drive.	El/Az electric drive.	El/Az electric drive.
6.0	Rx Frequency Band	1.5 to 1.58 GHz	1.5 to 1.58 GHz	1.5 to 1.58 GHz
7.0	Tx Frequency Band	1.62 to 1.7 GHz	1.62 to 1.7 GHz	1.62 to 1.7 GHz
8.0	Antenna Rx Gain (1.55 GHz)	33.7 dB	33.7 dB	33.7 dB

Table 1

BASIC PERFORMANCE PARAMETERS (Continued)

	PARAMETER	ROSMAN GROUND TERMINAL CHARACTERISTICS	[illegible] GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
L-BAND				
9.0	Antenna Tx Gain(1.65 GHz)	32.6 dB	31.9 dB	33.3 dB
10.0	Rx Noise Temperature	(a.) Ant. Temp. 84°K (b.) Rx Temp. 111°K (c.) System Temp. 195°K	(a.) Ant. Temp. 166°K (b.) Rx Temp. 99°K (c.) System Temp. 265°K	(a.) System Temp. with Tx off 168°K (b.) System Temp. with Tx on 255°K
11.0	G/T	10.8 dB	9.4 dB	9.8 dB
12.0	Tx, EIRP	+92.6 dBm	+91.9 dBm	+93.3 dBm
13.0	RF Operational Bandwidths			
13.1	Tx Operational Frequency ±5 MHz, Bandwidth	1.65 GHz	1.[illegible]5 GHz	1.65 GHz
13.2	Rx Operational ±12 MHz, BW		1.55 GHz	
	Rx Operational Frequency ±20 MHz, Bandwidth	1.55 GHz		1.55 GHz
14.0	Rx and Tx Phase Linearity			
14.1	Tx			
14.1.1	Delay Variations, measured over: ±3 MHz ±5 MHz	 3 nsec P-P 3 nsec P-P	 1 nsec P-P 3.6 nsec P-P	
14.1.2	Ripple (P.P.) Measured over: ±4 MHz ±5 MHz	 1 nsec P-P 1 nsec P-P	 1.7 nsec P-P 2 nsec P-P	
14.2	Rx			
14.2.1	Delay Variations, measured over ±20 MHz	3 nsec P-P	9 nsec P-P	
14.3	Tx/Rx IF to IF loop perfor mance			
14.3.1	Delay Variations, measured over: ±3 MHz ±5 MHz			 5 nsec P-P 6 nsec P-P
14.3.2	Ripple (P.P) Measured over: ±4 MHz ±5 MHz			 2 nsec P-P 2 nsec P-P
15.0	Rx and Tx Amplitude Response (flatness)			
15.1	Rx			
15.1.1	1 dB B. W.	±18 MHz	≥ ±20 MHz	
15.1.2	±16 MHz ±20 MHz	+1.2 dB	 ±0.5 dB	
15.2	Tx			
15.2.1	1 dB B. W.	±5 MHz	≥ ±5 MHz	

Table 1

BASIC PERFORMANCE PARAMETERS (Continued)

	PARAMETER	RUSSIAN GROUND TERMINAL CHARACTERISTICS	[illegible] GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
L-BAND				
15.2.2	±4 MHz B.W. ±5 Hz B.W.	±0.5 dB	±0.3 dB	
15.3	Tx/Rx IF to IF loop performance			
15.3.1	1 dB B.W.			> 15 MHz
15.3.2	±4 MHz B.W.			±0.2 dB
16.0	Rx and Tx Oscillator Stability			
16.1	Rx			
16.1.1	Long Term	±1 parts in 10^{12}/day	±1 part in 10^{12}/day	
16.1.2	Short Term	(a.) 10 Hz b.W. < -70 dB at 1000 Hz and less than -55 dB up to ≥35 KHz. > -55 dB from 35 KHz out to > 5 MHz.	(a.) 300 Hz B.W. -62 dB up to 90 KHz. (b.) 3 KHz B.W. -55 from 100 KHz to 5.0 MHz.	
16.2	Tx			
16.2.1	Long Term	±1 part in 10^{12}/day	±1 part in 10^{12}/day	
16.2.2	Short Term	(a.) 300 Hz B.W. < -65 dB up to ≈60 KHz. (b.) 3 KHz B.W. > -55 dB to > 5 MHz.	(a.) 3 KHz B.W. -55 up to 35 KHz. (b.) 3 KHz B.W. -55 up to 5.0 MHz.	
16.3	Tx/Rx IF to IF loop performance			
16.3.1	Long Term			±1 part in 10^{12}/day
16.3.2	Short Term			(a.) 1 Hz B.W. -30 dB to -50 dB from 100 to 500 Hz (b.) 3 KHz B.W. -65 dB from 50 KHz to 5.0 MHz
17.0	Modulator and Demodulator			
17.1	Type (Tx & Rx)	FM	FM	FM
17.2	Deviation		±20 MHz	±20 MHz
17.2.1	Tx mod	±20 MHz	±20 MHz	±20 MHz
17.2.2	Rx demod	±20 MHz		
17.3	Linearity			
17.3.1	Tx mod	2%	2%	2%
17.3.2	Rx demod	2%	2%	2%
17.4	Pre emphasis	Video Standard CCIR (525 lines)	Video Standard CCIR (525 lines)	
17.5	De emphasis	Video Standard CCIR (525 lines)	Video Standard CCIR (525 lines)	
17.6	Baseband frequency response			
17.6.1	Tx Mod	30 Hz to 8 MHz	30 Hz to 8 MHz	30 Hz to 8 MHz
17.6.2	Rx Demod	30 Hz to 4.2 MHz	30 Hz to 4.2 MHz	30 Hz to 4.2 MHz
17.7	Input/Output Characteristics			
17.7.1	Tx mod	75 ohm input 1 Volt P-P	75 ohm input 1 V P-P	75 ohm input 1 Volt P-P
17.7.2	Rx demod	75 ohm output 1 Volt P-P	75 ohm output 1 V P-P	75 ohm output 1 Volt P-P

Table 1

BASIC PERFORMANCE PARAMETERS (Continued)

	PARAMETER	ROSMAN GROUND TERMINAL CHARACTERISTICS	MOJAVE GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
B. ATSR				
1.0	Range accuracy	±1 Meter	±1 Meter	±1 Meter
2.0	Standard Frequencies and Time Outputs			
3.1	Frequency Outputs	(a.) 5 MHz (b.) 1 MHz (c.) 100 KHz (d.) 1 KHz	(a.) 5 MHz (b.) 1 MHz (c.) 100 KHz (d.) 1 KHz	(a.) 5 MHz (b.) 1 MHz (c.) 100 KHz (d.) 1 KHz
2.2	Time Outputs	(a.) 1000 PPS (b.) 500 PPS (c.) 100 PPS (d.) 50 PPS (e.) 10 PPS (f.) 5 PPS (g.) 1 PPS (h.) GMT code	(a.) 1000 PPS (b.) 500 PPS (c.) 100 PPS (d.) 50 PPS (e.) 10 PPS (f.) 5 PPS (g.) 1 PPS (h.) GMT code	(a.) 1000 PPS (b.) 500 PPS (c.) 100 PPS (d.) 50 PPS (e.) 10 PPS (f.) 5 PPS (g.) 1 PPS (h.) GMT code
C. Recording				
1.0	Analog	2 ea. 7 track T. R.	2 ea. FR600 7 Ch	2 ea. FR600 7 Ch
2.0	Digital	None	None	None
3.0	Video	2 ea. V. T. R. (Studio Type)	1 ea. video IVC (studio type)	1 ea. video IVC (studio type)
4.0	Chart	1 ea. X-Y 1 ea. X-Y 1 ea. 8 track	2 ea. strip char 2 Ch 2 ea. X-Y plot	2 ea. strip char 2 Ch 2 ea. X-Y plot

Table 1

BASIC PERFORMANCE PARAMETERS (Concluded)

PARAMETER		RUSSIAN GROUND TERMINAL CHARACTERISTICS	[illegible] GROUND TERMINAL CHARACTERISTICS	HYBRID GROUND TERMINAL CHARACTERISTICS
D.	ADP			
1.0	Storage capability	28 K/16 bit words (2 ea. computers)	28 K/16 bit words	28 K/16 bit words
2.0	Program type (format, etc.)	Machine language & Fortran	Machine language U Fortran	Machine language & Fortran
3.0	Speed	2M bits/sec.	2M bits/sec.	2M bits/sec.
4.0	Displays	(a.) 2 ea. CRT (b.) 2 ea. SCR (c.) 2 ea. X-Y recorders (d.) 1 ea. typewriters (e.) 1 ea. line printer	(a.) 2 ea. CRT (b.) 2 ea. SCR (c.) 2 ea. X-Y recorders (d.) 1 ea. typewriter (e.) 1 ea. line printer	(a.) 2 ea. CRT (b.) 2 ea. SCR (c.) 2 ea. X-Y recorders (d.) 1 ea. typewriter (e.) 1 ea. line printer
E.	T and C			
	<u>Not Included</u>			

1.4 EXPERIMENTS

Included in this section of the report are discussions of the various experiments which will be conducted with the ATS-F (6) Satellite, and for which the GSI has had some measure of responsibility. A general description of equipment configuration, and principal parameter considerations will be discussed for each of: the VHRR/IHDRAS; ITV/HET; PLACE; RFI; MMW; T&DRE; and SAPPSAC experiments. Block diagrams have been provided that identifying each experiment.

1.4.1 VHRR/IHDRAS

The following briefly describes how the Very High Resolution Radiometer (VHRR) Experiment and Interferometer High Data Rate Acquisition System (IHDRAS) Experiment ground equipment interfaces with the ground station equipments refer to Figure 1.8). The experiment requirements are that VHRR and IHDRAS information generated in the ATS-F Spacecraft be transmitted simultaneously from the spacecraft to the ground terminal.

The VHRR information may be either 72 KBS digital biphase data or a set of three sub-carriers, each frequency modulated by analog information (DC to 2 KHz). These subcarriers are at 32 KHz, 48 KHz and 176 KHz. The IHDRAS information is a digital signal at 512 KBS. These signals frequency modulate the Wideband Modulator in the spacecraft and are transmitted to the ground station on a C-Band carrier frequency craft and are transmitted to the ground station on a C-Band carrier frequency. The ground station equipment demodulates the received C-Band carrier (refer to Figure 1.7) by using its standard C-Band Down-Converters, 70 MHz IF Amplifier and Discriminator, together with a Modified PM Baseband Unit (filters removed and gain adjusted). The output from the Modified PM Baseband Unit, consisting of either the VHRR 72 KBS signal and the IHDRAS 512 KBS signal or the VHRR, 32 KHz, or 48 KHz or 176 KHz sub-carrier and the IHDRAS 512 KBS signal are divided, amplified and filtered to interface with the Experimenter Equipment.

The VHRR Experiment requires analog recordings for all received signals and the capability to play back these signals into the VHRR equipment, if required. A set of interface cables were routed to the station Analog Recording Subsystem (70A9) for this purpose.

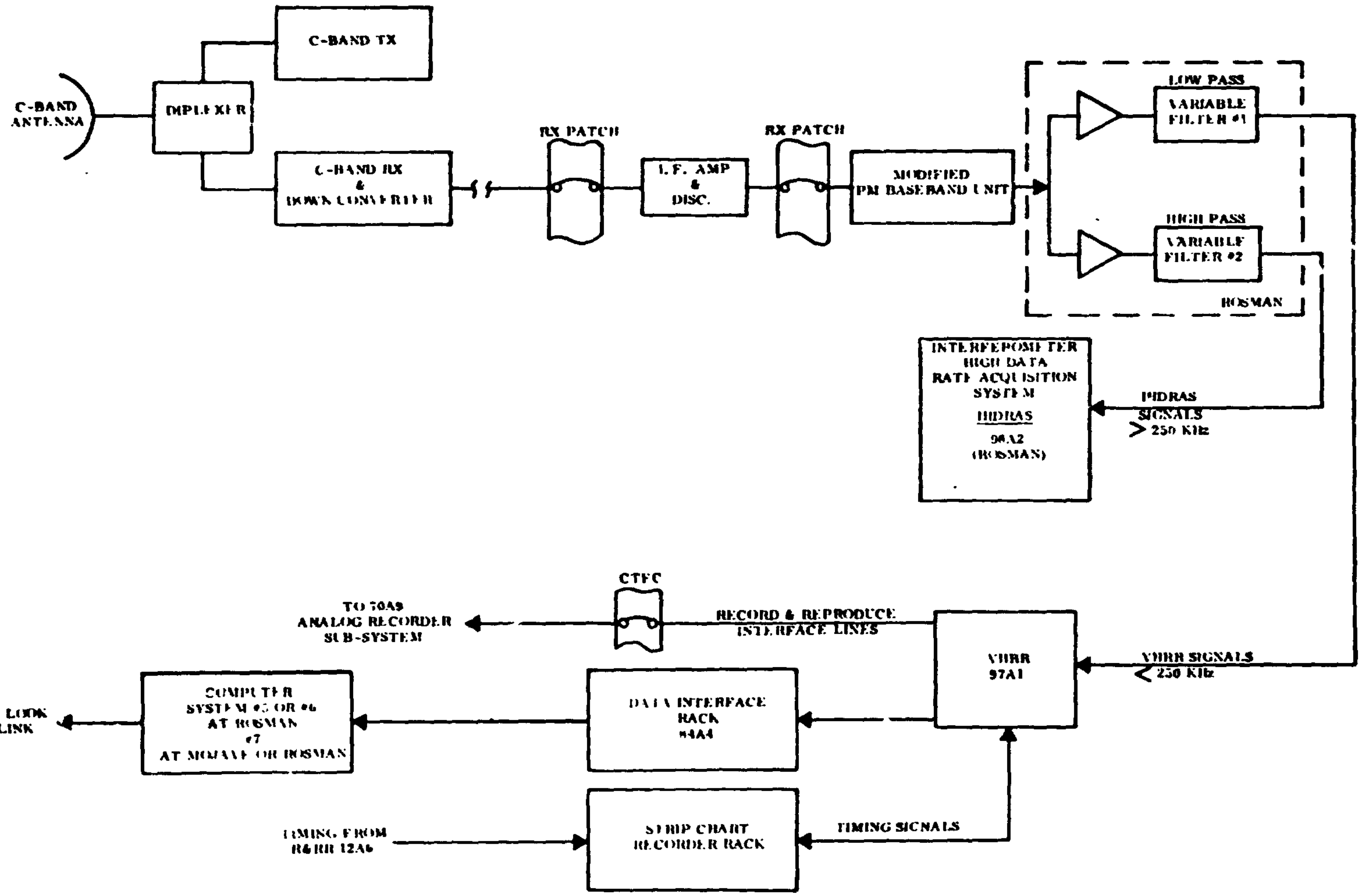


Figure 1.7. VHRR/IHDRAS Rosman Equipment Configuration (Hybrid, Mojave)

This experiment uses the ADP System. The interface to the computers (either #5 or #6) is made through the Data Interface Rack (84A4). Quick Look Data extracted from the processed data is sent periodically via the D3F modem and Nascom Data Link to Goddard.

The IHDRAS processed information, a strip chart display, is obtained on site within the IHDRAS equipment.

- Principle Parameter Considerations

The requirements of the ground station equipment to support this experiment as analyzed by GSI early in the program are reported in the Technical Note "ATS-F VHRR Experiment Communication Link Performance". dated July 30, 1971. The principle objective was to provide support interfaces to the VHRR experimenter such that a 9 bit grey scale resolution with an error probability of less than 3 parts in 10^{-3} could be obtained. This resolved an overall system requirement (S_{rms}/ N_{rms}) of 60.7 dB which included both thermal and intermodulation noise factors. GSI analysis indicated that the station support equipment, i.e. C-Band Parametric Amplifiers, C-Band Down-Converter, RCA IF Amplifier and Discriminator, could be used with a 12 MHz IF filter in circuit. In this configuration the thermal noise contribution would be adequate to support the experiment. From the data available, the station discriminator appeared to be very linear and would not introduce intermodulation noise of any significant extent in the back-up mode where three subcarriers are detected simultaneously. A discriminator sensitivity problem was resolved by employing a station PM Baseband Unit (RCA) modified to provide amplification at the output of the discriminator.

The recorder capabilities were investigated and recommendations made on the type of electronics required in the recorders to support the signal quality requirements for this experiment.

In Section 6.2 of Volume I, GSI Test Data Report, the results of the Experiment Unique Test for VHRR are discussed. The most significant result is that concerned with the 3 Tone test used to simulate the sub-carrier frequencies at 32 KHz, 48 KHz and 176 KHz where it is reported that the intermodulation products were -60 dB, referenced to the level of each tone. The intermodulation products were expected to be -80 dB from the calculations made on the discriminator.

Therefore, further investigation is warranted as the intermodulation may be caused by the baseband amplifier circuits rather than the discriminator.

Working with the experimenter, the GSI prepared a Simulation Test Plan and these tests were performed on a ground loop configuration at the Rosman terminal using actual recorded VHRR data signals and levels expected from ATS-F spacecraft. Test results indicated no significant problem with the station equipment and interfaces. The experimenter appeared satisfied with the results and the ground station configuration performance.

Toward the end of the program the High Speed Interferometer experiment was added and the IHDRAS equipment was installed at the Rosman station. Since this experiment was expected to be performed concurrently with the VHRR experiment, the concern was to reduce any possibility of mutual interference between station outputs from the baseband amplifiers. A test was designed by the GSI, whereby the VHRR output and the IHDRAS outputs are filtered and amplified as required to allow for variations of deviations, etc. in the particular test configuration.

To test this configuration, the GSI prepared a VHRR/IHDRAS Simulation Plan to be performed at the Rosman Station. The principle test performed each simulated experiment using the Satellite Simulator, with conditions as expected from ATS-F, to determine if the presence of one experiment affected the final data obtained from the other. This test was not performed prior to launch.

1.4.2 ITV/HET

The following briefly describes how the ITV/HET experiment equipment interfaces with the ground station equipment.

Two basic units, supplied by the experimenter for the ITV experiment at each site, are shown in Figure 1.8 as the ITV (TRUST) Transmitter and ITV (TRUST) Receiver. The ITV (TRUST) Transmitter accepts one video line and two audio lines from the station CTEC patch panel. These signals are combined (in the Normal Mode) into a video plus two modulated sub-carrier and are patched into the station 70 MHz modulator, whose output can be patched into the C-Band transmitter for subsequent transmission to the satellite.

In the Sub-Carrier S-C Mode, the ITV (TRUST) transmitter can be patched to sum the audio sub-carriers (translated to 70 MHz) with a 70 MHz carrier modulated by video only. This composite 70 MHz spectrum is then converted to C-Band and transmitted to the satellite.

The ITV (TRUST) Receiver can be patched through the Receiver Patch Panel to interface with the C-Band receiver at 70 MHz or to a UHF receiver and 15-ft. antenna, which also has a 70 MHz interface. The ITV (TRUST) Receiver demodulates the received signal either in the Normal or S-C Mode to provide a demodulated video signal and two demodulated audio signals. These signals are interfaced with the CTEC patch panel where they can be routed to the TV Baseband subsystem, CTEC Test Instrumentation or other destinations.

The HET experiment equipment configuration consists of a 10-ft. diameter antenna and the HET receiver subsystem interfaced with the CTEC patch panel. HET signals can also be received by the 85-ft. antenna, S-Band feed, at the Rosman Station. These HET signals are converted to 70 MHz and interfaced at the Receiver Patch Panel. By inserting appropriate audio sub-carrier demodulators in the ITV (TRUST) Receiver, the HET audio sub-carrier can be demodulated.

Tests to confirm the validity of the station interfaces with the experimenter equipment were performed during the GSI Test program.

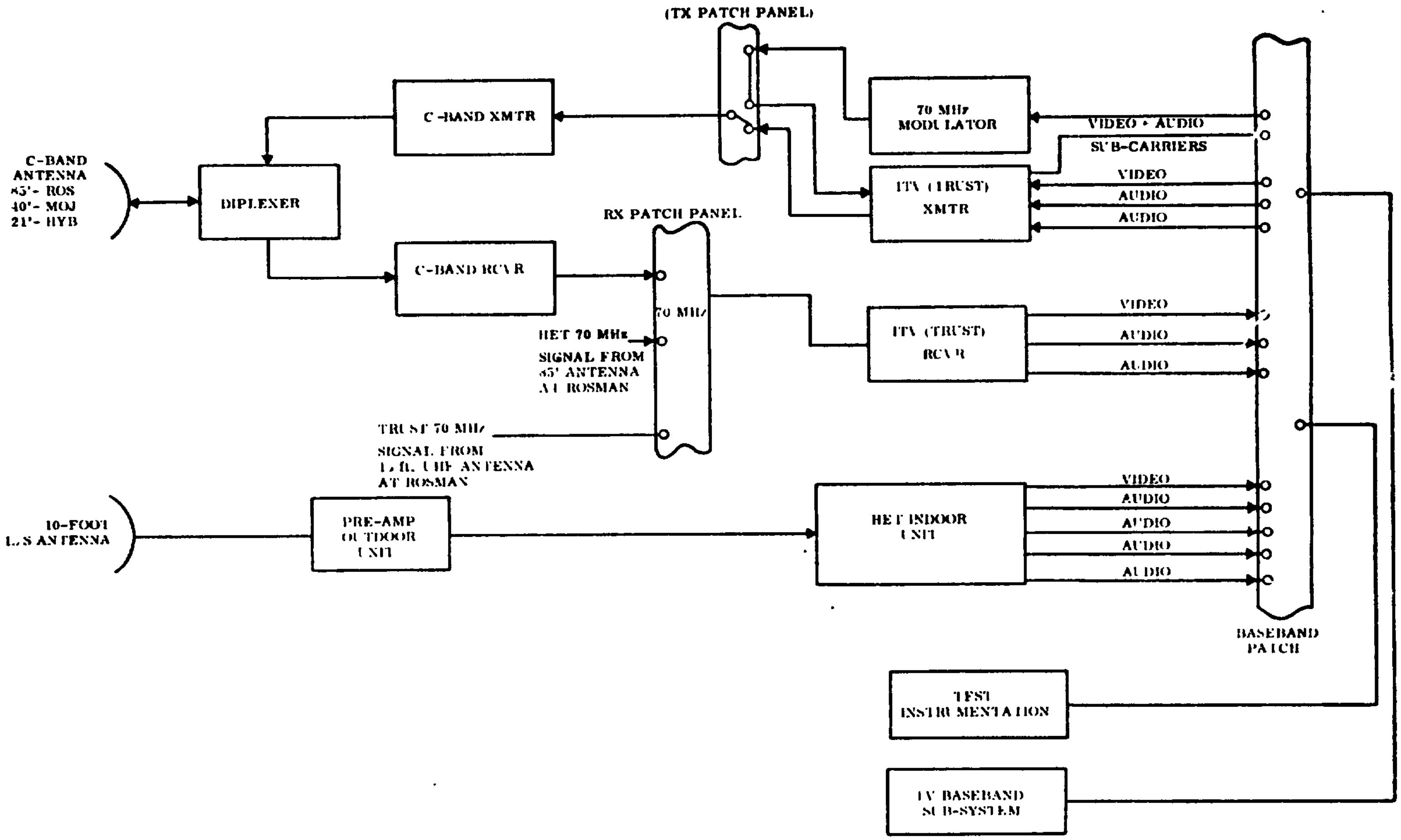


Figure 1.8. ITV/HET Rosman Equipment Configuration

- Principle Parameter Considerations

The station equipments utilized by the TRUST experimenter include the station 70 MHz Modulator, C-Band Transmitter and C-Band Receiver. Each of these equipments have been specified to provide CCIR type quality television and audio signals. Essentially, the equipment requirement for the TRUST experiment is that high quality equipment that is required to support this experiment. For example, the requirement to transmit and receive TASO 1 quality video (a TRUST objective) requires peak-to-peak video signal to rms noise (random noise) of approximately 53 dB, compared with 56 dB for the CCIR recommendations. Referring Volume 1, Table 2, of the GSI Test Data Report, the test results for the Rosman station C-Band Modulator-Performance Monitor Loop test for television (tests 2.6.4.1 through 2.6.5), demonstrated that the specifications for these units were met. These tests were performed in late 1972. When the C-Band Transmitter was introduced into the test loop, reference(Table 5 tests 2.11.12.1 through 2.11.3, Volume 1, GSI Test Data Report); there was a slight reduction in video signal to noise (random) ratio from 63.1 dB to 58.5 dB. There was however a considerable increase in spurious hum and periodic noise and a considerable increase in video/audio and audio/video crosstalk. These measurements were taken in late 1973.

The cause of increased noise and spurious outputs problems is a result of a fault in the klystron magnet power supply. The magnet power supply fault is liable to jeopardize the quality of the TRUST picture. The increase in crosstalk is attributed to a fault/misalignment in the performance monitor demodulator which occurred in the period between the two tests.

At the Mojave Station, the C-Band Transmitter essentially met all the specifications for the TV type tests (Refer to Volume 1, GSI Test Data Report, Table 23, Tests 2.11.12.1 through 2.11.13).

At the Rosman Station, the C-Band Receiver tests indicated that the TV performance was slightly out of specification. The continuous random noise test, indicated that the video signal to noise ratio was 57.5 dB (flat) which is attributed to phase noise generated by the LO multipliers and frequency synthesizer primary source. Other out of limit test results were believed to be caused by slight misalignment of either the Modulator or Demodulator (Refer to Volume 1, Table 10, GSI Test Report, tests 2.14.12.1 through 2.14.13). The results in Table 28, tests 2.14.12.1 through 2.14.13 are similar to those at the Mojave Station (Refer to Volume 1, GSI Data Report).

Overall it would appear that while very serious problems are not evident, some refinement in station equipment design, layout or alignment might improve the situation as regards to supporting the TRUST experiment requirements.

1.4.3 PLACE

The following describes how the Position Location Aircraft Communications Experiment (PLACE) equipment interfaces with the station ground equipments at the Rosman and Mojave Stations (Ref. Figure 1.9).

The experiment requires that the PLACE Control Center, situated at Rosman, transmit test signals to the ATS spacecraft on C-Band carrier frequencies. The satellite then translates the carriers to L-Band and retransmittes this signal to the equipments located in aircrafts and to the Rosman, Mojave and Santiago station. The L-Band Receiver and Transmit Subsystems at Rosman and Mojave S-L Shelter locations are used to simulate the aircraft equipment transmitters and receivers. The L-Band signal received by the 15-ft. antenna is translated to 70 MHz, then interface with the Aircraft Modem which is part of the PLACE equipment.

The Aircraft Modem delivers a test signal at 60 MHz, which is converted to the L-Band uplink frequency and transmitted by the 15-ft. L-Band antenna to the satellite. In the satellite, the received signal is converted to the C-Band downlink carrier frequency and received with the PLACE Control Center equipment where it is processed by the station computer (either #5 or #6).

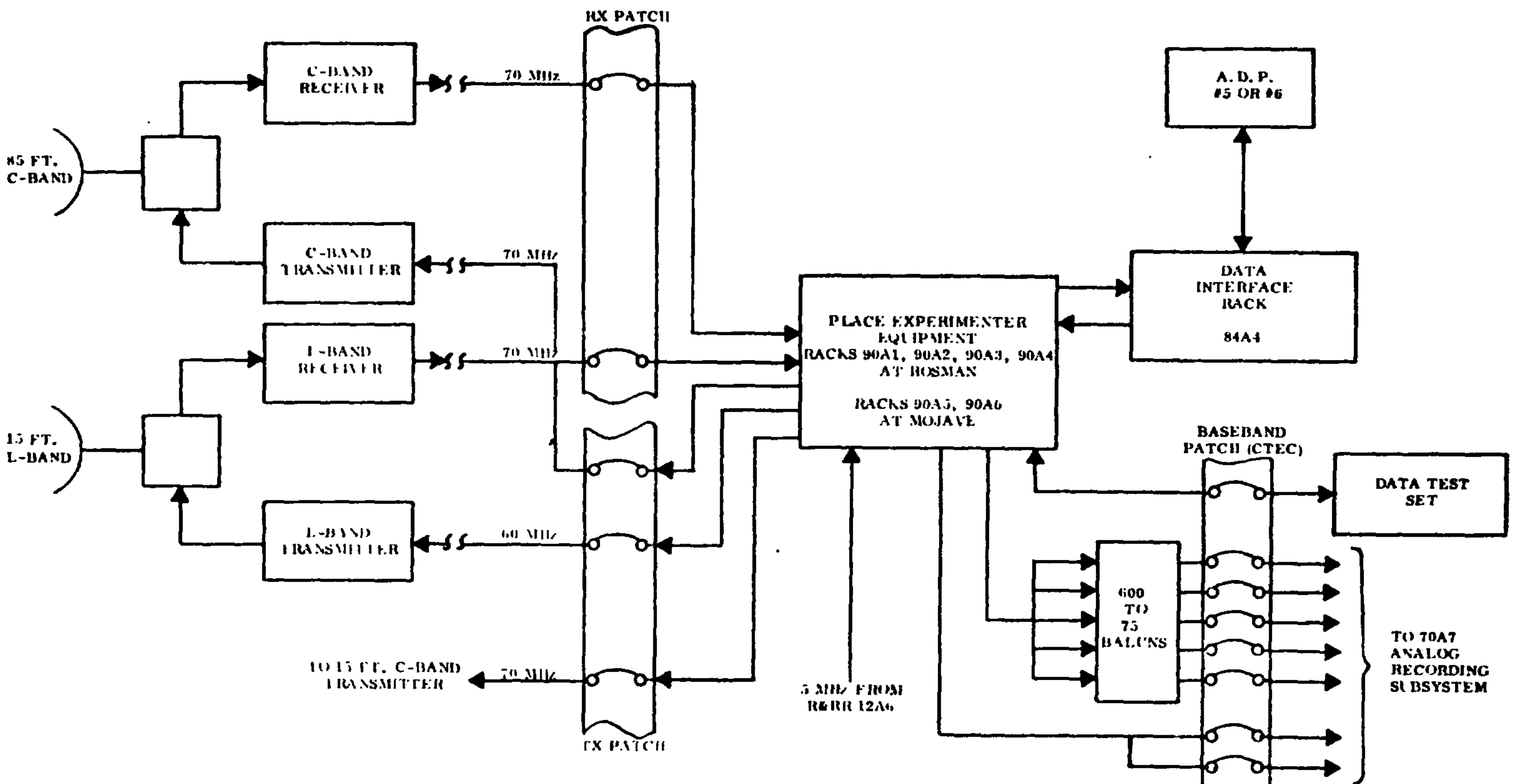
The PLACE equipments are all referenced to the station timing subsystem which is part of R&RR equipment (12A6).

Patching facilities are provided via the CTEC to record specified data on the station analog recorders and to interface the Data Test Set. The Data Test Set is part of the station compliment of special test instrumentation at each site.

For two satellite experiments, the station 15-ft. C-Band antenna and transmitter are used to send signals from the PLACE Control Center to ATS-5. A 70 MHz interface is provided from the PLACE Control Center to the transmitter patch panel which accomodate this mode of operation.

- Principle Parameter Considerations

The basic PLACE experiment equipment transmits and receives multiple carriers at C and L-Band in a bandwidth of less than 1 MHz. These carriers are intermittently modulated by either voice, data, and ranging tones.



NOTE. THE PLACE EXPERIMENT EQUIPMENT AT MOJAVE SIMULATES AIRBORNE EQUIPMENT ONLY. DOES NOT USE ADP OR C-BAND TRANSMITTER OR RECEIVER.

Figure 1.9. PLACE Rosman Equipment Configuration (Mojave)

Of principle concern to this experiment is the Short Term Stability of the ground station C-Band Transmitters and Receivers. Phase noise introduced by the ground station equipment on the multiple carriers passing through this instrumentation cause the reception to be noisy. If the close-in phase noise specifications for the C and L-Band ground station equipment were met (Ref. tests 2.9.7, 2.11.7, 2.12.6 and 2.14.7, of the Test Data Report, Volumes II and V), then the requirements of short term stability for this experiment would be more than adequately, since thermal noise will be fairly high on the RF path links. The sub-carriers are modulated either by voice (300-3000 Hz), data 600 BPS, 1200 BPS or ranging tones in the order 7000-8000 Hz. Phase noise or spurious hum frequency components below 300 Hz introduced by the transmitters or receivers are therefore unlikely to be of any great concern. Phase noise and spurious hum frequency components between 300-3000 Hz are of primary concern.

The data recorded by the GSI at the sites (Ref. 2.9.7, 2.11.7, 2.12.6, 2.14.6, of the Test Data Report, Volumes II and V), indicated that hum frequency components above 300 Hz meet the equipment specifications and that phase noise specifications have been met or are only a few dB's out of specification limits and appear to be more than adequate to support this experiment.

Another matter of concern in the station equipment was the linearity of the S and C-Band Transmitters and Receivers. While the transmitter and receiver equipment meet their respective linearity requirements, a potential problem to the experiment was discovered when the L-Band Transmitter and Receivers were operated simultaneously. Intermodulation products on the transmit carriers at 1650 MHz appeared in band for the receiver at 1550 MHz. A study of this potential problem was made by the GSI and fully documented in two reports dated Sept. 12, 1973, and Feb. 4, 1974, entitled "L-Band Interference Problem." The latter of the two reports addresses the possibility of this problem affecting the Extended L-Band Experiments now being added to the experiment program.

Simulation Plans for the PLACE experiment were written by the GSI for the PLACE experiment field locations (Rosman, Mojave, and Santiago Stations as well as the experimental aircraft). An interface problem was observed during the initial Simulation Tests. The interfaces between the Fredrick Data Test Set and the PLACE experiment equipments are not compatible. The incompatibility deals with the

Fredrick Test Set requirement for an unbalanced line while the experiment equipment uses balanced lines, the polarity and levels of the data logic being generated by the Fredrick equipment is also not compatible with the experimenters equipment. The experimenter is expected to remedy this situation.

1.4.4 RFI

The interfaces between the RFI experiment equipment and the Rosman ground station equipment is illustrated in Figure 1-10. No details are shown of the experimenter's equipment in this illustration; only that use which this equipment makes of the ground station facility is indicated. The major interface is at the 4 GHz incoming RF. Signals received by the 85-ft. antenna are passed through the duplexer, amplified in the C-Band receiver parametric low noise amplifier, and split into two parts by a hybrid. The main signal from the hybrid is transferred to the experimenter's equipment via low loss elliptical waveguide. Use is made of the full 500 MHz bandwidth of the satellite transponder and receiver LNA. The incoming signal is converted to a 70 MHz IF using the ground station downconverter. The 70 MHz signal is routed through the receiver patch panel and the station 70 MHz IF amplifier and AGC equipment. It may then either interface at 70 MHz with the experimenter's equipment, or may be demodulated in the station wideband demodulator. The demodulator output goes via the baseband patch panel to test equipment or the experimenter's unit.

A test signal may be introduced into the C-Band paramp. This is generated in the experimenter's equipment at a 74/84 MHz frequency and multiplied by 50 at the antenna location and then switched into the LNA input.

The C-Band transmitter can also be used for the purpose of transmitting test and communication signals to the spacecraft. Signals delivered to the 6 GHz upconverter at a 70 MHz IF are provided either by the experimenter's equipment or may be generated in the station 70 MHz wideband modulator. The modulator baseband input is routed via the baseband patch panel from the experimenter's equipment or test instruments.

The station ATSR equipment is used to provide a 5 MHz standard frequency input to the experimenter's equipment; and also to provide time code signals via the baseband patch panel to the tape recorders. Other station facilities used in this experiment include the analog tape recorders, various pieces of test equipment and portions of the ADP equipment. The station provides the interface cable between the experimenter's equipment and the experimenter-provided fixed calibration terminal (FCT).

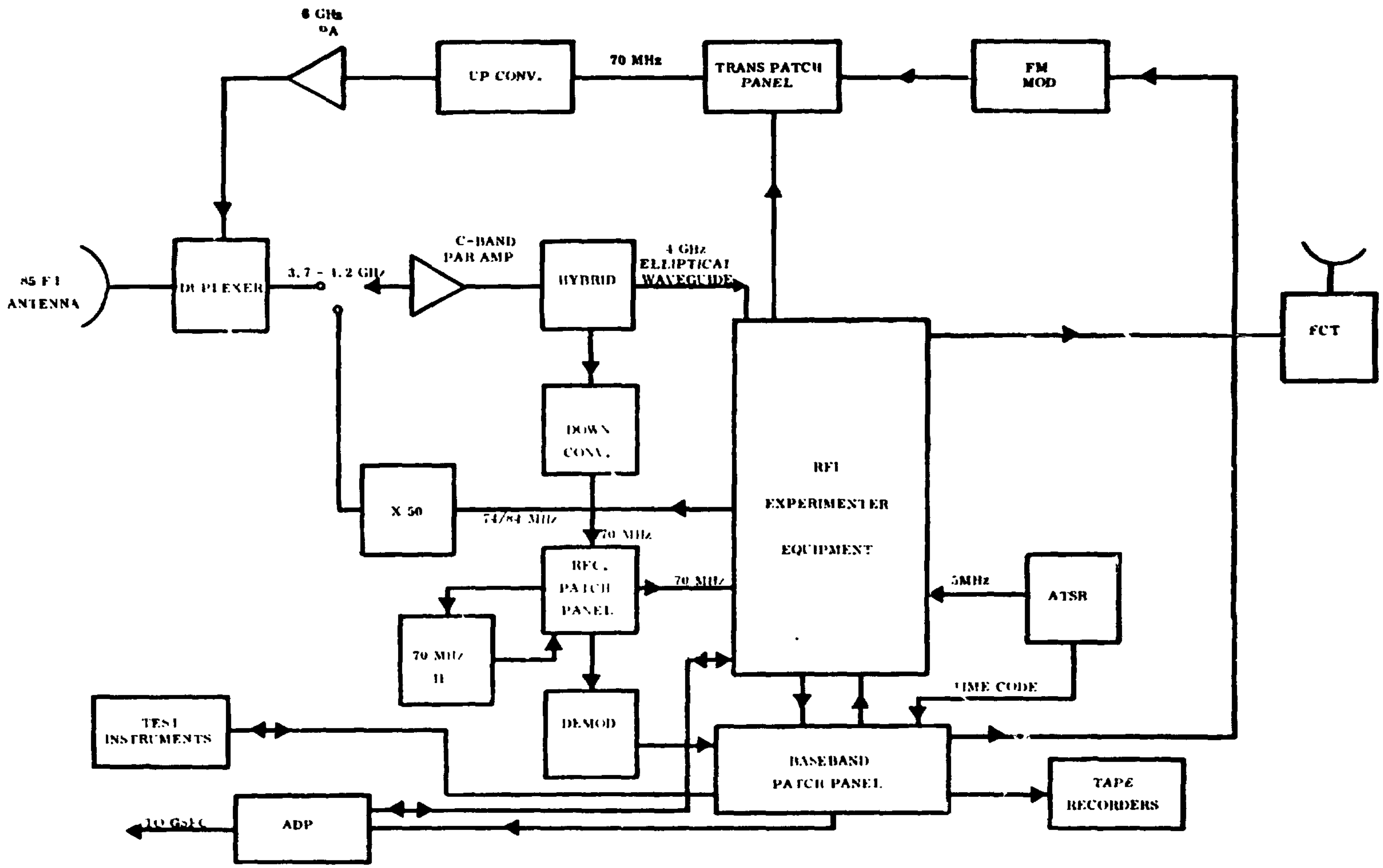


Figure 1-10. RFI Rosman Equipment Configuration

- <u>Principle Parameter Considerations</u>

The most critical parameters of the ground station performance affecting the RFI experiment are the flatness and freedom from spurious signals of overall RF response over the 500 MHz wide receiving band; and the gain stability with time of the receiving RF sections. These parameters are determined by the antenna feed system, the receiving C-Band low noise parametric amplifier, and the waveguide run to the experimenter's equipment. Other important factor affecting this experiment is the accuracy with which test signals can be injected into the paramp, which is determined by the 74/84 MHz cable and the X50 multiplier. The ability to generate C-Band RF signals at known level (EIRP) with low intermodulation when modulated with noise-like signals is important. Correct performance of the ATSR timing and reference signals and of the recording and ADP is required. The cable interface to the FCT (provided by GSI) is also important.

In Volume I, Section 2.1.3, GSI Testing, of the GSI Test Data Report documents the Rosman C-Band loop. These tests indicate the overall performance of the C-Band transmitter and receiver and include measurements of NPR which are pertinent when the C-Band equipment is used for the RFI Testing. Although the performance is in general outside specification limits, it is adequate to support this part of the RFI experiment. In Volume I, Section 6.2.1, (GSI Test Data Report) tests on the elliptical waveguide are reported. This waveguide is unique to the RFI tests and as already indicated is of great importance to this experiment. The results of this test indicate that the gain stability (variation of loss) of the elliptical waveguide is not adequate for the desired measuring accuracy of the RFI experiment. For example, in one, 3-1/2 hour period there was a 1.7 dB loss change utilizing a constant input signal. This indicates that there is a need for more frequent calibration during the course of experimental runs than would be desirable. As indicated in Volume I, Table 10 of Section 2 (Test Data Summary Sheets), the gain and flatness of the C-Band parametric LNA are within specification and adequate for this experiment. Overall it may be conclude that the Rosman station is capable of supporting this experiment, but that the gain variation of the RF waveguide will result in the need for more frequent calibration than had been planned.

1.4.5 MMW

In the millimeter wave communications experiment, signals will be transmitted to the ATS-6 Satellite at C-Band (6 GHz uplink) and then translated in the spacecraft to the 20 and 30 GHz frequencies and returned to earth. They may also be translated to the 4 GHz C-Band downlink for comparison measurements. The millimeter wave receiving equipment is furnished by the experimenter. The Rosman Ground station has furnished the C-Band equipment and also the 70 MHz modems and baseband equipment.

In the data test modes, signals modulated by data are delivered at 70 MHz by the experimenter. The ground station equipment then translates these to 6 GHz for transmission to the spacecraft. Received signals at 4 GHz are translated to 70 MHz and delivered to the experimenter equipment.

Measurements can be made at 70 MHz using a Microwave Link Analyzer provided by the ground station. This will allow measurement of the IF group delay variations and amplitude response in any of the available loop modes. Baseband tests may be similarly performed using the Microwave link analyzer in conjunction with the ground station wideband 70 MHz modulators and demodulators.

In the television test mode, the ground station equipment generates the required video and audio signals, modulates this complex signal on a 70 MHz IF carrier, translates it to 6 GHz and then transmits it to the satellite. The comparison signals received at 4 GHz are translated to 70 MHz. The 20 and 30 GHz signals are translated to 70 MHz in the experimenter millimeter wave receivers. These 70 MHz signals are then routed into the ground station wideband demodulator that produce baseband signals. The ground station provides the equipment for measurement and display of the baseband signals. In the multichannel test mode, the 70 MHz and C-Band equipment provided by the ground station are identical to the TV tests, with the exception that in the modulator and demodulator, appropriate preemphases and deemphasis networks are utilized. The baseband signals utilize "noise-loading" to simulate multiple FDM telephone channels. This signal is generated in test equipment provided by the ground station and measurements are made using ground station equipment. The ground station also provides recording equipment for use in the millimeter wave experiment.

- <u>Principle Parameter Consideration</u>

The ground station C-Band and 70 MHz equipment is capable of transmitting and receiving full NTSC television signals plus an audio subcarrier. The ground station is also capable of sending and receiving FDM telephone signals with up to 1200 voice channels. The test equipment is available to generate these signals and to make communication measurements.

The performance of the C-Band and IF equipment was specified to contribute only a normal amount of noise, intermodulation, etc., to the video and telephone signals. These specifications are compatable with the relevant Intelsat specifications for satellite ground equipment that meet the overall CCIR recommendations for satellite links. The actual performance of the C-Band equipment is summarized and analyzed in Volume I of the GSI Test Data Report. As indicated, in this report, certain of the performance parameters are below specification limits. The most serious being the phase noise; especially in the 4 GHz receiver. However, the performance allows the transmission of excellent quality TV signals, and FDM telephone signals with low noise performance (high channel S/N ratios); and is therefore adequate for the millimeter wave tests.

The GSI prepared a Simulation Test Plan and Procedures for the experimenter, to check out all communication experiment modes at the Rosman Station using the Satellite Simulator located at the collimation tower. These tests have not been performed due to the unavailibility of experiment equipment.

4.6 T&DRE

This section describes the Tracking and Data Relay Experiment (T&DRE) equipment that interface with the ground station equipments at Rosman (Mojave and Hybrid), Ref. Figure 1.11.

The experiment requires that command signals be transmitted from the Rosman Station to an orbiting Nimbus spacecraft via ATS-F. The command signals are transmitted to the ATS-F spacecraft on a C-Band carrier and then relayed to Nimbus at S-Band. Range and range rate measurements via ATS-F and Nimbus spacecrafts are made using modified ATS Range and Range Rate equipment supplied by the experimenter.

In the ranging mode, the ATS-F frequency standard is made coherent with the ground station frequency standard by locking the spacecraft oscillator to a pilot tone derived from the ground station standard.

In the command mode (Ref. Figure 1.11), the commands are delivered by FSK tones at 7680 Hz and 11,520 Hz, which are amplitude modulated by a superimposed 128 Hz clock signal, developed by frequency modulateing a HP 5105A synthesizer. This synthesizer contains a phase modulator, so the GSI provided an integrating network with adjustable output level prior to the phase modulator that would ensure true frequency modulation at the mark-space frequencies. The 70 MHz frequency modulated output signal from the synthesizer (adjustable in small increments to off-set doppler effects between the ATS-F and the Nimbus spacecraft) is then converted by the station equipment to the C-Band uplink frequency. A command verification loop is obtained by demodulating, using the station Tx Performance Monitor and the ACL general purpose receiver, a sample of the C-Band transmitted frequency. The command verifications are made at Rosman I station.

In the ranging mode, the pilot signal that phase locks the ATS-F satellite equipment is obtained from a ground station synthesizer set at 82.15 MHz. The ranging signal at 70 MHz is combined with this pilot signal in the Pilot Combiner Unit and both signals converted in the station transmitter to C-Band.

Return signals from the Nimbus spacecraft via ATS-5 include data from the onboard (Nimbus) Versatile Information Processor (VIP data), Digital Evaluation Module (DEM data) and Temperature Humidity Infrared Radiometer (THIR data).

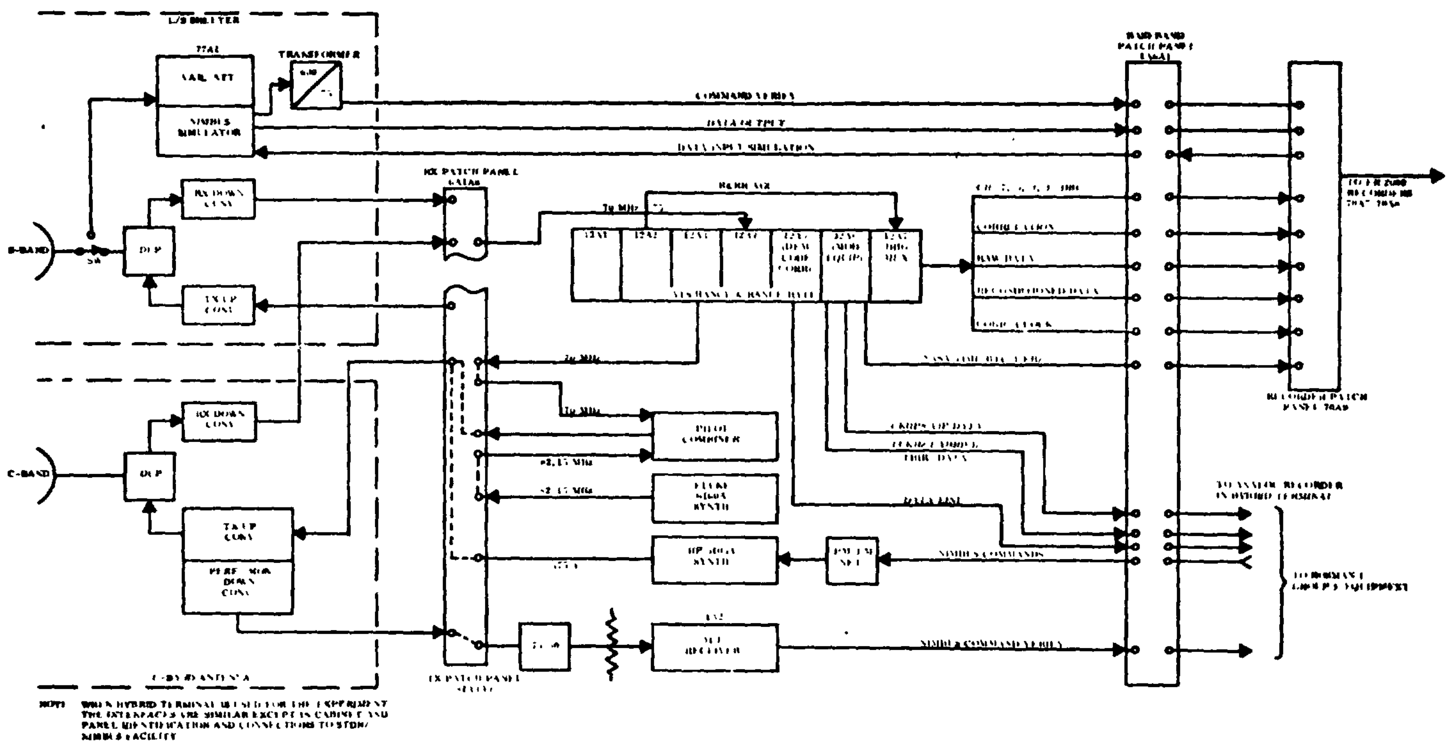


Figure 1.11. T&DRE Rosman Equipment Configuration (Hybrid & Mojave)

Interfaces are provided as shown to the station analog recorders and the Rosman I station for this data and for other monitors that comprice the modified Range and Range Rate equipment.

The S-Band 15-ft. antenna subsystem is equipped with a switch, for which the Nimbus Simulator can be attached at all sites to provide the capability to simulate the S-Band links for this experiment. Input and output interfaces to the station Baseband Patch Panel are provided. The Mojave Station is not equipped with command and command verification capability.

- Principle Parameter Considerations

The GSI activities in support of the T&DRE experiment were principally limited to directing the interface cabling as shown in Figure 1.11. The PM/FM Network was supplied by the GSI and consisted of an integrating circuit to accept a 600 ohm balanced 1 volt rms command signal line and provide an output of 50 ohm unbalanced to the HP 5105A Synthesizer for frequency modulate of 20 KHz peak deviation, that is variable $\pm$ 6 dB about nominal. The sensitivity of the HP 5105A phase modulator was measured at 2.1 radian/volt. This unit consisted of a balanced to unbalanced transformer driving a power type differential amplifier with an integrator to provide 6 dB/octave slope between 7 KHz to 12 KHz. The equipment has been successfully utilized to command the Nimbus Simulator during station loop testing.

A means of implementing the command verification function was derived using an existing microwave tuneable receiver (ACL Receiver) and the C-Band Performance Monitor. This also has been demonstrated successfully by the experimenter.

1.4.7 SAPPSAC

The block diagram shown in Figure 1.12 illustrates how the standard interface design at the Rosman Station is configured for the SAPPSAC experiment using either VHF commands and telemetry or C-Band commands and telemetry. The Group Sync, GAC Encoder and DHE equipments are interfaced with the appropriate transmitters and receivers via the Project Patch Panel (39A1). This diagram illustrates the configuration used for the Rosman SAPPSAC Simulation Tests which were prepared by the GSI and the experimenter. The main objective of the test was to determine if the 27 GAC commands could be reliably sent over the simulated command links utilizing the T&C simulator at the Near Field Collimation Tower. The test was designed to evaluate the operational readiness of the GAC encoder, the communication link, the internal ground command verification links and any interface problems related to this configuration.

The GSI assisted in the testing the SAPPSAC configuration under the direction of the experimenter. The results were published by the experimenter who found no fault with the GSI integrated equipment.

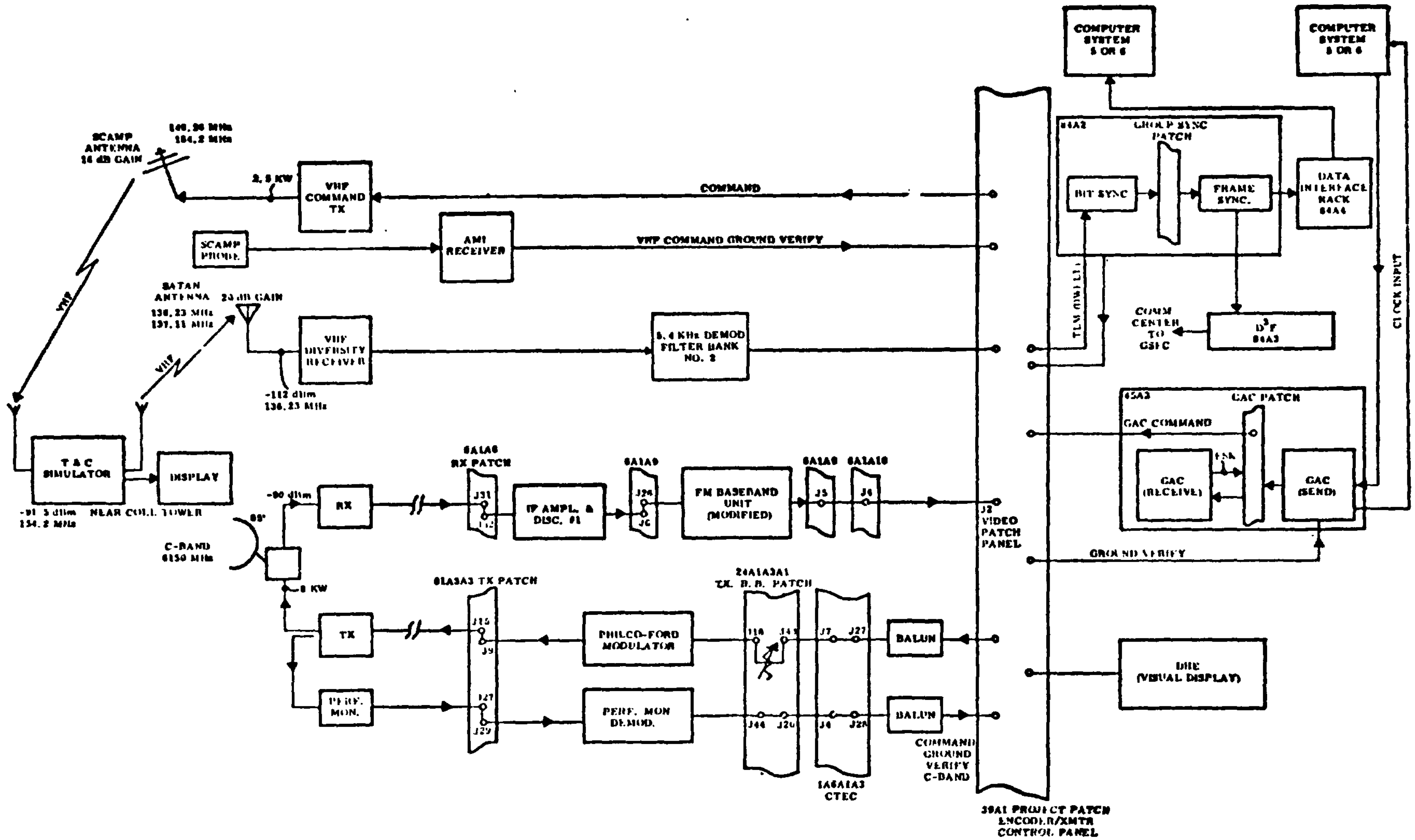


Figure 1.12. SAPPSAC Rosman Equipment Configuration

1.5 AUTOMATIC DATA PROCESSING (ADP) SUBSYSTEM DESCRIPTION

The ADP subsystem was designed and developed under the concept of flexibility and commonality. An ADP Plan was developed under a joint NASA/FII/Ⓦ effort to provide computer systems that could operate the ATS-F satellite from the ATS Operations Control Center (ATSOCC) at GSFC, test the Spacecraft at Fairchild and provide spacecraft operations backup and support experiment operations at the Ground Stations. Certain unique equipments were required to accomplish each of the assigned applications. Westinghouse actively participated in the design effort for all areas, but was specifically responsible for the Ground Stations. Wherever applicable, NASA utilized the design concepts developed by Westinghouse for all there applications.

- Computer Selection

The computer selection was based on performance, flexibility, price, software requirements, maintenance record, and delivery schedule. The computer that was finally selected from the many which were under consideration was the Digital Equipment Corporation (DEC) PDP-11 Model 20. One of the most important features of this equipment was the UNIBUS concept which allows the addition of interfaces as required, which had a "horizontal and vertical" interrupt structure that allows for almost 5,000 interrupt levels if required, and provided the capability of switching sections of the UNIBUS between computers via UNIBUS Switches. This flexibility allows for nearly unlimited expansion of interfacing without an effect on the original configuration. Another important consideration was the availability of a FORTRAN package, a Disk Operating System (DOS) which is convenient for software development, and extensive diagnostic software. The computation speed of the basic computer with the Extended Arithmetic Package is not extremely fast, however, it did provide all the required capability and speed. Certain other systems evaluated, proved to have faster CPUS, however, when traded off against the PDP-11/20 Input/Output capability and price, they were rejected.

Interfaces were provided at the Ground Stations by the GSI which made possible the acceptance of various experiment data inputs and its control, pre-processing, display of the data with subsequent digital magnetic tape recording and later data transfer to NASA/GSFC. Interfaces were provided to make possible command and control (via telemetry monitoring) of the Spacecraft as a backup or supplement to ATSOCC. Additional interfaces were provided to allow commanding from ATSOCC via the D3F Decoder while ATSOCC is in control of the spacecraft.

The attached illustrations depict the ADP configurations utilized for each of the experiments and for Spacecraft Operations. A figure depicting data flow has been provided as an overview on total spacecraft operations. A figure depicting the PDP-11/20 configurations at each ground station has also been provided.

- Data Flow

The block diagram shown in Figure 1.13 depicts the flow of telemetry and commands, experimenter status/VHRR Quick Look, and Digital Magnetic Tape (DMT) transfer between an ATS ground station and NASA/GSFC.

Telemetry (Normal, Dwell and EME) is recorded on Analog Tape which provides a backup to the D3F transfers to GSFC. In the event of a communications problem, this data is mailed to NASA/GSFC. The telemetry is Bit and Frame Synchronized and routed to the computers at the ground station and to the D3F for transmission to ATSOCC and the IPD (Information Processing Division). A backup is provided (in the event of D3F failure) where Normal Telemetry may be routed asynchronously to ATSOCC where it is bit and frame synchronized. A D3F interface to the Ground Station Computers allows for transfer of certain preprocessed data to and from ATSOCC. The Wideband line can be scheduled for a variety of purposes including the transfer of DMT to IPD via a 303 Modem operating at 230.4 KB. Normal Commands are generated at the ground station or ATSOCC and are routed to the Normal Command Encoder (NCE) via an interface and switch in the Data Interface Rack (DIR). The NCE records commands on a line printer for use as required. An operator may also send commands from the NCE, either manually or by using a prepunched paper tape. Ground Attitude Control (GAC) commands are sent to the Spacecraft from either of two computers via a manual switch and the GAC Encoder.

D3F Data is received and transmitted from ATSOCC via the Data Interface Buffer (DIB). Data may be received from the ATS stations or from other STDN sites equipped with an equivalent of the D3F.

A variety of patching is provided as part of the GSFC Data Link to route data from the appropriate station to ATSOCC and IPD Patches are available at ATSOCC to route data and configure interfaces to the appropriate computer(s).

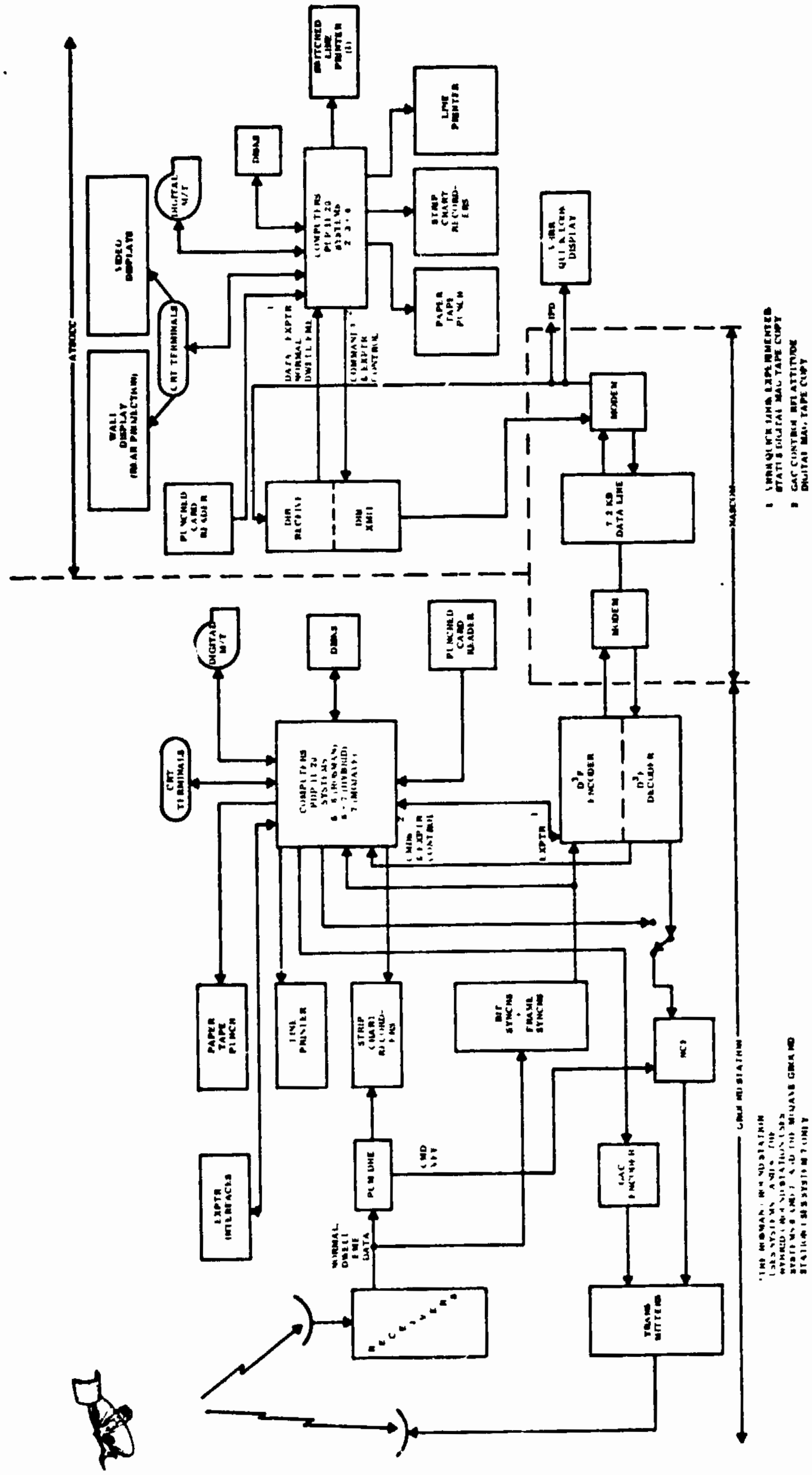


Figure 1.13. ATS-F Data Flow

- **Software**

A flexible Real Time Executive (ATSEX) computer program was developed and is being utilized for the ATS-6 Operating Control System as well as by one experimenter. The ATSEX program, because of it's user independence and extensive peripheral/interface input/output driver requirements, can be utilized by any one desiring such a real time system.

ATSEX program uses the first 16KB of the core memory to contain the executive user resident programs, common tables, and interrupt pointers. The remaining 12KB is divided into six 2KB overlay segments. The use of the overlay areas is scheduled when the system is generated. During run time, each overlay is loaded from the DISKS, with the ATSEX program acting as the scheduler. When the processing is completed, the overlay(s) is then free for the next scheduled job. This, in effect, expands the memory to the size of the DISKS (presently 512KB words.) The DISKS is loaded by the System Mag Tape equipment when the particular job is to begin.

The resident programs developed for the ground station are the telemetry handlers, command output programs, System Initialization and certain houskeeping routines. The overlay programs are primarily common software since they are also used at the ATSOCC and at the Fairchild complex. These programs include limit check and calibration, attitude determination, CRT paging and display, strip chart output, printer output, command sequencing, an Automatic Sequence Processor (ASP), and other special routines.

The software developed by the experimenter, forms separate packages that are independly operated under the ATSEX programs or their own Executives. Some software that was developed for Spacecraft Operations at the Ground Station or ATSOCC has been used or emulated by the experimenters.

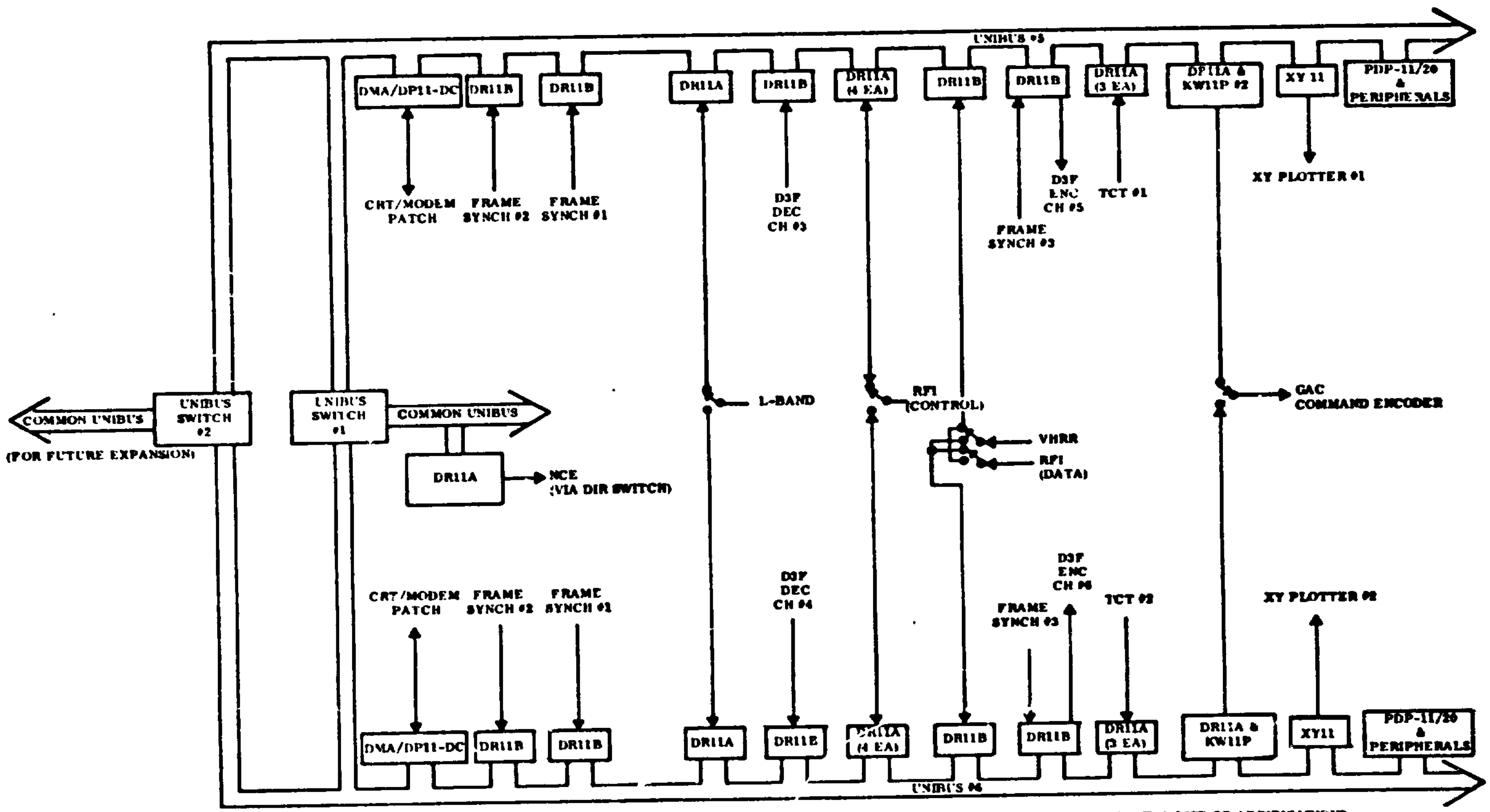
1.5.1 ROSMAN GROUND STATION ADP

The prime function of the Rosman Ground Station ADP subsystem is control and data gathering, preprocessing and digital recording of the: RFI measurements experiment, the VHRR (Very High Resolution Radiometer) Experiment, Integrated L-Band Experiment, GSFC Millimeter Wave Experiment and the SAPPSAC (Spacecraft Attitude Precision Pointing and Slewing Adaptive Control) Experiment. A secondary function of the Rosman ADP is to act as a backup to ATSOCC for Spacecraft Operations and Control. These functions are independent from the routine use of various interfaces for the modem transmission of telemetry to ATSOCC and the Information Processing Division (IPD) at NASA/GSFC and the receipt, checking reformatting and transmission of commands generated at ATSOCC. This section, in conjunction with the attached figures will individually describe each of the functions performed at the Rosman Ground Station. Figure 1.14 provides a block diagram of the individual components of the PDP-11/20 that may be utilized to perform each of the required functions. Table 1,lists the ADP equipment breakdown and abbreviations. Each function is individually performed through application of the appropriate software. Other applications are provided through implementation of substitute hardware interfaces and the necessary software. Each function makes use of the Time Code Translator (TCT) (BDC milliseconds of day and day of year) for time tagging events. Each experimenter uses the D3F Encoder for transmission of pertinent experiment status data to ATSOCC. The Digital Mag Tape (DMT) transmit and receive capability via the D3F and the high speed DMT transfer to IPD via the DMA/DP11-DC and 230.4 KB modem and wideband data line is available as required by each user. The Line Printer is available to all users for hard copy results. Two Strip Chart Recorders are available whose analog channels (8 ea) can be patched to the Radiation PCM/DHE or the computer on an individual basis. An edge track records time, on each recorder while 7 inter channel event pens are hard wired to the computer. Forty-eight additional event drivers are available in the computer as required for lamps, relays, or other special purposes.

The following paragraphs are intended to provide the reader with a description of the functions of the ADP subsystem during the performance of the varied experiments.

- VHRR Experiment

The block diagram shown in Figure 1.15 depicts that part of the hardware that is utilized by the VHRR Software. The VHRR equipment provides word synchronized instrument data; 10 bits per word at a rate of 7,200 Words per second. The data is routed into computer #5 or #6 via a manual switch and a DR11B. The DR11B is activated to input a line of data plus housekeeping information in 1.2 seconds. The line is preprocessed and written onto a DMT in 14,780 bit records. Meanwhile



NOTE: TABLE I PROVIDES AN EQUIPMENT BREAKDOWN AND A LIST OF ABBREVIATIONS.

Figure 1.14. Rosman PDP 11/20 Configuration

Table 2

EQUIPMENT BREAKDOWN AND ABBREVIATIONS

PDP-11/20	16 Bit Central Processor (KH11) Operators Console 28 K Ccre Memory Extended Arithmetic Unit (Multiply & Diode) Paper Tape Bootstrap Mag Tape and Disk Bootstrap Real Time Clock (KW11P#1)
Peripherals	Disk, 256 K Fixed head (2 ea) Digital Mag Tape, 8 Track/800 BPI (2 ea) Card Reader Line Printer, 128 column High Speed paper tape reader and punch DECWRITER (typewriter)
XY11	XY Plotter Interface
DR11A	General Purpose Program Input/Output Interface
KW11P#2	Real Time Clock #2
DR11B	General Purpose DMA (Direct Memory Access) Input/Output Interface
DMA/DP11-DC	40.8 KB Communications Interface, DMA
XY Plotter #1 or #2	Calcomp 565 Drum plotters
GAC Command Encoder	Ground Attitude Control Command Encoder
TCT #1 or #2	Time Code Translators
D3F ENC Ch #5 or #6	Duplex Digital Data formatter Encoder Channel #5 or #6
Frame Synch #1, #2, or #3	Monitor 403 Frame Synchronizers
D3F DEC Ch #3 or #4	Duplex Digital Data Formatter Decoder Channel #3 or #4
CRT	Cathode Ray Tube Input/Output Display Terminal (Hazetine 40000, Model 2)
Modem	Data Communications Modulator/Demodulator
NCE	Normal Command Encoder
DIR	Data Interface Rack

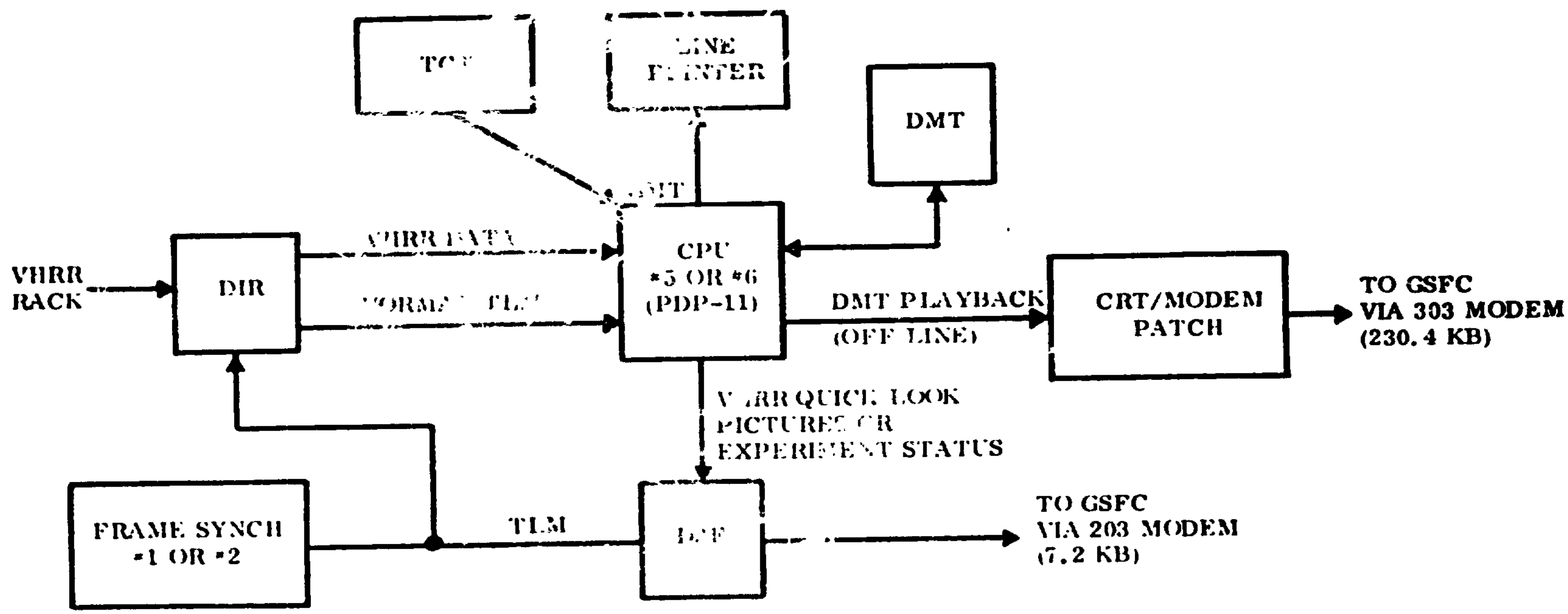


Figure 1.15. VHRR Experiment ADP - Rosman

the ATS Normal Telemetry (1152 Words per 3 seconds) is read into a DR11B via the Frame Synch interface in the DIR to provide housekeeping data on the instrument for monitor and calibration perpaces during one of it's modes of operation. This sequence is repeated until the recording of the picture is completed. An option exists in the software to send "Quick Look Data" via the D3F for display at ATSOCC. For quick look purposes only 1/6 of the data words are transmitted and each word is scaled down from 10 bits (9 bits plus parity) to four bits. The next picture is then recorded on the other DMT, etc. The DMT recordings that are generated can then be mailed to NASA/GSFC or transferred via the wideband link.

- RFI Measurement Experiment

The block diagram shown in Figure 1.16 depicts that part of the hardware that is utilized by the RFIME. The RFI equipment provides data to the computer from an A/D convertor at a rate of one 12-bit word every 200 usec. Samples are made input to the computer via a manual switch and a DR11B. The DR11B is programmed to input 40 data points at each frequency (8 ms blocks). These blocks are made input for each frequency by scanning over a 500 MHz band in 10 KHz or 1 KHz steps. The various frequency, configuration, analog recording and mode controls are accomplished by setting or reading the appropriate data bits of four DR11A interfaces that are manually switched to either of two computers. The data is preprocessed and recorded on the DMT. The frequency spectrum may be examined at the several geographical pointings (under ATSOCC Control) established in the daily experiment plan. A scan of the entire U.S.A. (one mode) involves 31.5 million measurements and 9 hrs of operation. The resultant DMT(s) are normally mailed to NASA/GSFC for reduction, although the high speed transfer mode may be used when required. ATS Normal Telemetry (1152 Words per 3 Seconds) is read into a DR11B via the Frame Synch Interface in the DIR to provide housekeeping data that is used for calibration of the received signals. The ATS-6 attitude computed at ATSOCC is transferred into the computer via a DR11B and an interface in the DIR.

This equipment is also used to develop the ATS-6 Antenna Patterns by utilizing a separate software package that is used in addition to the ATSEX program.

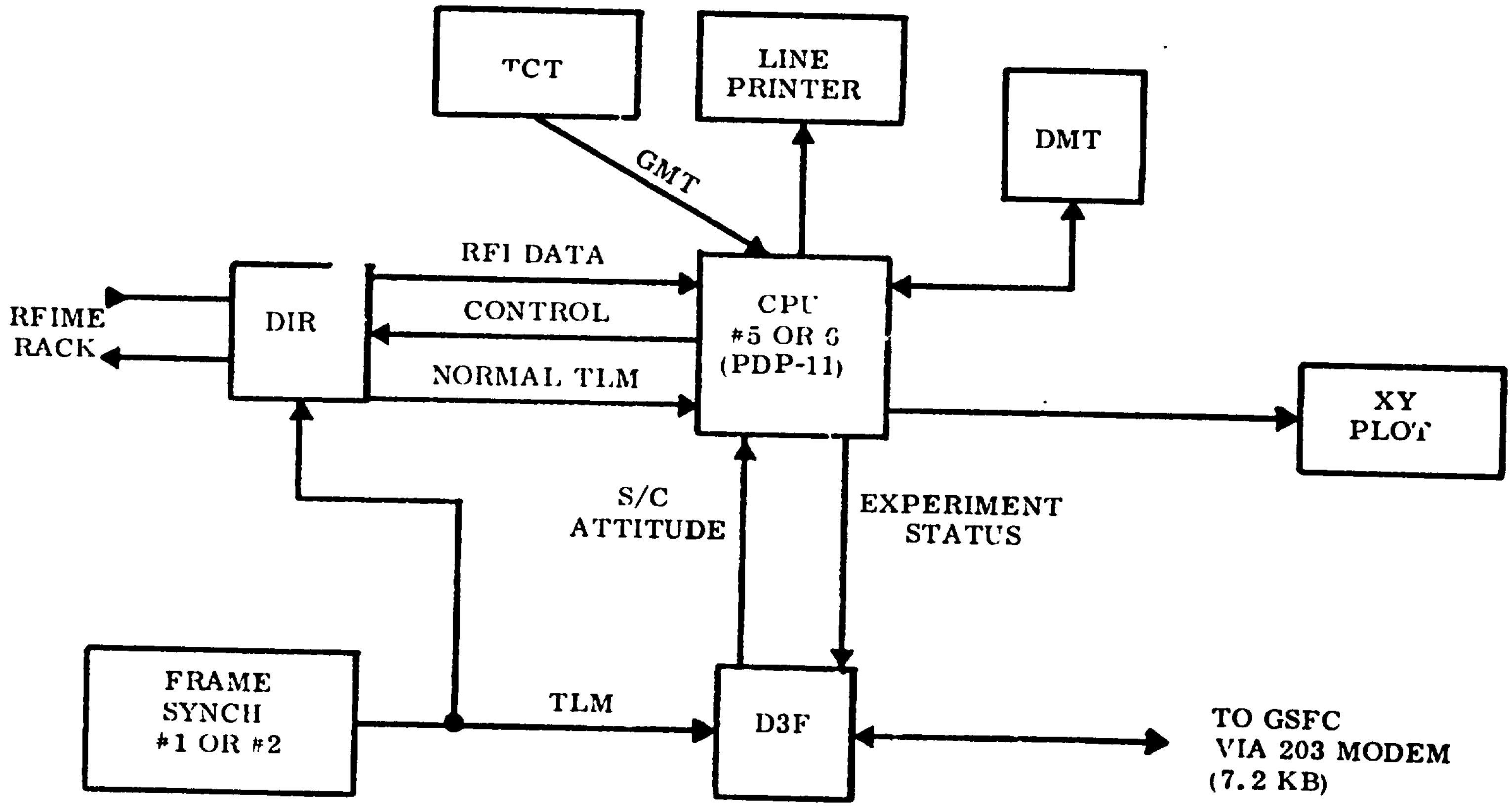


Figure 1.16. RFI Measurement Experiment ADP - Rosman

- **SAPPSAC Experiment**

The block diagram shown in Figure 1.17 depicts that part of the hardware that is utilized by the SAPPSAC software. SAPPSAC can be operated independently from Rosman or under the control of ATSOCC via the D3F link. In the independent mode, normal and dwell telemetry (1152 words per 3 seconds, each) is read into either computer via two DR11B's, and the Frame Synch #1 & #2 interfaces in the DIR. The appropriate attitude sensor information and spacecraft ephemeris is utilized by the software to calculate spacecraft pointing and the offset from desired pointing. This information is then used to calculate the torques (jet pulses or wheel rotations) that are required on each axis in the next 3 seconds to provide the necessary correction. These commands are then sent to the Spacecraft via a DR11A, the GAC switch and GAC Encoder at the rate of one command every 10.8 ms. Real time Clock #2 is used to count and control the number of commands transmitted. This procedure is repeated every telemetry frame. Results are displayed on the CRT Terminal(s) and recorded on Strip Charts and on the DMT. A mathematical model of Spacecraft dynamics is updated each time the experiment is performed and is used for calculations and predictions.

The sequence is essentially the same when ATSOCC control is added except that control information and parameters are sent to Rosman based on CRT inputs by the Experimenter at ATSOCC. This information is received and acknowledged at the Rosman station via the D3F Decoder and Encoder respectively. Status information is relayed to ATSOCC via the D3F Encoder at Rosman.

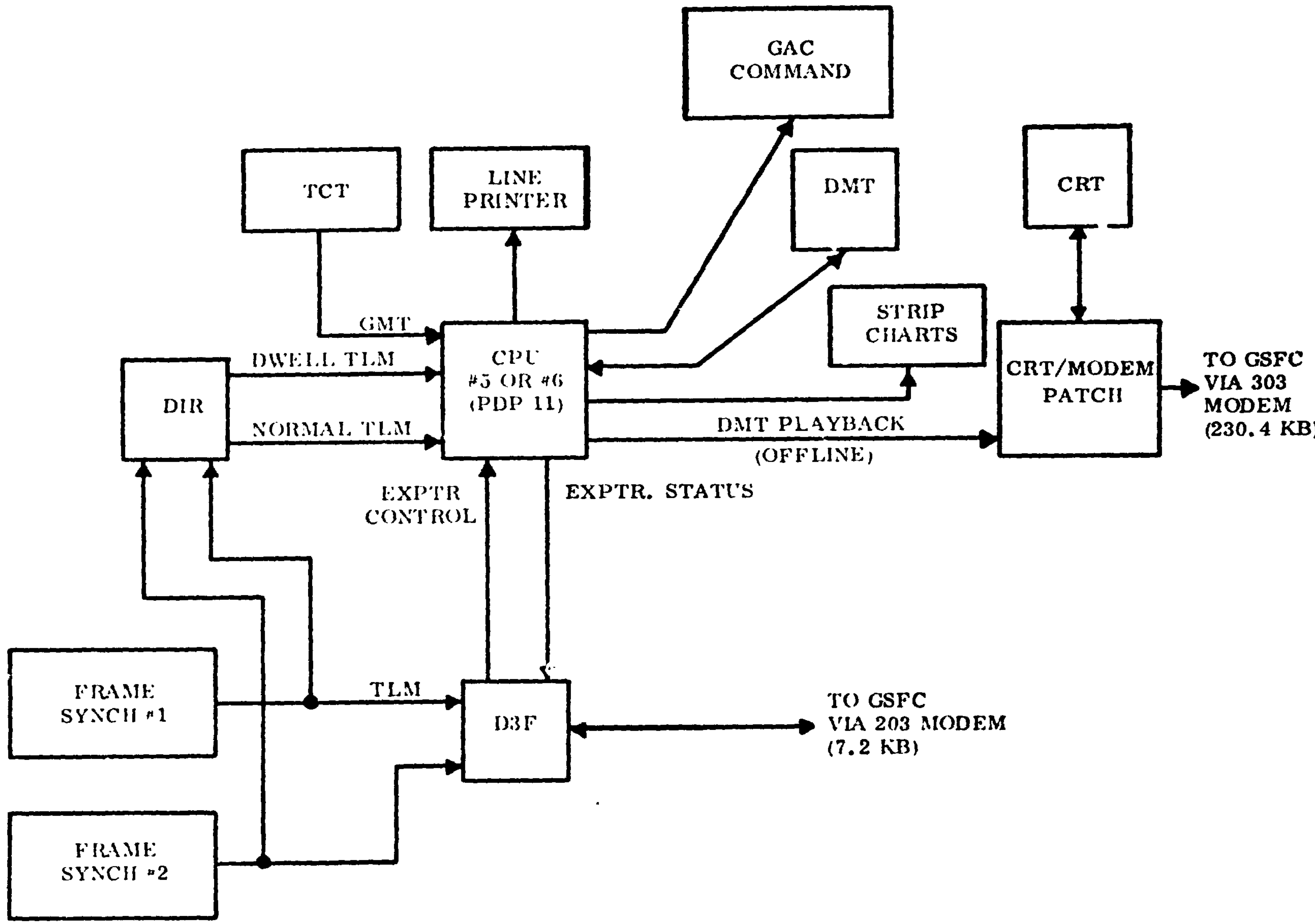


Figure 1.17. SAPPSAC Experiment ADP - Rosman

- **Integrated L-Band Experiment**

The block diagram shown in Figure 1.18 depicts the ground station hardware that is utilized by the L-Band Experiment. A mechanical switch in the DIR provides access to a DR11A in either of the two computers by equipment in the PLACE (Position Location and Aircraft Communications Experiment) Rack. PLACE is the only portion of the L-Band Experiment that currently makes use of the ADP Equipment. The software calculates position of a target aircraft or ship by utilizing ranging from two satellites - ATS-5 and 6. Tri-lateration data on ATS-5 is received via TTY in punched paper tape form from a General Electric Facility in Schenectady, N. Y. and is entered into the computer via the Paper Tape Reader. ATS-6 position data is received from NASA/GSFC via the DMT and entered into the computer. ATS-6 Tri lateration is also computed based on the L-Band Ranging inputs, and recorded on punched paper tape. The target and satellite position information is recorded on the DMT. The punched paper tape is transmitted hourly to the various experiment participants while the DMT is mailed to NASA/GSFC for off line analysis.

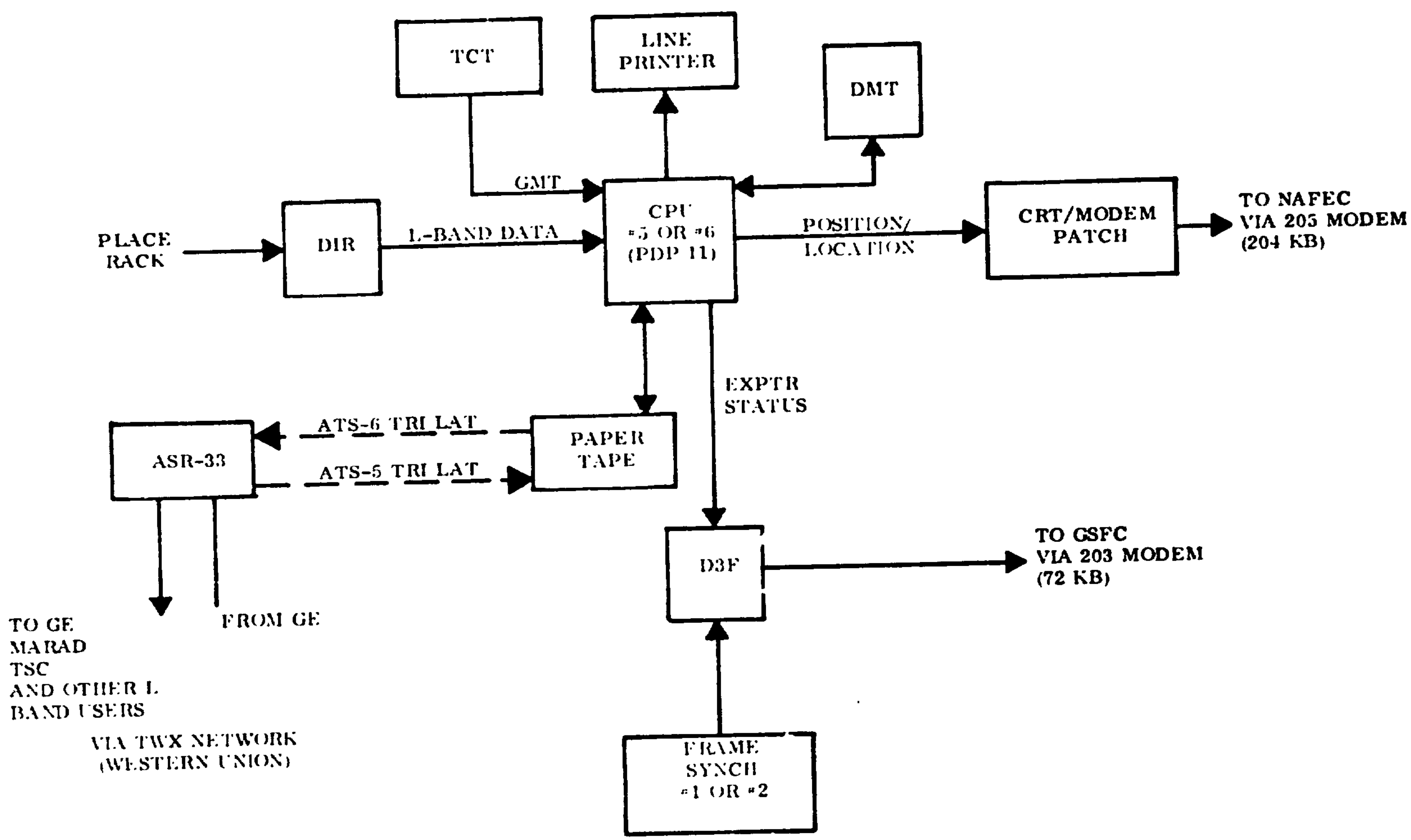


Figure 1.18. L-Band (PLACE) Experiment ADP - Rosman

- **GSFC Millimeter Wave Experiment**

The block diagram shown in Figure 1.19 depicts those parts of computer systems #5 & #6 that are used by the MMW Experiment. The bulk of the computations are performed on a separate computer. ATS Normal Telemetry is provided to the MMW Computer via an interface switchable in the DIR between Frame Synchs #1 and #2. This data is utilized by the MMW software to calculate ATS Transmit Power and calibrate the MMW signals received on the ground. The resultant data recorded on the DMT may be transmitted to NASA/GSFC using the Wideband Data Link and Computer #5 or #6.

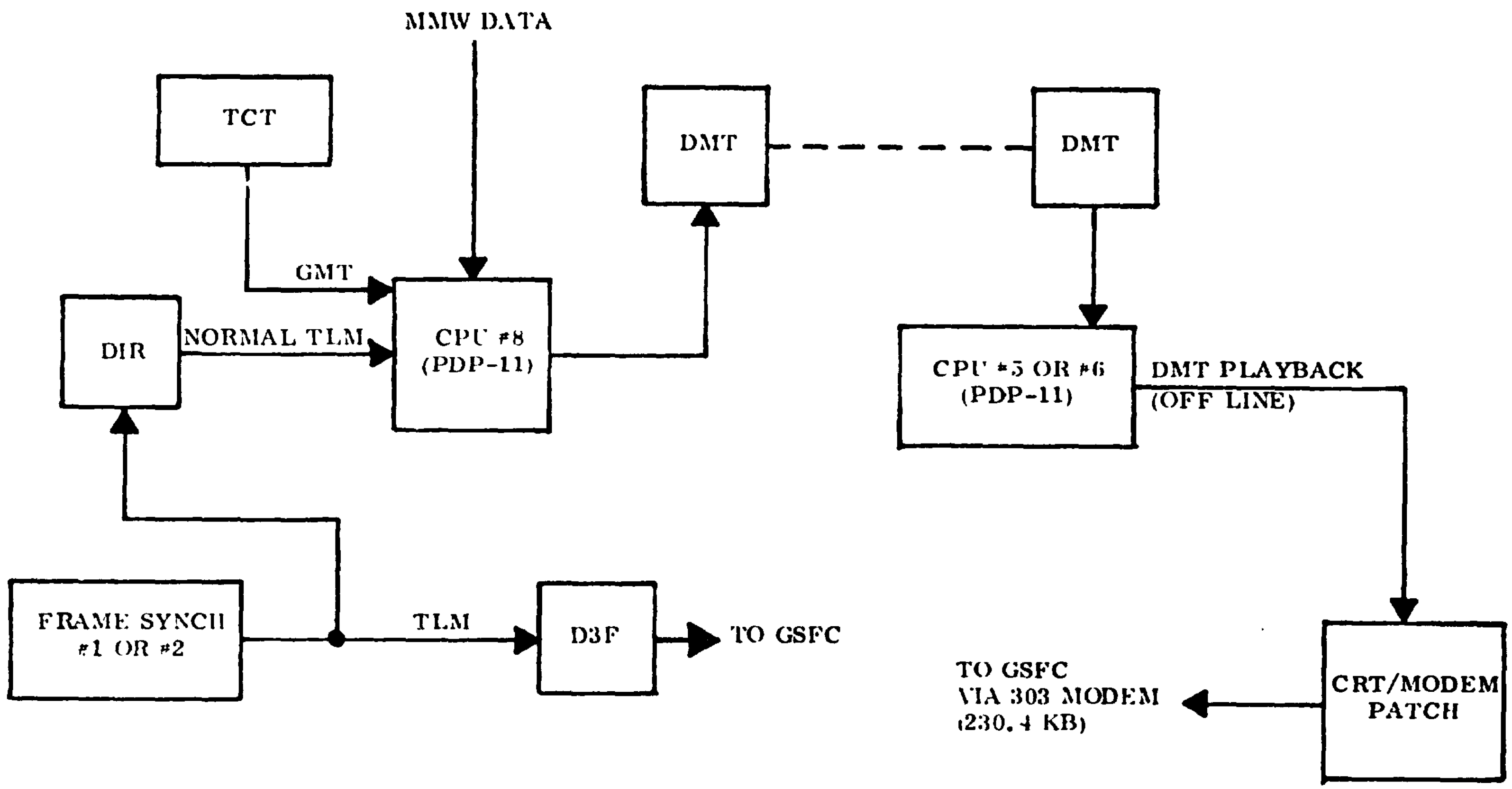


Figure 1.19. Millimeter Wave (MMW) Experiment ADP - Rosman

- **Interferometer Experiment**

The block diagram shown in Figure 1.20 identifies the capability of transmitting previously recorded DMT data to NASA/GSFC via the Wideband data link and Computer #5 or #6. Performance of the interferometer experiment is determined via off line analysis of the DMT at NASA/GSFC.

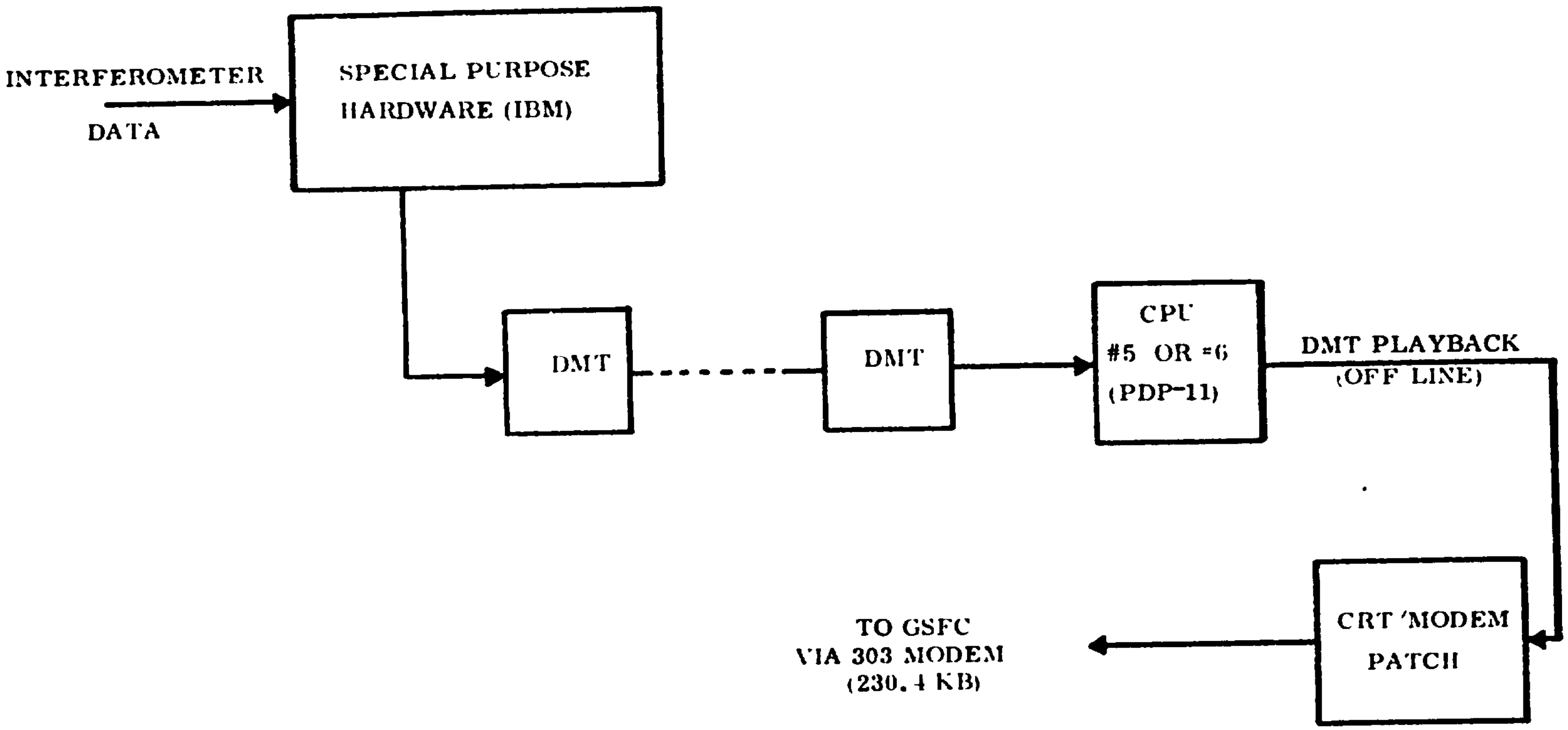


Figure 1.20. Interferometer ADP - Rosman

- **EME**

The block diagram shown in Figure 1.21 identifies the interfacing of Frame Synch #3 (EME) to a DR11B in Computer 5 and a DR11B in Computer 6 via the DIR. The EME data is made input at a rate of 113 words per frame (1 sec). No software is presently available at the Ground Stations to process this data. All processing of EME data is performed at NASA/GSFC (IPD and ATSOCC).

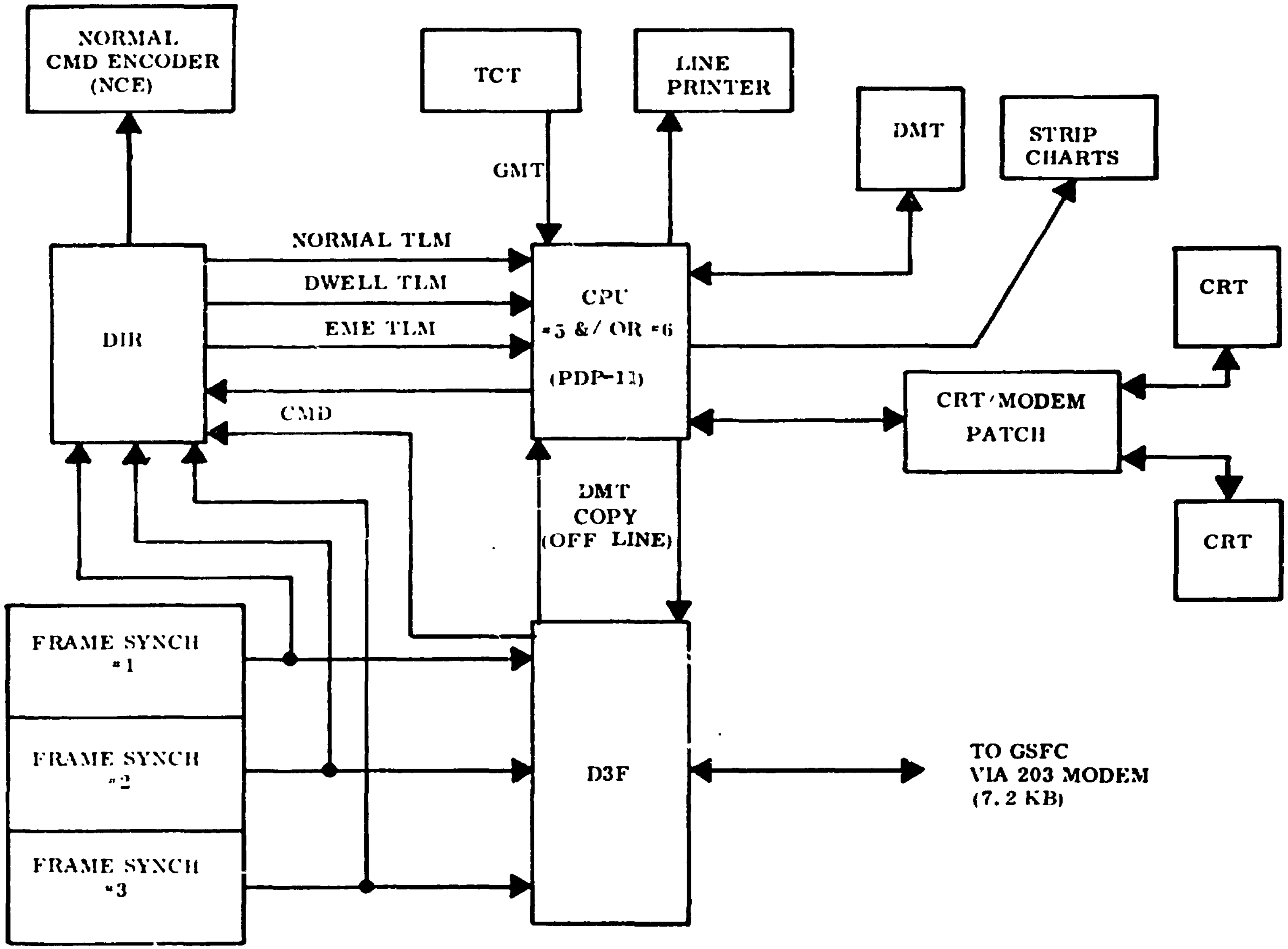


Figure 1.21. Rosman Spacecraft and EME Operations ADP

- **Rosman Spacecraft Operations**

The block diagram shown in Figure 1.21 identifies the hardware used at the Rosman station to provide a monitor of spacecraft operations as a supplement to ATSOCC, or the monitor and control of ATS-6 as a backup to ATSOCC. Normal and Dwell Telemetry is entered into the computer(s) via interfacing in the DIR. Normal and Dwell Telemetry consists of 128 words each per 3 seconds is utilized. This data is converted to engineering units via various calculations (the most complex being ATS-6 pointing) and displayed on Strip Charts and CRT Terminals. The Line Printer is utilized to provide hard copy of errors, commands and other events. The displays desired on the Strip charts and CRTs are selectable on an individual or page basis. Commands are sent to the NCE from either of two computers via a Unibus Switch. A DR11A and a solid state switch in the DIR selects either CPU (local) or D3F (Remote) commands for the NCE.

A DMT is generated that records all data and events for future use as required. DMT transfer of this history tape to NASA/GSFC may be performed off line via a DR11B, an interface in the DIR, and the D3F. DMT containing experiment data (previously described), ephemeris tapes, new programs, etc. may be transferred to or from ATSOCC.

Transmission of telemetry data to ATSOCC is independent of the computer operations. The capability to command ATS-6 from ATSOCC is provided via logic in the DIR. This logic will accept data from a D3F Decoder Channel if the D3F/CPU switch is in the D3F position. The logic examines the first data word which is 1200 octal (indicating a command will follow) and stores the second and third data words which is the command. If the Polynomial Error bit in the trailer words of the D3F block is zero (indicating no data bit errors) and the NCE is ready; the two word command is sequentially transferred to the NCE where it is prepared for transfer to the spacecraft.

1.5.2 MOJAVE GROUND STATION ADP

The Mojave ADP is similar to the Rosman Station equipment but has been reduced in scope. Specifically, the VHRR and SAPPSAC experiments are the only ones to be supported. The Spacecraft ADP Operational Requirements constitute secondary backup to ATSOCC.

This station has only one computer (therefore experimenter switching or CRT/Modem patch is not required) and will be used from post launch, to launch +7 months at which time it would be shipped to Spain with the Hybrid Terminal. Therefore, it's operational span will be from the end of July until the end of Dec. 19, 1974. However, the basic Command telemetry and data communications is available during the entire life of the S/C over the USA. The block diagrams shown in Figure 1.22 (VHRR), Figure 1.23 (SAPPSAC) and Figure 1.24 identify the ADP subsystem as implemented at the Mojave Station (S/C Operations) and Block Diagram for the Mojave Configurations, Figure 1.25.

1.5.3 HYBRID GROUND STATION ADP

The Hybrid ADP was designed for implementation in the Madrid Station using CPU #7, GAC Encoder, Strip Chart Recorders and Time Code equipment from the Mojave station and the CPU #6 and Time Code equipment from the Rosman station. This was considered the most cost effective and safe approach since it would make use of proven computers and other key equipments. Implementation and check out of all of the other interfaces is being conducted while the Hybrid terminal is at the Mojave Station.

The planned operation date at Madrid Spain for part of the system is 5/1/75 (less CPU #6 and Ros Time Code Equipment) and 6/1/75 for the full system.

The full system is identical to the Rosman system with the exception that the VHRR and SAPPSAC are the only experiments presently contemplated to be supported, thus reducing the experimenter switching requirement. There is no wide band (230.4 KB) data line available to NASA/GSFC, eliminating the requirement for transfer of Digital Mag Tapes via the CRT/Modem patch.

The block diagrams shown in Figures 1.22, 1.23, 1.24 and 1.26 identify the configuration for the Hybrid Terminal ADP as well as depicting the Mojave configuration with the (*) showing additional equipment that will be used by the Hybrid Terminal.

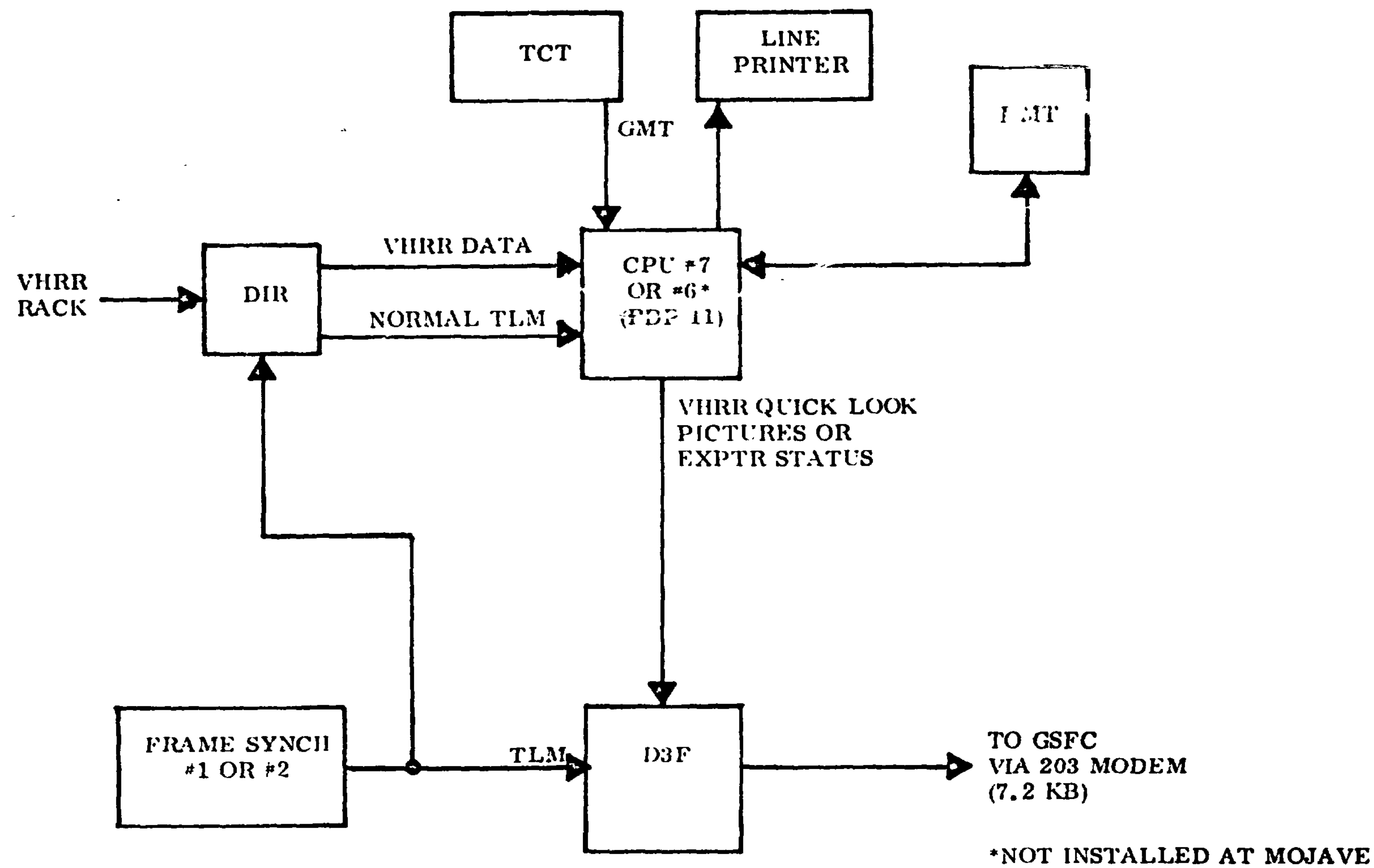


Figure 1.22. VHRR Experiment ADP - Mojave or Hybrid

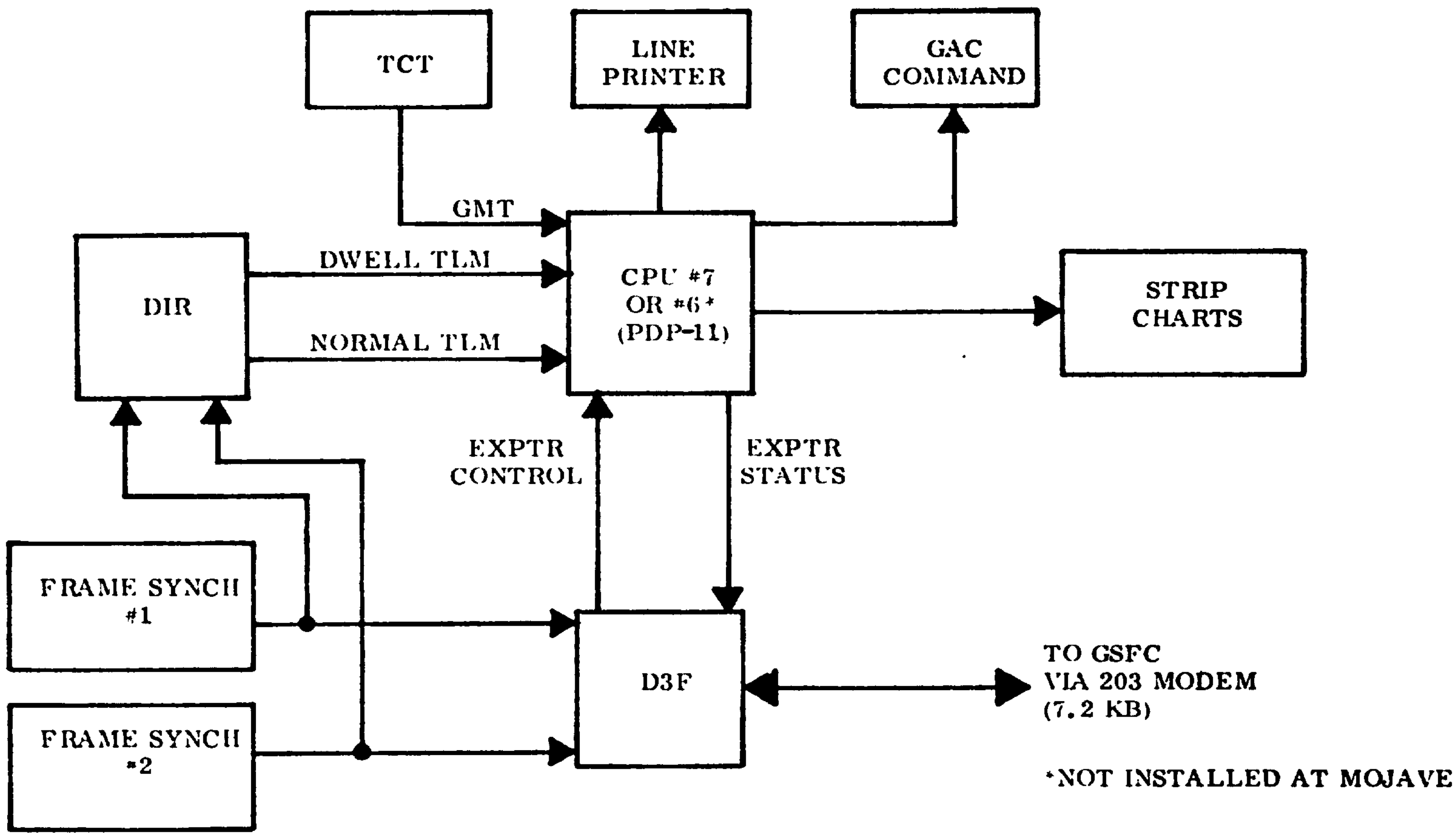


Figure 1.23. SAPPSAC Experiment ADP - Mojave or Hybrid

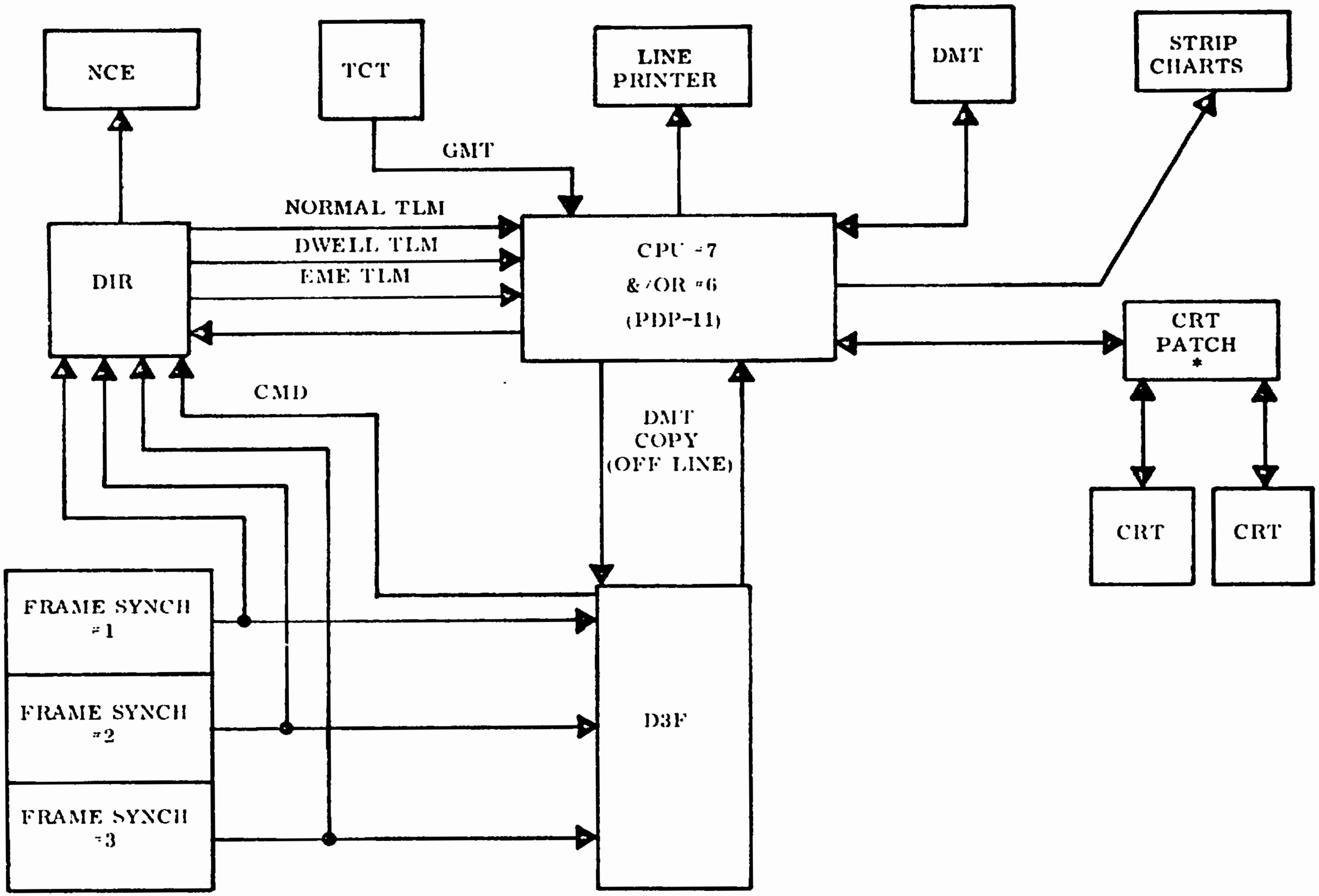
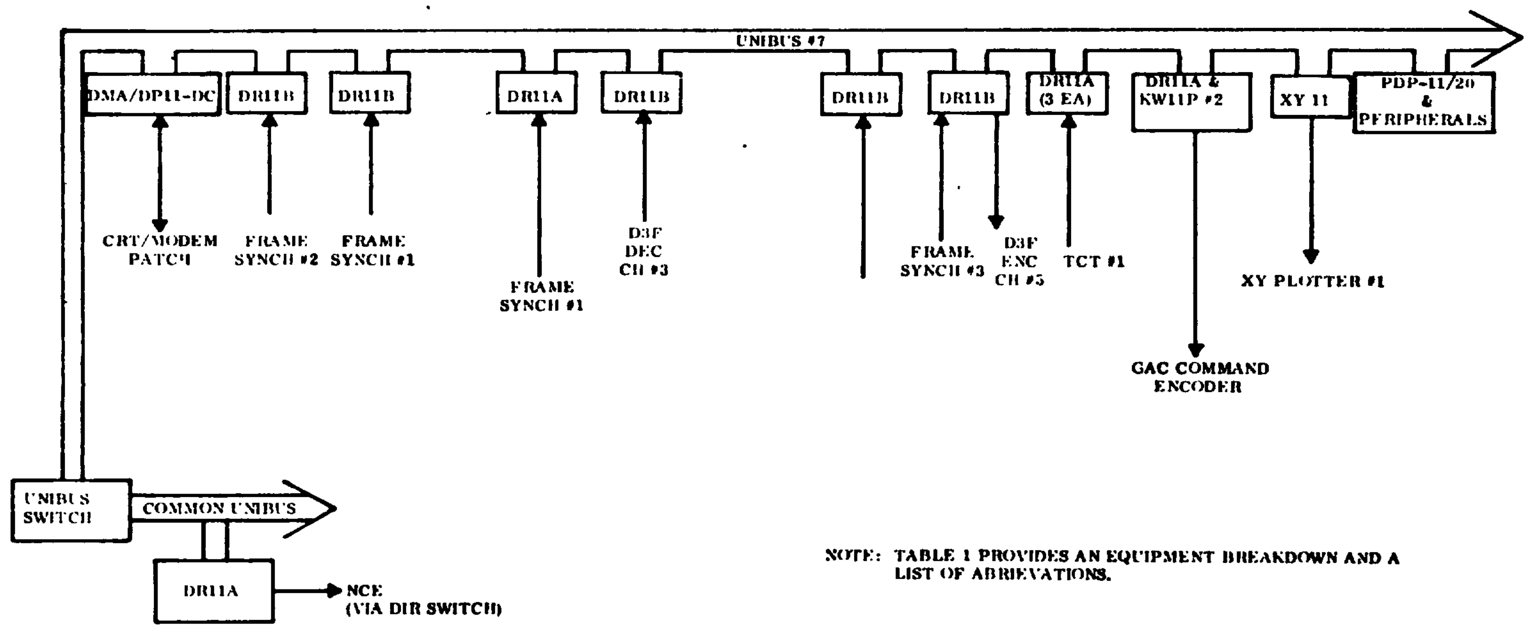
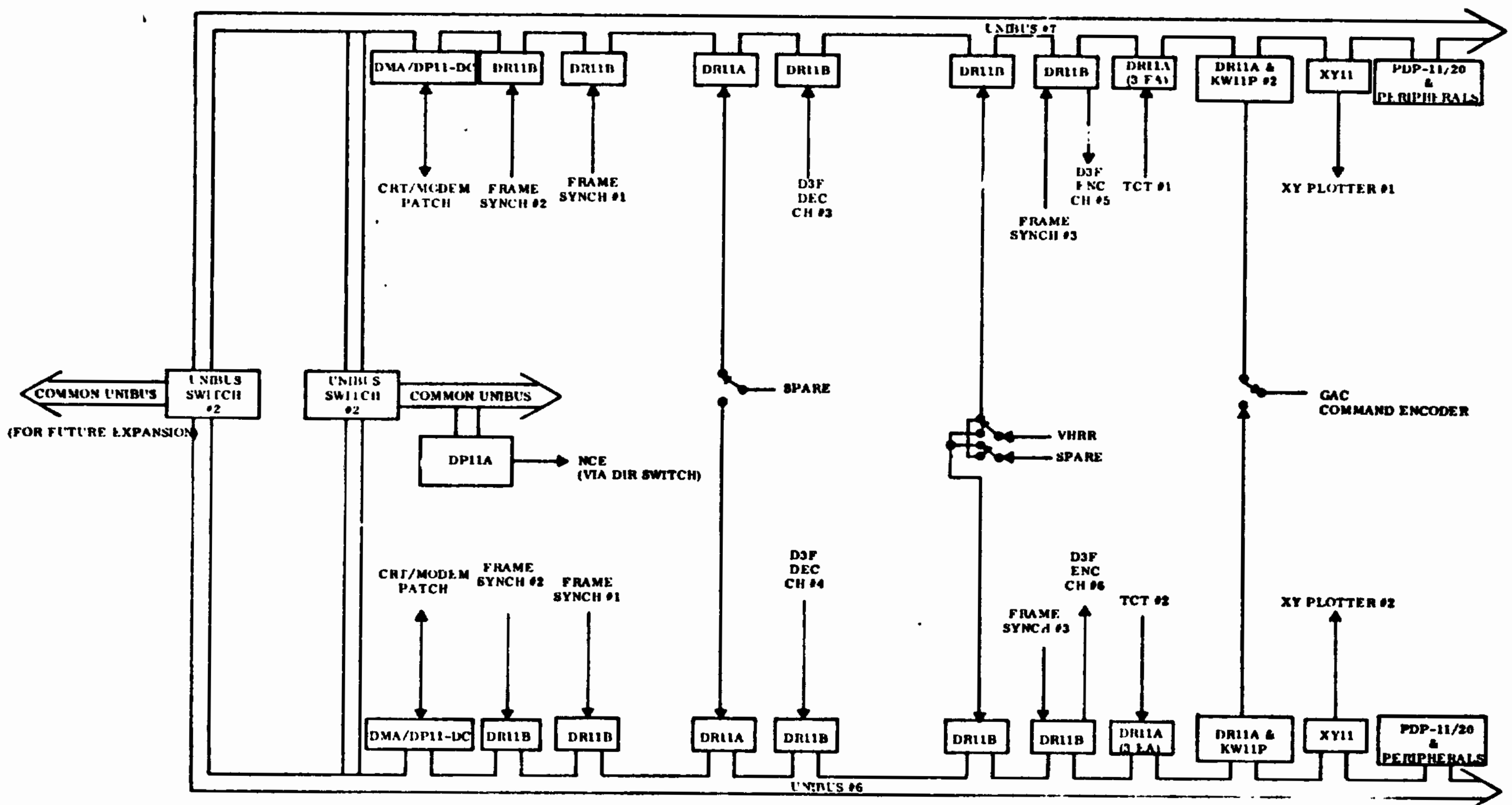


Figure 1.24. Mojave or Hybrid Spacecraft Operations ADP



NOTE: TABLE 1 PROVIDES AN EQUIPMENT BREAKDOWN AND A LIST OF ABRIEVATIONS.

Figure 1.25. Mojave PDP 11/20 Configuration



NOTE: TABLE I PROVIDES AN EQUIPMENT BREAKDOWN AND A LIST OF ABRIEVATIONS.

Figure 1.26. Hybrid PDP 11/20 Configuration

1.6 GSI TEST DATA REPORT

The results of the GSI field test activities have been documented in the GSI Test Data Report. This report consists of seven (7) volumes that deal with the various aspects of the Westinghouse integration and test activities. The following identifies the content of the various volumes that comprise the GSI Test Data Report.

1.6.1 VOLUME I - ATS-F TEST DATA REPORT

Test Data Analysis
Test Data Summary

This volume of the GSI Test Data Report is divided into three (3) parts. Section 1 contains a summary and analysis of the test data results obtained during the integration and checkout testing of the Rosman and Mojave sites. Recommendations for corrective action to be taken or precautions to be observed are also given in this section.

Section 2 of this volume contains the tabulation of the accumulated test data in summary form. This method of data presentation affords quick and easy access to the integration test results without the necessity of examining the large quantity of detailed data acquired in order to find the desired test parameter. The data summary sheets show the suggested or specified limits for each measured parameter as well as the actual results obtained in each test. Other volumes of this report contain the individual test procedures and data obtained from each test at each ground station. These latter documents are expected to be of more interest and use to the site operational personnel because of the details and voluminous data contained. This is especially true for those tests including a photographic record of wave forms encountered.

Section 3 contains the letters, documents and reports generated during the integration program covering problem areas and equipment short comings uncovered. These documents also contain the GSI contractor's suggestions for corrective action to be taken to minimize degrading impact on the ATS-F program. These documents are included in this volume of the Test Data Report because numerous references are made to them in the data analysis portion of the report (Section 1).

It will be noted that the data summaries and analysis do not include that of the Hybrid Station. This is because of the delays encountered in the implementation and modification of this equipment. As directed by Goddard, the GSI Contractor is supplying the test plan and data under separate cover rather than holding this Test Data Report to accumulate and analyze the Hybrid data. In addition, there will be no separate analysis and discussion of the test results for this equipment.

The test data package for the Automatic Data Processing (ADP) subsystem is also found under a separate cover. Since this equipment operates in a "Go/No-Go" environment, there is no quantitative data measurement to be recorded and presented in this Test Data Report. The "Acceptance Test Plan" for this equipment has been published and forwarded to Goddard under separate cover. It is identified by the above title under Contract NAS 5-21548, Task VII Mod. 6, Article III Item 12e, dated 21 February 1974.

Finally, this document will be seen to contain no mention or test results for the T&C subsystem. This subsystem was not a part of the GSI Contractor's responsibility for refurbishment or modification for the ATS-F program. Certain minor interface requirements (such as supplying timing signals) were the limit of responsibility under the integration contract.

1.6.2 VOLUME II - ROSMAN SUBSYSTEM TEST PROCEDURE AND SUBSYSTEM TEST DATA SHEETS

This volume of the GSI Test Data Report is divided into three (3) books because of the large amount of data that has been presented. It consists of the tests, test procedures and test data recorded at the Rosman Station during the evaluation phase of the subsystems that were integrated to form the ATS-F ground station systems. These tests were performed in order to examine the performance of the modulators, demodulators, C/S/L-band transmitters, C/S/L-band receivers and antennas at the Rosman Station. Each subsystem was tested independently of other subsystems, using its own performance monitor or test equipment. The tests performed were directed towards establishing the performance of the subsystem in terms of classical communications test parameters.

The tests performed were in accordance with those procedures submitted as part of the ATS-F Ground Station Integration and Acceptance Test Plan. The Test Data contained herein are those which were recorded on station using the Test Data Sheets provided to performing these tests. These deviations from the original plan are shown as they were conceived and performed, with data and explanation provided. The GSI considers this documentation to be of more value to the technically oriented community.

Subsystem testing began at the Rosman Station when a subsystem was accepted by NASA/GSFC, and made available to the GSI. Due to the delivery schedule of the various subsystems, testing was not necessarily performed in the sequence as listed. It must be noted that the "expected results" given in these data sheets were based on original equipment specifications or on CCIR recommendations, when no applicable specification value was available. The test results provided reflect the as-built equipment performance.

1.6.3 VOLUME III - ROSMAN SYSTEM TEST PROCEDURES AND SYSTEM TEST DATA SHEETS

This volume describes the tests that were performed, test procedures that were utilized and the test data recorded at the Rosman Station during the evaluation phase of the ground terminal system as integrated by Westinghouse. These tests were performed as an extension of the subsystem tests, using RF Translator to connect transmitters to receivers. The Translator was located in the collimation tower, except in the case of the C-band system which also has an antenna mounted translator. Tests were performed at C-band, S-band and L-band employing classical communications tests.

The tests performed were in accordance with those procedures submitted as part of the ATS-F Ground Station Integration and Acceptance Test Plan. The Test Data contained herein are those which were recorded on station using the Test Data Sheets provided to perform these tests. Those deviations from the original plan are shown as they were conceived and performed, with data and explanation provided.

System testing was conducted at Rosman subsequent to completion of subsystem tests on both a transmitter and receiver for a frequency band. Due to the delivery schedule of the various subsystems, system testing was not necessarily performed in the sequence as listed. It must be noted that the "expected results" given in the data sheets were based on original equipment specifications on on CCIR recommendations, when no applicable specification value was available. The test results provided reflect the as-built equipment performance.

1.6.4 VOLUME IV - ROSMAN NETWORK TEST PROCEDURES AND NETWORK TEST DATA SHEETS

This volume describes the tests that were performed, test procedures that were utilized and test data recorded at the Rosman Station during the evaluation phase of the ground terminal network as integrated by Westinghouse. The Network Tests supplement the subsystem and system tests, which were general, and provided baseline data for any potential user of the communications systems. The Network Tests were intended to verify the communications links for the specific ATS-F experiments.

The tests performed were in accordance with those procedures submitted as part of the ATS-F Ground Station Integration and Acceptance Test Plan. The test data contained herein is that which was recorded on station using the Test Data Sheets provided to perform these tests. These deviations from the original plan are shown as they were conceived and performed, with data and explanation provided.

Performance of these tests indicated the readiness of the ground station communications equipments to support the planned experimentation for the ATS-F program, and provided baseline data on the ground station performance for the experimenters. The communications system was set-up as required to support each experimenter, and tests were performed to determine the parameter of interest for that particular experimenter. The test results provide reflect the as-built equipment performance.

1.6.5 VOLUME V - MOJAVE SUBSYSTEM TEST PROCEDURES AND SUBSYSTEM TEST DATA SHEETS

This volume of the GSI Test Data Report is divided into three (3) books because of the large amount of data that has been presented. It consists of the test that were performed, test procedure descriptions and the test data recorded at the Mojave Station during the evaluation phase of the subsystems that were integrated to form the ATS ground station system. These tests were performed in order to examine the performance of the modulators, demodulators, C/S/L-band Transmitters, C/S/L-band receivers and antennas at the Mojave Station. Each subsystem was tested independently of other subsystems, using its own performance monitor or test equipment. The tests performed were directed towards establishing the performance of the subsystem in terms of classical communications test parameters.

The tests performed were in accordance with those procedures submitted as part of the ATS-F Ground Station Integration and Acceptance Test Plan. The Test Data contained herein are those which were recorded on station using the Test Data Sheets provided to perform these tests. Those deviations from the original plan are shown as they were conceived and performed, with data and explanation provided. The GSI considers this documentation to be of more value to the technically oriented community.

Subsystem testing began at the Mojave Station when a subsystem was accepted by NASA/GSFC, and made available to the GSI. Due to the delivery schedule of the various subsystems, testing was not necessarily performed in the sequence as listed. It must be noted that the "expected results" given in these data sheets were based on original equipment specification value was available. The test results provided reflect the as-built equipment performance.

1.6.6 VOLUME VI - MOJAVE SYSTEM TEST PROCEDURES AND SYSTEM TEST DATA SHEETS

This volume describes the tests that were performed, test data recorded at the Mojave Stations during the evaluation phase of the ground terminal system as integrated by Westinghouse. These tests were performed as an extension of the subsystem tests, using RF Translator to connect transmitters to receivers. The translator was located in the collimation tower, except in the case of the C-band system which also has an antenna mounted translator. Tests were performed at C-band, S-band and L-band employing classical communications tests.

The tests performed were in accordance with those procedures submitted as part of the ATS-F Ground Station Integration and Acceptance Test Plan. The test data contained herein are those which were recorded on station using the Test Data Sheets provided to perform these tests. These deviations from the original plan are shown as they were conceived and performed, with data and explanation provided.

System testing was conducted at Mojave subsequent to completion of subsystem tests on both a transmitter and receiver for a frequency band. Due to the delivery schedule of the various subsystems, system testing was not necessarily performed in the sequence as listed. It must be noted that the "expected results" given in the data sheets were based on original equipment specifications or on CCIR recommendations, when no applicable specification value was available. The test results provided reflect the as-built equipment performance.

1.6.7 VOLUME VII - MOJAVE NETWORK TEST PROCEDURES AND NETWORK TEST DATA SHEETS

This volume describes the tests that were performed, test procedures that were utilized and test data recorded at the Mojave Station during the evaluation phase of the ground terminal network as integrated by Westinghouse. The Network tests supplement the subsystem and system tests, which were general, and provided baseline data for any potential user of the communications systems. The Network tests were intended to verify the communications links for the specific ATS-F experiments.

The tests performed were in accordance with those procedures submitted as part of the ATS-F Ground Station Integration and Acceptance Test Plan. The test data contained herein is that which was recorded on station using the Test Data Sheets provided to perform these tests. These deviations from the original plan are shown as they were conceived and performed, with data and explanation provided.

Performance of these tests indicated the readiness of the ground station communications equipments to support the planned experimentation for the ATS-F program, and provided baseline data on the ground station performance for the experimenters. The communications system was set-up as required to support each experimenter, and tests were performed to determine the parameters of interest for that particular experiment. The test results provide reflect the as-built equipment performance.

SECTION 2 - FINAL REPORT

ATS-F (6) GROUND TERMINAL PROGRAM TASK DESCRIPTIONS

2.0 INTRODUCTION

This section of the Final Report is intended to provide the reader with a description of each program task, and a summary of the activities performed. The basic contract, and subsequent modifications, divided the GSI work effort into twelve (12) separate tasks. These efforts were accomplished at the Rosman II Ground Station, located near Rosman N. C., the Mojave Ground Station, located near Barstow Ca., and the GSI Contractors plant located near Baltimore, Md. In all, three terminals were involved which included the fixed stations at Rosman and Mojave, and a Hybrid Terminal, also located at Mojave. This Hybrid Terminal was formed from portions of the Transportable Ground Station, which was located at Mojave, and a Mobile Terminal, initially shipped to Rosman, tested, then reshipped to Mojave, where they were integrated into a Hybrid Terminal.

2.1 SYSTEM ANALYSIS AND DEFINITION OF INTERFACES (TASK I)

The objective of the Task I effort, which was started in November 1970, was to define the capabilities of the three ATS Ground Stations as they would be configured after the planned modifications. It was intended that the study and planning effort show the compatibility of the modified stations with respect to the requirements of the planned experiments. As the study progressed, it became evident that it was too early to specifically define the requirements of the experiments. As a result, the Task I effort was redirected to show the planned capabilities of the stations, and the degree to which they supported the experiments as was known and projected at the time. This study result would then form a basis for the experimenters to plan their equipment specifications.

An expected result of the Task I study was the disclosure of potential problem and deficiency areas. The purpose of which was to bring out problems in time for resolution. Each problem or deficiency was discussed in detail and a recommended course of action given. Ten such areas were found, and reported upon.

Some of these deficiencies related to lack of information on the experimenters' equipments, which in turn was due to the preliminary stage of the experimenters' specifications and designs. The timely disclosures in the report, made the experimenters aware of requirements, and permitted them to coordinate their designs.

A few examples of some deficient areas reported upon are:

1) MMW experiment downlink signal level & IF level.

2) Duplicate instrumentation required for certain simultaneous measurements.

3) Digital Modem capabilities and modulation characteristics.

4) Method of incorporating spacecraft data into experimenters data.

The marginal received signal level of the MMW experiment appeared to be the only deficiency area wholly outside the GSI responsibility. The other deficiencies, as can be found in the tabulation, were resolved by coordination between the GSFC Project Office, the Experimenters, and the GSI.

Another significant deficiency disclosed, was the need for expansion of the patching facilities and also the resolution of the question of IF switching versus IF patching. This disclosure lead to expansion of the patching facilities in the Baseband (1A6), receiver (6A1) and transmitter (81A3) racks. Other deficiencies and recommendations noted related to remote ON-OFF switching at the collimation towers (especially Rosman) and to the arguments for and against retention of the v-f multiplex units.

As a result, several technical meetings were held with NASA-ATS representatives to discuss and act on the recommendations provided in the report. The discussions resulted in a mutual understanding of the problems, and the GSI was directed to take the lead in their solutions, following the guidelines mutually developed.

An additional objective was to define the subsystem interfaces for the benefit of both the experimenters and the GSI Task IV effort which would follow Task I in time sequence. Most of the engineering team that developed the Task I report continued into the Task IV engineering effort.

The preliminary copy of the Task I report "System Analysis and Definition of Interfaces" was submitted in two volumes, plus a packet of drawings on

25 January 1971. The first volume contained the discussion body of the report. The subsystem and equipment lists, Interface Definition sheets and Experiment Description sheets were contained in the second volume. The drawing packet contained the flow diagrams for the then contemplated four ground stations, their antenna subsystems and the Network Flow diagrams for each experiment.

The Task I Report draft was updated several times to reflect newly acquired information, and was submitted in "final" form on 31 March 1971. Preparation of the Final Report for Task I was withheld until such time as the Experiment requirements could develop more clearly, and until a very important document - the Experiment GSSR's were received. Interface engineering was required to proceed even though the above information was still not available. Eventually, the need for the Task I Final Report diminished to the point where it was mutually agreed by the GSI and GSFC that it would no longer serve a real purpose. The Task I final report was deleted as a contractually deliverable item, by contract modification No. 8 dated 6 July 1972.

REFERENCES:

- Report, Task I - System Analysis & Definition of Interfaces, 25 January 1971
- Volume I (Study, Analysis, Recommendations)
- Volume II (Subsystem Interfaces, Experiment Descriptions)
- Report, 1st Quarterly - 25 Nov. 1970 to 28 Feb. 1971
- Report, 2nd Quarterly - 01 Mar. 1971 to 30 May 1971
- Report, 3rd Quarterly - 01 Jun. 1971 to 30 Aug. 1971
- Report, 4th Quarterly - 01 Sept. 1971 to 30 Nov. 1971
- Report, 5th Quarterly - 01 Dec. 1971 to 29 Feb. 1972

SUBSYSTEM INTERFACE DRAWINGS

- Ⓦ Dwg SK 610J641 Rosman Station Instrumentation Room
- Ⓦ Dwg SK 610J946 Rosman L-S-C Antenna Configuration
- Ⓦ Dwg SK 608J383 Mojave Station Instrumentation Room
- Ⓦ Dwg SK 610J947 Mojave L-S-C Antenna Configuration
- Ⓦ Dwg SK 610J945 TGS Station Instrumentation Room
- Ⓦ Dwg SK 610J944 TGS L-S-C Antenna Configuration
- Ⓦ Dwg SK 610J943 ATS Mobile Terminal

EXPERIMENT FLOW DIAGRAMS

- Ⓦ Dwg SK 344D517 SAPPSAC Network
- Ⓦ Dwg SK 344D518 PLACE Network
- Ⓦ Dwg SK 344D519 TTV Network
- Ⓦ Dwg SK 344D520 Trust Network
- Ⓦ Dwg SK 344D521 DRE Network
- Ⓦ Dwg SK 344D522 VHRR Network
- Ⓦ Dwg SK 344D523 RFI Network
- Ⓦ Dwg SK 344D524 MMW Network
- Ⓦ Dwg SK 344D525 EME Network

2.2 LIAISON AND TECHNICAL SUPPORT (TASK II)

The objective of the Task II effort encomposed four major areas:

a) Provide Technical Liaison services for the Technical Officer (T. O.) with the ATS-F experiment coordinator, in support of the ATS-F Ground Station Modification Program.

b) Review modification contractors acceptance Test Plans and notify the T. O. of any program incompatibilities with the ATS-F Mission. All technical data, drawings spec's., etc were to be provided to the GSI by the T. O.

c) In the event that changes were required to the GFE, the GSI was required to prepare specifications which would adequately describe the required modifications.

d) During In-Plant Acceptance Testing of the GFE subsystems, the GSI was required to provide engineering personnel to observe the various activities.

Engineering effort on this task commenced at Contract date, with GSI attendance at the Mobile Station Design Review meeting held at NASA/GSFC on 23 November 1970. Follow up comments and recommendations were provided to the T. O., as appropriate. Technical Liaison services were provided on a continuing basis throughout the program, and a smooth flow of information was established between the T. O. and the GSI. Review, comments and recommendations of design specs., Design Review meetings, drawings, test apecs, Acceptance Test Plans and Acceptance Test witnessing was provided as applicable. As the program progressed, Design Reviews were held at the various vendors plants, and the GSI provided system engineering personnel in attendance as Technical support to the T. O., or experiment coordinator as required. These meetings were followed by Comments, Trip Reports, and Technical Memo's which were submitted to the T. O.

As the result of a series of Experimenter Review Meetings, the GSI was able to gather a sufficient amount of information to prepare Part I of the GSI originated "Station Interface Specifications" in June of 1971. A second series of meetings was then scheduled in order to obtain information for Part II of the Interface Specification.

In July 1971, the GSI provided engineers at both Martin Marietta in Florida, and at Hughes in California to witness the Final In-House Acceptance Testing on the C, S/L Transmitter, and the Mobile Terminal. Trip reports were submitted to the T.O. to document activities, and the observed test results.

Interface coordination meetings were initiated with the GSFC Principal Investigators for the TRUST, Millimeter Wave, and the T&DRE experiments in September 1971. The purpose was to obtain information for use in completing Part II of the Interface Specifications. It was agreed, that these meetings would continue in October 1971, with the Principal Investigators, and contractors for the PLACE, RFI and VHRR experiments. It was expected, that sufficient information would be gained to allow the interface specifications to be prepared and submitted to GSFC for review, at the conclusion of these meetings. In October, the coordination meetings completed, sufficient information was available to prepare a preliminary working draft of the six experiments. These were submitted for review in November.

In-Plant Acceptance Testing at MMC Orlando, Florida, of the L/S/C transmitters, Unit No. 2, was witnessed by a GSI system engineer from 8/31/71 through 9/11/71. A complete report was prepared, and submitted to the T.O., covering these activities. In-Plant Acceptance Testing of Unit No. 3 was accomplished at MCC, Orlando, Florida on 11/15/71 through 11/22/71. A complete report was submitted to the T.O. as required.

Effort under this task was suspended in March 1972, due to lack of experimenter information, contractors delivery problems, and, that a major part of the effort under this task was completed. The task became active again in February 1973, when test data received from Rosman and Mojave indicated a need to analyze the results of certain tests to determine whether an equipment problem existed, and work to a solution of any problem uncovered. The T.O. was kept informed of this investigation by the submission of periodic reports.

Starting in June 1973, the efforts provided under this task were complementary to Task VI, in the respect that technical support and analysis was being provided to the sites in the interest of solving equipment problems. Also started at this time, was the gathering and reviewing of documentation relevant to the preparation of preliminary Experiment Simulation Test Plans. The GSI gathered the necessary information as a result of meetings both at GSFC, and at various experimenters plants. Simulation test outlines were presented to GSFC in September, and go ahead on VHRR and MMW was authorized. Further meetings developed additional required information on the remaining experiments and work began as authorization was received. In October 1973, the GSI started delivery on the Draft Experiment Simulation Test Plans. This action completed the effort required under this task.

REFERENCES:

• GSI Ltr. ATSN-002 dtd. 12/3/70	Comments on L/S Band Acceptance Test Plans
• GSI Ltr. ATSN-003 dtd. 12/7/70	Comments and Recommendations for Fixed Station L/S Band, 15 ft. Ant. Responsibilities at Mojave
• GSI Ltr. ATSN-006 dtd. 1/6/71	Comments & Recommendations on L/S Band Xmtr. VSWR Spec. Change
• GSI Ltr. ATSN-007 dtd. 1/8/71	Contractor O&M Support Requirements
• GSI Ltr. ATSN-009 dtd. 1/15/71	Comments on ATS F&G Mobile Terminal Design Review Material, "Experimenters Interface Spec"
• GSI Ltr. ATSN-021 dtd. 3/15/71	Analysis of NASA Memo of 3/8/71 - "Use of Honeywell 316 Computer"
• GSI Ltr. ATSN-023 dtd. 3/23/71	Comments on EMC Characteristics of L/S Band Power Amplifier S/N 1209
• GSI Ltr. ATSN-024 dtd. 3/31/71	Comments on Acceptance Plan, Mobile Terminal Up & Down Converter, Mod. & Demod. & Grp. Del Equal
• GSI Ltr. ATSN-025 dtd. 4/1/71	ATS-F Timing Subsystem Recommendations
• GSI Ltr. ATSN-030 dtd. 4/26/71	Recommended Outline for Ground Station Experiment Interface Specs.
• GSI Ltr. ATSN-043 dtd. 6/4/71	ATS-F S-Band Footprint for Nimbus Orbit
• GSI Ltr. ATSN-044 dtd. 6/7/71	Analysis and Comments on Test Results, S-Band Xmtr. Phase and Amplitude Response

- GSI Ltr. ATSN-046 dtd. 6/9/71 — Interface Specifications for ATS Stations
- GSI Ltr. ATSN-047 dtd. 6/11/71 — C-Band Xmtr. Incidental FM, Study Report
- GSI Ltr. ATSN-048 dtd. 6/11/71 — Radio Beacon Experiment - Phase Verification, Study Report
- GSI Ltr. ATSN-062 dtd. 7/23/71 — Xmtr. O&M Manuals (6 Volumes), Comments on
- GSI Monthly Reports
- GSI Quarterly Reports
- GSI Trip Reports

The above listing is a representative sampling of the varied studies and reports. Complete lists are provided in Monthly and Quarterly Reports, when they were submitted.

2.3 SUBSYSTEM INTERFACE, CONFIGURATION, AND DISPLAY EQUIPMENT (TASK IV)

The objective of this task was to provide the materials, special equipments, drawings and installation information for the integration of the ATS-F communication subsystems, and experimenter subsystems at each of the ATS ground stations. Execution of the objective required the engineering to (a) reconfigure the physical layout of the equipments at the stations, (b) design the subsystem interfacing circuitry and cabling, and (c) determination of appropriate display equipments and their designs. Supporting these efforts was the selection of materials and interfacing equipments, their procurement (purchase or fabrication), preparation of drawings and the preparation of installation instructions for field use and modification of vendors manuals.

The principal Task IV effort was started on 25 January 1971 coincident with the release of the Task I study and interface report. The principal members of the engineering team that developed the Task I report, carried over into the Task IV engineering effort.

The first output of the Task IV effort was a detailed work plan which was presented to NASA on 11 February 1971. This plan was favorably received, and the specific work effort was started.

2.3.1 CONFIGURATION, INTERFACE AND DISPLAY PLANS

In accordance with the schedule, the first official release of the Task IV effort was the draft of the Configuration, Interface and Display Plan, submitted on 25 March 1971. This draft consisted of three sections, dealing with the three title topics. It was, by necessity, preliminary in nature due to the lack of specific vendor data and experimenter requirements (GSSR's).

The configuration section presented new floor plan layouts for the three stations. The then known new subsystem equipments were integrated with a minimum relocation of existing equipments. Surplus or superceded equipments, principally the G. E. multiplex and specialized test/patching racks were removed because there were no indicated future requirements, and because the floor space was needed for added experimenter and ADP equipments. This approach reflected an elaborate minimum rework and minimum cost effort.

The interface section was incomplete due to the lack of specific experimenter data, but defined in general terms the anticipated GSI approach.

The display section presented the Westinghouse philosophy for the Master Control Console (MCC) and the parameters to be displayed. This approach was taken because it was believed that the MCC layout and displays should be a matter of mutual agreement.

A review meeting between GSFC and Westinghouse was held on 31 March 1971. The problem of obtaining vendor and experimenter data within a required time schedule was recognized. The decision was made to treat the complete plan or document as three separate entities in accordance with their titular topics in order to obtain greater flexibility. The three sections would thus be re-issued as data became available, and timed to pace the field installation effort.

REFERENCES:

- CONFIGURATION, INTERFACE AND DISPLAY PLAN, for Rosman, Mojave and TGS., Draft: 25 March 1971

- Configuration Plans

At the review meeting of 31 March 1971, it was further agreed to regroup subsystem equipments into functional areas. The purpose of this decision was to concentrate, and thereby facilitate, like operations. In accordance with this decision, the floor plans were reworked to optimize the operations aspect.

One of the comments to the first Rosman configuration (March 1971) was that the new transmitter cabinets faced existing transmitter and receiver test equipment racks. This problem did not arise with the Mojave configuration. Sufficient space existed at the end of the transmitter row.

A further comment related to separation of the different experimenters. This resulted, also, from the effort to minimize relocation of existing racks. The desire was expressed by NASA to consolidate experimenter equipments as much as reasonably practical. Additionally, by this time, the requirements for an increased computer capability were developed to the point where its physical size could be approximated. The impact of this requirement had not been fully reflected in the previous configuration.

Accordingly, the Rosman and Mojave floor plan drawings were modified and resubmitted 14 July 1971. In the new Rosman configuration, the new frequency generation, modulation and control cabinets were aligned in one row together with baseband, receiver, test and control equipment racks. This was accomplished by extending the row and relocating the transmitter power supplies (2).

Later developments dictated removal of the FM transmitter. Further consolidation was accomplished by aligning the experimenter and recording equipments in two rows in the area previously occupied by the G. E. multiplex and video units. Space for the computer complex was realized by removal of the glass enclosure (visitors area) at the entrance to the operations room.

Further considerations showed the desirability of interchanging the MCC and computer complex. This redeployment provided improved visibility for the MCC operator and brought the computer closer to the experimenter group. By this time (7 Dec. 1971) there appeared to be a consensus and the basic configuration remained essentially as shown at this point. One anticipated addition was made later; namely, the MMW experiment. To accommodate these racks, it was necessary to remove the glass enclosures forming the two conference and general purpose rooms.

The Mojave floor plan layout also underwent several re-iterations. Because of fewer new cabinets, the changes were accomplished more readily. Space previously occupied by the v.f. multiplex cabinets, video, recorder and specialized test equipment racks was reserved for experimenter, computer and new recorder equipments.

Two important changes were made to the Mojave floor plan. For general improvement of operator supervision, the Master Control Console was rotated 90-degrees and translated slightly towards the East-West center-line of the room. The second change redeployed three CTEC racks, which formed the bottom of the CTEO "U" (or horseshoe) configuration, into alignment with the first three racks of the CTEC series. This change reduced congestion in the transmitter-receiver area and improved visibility of these equipments from the new MCC lo... ...n.

Final approval of the Rosman and Mojave floor plan drawings was received in February 1973 (CF 2197).

In reconfiguring the TGS station for the F&G program the space problem restrictions were increased by an order of magnitude. As a result, the floor plan layout underwent several revisions. The final layout was submitted to NASA on 15 November 1971 with the TGS Communications Interface Plan.

In essence, the floor plan submitted, grouped all basic communications equipments (Tx, Rx and Auxiliaries) in TGS Van 1. Vans 2 and 3 were reserved for experimenter and computer equipments with the exception of the R&RR subsystem which remained in its original location in Van 3.

In order to accomplish this consolidation in Van 1, only the essential items were retained. This action had its greatest impact on the CTEC subsystem which was moved to Van 1 from Van 2. In its final form, the indispensible CTEC panels were consolidated into three racks. While this floor plan configuration appeared acceptable to NASA, it was not acted upon. By December 1971, developments relative to the TGS F&G concept lead to a directive by NASA to the GSI to stop TGS work. As a result, approval of the TGS floor plan layout was held in abeyance by NASA. The GSI configuration activities on the TGS was terminated on 13 January 1972.

Contract Modification 8, dated 6 July 1972, formally established unification of the TGS units and the ATS F&G Mobile Terminal. This configuration is more generally known as the Hybrid Terminal. The Task IV engineering effort was not started until February 1973. During this interval, contractual and conceptual details of the Hybrid terminal were being resolved.

A plan, Communications Subsystem Configuration and Interface, for the Mobile/TGS Ground Station, was prepared and submitted on 8 June 1973. This plan described Westinghouse's concept for the Hybrid Terminal in specific detail. Major topics discussed were site configuration layouts for both the Mojave and the Madrid locations, stations interface requirements, electrical interfaces, special mechanical interfaces, and equipment layout in TGS Vans 2 and 3.

Two of these topics, site configurations and equipment layout, deserve individual mention here. The site configuration was complicated by several conditions: (1) two different locations, (2) the new ground station was a combination of two previously independent stations, (3) antenna orientation, and (4) dispensible TGS Vans. Equipment layout involved TGS Vans 2 and 3 only. The original Mobile Terminal vans were designed initially for the F&G programs and were therefore suitable without layout modification. TGS Van 1 essentially duplicated the transmitting and receiving functions, except for antenna size, of the Mobile "electronics" van. It was therefore dispensible, and had to be completely divorced electrically from its companion vans.

The TGS Van 5 contained the Telemetry and Command Equipment and Operator Console and required no layout modification. In fact, Van 5 was not a GSI contract responsibility.

Van 2, modified, contained the reconfigured MCC, two computer systems and peripheral equipment racks. Van 3 contained the original Range & Range Rate Subsystem, recording equipments, printers and space for experimenter equipments.

Floor plan layout configurations for the three L/S Shelters were an additional GSI responsibility. These shelters were new buildings and did not present the redeployment and compromise problems associated with the established stations. Furthermore, both buildings and equipments were similar. Thus the floor plans were similar but tailored to the peculiarities of each. These differences were essentially due to the antenna differences (type and mountings) and the impact of this on the coax transfer switch.

The floor plan provided for the L/S (two band) receiver - one cabinet, and the L/S (two band) transmitter - three cabinets. These cabinets were aligned in one row parallel to the long axis of the building. Access space was provided at the rear of the cabinets. Auxiliary equipments included air-conditioner, dry-air pump, coax transfer switch, storage cabinet and work table. The L/S receiver cabinet had approximately 40% unused panel space which was reserved for experimenter use mainly the T&DRE and ITV. The specified equipments completely utilized the floor area.

A final floor plan effort undertaken by the GSI was the Near Collimation Tower building at Rosman. This building was a new structure adjacent to the existing equipment building. At the time of the effort, only one equipment rack was specified, the T&C translator. However, as the floor plan was arranged, two rows of racks up to six each could be eventually installed. Three racks were installed; one containing the T&C unit and the other two empty (the three were an integral piece) for expansion.

REFERENCES:

- Floor Plan, Operations Room - Rosman: Ⓦ Dwg. SK 670J645
- Floor Plan, Operations Room - Mojave: Ⓦ Dwg. SK 608J409
- Floor Plan, TGS Vans 1, 2 & 3 - Ⓦ Dwg. SK 608J388
- Floor Plan, Hybrid Vans 2 & 3 - Ⓦ Dwg. SK 346D480
- Floor Plan, L/S Shelter - Rosman Ⓦ Dwg. SK 344D678
- Floor Plan, L/S Shelter - Mojave Ⓦ Dwg. SK 344D676
- Floor Plan, L/S Shelter - TGS/Mojave Ⓦ Dwg. SK 344D677
- Configuration Plan - TGS (Draft)
- Configuration Plan - TGS (Revised Draft) 15 November 1971
- Configuration Plan - TGS (Revised) 21 January 1972
- Configuration & Interface Plan - "Hybrid" 8 June 1973
- Configuration & Interface Plan - "Hybrid" (Final) 8 October 1973

- **Interface Plan**

The next milestone of the Task IV effort was the revised Interface Plan. In accordance with the decision of the 31 March 1971 joint meeting, this plan was prepared in three sections, one dealing with each of the stations.

Interface philosophy, as seen by the GSI, was discussed in detail. A major conclusion of this discussion was that there were several common interface points shared by the communication subsystems and the experimenters. The most common point was the IF, both transmit and receive. It was concluded that patch panel interfacing provided the necessary flexibility for the ATS-F programs, coupled with economy.

The need for expanded capacity of the ATSR time and frequency signal distribution was developed.

The increased use of recorder equipment for data recording and consequent large number of combinations needed, was recognized. This dictated a high degree of flexibility which could be fully provided only by patch panel technique.

The Interface Plan described the interface engineering from the standpoint of rack configuration, internal layout and interface between subsystems. The significant changes in rack configurations and interfaces were explained. The impact on interface hardware of the major changes in the transmitter and receiver subsystems was detailed. For example, in previous operations the ATS system was mode oriented. The ATS-F system is band oriented. This meant shared common equipments, the flexibility of which was accomplished by means of patching, IF and baseband.

Because of the change from mode orientation, the original loop test scheme was no longer applicable. Hence, the recommendation for removal of the existing loop test equipment was made. Manual loop test patching was recommended as fulfilling the need for loop tests.

In addition to the major changes, noted previously, for the transmitting and receiving subsystems, there were major revisions recommended for the CTEC subsystem. These included removal of obsolete or superceeded equipments such as the Loop Test Control Panel (1A2A5), AGC Amplifier (1A3A5) and the Automated Test Panel (1A6A2). Redeployment of other panels was recommended and an expansion of the patching capability of CTEC Rack 1A6.

Two supplemental interface plans were prepared and submitted. These plans recommended modifications to the ATSR subsystem for increased number of outputs for time and frequency signals. The first applied specifically to Rosman and the other applied to Mojave. None was prepared for the TGS station because the existing TGS ATSR subsystem capability appeared adequate.

REFERENCES:

- ATS-F GROUND STATION MODIFICATION, COMMUNICATION INTERFACE PLAN, Rosman - 20 September 1971
- ATS-F GROUND STATION MODIFICATION, COMMUNICATIONS INTERFACE PLAN, Mojave - 15 October 1971
- ATS-F GROUND STATION MODIFICATION, COMMUNICATIONS INTERFACE PLAN FOR THE TRANSPORTABLE GROUND STATION - 15 November 1971
- ATS-F GROUND STATION MODIFICATION, REVISED CONFIGURATION PLAN FOR THE TRANSPORTABLE GROUND STATION - 15 November 1971
- ATS-F TIMING SUBSYSTEM RECOMMENDATIONS - 1 April 1971
- REVISED RECOMMENDATIONS FOR EXPANSION OF THE NASA DISTRIBUTION PANEL IN THE RANGE & RANGE RATE AND TIMING SUBSYSTEM - 27 MARCH 1972
- REVISED COMMUNICATIONS SYSTEM CONFIGURATION & INTERFACE PLAN FOR THE TRANSPORTABLE GROUND STATION - 21 January 1972
- COMMUNICATION SYSTEM CONFIGURATION & INTERFACE PLAN FOR THE MOBILE/TGS GROUND STATION - 8 October 1973

(Includes reference to MCC Configuration)

- Display Plan

The third major category under Task IV was modification of display equipment. At each station, the display units were centralized in the Master Control Console (MCC). At this location, the station operator monitors selected parameters of the major subsystems. In this manner, important malfunctions can be detected early and remedial measures taken.

To support the ATS-F system, it was necessary to make changes to the display equipments which served the prior ATS programs. The Display Plan formalized these modifications. In the Plan, the philosophy of the MCC was developed, Westinghouse's approach to the display modification was presented, and finally, recommendations for the reconfigured MCC were made.

The Plan stated the basic parameters which should be monitored. Some of the dispensible or unessential parameters were also stated. Additionally, obsolete displays, e.g. multiplex status and video monitors, were identified for removal. The major changes in the transmitter and receiver subsystems required corresponding changes in their status display panels, and the added L-Band and S-Band equipments required displays. The Plan presented the GSI proposed layout for a new communications status display panel consolidating the retained transmitter and receiver displays and adding those for the L and S-Band functions.

A second new panel recommended, was a control panel for the ATS-F satellite. The original spacecraft control panel, for the ATS 1-5 satellites, was retained because of continuing operations with those satellites. Fundamentally, the new panel was similar to the previous one, however, details of the ATS-F panel could not be given at the time of submittal of the Display Plan. A series of meetings were held between the GSI, NASA and the manufacturer of the satellite, from which the control scheme was developed.

Two new display units were added to the MCC. These were the cathode ray tube (CRT) displays in table top cabinets similar to domestic TV sets. The two CRT's were identical, could be used independently, and were computer operated. The data displayed depended primarily on the program in the computer. One prime function was to display spacecraft attitude and spacecraft housekeeping data. These items could be displayed on command.

Finally, the display plan presented line drawings showing the proposed modified MCC as a whole thus presenting a coordinated view of the regrouped panel arrangement. Additional line drawings showed each bay of the MCC, full front and rear views, with panels identified and scaled to size.

The TGS Display Plan was carried over intact to the new Hybrid Terminal.

REFERENCES:

- Rosman ATS-F Display Plan - 20 September 1971
- Mojave ATS-F Display Plan, 1 October 1971
- Display Plan, Transportable Ground Station, 15 November 1971

2.3.2 CABLE MARKING SYSTEM PLAN

The GSI was required to establish the format, prepare, and deliver a Cable Marking System Plan in conformance with the then existing ATS Interface Cable Marking System. A preliminary plan was submitted for approval on 25 March 1971, which afforded a unified method of marking cables for easy identification. This plan was a continuation of the then existing cable marking system in use at the ATS Ground Stations.

The final plan submitted on 1 June 1971, was an expansion of the existing cable marking system in use by ATS stations, which incorporated comments received from GSFC, and the Ground Stations. The format of the final cable marking system was such, as to permit continuous updating. The cabling documents were updated throughout the integration program, continuing through to the configuration cut off date of 31 January 1974, and represent the "As-Built" Cabling documentation as of that date.

REFERENCES:

- DD250 No. CBA 0005 dated 11 February 1973, Item 4
- Cable Marking System Plan, DD250 Accepted 19 February 1973

2.3.3 EQUIPMENT FURNISHED BY GSI CONTRACTOR

The GSI was required to provide all interface cables, connectors, filters, amplifiers, patch panels and other hardware necessary to perform the integration of the ATS-F Ground Stations. The GSI also provided selected display and monitoring equipment, required to maintain operational efficiency, and considered as necessary by the Technical Officer.

During the program, the required material was ordered as the Interface Engineering progressed, and the hardware design was developed. Phase delivery schedules provided a constant flow of materials to the sites, which sustained the installation and integration program in an orderly fashion, yet prevented a material surplus on-station, and its attendant problems.

- Collimation Tower Equipment

Prior to the receipt of Contract Mod. 3 dated 10/1/71, which added the requirement for collimation tower equipment to the GSI contract, the GSI was deeply involved in GSFC requesting engineering studies and evaluations.

In January of 1971, the GSI initiated a study concerning remote control for Collimation Tower Equipment at the three (3) ATS F&G Stations. An engineering evaluation was prepared which compared Land Line vs. Microwave Link, listed deficiencies in existing equipment; and, developed requirements for control equipment and functions to be provided. This effort resulted in a study of the existing facilities, functions controlled, limitation of the existing equipment, and the requirements of the ATS F&G Experimenters. Due to the experiments being in just the early planning stages, much difficulty was experienced in this area.

In February of 1971, a study of available UHF communication equipment was performed. Cost and delivery was of principal interest. HAC submitted a plan to GSFC in March of 71 for instrumentation of the collimaterion towers. The GSI conducted an evaluation of this plan and provided itemized comments. Efforts to obtain a more concise definition of collimation tower equipment to be controlled were not successful due to the fact that most of the equipment was in its early design stage.

In May of 1971, the GSI working in advance of official Go-ahead, instituted studies to determine possible locations of collimation tower equipment and control system. Advantages and disadvantages were considered, and rough cost estimates were prepared.

In July of 1971 the GSI received a block diagram for a proposed system, from GSFC. Using this information as a basis, a meeting was held at GSFC to define the GSI effort in the area of control equipment for collimation tower equipment. The following points were noted:

a) The transmission frequencies were defined as 420.125 and 425.125 MHz.
b) Rosman and Mojave systems were to be identical.
c) The GSI was to supply two (2) systems with options for a third.
d) Do not use the existing tone control system, use a digital code system instead.
e) GSI inputs to tower equipment were to be contact closures.
f) The GSI was to provide spare control capability for growth potential.

g) Documentation was to include
   1) An outline with interfaces listed
   2) A Maintenance Manual
   3) Collimation tower effort to be scheduled per PERT charts

Immediately subsequent to this meeting, the GSI proceeded contacting possible vendors of control equipment, which included UHF transceivers, multiplexing equipment, and antennas. Quotes were received and preliminary discussions ensured regarding desired options such as handsets, intrusion alarm and emergency power provisions. During this period, the GSI plans for the collimation tower effort were "firmed-up", including such schedule items as:

a) Prepare a Design Plan,
b) Place Purchase Orders, and follow,
c) Prepare Engineering Sketches,
d) In-Plant Testing of Control Equipment,
e) Field Installation of Equipment,
f) Field checkout and test,
g) Prepare O&M Manual, and
h) Prepare Final Report (this requirement later deleted)

During the latter part of September 1971 the GSI received a go-ahead from GSFC to prepare a design plan and submit a rough draft as soon as it was available. Mod. 3 to the contract, dated 10/1/71, was received and by the middle of October 71, the first draft of the design plan had been reviewed by GSFC. Comments were incorporated and the preliminary design plan dated 11/12/71 was submitted. GSFC acceptance of the design plan was received on 12/17/71.

The GSI fabrication effort was started in January 1972. In March, 1972, an Acceptance Test Plan was prepared which included information on the testing and evaluation of collimation tower equipment, once installation was completed. The draft O&M Manual was started in April 72. In-plant testing of GSI fabricated items was conducted in May, and in June these items were shipped to Rosman. Installation effort at Rosman was conducted during the months of June and July 1972, and at Mojave during August and September. Installation and test at the Rosman Bald Knob collimation tower was completed in August 72, and the near collimation tower effort was started. The installation effort at Mojave was completed in September 1972.

In December 72, the initial L&S Band links through the collimation tower at Rosman was established.

REFERENCES:

- DD250 No. CBA 0005 dated 11 February 1973, Item 6
- Interface & Display Equipment - Rosman Collimation Tower Equipment completed December 1972. Mojave Collimation Tower Equipment completed December 1972
- System Integration and Acceptance Plan, Item 9
- Collimation Tower Acceptance Test Plan
- Item 9A Draft Plan Ltr. C/F 9706 dtd. 8/8/72
- Item 9B Final Plan Ltr. C/F 9782 dtd. 8/30/72
- O&M Manual for ATS-F Collimation Tower Control Equipment Ltr. C/F 2197 dtd. 2/25/73

- MCC Communications Panel

The requirements for a communication subsystem display panel were developed in the Display Plan (ref. Section 2.3, Display Plan this report). In this plan, a proposed layout for the panel was presented, which included those minimum parameters that would indicate normal functioning of the basic subsystems. The parameter display indicators were grouped by subsystem. In addition, a malfunction alarm and a safety cut-off switch for the transmitter were included.

One panel was required for each ground terminal. For ready monitoring by the station operator, the panel was located in the Master Control Console (MCC). Because of its design and function, the panel was designated "C/S/L Communications Subsystem Status Panel".

Upon receipt of approval of the Display Plan, detail design of the panels was started in September 1971. Since the final configuration and use of the TGS Terminal was still undetermined, the GSI was directed to fabricate panels for Rosman and Mojave only. These panels were completed and shipped on 15 April 1972.

REFERENCES:

- ATS-F MCC Communications Subsystem Status Panel, Layout - SK 345D179
- ATS-F MCC Communications Subsystem Status Panel - Operation and Maintenance Manual - 21 December 1971

- MCC Spacecraft Panel

The philosophy underlying the spacecraft panels was presented very briefly in the Display Plans Section of this report. The existing spacecraft panel covered functions related to the ATS 1-5 spacecraft. This panel was retained intact for continued use as required on the existing satellites. The ATS-F satellite required display and control of new functions.

At the time the Display Plans were submitted, details of the ATS-F panel could not be presented because the interface with the Normal Command Encoder (NCE) had not been developed to a definitive point. Starting in early 1973, close liaison was maintained between the design engineer, and the personnel involved with the NCE. As a result of this action, it was possible to prepare a definitive design plan for the ATS-F S/C Control Panel in April 73. This plan incorporated a requirement for a "data punch" tape to store commands and spacecraft data for subsequent use, and was submitted to NASA on 21 May 1973.

On review of the plan, the decision was made to delete the data punch. This decision required a change to electrical storage of data, a major revision in the design approach. A revised design plan was prepared and submitted on 8 June 1973. This plan was accepted and design effort was started in late June after authorization to proceed. The design was completed in August and component procurement and fabrication started. The first panel was shipped to Rosman in November 1973. The Mojave and Hybrid panels were held for modification to incorporate development changes as found to be required by the Rosman installation. These two units were shipped in February, 1974.

Two problems developed in the field (Rosman). Cross-coupling between the wires of the multiconductor cable from the NCE to the S/C panel caused false triggering of the display circuits. This problem was cured by applying feed-thru capacitors to each input line. These capacitors slowed the pulses and thus reduced the induction into the bundled wires below the threshold point.

A second condition of false display triggering occurred when the incandescent indicator lamps on the panel were energized. This was traced to the in-rush current in the cold lamp filaments. The problem was remedied by bleeding a small current permanently through the filaments. This current was adjusted to a point where the lamps were not visible but sufficiently warm to reduce the steepness of the normal in-rush current to a harmless level.

REFERENCES:

- ATS-F S/C Control Panel - Layout SK 347D244
- ATS-F Spacecraft Control Panel, Operation & Maintenance Manual - 1 April 1974

- PM/FM Network

Design of this unit was started during August 1973, based upon the requirements outlined by the T&DRE Experimenter. The Nimbus Command Link required a narrowband frequency-modulated signal at a nominal 82.15 MHz IF, to be generated within the station. The HP 5105A Synthesizer is used in the system to generate this signal, and its internal phase modulator output is converted to the required frequency modulation by the PM/FM Network.

The Breadboard design and test effort began in September 1973.

Assembly of this unit was started in late October 1973, and was ready for testing approximately one week later.

The PM/FM Network, as delivered, provides the integration and drive power necessary, in order to realize a deviation of at least ±20 kHz with ample adjustment.

The unit was shipped to Rosman in early November and was checked on arrival against the factory test data. The unit appeared to be operating properly. However since the complete Command System for the T&DRE Simulator was still awaiting system checkout, final testing could not be accomplished at that time.

REFERENCES:

- GSI Ltr. C/F 2187A dtd. 2/25/74 Task IX Item 16a - Preliminary O&M Manual Rosman Ground Station PM/FM Network
- DD250 CAA 0014 dtd. 11/9/73 Task IV, Item 6 - Interface & Display Equipment PM/FM Network Panel Assembly

- **Frequency Sources**

As the result of a series of tests, and studies performed by the GSI at the request of the T.O., on the GFE Phased Locked frequency sources, it was determined that the existing GFE sources could not be modified to perform as desired. The GSI was therefore authorized to obtain quotes and procure seven (7) frequency sources. Purchase orders were placed with the Engelmann Microwave Company, and delivery was accomplished in November 1973. Subsequent to in-plant tests, the units were hand carried to the field and installed. Field tests of the sources in their operational environment, revealed the requirement for addition of amplification of the output signal. Accordingly, the GSI designed and fabricated the required amplifiers which were shipped to field locations in April and May 1974. (Refer to Section 2.10 for additional information).

2.3.4 SPARE PARTS LISTS (INTERFACE & DISPLAY EQUIPMENT)

The GSI was required to prepare and delivery to the GSFC Technical Officer, a one year's Interface and Display Equipment Spare Parts List.

The GSI started this task in November 1973 on a limited basis. All of the pertinent drawings and O&M Manuals, including vendor equipment were reviewed, and a preliminary Spare Parts List was submitted to the Technical Officer in February 1974. Discussions with Code 854.2 regarding the Spares List submitted indicated that the format used was not the preferred form. The GSI agreed to prepare the final list in accordance with NASA Spec. S-530-P-5 dated March 1970, which superceded Spec. S-535-P-1A which was the specification initially provided to the GSI, and to which the GSI conformed for the preliminary submission. The effort to prepare the Final Spare Parts List was started in March 1974 and delivery was accomplished in April 1974.

REFERENCES:

- GSI Letter C/F 2172A/99905 dated 2/20/74
- GSI Spare Parts List

2.3.5 INTERFACE DRAWINGS

The subsystem interface drawings were furnished to provide the body of technical information required by field installation teams to install equipments and integrate the individual subsystems. These drawings are also vital to the maintenance and the troubleshooting of equipment problems experienced during the operational phase of the project. In addition, the drawings provide the starting point for any future modification of the station(s). Therefore the constant updating of these drawings throughout the program was an important and necessary effort.

As noted in Section 2.3.1, complete data on all subsystems including experimenters was not available at the beginning of the Task IV effort. The interface drawings were consequently first prepared on the basis of existing and available data, and as new data was obtained, the drawings were updated. As a result, the interface drawings were "living" documents and there was, in effect, a series of releases. The releases and the field installation work were inter-coordinated to allow the field integration effort to proceed without interruption.

A listing of the interface drawings is included in the complete list of GSI drawings as part of this report under Section 3, (g). The interface drawings breakdown into four sub-groups, namely: (1) floor plans, (2) rack assemblies, (3) patchpanel assembly/layouts and (4) subsystem interface cabling & connections.

The first three subgroups are not strictly interface drawings but are very closely associated with the interface effort both on the engineering part and on the field integration part. The specifics (rack designations, equipment terminals etc.) of the subsystem interface subgroup could not be designated until the relevant data of the first three subgroups were determined. Therefore, all four subgroups were worked as an entity.

The floor plan drawings have been individually identified and described under the Configuration Plan (2.3.1).

The rack assembly and the patchpanel drawings are too numerous to list in this report. The delivered rack assembly drawings show an elevation view, delineating each equipment panel, and a bill-of-material for each rack (or cabinet) of each subsystem except experimenters. The patchpanel drawings show the face view of each patchpanel with circuit designations or titles for each jack on the panel. Bill-of-materials are also shown on the patchpanel drawings so that each part, especially the jacks, can be identified. Unused jack positions are shown so that the engineering for future modifications will be facilitated.

Subsystem interface drawings show the title subsystem as a central block and interconnected, or associated, subsystems as satellite blocks. Each cable or wire from the central subsystem to an associated one was shown and identified by cable number and signal carried. Terminal connections at each end of the cables were identified by the full terminal nomenclature, i.e., by rack, panel and jack or terminal designations in accordance with the cable numbering system (reference: Section 2.3.2). Each subsystem interface drawing showed only the interconnections associated with the title subsystem. Interconnections between other subsystems (shown on the drawing as associated subsystems) were shown only on their own interface drawings. Thus the complexity of each interface drawing was kept to a minimum.

In three cases, MCC, receiver and CTEC subsystems, panel interconnections within the subsystems had to be made in the field. These interconnections were extensive and required interface type drawings. To distinguish this category from the normal interface drawing, they were designated as "internal" in the title block. In the tabulation that follows this section, these "internal interface" drawings are clearly identified.

In an integration effort, the scope of the ATS-F program, it is inevitable that changes in the interfaces would be required. Control of changes was maintained by means of prints "red-lined" in the field. The drawing masters were periodically updated, as red lined drawings were received from the field. The new corrected drawings were sent to the sites for their use, and update as required.

At the conclusion of the GSI phase of the integration effort, each interface drawing was verified by comparing it line-by-line with the actual cabling in each station. The drawing masters were then corrected as necessary to reflect the "as built" configuration. The cut-off date for this final updating was established as 31 January 1974, by mutual agreement between NASA and the GSI. Each drawing was reviewed and, for identification, was stamped "GSI Final Drawing - 31 January 1974".

TABLE 2

ATS-F GSI INTERFACE DRAWINGS

REFERENCES:

- The subsystem interface drawings generated by Task IV are tabulated below:

SK 140C 832	Operations Building Equipment Interface	(Mojave)
SK 140C 834	Interface, Rosman Base Terminal	(Rosman)
SK 328D 507	Wiring Diagram - MCC Subsystem (Internal)	(Ros-Moj Hyb)
SK 345D 527	Recording Subsystem Interface	(Rosman)
SK 345D 528	Recording Subsystem Interface	(Mojave)
SK 346D 111	Collimation Tower Interface	(Mojave)
SK 346D 114	Interface, Bald Knob Tower Terminal	(Rosman)
SK 347D 182	PLACE Experiment Interface	(Mojave)
SK 347D 203	TRUST Experiment Interface	(Rosman)
SK 347D 617	RFI Experiment Interface	(Rosman)
SK 347D 688	Cable Interface -Vans 2 & 3 External	(Hybrid)
SK 347D 736	T&DRE Experiment Interface	(Rosman)
SK 347D 777	Cable Modification - Mobile Elect. Van	(Hybrid)
SK 348D 986	Cable Interface - Vans 2 & 3 Internal	(Hybrid)
SK 349D 576	VHRR Experiment Interface	(Rosman)
SK 349D 698	Logic Diagram, Frame Sync. Interface	(R-M-H)
SK 349D 699	Logic Diagram, MMW Frame Sync. Interface	(R-M-H)
SK 349D 700	Logic Diagram, D3F Encoder Interface	(R-M-H)
SK 349D 701	Logic Diagram, D3F Decoder Interface	(Ros-Hyb)
SK 349D 702	Logic Diagram, D3F Decoder Interface	(Mojave)
SK 349D 703	Timing Diagram, Frame Sync/D3F Interface	(R-M-H)
SK 349D 706	Logic Diagram, NCE Interface	(R-M-H)
SK 349D 707	Timing Diagram, NCE Interface	(R-M-H)
SK 349D 708	Block Diagram, NCE Interface	(R-M-H)
SK 349D 713	TV Baseband Subsystem Interface	(Rosman)
SK 349D 749	VHRR Experiment Interface	(Mojave)
SK 350D 070	TRUST Experiment Interface	(Hybrid)
SK 350D 071	T&DRE Experiment Interface	(Hybrid)
SK 350D 072	VHRR Experiment Interface	(Hybrid)
SK 350D 073	MMW Experiment Interface	(Rosman)
SK 572F 479	TV Baseband Subsystem Interface	(Mojave)

TABLE 2 (continued)

SK 608J 410	CTEC Subsystem Interface	(Rosman)
SK 608J 411	RCVR Subsystem Internal Wiring	(Rosman)
SK 608J 412	CTEC Rack 1A6, Wiring Diag. (Internal)	(Rosman-Mojave)
SK 608J 419	Transmitter Subsystem Interface	(Rosman)
SK 608J 421	RCVR Subsystem Interface	(Rosman)
SK 608J 424	CTEC Subsystem Interface	(Mojave)
SK 608J 425	Transmitter Subsystem Interface	(Mojave)
SK 608J 427	RCVR Subsystem Interface (Internal)	(Mojave)
SK 608J 428	S/L Shelter/Antenna to Ops. Bldg. Interface	(Rosman)
SK 608J 429	S/L Shelter/Antenna to Ops. Bldg. Interface	(Mojave)
SK 608J 430	S/L Shelter/Antenna to Ops. Bldg. Interface	(TGS)
SK 608J 436	MCC Subsystem Interface	(Rosman)
SK 609J 125	PLACE Experiment Interface	(Rosman)
SK 610J 973	MCC Subsystem Interface	(Mojave)
SK 610J 974	CTEC Racks 1A7-1A8-1A9 W/D (Internal)	(Rosman)
SK 610J 975	CTEC Racks 1A1-1A2-1A3 W/D (Internal)	(Ros-Moj)
SK 610J 976	CTEC Rack 1A4 W/D (Internal)	(Ros-Moj)
SK 610J 982	R&RR Timing Subsystem Interface	(Rosman)
SK 610J 984	R&RR Timing Subsystem Interface	(Mojave)

2.4 INSTALLATION (TASK V)

As a major objective of this task, the GSI was required to prepare and deliver an Installation Plan, which would describe the procedures and scheduling to be employed in the installation and interface of the equipment for each of the ground stations. Additionally, the GSI was required to integrate the equipment described in the System Configuration, Interface and Display Plan, (Task IV) in conformance with the approved Installation Plan, on a basis of non-interference to station operations.

Work on the Installation Plan was started in March 1971, and was continued as a low-keyed effort. Due to the slow development of GFE vendor information, work was suspended in the middle of April, when it was agreed that portions of the plan should be completed, and submitted individually, as the needed information became available. The submission date of the draft plan was rescheduled for 25 August 1971.

Submission on the Draft Plan was accomplished on scheduled, and inputs from GSFC, and the sites were incorporated. The GSI Installation Engineer arrived at the Mojave Fixed Station, and the TGS in July 1971, and at Rosman in August 1971. The installation activities started immediately, in conformance with the schedule and the draft plan. Detailed installation progress was reported by subtask number via the Monthly Report.

Preparation for the S/L Antenna and Receiver Installation was accomplished in August 1971 at Rosman, Mojave and the TGS. This effort included activity at both the S/L shelter, and in the Operations Building. The major S/L shelter installation effort was completed in February 1972.

General installation effort at all sites commenced with the arrival of the GSI engineer. This effort included not only the GSI installation requirements, but also the monitoring of installation and test, of the various GFE vendors equipments performed by their personnel. Installation effort was provided throughout the scheduled program, and included on-site engineering, installation supervision, the physical installation effort, and maintaining documents, logs and drawings in an updated condition. The site installation engineers assigned to the Rosman and Mojave fixed stations were reassigned in November 1972, when the major installation effort was, in essence, completed.

During August 1972, the installation effort at the transportable ground station was halted, at the direction of GSFC. This action came as a result of a study to determine the benefits of a Transportable Ground Station vs. a Hybrid System, and it was determined that a Hybrid Terminal would be of greater value. In May 1973, following integration engineering, the preparation of Hybrid Terminal installation subtasks was started. Preparation of the Pad area for the arrival of the Mobile Terminal at Mojave was accomplished in June, and those vans of the TGS not required for the Hybrid Terminal were removed from the pad, except for Van 1. The installation effort commenced in June with TGS Van clean up, and cabling activities. The Mobile Terminal was received at Mojave during September 1973, and the formal marriage of the chosen TGS Vans with the Mobile Terminal was started. By the end of December, the principal integration effort had been accomplished.

The equipment required by the experimenters to perform their experiments was installed at each site, as the equipment became available. These actions were accomplished by the GSI Integration Engineers, as required, without any impact to the test program.

REFERENCES:

- GSI Letter C/F 8649 dtd. 8/25/71 - Draft Inst'l. Plan Submission
- GSI Letter C/F 8716 dtd. 9/20/71 - Draft Inst'l. Plan Resubmission
- GSI Letter C/F 2449A dtd. 4/30/74 - Final Inst'l. Plan Submission
- GSI Monthly Reports

2.5 SYSTEM INTEGRATION AND ACCEPTANCE TESTING (TASK VI)

The test program of the GSI integration effort was performed under Task VI of the contract. The scope of this task included analysis of the ATS-F mission performance requirements, selection of tests to reveal the measure to which the requirements are met, the preparation of detailed procedures to perform these tests, analysis of test results, and recommendations and conclusions.

2.5.1 TEST PHILOSOPHY

The GSI approach to the integration test program was to assume a lead role in planning and executing a comprehensive program. Before inter-related and fully meaningful tests could be conducted, it was necessary to determine the equipment and subsystem parameters which supported the experiment performance requirements. A comprehensive set of coordinated detailed test procedures was produced. These tests were grouped into progressive categories as follows:

1) Equipment & Interface Tests (Phase I)
2) Subsystem Tests (Phase II)
3) System Tests (Phase III)
4) Network Tests (Phase IV)
5) Experiment Simulation Tests

The Phase I tests included individual interfacing units and cabling checkout and power and grounding measurements. The purpose of check tests of this level and time sequence was to disclose interfacing and basic equipment degradations before the start of parameter measurements. Thus, repairs or corrections could be made without interrupting or complicating a parameter measurement.

The Phase II tests included a complete series of basic performance measurements on the transmitter and receiver subsystems independently of other subsystems. Basic antenna measurements were also included in this phase. The purpose of these tests was to measure all important basic parameters at their fundamental equipment level. In this manner, degraded or substandard performance could be pinpointed at its source and repairs or readjustments would be facilitated.

An additional advantage was recognized in devising these tests. A number of parameters, for example, modulator sensitivity and distortion, are inversely related. Thus, the objective was to optimize total performance. The value of tests at this level was that performance of the transmitter and receiver subsystems, the heart of the ground stations, was optimized before Systems and Network tests were made.

The Phase III or Systems-level tests were fundamentally loop tests involving the transmitter and receiver subsystems. The two subsystems had previously been optimized on an individual basis so that there was confidence of normal performance on a systems basis. The purpose of the system test was to measure overall performance due to ground station equipment.

Tests in this series were designed to be performed in progressive loop stages, namely, baseband loop, IF loop and RF loop. The latter (RF) loop was closed through the collimation tower translator. Tests were performed at all three RF bands, C, S and L.

The Phase III tests were an extension of the Phase II series to a systems level. At this point, the test program gave a reliable measure of overall system performance in terms of standard communication system parameters. They, therefore, provided the basis of performance for the final communication series, Network Tests, involving the experiment simulation and the spacecraft tests.

The Phase IV, or Network, tests simulated normal operation with the Test Translator substituting for the spacecraft. At the time the tests were to be performed, the spacecraft was not available. The test translator is equipped with "cross-strapping" modes for crossband translation as well as the normal in band translation. This unit is located in the collimation tower and substitution for the spacecraft is its normal function. The network test series included selected experiment and spacecraft tests and special RFI tests.

This test series was designed to measure system performance parameters, on a network basis, which were of particular interest to each designated experiment. It thereby served to verify the readiness of the ground station communication links for the specific ATS-F experiments.

Throughout the planning of the entire series of equipment, subsystem, system and network tests, future operation of the ground station equipment was also in high priority. The various ground station equipments were procured to high performance specifications. The actual "as-built" equipments can be expected to meet or approach most of the specification goals but also to have short falls in some areas. This fact of life complicates the activities of operation and maintenance personnel. However, the series of tests, as planned, provide a body of actual performance values for the communications subsystems. Moreover, this data bank gave realizable values at all important stages and points throughout these subsystems. Thus, operations and maintenance personnel have attainable values for operating adjustments and maintenance repairs.

2.5.2 TEST PREPARATION AND SCHEDULING FACTORS

The objective of this task was to provide test procedures and perform test measurements which would fully define the realized performance of the ATS-F stations. Task VI activity started May 1971 by the assignment of two senior engineers and a test director to develop the task objectives.

The initial effort of this team was to apply the analysis of equipment capabilities and experiment requirements developed in Task I. This effort, extending approximately 10 weeks, formed the foundation for the selection of appropriate performance parameters and the development of procedures to measure them.

Relevant performance parameters were determined through a series of evaluations. The results of these studies were discussed in reviews with NASA with the result that a comprehensive set of basic performance measurements were obtained. The body of data which was acquired by these measurements characterized the stations' capabilities and thus formed the technical basis for predicting experiment performance and equipment areas needing improvement.

A Test Plan outline of all the tests devised, is attached to this report as Appendix A. These tests are listed by the test phase categories as defined in the previous section.

With agreement on the selected performance parameters, the team turned to generating specific test procedures. These were prepared in accordance with MIL-T-1830B. The procedures thus produced, included "self-contained" instructions. The purpose of this provision was to insure, as far as practicable, uniformity in procedure, method and configuration for both repeatability and for valid comparison basis between stations.

Westinghouse's previous experiences in performing test similar to those of this contract have shown that variations in "patching-up" a test configuration generally resulted in identifiable variations in the measured values. A prime reason for this is variation in cable loss due to different lengths. Problems of this kind were avoided by test procedures which were detailed to specific panel jacks, cables, test equipments etc. for each test configuration.

To further insure repeatability and also test completeness, data sheets unique to each test were prepared. These data sheets, except where not applicable, included expected values for each measurement. This point was important because it provided an objective for the technician in pre-test setup adjustment and an immediate measure of excellence when test measurements and readings were taken. The formatted data sheets were also a step in assuring that all required data was obtained or that when omitted, an explanation would be necessary.

A major problem encountered in the conduction of the tests was the time element. Although equipment installation was proceeding as expeditiously as possible, time allocated to testing was continually being compressed. Among the more vexing test scheduling problems was unanticipated down-times for major equipments. For examples, the Rosman C-band transmitter was down for approximately 8-months and the Rosman 85 ft. antenna for nearly six-months. The Mobile 15' and 21' antennas were returned to HAC for repair and instead of being available on November 1973 for scheduled start of Hybrid tests, became available in April 1974. To provide flexibility, each test procedure was written as an independent self-contained entity. The sequence of tests was therefore flexible, permitting a test to be rescheduled to suit equipment availability. An example was the frequency stability and lock-on problems which developed in the transmitter 810-frequency source module. Related tests were postponed until a fix was developed (Englemann November 1973) and all other tests continued without compromise.

Phase II tests were started before the procedures for Phase III were fully written and an advantage was realized from this. By analyzing Phase II results concurrent with the preparation of Phase III, procedure adjustments were made to probe trouble areas - for example, unexpected receiver response spurs. In every case, however, test plans were available well ahead of need and with a minimum of manhours expended.

2.5.3 PERFORMANCE OF TESTS

The series of integration tests described above were conducted at each site under the immediate supervision of the GSI field Engineer-in-Charge (EIC) supported by the station technical operating personnel. The latter performed the actual equipment configuration setup and equipment adjustments in accordance with the step-by-step test procedures. This arrangement provided on-the-job training on the modified and the new equipments for the operating people. Data readings were either taken by or witnessed by the GSI engineer. Throughout all test operations the GSI on-site engineer was in constant communication with the Test Director, at GSI Headquarters, by phone on urgent problems, and by weekly written summaries and test data sheets. The latter were complete and original records of all the raw data. This data was analyzed as received and the results and suggestions transmitted back to the on-site engineer either by phone or by letter as appropriate. In this manner, the field engineer was given full support with solutions to problems provided on a timely basis.

The tests were started first at Rosman in May 1972, at Mojave in June 1972, and the Hybrid in April 1974, as equipment installation was completed and made ready.

During the testing effort, problems developed in two general areas. First was the need to restore the equipments to normal and proper operating conditions and the second was repeated equipment failures which were experienced from time-to-time throughout the test effort. These failures were additional to the scheduled downtimes noted previously and involved:

- Klystron Focus Magnet Failures
- High Power Waveguide Isolator Failure
- TWT (IPA) Power Supply
- Coolant Failures

- Circuit Failures
- Waveguide Pressure Window Failures
- Parametric Amplifiers Failures

By monitoring both the test progress and the schedule milestone dates and by close coordination with GSFC, the GSI successfully scheduled around the problems mentioned above. All tests of Phases I, II, III and IV categories were completed with satisfactory data before the scheduled start of Experiment Simulation Tests in November 1973.

Testing of the Hybrid Terminal began in mid-April 1974, a date dictated by the return of the two mobile antennas that had been undergoing repair. Testing was completed in May 1974, except for two tests awaiting delivery of two GFE items, the PCM and NCE units. Seven antenna tests involving the collimation tower were not performed by direction of GSFC because of the difficulty of repositioning the mobile antennas.

The Hybrid terminal test data will be submitted directly from the site to GSFC and neither this data or the data analysis will be part of this report, again by direction of GSFC.

REFERENCES:

- ATS-F Ground Station Integration Test Plan, Phases I and II, February 21, 1972.
- ATS-F Ground Station Integration Test Plan, Phase III System Tests, February 21, 1972.
- ATS-F Ground Station Integration Test Plan, Phase IV Network Tests (Communications Systems Readiness Tests), May 23, 1973.
- Experiment Simulation Test Plans
  - a) VHRR, November 2, 1973
  - b) SAPPSAC, November 9, 1973
  - c) Millimeter Wave, November 26, 1973
  - d) High Speed Interferometer, February 12, 1974
  - e) PLACE, March 10, 1974

2.5.4 TEST DATA REDUCTION AND ANALYSIS

As noted previously, the objective of the integration test effort was to demonstrate the capabilities of each ground station terminal to support the planned experiments. The required capabilities were translated, under the Task VI effort, into appropriate measurement parameters and test procedures. The test data so obtained was the raw data.

The final effort under Task VI was reduction of the raw data into engineering performance terms and the analysis thereof in view of the stated objective.

Because of the large volume of data acquired and analysis discussion, all of this material is published under separate covers as references to this report. The analysis is presented in a test-by-test basis under separate subsections for the Rosman and the Mojave ground terminals. In summary, the analysis showed:

a) Full specification values were not met in all cases.

b) A few listed deficiencies should be investigated further.

c) The ground terminals appear to be fully capable of supporting the planned experiments. It is not expected that the deficiencies noted will compromise the experiments because of the state-of-the-art specification values in these instances.

REFERENCES:

- GSI Test Data Report: Vol. II Rosman Subsystem Test Procedures and Data Sheets; Vol. III Rosman System Test Procedure and Data Sheets; Vol. IV Rosman Network and Collimation Tower Test Procedures and Data Sheets; Vol. V Mojave Subsystem Test Procedures and Data Sheets; Vol. VI Mojave System Test Procedure and Data Sheets; Vol. VII Mojave Network and Collimation Tower and Data Sheets.
- GSI Test Data Report Vol. I, Rosman Test Data Analysis; Mojave Test Data Analysis; Rosman Data Summary Sheets; Mojave Data Summary Sheets.

2.6 DATA HANDLING AND PROCESSING (TASK VII)

2.6.1 SUMMARY OF WORK PERFORMED

- Data Plan

A preliminary data plan dated January 1972, was prepared and delivered to GSFC. The requirement for a final plan was replaced by the generation of software requirements and subsequent specifications which led to the software systems described in 2.6.3.

- ADP Acceptance Test Plan

A preliminary acceptance test plan dated December 1972, was prepared and delivered to GSFC.

From this preliminary plan, a specification for a system of diagnostic software was generated. The software system was generated by another GSFC contractor under the close supervision and approval of Westinghouse. The resultant software system was checked out by Westinghouse and the system and documentation was delivered to GSFC by their contractor. The software descriptions which formed a part of the documentation were included as attachments to the final acceptance test plan. A final plan, dated 21 February 1974, was delivered to GSFC. The plan specifies tests for all ADP related hardware that was deliverable by Westinghouse.

- ADP Interface Specification

A preliminary interface specification dated 1 December 1972, was prepared and delivered to GSFC. This plan was approved by GSFC and the manufacturing phase was begun. Upon completion of manufacturing, installation and checkout, a final specification dated 15 April 1974, was generated. This plan references all drawings that were prepared under Task IX and describes in detail the ADP system fabrication, cabling and electronics.

- ADP System Design

Westinghouse engineers were instrumental in the system coordination and interface hardware selection for the ADP equipment utilized for experiment and spacecraft operations and data handling at the Rosman, Mojave and Hybrid Ground Stations and at the ATSOCC. A Westinghouse engineer visited all experimenters, the ground stations and ATSOCC while actively participating in GSFC design reviews. This engineer controlled most of the hardware configurations through his chairmanship of the GSFC ADP Hardware Committee. Westinghouse personnel worked closely with GSFC Network Engineering personnel in specifying the design requirements, installation procedures and checkout procedures for the telemetry, command and data communications equipment.

- ADP Feasibility Studies

A Westinghouse engineer and a Westinghouse programmer were key members of the committee for mini-computer selection. They were instrumental in gathering the information needed for the selection process and subsequent generation of a Feasibility Study. They participated in the writing of the feasibility study that resulted in ADPE 441 and in writing several follow-up studies as requirements were updated.

- ADP Configuration Management

A Westinghouse engineer maintained files and control of the configuration of the seven PDP-11/20 systems at ATSOCC, the STC at Fairchild, and at the experimenters facilities (during software development) and ground stations.

- STC Support

An ADP "mini" station was assembled from GFE, and hardware fabricated by Westinghouse for this subtask. This station provides the capability for telemetry and command of the ATS-F Spacecraft (at Fairchild STC) from ATSOCC in a manner similar to ground station operation. A Westinghouse engineer supported the operation and maintenance of this station.

- MMWPE Bit Twisting Modifications

A modification to the DMA/DP11-DC interfaces in PDP-11/20 systems 5 and 6 at Rosman was designed, installed and checked out by Westinghouse. This modification allows the transmission of data from a DMA/DP11-DC with either most significant or least significant bit first (as selected by the software).

- DR11B/IDI CRT Interface

An interface between a PDP-11/20 computer and an IDI CRT terminal was designed, fabricated, installed and checked out by Westinghouse. This unit was demonstrated at the FII STC on 31 January 1973, as a means of providing a low cost, high speed CRT terminal interface using parallel character transfer.

- **Manufacturing**

All necessary ADP system parts were ordered and assembled at Westinghouse. Certain GFE was modified and integrated into the final system as required. Final equipment delivered is listed in 2.6.2 below.

- **Ground Station Software System (GROSS)**

An operational software system that operates at all ATS-F ground stations has been generated in accordance with launch support requirements. The additional software, that is required post launch, has been generated for operation effective 2 July 1974. This total effort involved modification and integration of the common (ISS) software required for GROSS and the generation and integration of the Ground Station unique software into the total GROSS package. The system was then tested and certified.

2.6.2 HARDWARE SUPPLIED

- Rosman

The following items were delivered under DD250, Shipment No. CAA0007, 27 June 1973.

Description	Qty.	Unit
1. Computer Panel 85A2A10 S/N 1	1	ea.
2. Computer Panel 86A2A10 S/N 1	1	ea.
3. Computer Peripheral Panel 85A1A10 S/N #1	1	ea.
4. Computer Peripheral Panel 86A1A10 S/N #1	1	ea.
5. Cable Assy. W9493	1	ea.

The following items were delivered under DD250, Shipment No. CAA0009, 30 August 1973.

Description	Qty.	Unit
1. Data Interface Rack Ⓦ SK150B650 consisting of: Control & Display Panel 84A4A10 S/N 001 Experimenter Switch Panel 84A4A4 S/N 001 RFI Switch Panel 84A4A9 S/N 001 Data Interface Panel 84A4A5 S/N 001	1	lot

Description	Qty.	Unit
XY Plotter Connector Panel 84A4A6		
S/N 001		
Experimenter Connector Panel 84A4A7		
S/N 001		
Experimenter Connector Panel 84A4A8		
S/N 001		
XY-Plotter Computer Five 84A4A2		
S/N 001		
XY-Plotter Computer Six 84A4A3		
S/N 002		
2. Spare Logic Modules	11	ea.
3. GFE Equipment as follows:		
Ref. Ⓦ RGP 2803		
Cal. Comp. 565 XY Plotter S/N 245	1	ea.
Gov. Prop. No. 249242		
Cal. Comp. 565 XY Plotter S/N 211	1	ea.
Gov. Prop. No. 249246		
4. Group Sync. Connector Panel	1	ea.
S/N 002 84A3A9		
5. Cable Assemblies	60	ea.

The following items were delivered under DD250, Shipment No. CAA0010.

Description	Qty.	Unit
Cable Assemblies	10	ea.

The following items were delivered under DD250, Shipment No. CAA0016, 6 February 1974.

Description	Qty.	Unit
1. Xerox BT10 Logic Module	1	ea.
2. Xerox PT10 PRW. Supply S/N 4794	1	ea.

The following equipment was delivered via L-Order Shipment Notice, in November 1973. These parts were utilized for on-site fabrication of the CRT patch panel and associated cables and for various installation tests.

Description	Qty.	Unit
Support equipment consisting of miscellaneous installation materials.	1	lot

The following items were delivered for fabrication and installation on-site.

Description	Qty.	Unit
1. Strip Chart Recorder Connector Panel 84A1A5 S/N 0001	1	ea.
2. Time Code Translator Connector Panel 84A1A6 S/N 0001	1	ea.

The special tools necessary for installation and maintenance have been delivered to the site and will be incorporated into the station tool crib upon termination of the contract.

- Hybrid Terminal

The following equipment was delivered under DD250, Shipment No. CAA0008.

Description	Qty.	Unit
1. Cable Assemblies	41	ea.

The following equipment was delivered under DD250, Shipment No. CAA0013.

Description	Qty.	Unit
1. Data Interface Rack Ⓦ SK150B650 consisting of:	1	ea.
Control & Display Panel V284A4A10 S/N 001		
Data Interface Connector Panel V284A4A5 S/N 001		
XY Plotter Connector Panel V284A4A6 S/N 003		

Description	Qty.	Unit
Experimenter Switching Matrix Connector Panel V284A4A7 S/N 001		
XY Plotter Computer Seven V284A4A3 S/N 004		
Experimenter I/O Switch Panel V284A4A4 S/N 001		
2. Spare Logic Modules	13	ea.
3. GFE equipment as follows:		
Cal. Comp. 565 XY Plotter S/N 210 Govt. Prop. No. 249244	1	ea.
UDC-11 (Part of PDP-11/20 S/N 1711) Includes H964AA Cabinet and Unibus Cable Govt. Prop. No. - None	1	ea.
Parts, Excess, ATS PCM Group Synch Installation and D3F Installation (EC: 0808-206 I and EC: 0815-408 T)	1	lot
NOTE: Excess from Vouchers S-04242, S-04295		
NCE Cables for PCM/DHE & MCC	1	box
DR11A consists of 3 modules for NCE Interface (M786, M7820, M105)	1	lot
4. Computer Peripheral Connector Panel S/N 001 V287A1A1-0	1	ea.
5. Computer Connector Panel S/N 001 V287A2A10	1	ea.
6. Group Sync Connector Panel S/N 001 V284A3A9	1	ea.

The following item was shipped to Hybrid under DD250, Shipment No. CAA0017, 6 February 1974.

Description	Qty.	Unit
1. Xerox PT 10 PRW. Supply S/N 4936	1	ea.

Special equipment was delivered via L-Order Shipment Notice, November 1973. These parts were utilized for on-site fabrication of the CRT patch panel and associated cables and for various installation tests.

Description	Qty.	Unit
Special support equipment and materials	1	lot

The following items were delivered for fabrication and installation on-site.

Description	Qty.	Unit
1. Strip Chart Recorder Connector Panel V284A1A5 S/N 0001	1	ea.
2. Time Code Translator Connector Panel V284A1A6 S/N 0001	1	ea.

The special tools necessary for installation and maintenance have been delivered to the site and will be incorporated into the station tool crib upon termination of the contract.

- Mojave

The following items were delivered under DD250, Shipment No. CAA0012.

Description	Qty.	Unit
1. Data Interface Rack Ⓦ SK150B650 consisting of:	1	ea.
Control & Display Panel 84A4A10 S/N 001		
Data Interface Connector Panel 84A4A5 S/N 001		
XY Plotter Connector Panel 84A4A6 S/N 002		
XY Plotter Computer Six V284A4A2 S/N 003		
2. Cable Assemblies	18	ea.

Description	Qty.	Unit
3. Group Sync Connector Panel S/N 001 84A3A9	1	ea.

- Goddard Space Flight Center

The following items were delivered under DD250, Shipment No. CBA 0006, 4 January 1973.

Description	Qty.	Unit
DR11B/IDI CRT Interface Logic Unit		
(W) SK143C308 S/N 1000		
Consisting of:		
BB11 System Interfacing Unit	1	ea.
M111 Module Board	2	ea.
M113 Module Board	2	ea.
M660 Module Board	4	ea.
M205 Module Board	2	ea.
Cable Assemblies	4	ea.

Special items were delivered to the STC at Fairchild Industries for GSFC under DD250, Shipment No. CAA0019, 14 March 1974.

Description	Qty.	Unit
One lot spare parts for Data Handling & Processing Equipment	1	lot

The following items were delivered to the STC at Fairchild Industries for GSFC under DD250, Shipment No. CAA0011.

Description	Qty.	Unit
1. One Xerox MT34 Interface Wire Wrapped Bucked "C" Containing 8 Modules.	1	lot
2. Cable Assemblies	8	ea.

The following items were delivered by letter and/or DD250 to the GSI Technical Officer.

1) Data Plan - Preliminary January, 1972
   Final - Canceled by Contract Officer
2) ADP Interface Specifications - Preliminary 1 December 1972
   Final - 15 April, 74 (DD250, CAA0020, 29 March 1974)
3) ADP Acceptance Test Plan - Preliminary 1 December 1972
   Final - 21 February 1974 (DD250, CAA0021 6 May 1974)
4) PDP-11/20 IDI CRT Interface Document - 31 January 1973

2.6.3 SOFTWARE SUPPLIED

- GROSS Package (Launch Support)

All ground station unique software has been integrated with the most recent versions of the common (ISS) software.

- GROSS Package (Post Launch Support)

Additional ground station unique software has been written and will be integrated with the launch support package to provide additional operational capabilities by 2 July 1974.

- Ground Station Unique Launch Support Software
  1) System Initialization (GSINIT)
     Initializes the common core tables and program options via a DECWRITER prompting scheme.
  2) ADP Equipment Error Monitor (ERRMMON)
     Monitors peripheral equipment errors and frame synch dropouts and outputs the appropriate error message with GMT time tag to the DECWRITER.
  3) Telemetry Handlers
     a) TPP1, telemetry pre-processor for frame sync interrupt 154. Will process either normal or dwell telemetry.
     b) TPP2, telemetry pre-processor for frame sync interrupt 164. Will process either dwell or normal telemetry.

c) TOTPP1, time out processor for telemetry dropouts for frame sync interrupt 154.

d) TOTPP2, time out processor for telemetry dropouts for frame sync interrupt 164.

4) Echo Word Pre-Processor (EWP)
Pre-processess the command echo words in the telemetry and calls the Telemetry Command Load Execute Monitor (TCLEM) if a change in the echo words is detected.

5) Normal TelemetryBuf fer Dump (DMPNRM)
Prints normal telemetry to line printer on a minor frame basis.

6) Dwell Telemetry Buffer Dump (DMPDWL)
Prints dwell telemetry to line printer on a minor frame basis.

7) COMMAR Table Dumps

a) D54 COM prints contents of the COMMAR Table to line printer every minor frame using interrupt 154.

b) D64 COM same as D54 COM except it uses interrupt 164.

8) Normal Telemetry User Table, NTUT, Dump (DMPNTU)
Prints contents of NTUT to the line printer on a minor frame basis.

9) Dwell Telemetry User Table, DTUT, Dump (DMPDTU)
Prints contents of DTUT to the line printer on a minor frame basis.

10) Initialization Data Table, IDAT, Dumps

a) D54IDA prints the contents of the IDAT table to the line printer using interrupt 154.

b) D64IDA same as D54IDA except it uses interrupt 164.

11) Strip Chart Recorder Calibration Programs

a) SCRCAL initializes strip chart calibration program.

b) SCRUP calibrates the strip chart recorders.

12) Auxilliary ERRMON Set up (DRIVER)
Sets bits in tables checked by ERRMON in known patterns for test purposes.

13) ERRMON Table Dump (DMPEZE)
Prints contents of the tables monitored by ERRMON to line printer.

14) Real-Time Debus Utility, XXBUGG
Provides tracking and core alterations for any job in core.

15) Magnetic Tape ASCII Print Utility (PRATAP)
Prints the contents of a magnetic tape in ASCII format to the line printer.

- Ground Station Unique Post Launch Support Software

1) Command Receive Processor
   a) SOBCMD, initializes input from D3F of the ATSOCC - generated commands.
   b) CMDRCV, monitors ATSOCC-generated commands for errors and sets up the command for transmission to the NCE when the GROSS system has been initialized in the Relay mode.

2) Command Transmission (CMDXMT)
Transmits ATSOCC-generated commands to the NCE.

3) Checkout Programs for Command Receive Processor
   a) CMDINP checks Command Receive Processor internal to the computer by stuffing the SOBCMD input buffers with test D3F blocks of command data.
   b) CDCTST checks Command Receive Processor by outputting test command blocks to the D3F and these blocks are looped back on the D3F and received by the SOBCMD program for processing by the CMDRCV program.
   c) DMPCMD dumps the D3F command data blocks to the line printer when intervaled.
   d) DMPD3F automatically dumps to the line printer any D3F block received by the Command Receive Processor that is not recognized as a command data block.
   e) DMPXMT dumps the ATSOCC generated commands that have been stored in the output buffers for transmission by CMDXMT.

2.6.4 SUMMARY OF ACCEPTANCE TEST RESULTS

- Rosman ADP Hardware

The test was completed without problems in January, 1974. Test was witnessed by Bendix O&M personnel and approved by E. Taylor, Rosman assisted STADIR. Test results were submitted to GSFC along with 10 copies (blank) of the test plan as specified in Section 2.6.2, Goddard Space Flight Center.

- Mojave ADP Hardware

Those portions of the test that can be run without a computer were completed in April, 1974. The computer related items were tested following the computer installation (after ATS-F launch). The test occurred in July, 1974.

- Hybrid Terminal ADP Hardware

Those portions of the test that can be run without a computer were completed in May, 1974. The computer related items will be tested following the computer's installation at Madrid as part of the Madrid task. The test will occur on or about 31 May 1975.

- Rosman GROSS Software

Four acceptance tests have been performed on the Launch Support GROSS System. The first acceptance test was performed the week of April 1, 1974. The second acceptance test was performed the week of April 22, 1974. The third test was performed during the week of May 13, 1974. The fourth test was performed on the Launch system May 25, 1974.

These acceptance tests involved the following general tests to show that the current GROSS system is capable of monitoring the health and safety of the spacecraft and is capable of commanding the spacecraft:

1) The telemetry handlers are tested to show that they can handle any combination of normal and dwell data on frame sync #1 (interrupt 154) and #2 (interrupt 164). This test is performed by manually setting frame syncs #1 and #2 to input normal or dwell telemetry and dumping the raw data and the appropriate telemetry user table (NTUT vs. DTUT) to the line printer. The line printer output is manually checked to determine that the data has been properly processed. The problem discovered during the first acceptance test was that handlers did not process dwell data on frames

sync #1 and normal data on frame sync #2 properly. This was resolved and did not appear during acceptance test #2.

2) Prime command mode (only mode required for launch) is tested by sending various single commands and groups of commands from the current data base using all commanding modes (1 through 6) and watching the command status display on the CRT to see that the proper verification is received via the telemetry for each of the commands.

For the second acceptance test, an ASP magnetic tape containing all of the commands contained in Flight Data Base #6 was used. This tape uses only command mode #6 to transmit commands so the other modes (1 through 5) had to be checked separately. In addition, the Flight Data Base #6 tape, sent to the ground station, contained errors and only that portion of the data base that included the first group of commands could be salvaged. The rest of the groups of commands and the canned strip chart recorder pen assignments were lost. Therefore, all of the single commands and the first group of commands from the Command ASP tape were used and were found to be correct.

ATSOCC is working with the ground station during some of the acceptance testing and the command status CRT displays for the two sites are compared. During the second acceptance test, there were no discrepancies between the command displays for ATSOCC and the ground station.

During the second acceptance testing with ATSOCC, it was discovered that normal telemetry channel 114, subcoms 13 and 14 were changing at the ground station, but not at ATSOCC. Raw telemetry dumps were performed at the ground station and these dumps showed these data points to be constant as they should be for Collimation Tower data.

3) System initialization (GSINIT) was found to have a problem during the second acceptance test. Although GSINIT was re-enterable without loss of telemetry data, it would reset the XXCRT table and this would terminate the updating of the CRT screen. The necessary changes have been made to GSINIT and the program has been checked out and has been found to be completely re-enterable without loss of telemetry or CRT updates.

4) Strip chart recorders were tested using the canned pen assignments and the user assigned pen assignments via the CRT during the first acceptance test; but only user assigned pen assignments were used during the second acceptance test because of the problem with Flight Data Base #6 tape described in (2) above. Both tests showed that the normal telemetry strip chart software was working correctly but not the dwell software. The updated dwell strip chart software has been corrected and is available on the Launch System.

- Mojave GROSS Software

A steamlined version of the Rosman acceptance test specified in Section 2.6, Rosman GROSS Software will be conducted at Mojave following the ADP hardware installation and checkout (July, 1974).

- Hybrid GROSS Software

A streamlined version of the Rosman acceptance test specified in Section 2.6, Rosman GROSS Software will be conducted at the Hybrid following relocation to Madrid and installation and checkout of the ADP Hardware (May 1975).

2.6.5 ANALYSIS AND RECOMMENDATIONS

The system design, fabrication and installation has been cost effective and provides flexibility and optimum performance. The role of Westinghouse as a system integrator has provided the needed engineering support in assuring that all NASA sections and experimenters have complied with system requirements and have avoided hardware duplications. It is essential that NASA continue this effort on future projects and as an ATS continuation to assure this same effectiveness in the future.

It is recommended that networks make full use at the ground stations of the Interface Specification and the Acceptance Test Plan for use in periodic testing and training and that these procedures be incorporated with the various documents that are used on site for O&M.

2.7 TRAINING, OPERATION AND MAINTENANCE (TASK VIII)

The objectives of this task were to develop a program to train station operational and maintenance personnel on the new equipment integrated into the stations as part of the ATS-F Program. Additionally, the GSI was expected to monitor the operation and maintenance of the ATS-F station modified equipment in support of site personnel, as a final step in ensuring the proficiency of these people.

A Formal Training Plan was developed,outlining program content for one week of formal training and one week of OJT, and indicating that the training program would be conducted at each of the ground station locations. The formal training was to be conducted in a formal classroom setting by the GSI System Integration and Test engineers, while the OJT, considered an extension of and closely related to the one week of formal training, continued the course from one of classroom explanation, to one of equipment demonstration.

A Program Training Plan containing all the details of course design, material, outline, handouts, and methods of conducting the course, dated August 15, 1973,was delivered to GSFC as a Preliminary Plan on August 17, 1973.

Scheduling of the course became most vexing, since by the time the O&M manpower buildup was attained, and the site personnel were available for GSI training, the O&M contractor started conducting classes. A conflict thus existed with the O&M contractor classes taking precedence and a meeting was held at GSFC on September 12, 1973, to resolve the schedule program. This resulted in several Training Plan changes that were incorporated in the Final Program Training Plan.

The Final Program Training Plan specified a four-day course to be conducted at Rosman only. The course was planned to start at the subsystem level, and build up to include a fully operating, experiment interfaced system. Basic maintenance and operational loops were to be discussed and extended into techniques for isolation of system malfunctions. To be included were GSI test data and system parameters. The T&C and ADP systems were not within the scope of the GSI training course. One day of the course was scheduled to be devoted to general considerations of the various experiments. The Final Program Training Plan dated October 1, 1973 was delivered on October 5, 1973 to GSFC.

The Training Course was conducted as called for in the Final Plan, beginning on September 25, 1973 at the Rosman facility for both the Rosman and Mojave O&M contractor personnel.

OJT was performed informally by the System Integration and Test engineers at both Rosman and Mojave by involving O&M personnel in the on-going GSI test program.

Supervision of O&M activities were performed by the GSI System Engineers during the experiment simulation testing and station readiness exercises.

The O&M supervision and OJT program was conducted by on-site Ⓦ system engineers instead of specialized Ⓦ training personnel that had been intended to be sent to the field location from Baltimore, Maryland. This was a cost saving to the Government and had the additional advantage of using the best qualified engineering personnel to perform the training functions.

REFERENCES:

- DRAFT PROGRAM TRAINING PLAN — Dated August 15, 1973
- FINAL PROGRAM TRAINING PLAN — Dated October 1, 1973

2.8 DOCUMENTATION (TASK IX)

The GSI was required to prepare, and maintain in current condition, documentation generated in the performance of the contract. This effort included:

a) Subsystem equipment drawings and performance specifications for equipment furnished by the GSI,

b) Acceptance Test Plans,

c) GSI furnished Interface Drawings,

d) Subsystem Equipment Log Books, and

e) Operations and Maintenance Manuals.

Also considered under this item were the various Monthly, Quarterly and periodic reports including Trip Reports, Minutes of Meetings, Analysis of Equipment Test Reports, and miscellaneous reports and documentation required by other contract items and generated in the course of the contract.

The first documents delivered per contract schedule requirements on 25 January 1971, were the Safety and Health Plan, and the Draft Task I Report. Drawing files and controls were created and updated, as required, and Documentation

Procedures established and methods implemented. The drawing effort started in June 1971 and continued throughout the life of the program. Prior to the periods of installation and preliminary checkout, the GSI made drawing revisions as required, on an informal basis. The drawings were sent to the sites, when and as completed, and marked up on site as changes became necessary. The GSI maintained a file of "red-Lined" drawings for ready reference and history throughout the program, and updated the masters on a periodic basis and reissued the updated drawings to the sites as they were completed.

In January 1974, the GSI integration engineer reproduced and hand-carried a complete set of Rosman drawings to the site, and devoted a period of two weeks to the review of all GSI drawings, and verification to the "As-Built" configuration. The drawings were red lined as deviations or changes were noted or required, and returned to Baltimore where the changes were incorporated into the masters. In February he made a similar trip to Mojave and the Hybrid Terminal for the same purpose. The GSI drawings package consisting of one (1) reproducible and three (3) copies, were delivered to GSFC on May 5, 1974.

The various reports, memos and manuals which constituted the required documentation were delivered throughout the life of the program per the approved schedule. The final O&M Manuals were delivered in April 1974.

REFERENCES:

- GSI Letter C/F 9254 dated 3/6/72
- DD250 CAA 0001 dated 10/20/71
- DD250 CAA 0002 dated 2/24/72
- DD250 CBA 0002 dated 4/6/72
- DD250 CBA 0005 dated 2/11/73
- DD250 CBA 0006 dated 1/4/73

2.9 NEW TECHNOLOGY (TASK X)

The GSI was required to conform with the provisions of the New Technology Clause, NASA Form 1162, by submitting a written report concerning each "reportable item". These items are classified as discoveries, inventions, improvements, or innovations. Reports were required to be submitted to the New Technology Representative "promptly upon the making thereof". Additionally, the GSI was required to furnish a written summary report of the review activities undertaken to uncover items of new technology, both on an annual basis, and upon the completion of the contract. In the event that there were no reportable items during the review period, it was required this fact to be so certified in the summary report.

The GSI Program Management was, and is oriented to the importance of New Technology Reporting. At the outset of the GSI Program, a letter was issued to all personnel involved, defining "reportable items", and providing reporting forms. Personnel were urged to monitor their own activities, and those of others, in an effort to uncover any reportable items. Additionally, management performed periodic reviews of all activities and processes to determine possible areas of reportable items.

It was recognized, that due to the nature of the GSI program, the possibility of reportable items was remote, since the principal function of the GSI was system engineering, and monitoring the activities of various GFE vendors and their personnel. Periodic reviews paid specific attention to any innovations, improvements, or discoveries in an attempt to ascertain whether or not their submission would serve some useful purpose. Annual reports were submitted which certified that there were no reportable items.

REFERENCES:

- GSI Letter dated 9/28/71 First Annual New Technology Report
- GSI Letter dated 10/2/72 Second Annual New Technology Report
- GSI Letter dated 11/8/73 Third Annual New Technology Report

2.10 REPAIR OF DEFECTIVE GFE (TASK XII)

Comparison of test problems that were apparent, at the ATS Ground Stations in the early part of the test program indicated a common problem. It appeared that during the frequency stability testing, much difficulty was being experienced in obtaining phase lock of the up converter and down converter sources across the full operating range of frequencies. Frequency adjustment of the sources was required as the ambient temperature varied. No specific data had been collected at that time to quantitatively define the problem. However, in the judgment of the GSI, the equipment did not appear to be in a condition to operate suitably for the intended use. It was suggested to GSFC that there was a strong possibility of a design problem existing in the equipment, which would require correction. In July 1972 the GSI was given direction to perform a thorough investigation into the nature of the problems.

Investigation into the problems, and extensive testing on the GFE Up and Down Converter Drawers was performed in an attempt to determine a valid and permanent fix. In January 1973, it was concluded that the problems which were being experienced were of sufficient magnitude that repair could not be effected by rework. Therefore, it was recommended that the entire assembly be replaced by a proven design such as Engelmann, or equivalent.

Task 12, "Repair of Defective GFP" was added to the GSI contract by Modification No. 20 dated 30 April 1973. This contract mod provided for the following tasks to be accomplished: provide for the integrity of the grounding of the base lead of the oscillator transistor and of certain circuit grounding lugs in the phase locked frequency sources in the S/L up converters, the S/L down converters, and the 810 circuits comprising 23 circuits in all; and to provide replacement Engelmann frequency sources for the C-Band up converters and down converters, comprising 7 in all. Grounding integrity was assured by the application of silver epoxy to the critical points.

On 5 May 1973,an order was placed with Engelmann Microwave for the seven (7) frequency sources with delivery of four (4) units scheduled 10 weeks and 3 more units in 12 weeks. Problems at Engelmann, such as schedule priorities, parts delivery and then technical difficulties, slowed delivery of first four (4) units to October, 1973.

GSI In-Plant Testing of these first units over the temperature range of -25.6° F to +122° F revealed that two of the units were unable to meet the phase lock criteria, and they were returned to Engelmann for readjustment.

Three basic problems were noted:

a) Tuning range not properly centered to provide both high and low frequency limits as specified.

b) One of the two Phase Lock Loops (inner loop) was too sensitive to temperature changes.

c) The appearance of two spurs about the phase-locked carrier one separated about ± 1.5 MHz and the other about ± 10 MHz.

The GSI engineer who had tested these units and was familiar with the problems, was assigned to personally deliver them back to Engelmann, and to remain there to monitor the rework and adjustment, and to verify that they were in fact viable over the specified temperature range. Abbreviated tests were performed at room temperature, as were high and low specification temperatures. The completed units were hand carried back to Baltimore, where more extensive testing was performed. The units operated satisfactorily and were hand carried to both Rosman and Mojave by a GSI engineer. He installed the new frequency sources in the C-Band up converter and C-Band performance monitor.

Testing of the equipment in its operational environment revealed the requirement for additional amplification from the Engelmann unit. The Engelmann frequency source delivered a nominal +10 dBm output while field testing revealed the need for +25 dBm. Design reviews with GSFC resulted in the GSI manufacturing additional amplifiers that bridged the Engelmann output deficiency. Seven amplifiers were delivered in May 1974.

REFERENCES:

- Westinghouse Proposal for Repair of Up-Converter Frequency Multiplier Drawers, dated 4 August 1972.
- GSI Letter C/F 9735, Repair of GFE dated 15 August 1972
- GSI Letter "False Locks" dated 16 August 1972
- GSI Letter "Pre-Proposal SOW" dated 14 September 1972
- GSI Letter C/F 9874 Repair of GFE, Proposal dated 2 October 1972
- GSI Progress Reports dated October, November and December 1972
- GSI Letter ATSN-109, Major Equipment Problems dated 14 December 1972
- GSI Letter ATSN-112 Phase Locked Frequency Source Mod. dated 26 December 1972
- GSI Letter ATSN-116, Phase Locked Oscillators dated 5 February 1973
- GSI Letter ATSN-122, Adjustment Phase Locked Frequency Sources dated 16 February 1973
- GSI Letter ATSN-131, Design Review Report Phase Locked Oscillators dated 23 May 1973
- GSI Memo Phase Locked Frequency Source Test Results dated 31 October 1973
- GSI Memo Final Acceptance Testing Report dated 15 November 1973
- GSI Monthly Reports
- GSI Design Review Meetings
- GSI Trip Report dated 21 November 1973
- GSI Trip Report dated 13 July 1973

2.11 POST LAUNCH ENGINEERING (TASK III)

This task delineates the requirement to provide the necessary personnel to perform post-launch operational analysis and engineering assistance, at the senior engineering level. These services were stipulated to start 3 months prior to launch of ATS-F, and the beginning of this effort was to coincide with the completion of the Integration and Test period. For contractual purposes, this date was established as January 15, 1974. As this date approached, it became necessary, due to various ATS Program delays, to extend the Integration and Test period two months. This post-launch engineering support did actually begin, by definition and agreement, on March 15, 1974.

Initially, the GSI was required to furnish 10 engineers that would be apportioned to the ground stations as the need required. By RFP 5-93608-240 dated October 23, 1973, GSFC requested a cost proposal reflecting previous verbal directives that reduced the 10 Post Launch engineers to 5. The cost reduction proposal was submitted December 12, 1973. This reduction of post-launch engineers has not been formalized by contract modification, however the GSI has been responsive to the verbal directive to furnish 5 such engineers.

The responsibilities of these engineers include being cognizant of the station equipment health including RF, ADP and experimenter equipment, interfaces, and overall ability and readiness of the station to properly support the experiment. They will assist in resolving experiment test procedure discrepancies, and will assist in devising and conducting special test procedures where they are needed but do not already exist, and will help in defining as completely as possible the problem parameters. If required, they will assist in isolation or analysis of special equipment or system troubles and in general will make their knowledge and expertise available to any situation requiring it.

Since this assignment has just started there is no writeup on their past activities for this report.

2.12 PROGRAM MANAGEMENT

In order to perform effectively and to conform with the various contract articles, the GSI Program Manager, prior to contract start, prepared and issued to all GSI personnel a "Program Management and Cost Control Plan". This internal document provided the guidance to each 51 engineers for the accomplishment of all task objectives, allowed an immediate start with contract go ahead, and established a spend plan for each task. This document was used by the GSI Program Management to ensure that Westinghouse fulfilled all contractual obligations, and that progress was made with minimal problems and according to schedule. From this initial management activity to the present time, Management remained alert and responsive to the Program and GSFC requirements. In order to provide and maintain close contact with GSFC, a liaison engineer was immediately assigned at start of contract to GSFC. This liaison engineer at all times kept GSFC appraised of GSI activities and progress, and provided a constant and reliable channel of communication between the GSI and GSFC. This liaison was especially important during the formulation of the program in the early months of the contract.

An important management tool devised early in the program was the Master Control Networks. The Network format and content was developed and delivered in preliminary form to GSFC in December 1970. Approval of the Network was obtained and the final version was delivered in January, 1971. A derivative of the Master Network Plan was the bi-weekly Milestone Listing which was compiled and delivered in mid-February 1971. For approximately the next two years, the useful life span, the Master Control Network and Milestone Listings were updated and submitted regularly.

Constantly changing program conditions required a great deal of flexibility and the exercise of dilligence on the part of Management in optimizing schedules and work efforts, and in effectively utilizing and assigning personnel. Schedule changes were frequently required and made. Recommendations for improvement of specific items affecting schedule were often made to GSFC or to the GSI Integration Team. To keep abreast of all events, Westinghouse Management conducted regular and frequent internal staff meetings. These meetings provided the vital cross flow of information and the visibility necessary for effective and good management. Any resulting action items were tasked to the proper GSI engineer or to GSFC, with the staff meeting minutes providing the vehicle of record and response.

The GSI provided strong management control of the schedule, GSI performance, and personnel resources throughout the program. As a result, timely execution of the program was obtained, cost effectiveness was maintained, and most important ground station readiness was accomplished to support the launch of ATS-F and post-launch missions.

Management also served to produce and issue a number of management oriented plans and/or reports. A preliminary Safety and Health Plan was delivered in preliminary form in early January and then in final form at end of January, 1971. Also prepared and delivered was the monthly Financial Report, NASA Form 533 that provided GSFC visibility for financial control of the Program.

GSI Performance Evaluation Reports were submitted every six months throughout the contract. New Technology Reports were issued on an annual basis in conformance with Contract Article XV.

Upon completion of the Integration and Test effort, management directed and controlled the compilation and production of a very important and useful set of documents entitled the Test Data Report. This report consisted of eleven books in seven volumes. It contained all the GSI Test Procedures and resultant test data. Volume I contained a summary of all the test data, a test data report and a test data analysis. The information in these volumes is valuable as a baseline of equipment performance and giving procedures that can test for that performance.

REFERENCES:

- BI-Monthly Milestone Reports
- Financial Management Reports (NASA Form 533)
- Monthly Reports
- Quarterly Reports
- Annual New Technology Reports
- Master Control Network Submissions (PERT)
- GSI Ltr. C/F 8196 dated 1/25/71 Safety and Health Plan Submission
- Test Data Report

APPENDIX A

TEST PLAN OUTLINE

PHASE I

EQUIPMENT AND INTERFACE TESTS

1.1	GSI FURNISHED EQUIPMENT AND INTERFACE TESTS
1.2	GFE FURNISHED EQUIPMENT AND INTERFACE TESTS
1.3	POWER AND GROUND TESTS
1.3.1	Prime Power Voltage Test
1.3.2	Neutral Isolation Test
1.3.3	Rack Ground Current Test
1.4	INTERFACE CABLE TESTS
1.4.1	IF Cable Impedance Profile (TDR Measurements)
1.4.2	IF Return Loss Test

PHASE II

SUBSYSTEM TESTS

2.1	TRANSMITTER MODULATOR TESTS
2.1.1	Sensitivity, Linearity and Group Delay
2.1.2	70 MHz Output, Spurious and Harmonics
2.2	RECEIVER PERFORMANCE MONITOR DEMODULATOR TESTS
2.2.1	Sensitivity, Linearity and Group Delay
2.2.2	70 MHz Output and Spurious Levels
2.3	RECEIVER #1 IF AND DEMODULATOR TESTS
2.3.1	Sensitivity, Linearity and Group Delay
2.3.2	AGC Characteristics, Instantaneous Bandwidth and Amplitude Flatness
2.4	RECEIVER #2 IF AND DEMODULATOR TESTS
2.4.1	Sensitivity, Linearity and Group Delay
2.4.2	AGC Characteristics, Instantaneous Bandwidth and Amplitude Flatness
2.5	TRANSMITTER PERFORMANCE MONITOR DEMODULATOR TESTS
2.5.1	Sensitivity, Linearity and Group Delay
2.5.2	AGC Characteristics, Instantaneous Bandwidth, and Amplitude Flatness
2.6	TRANSMITTER MODULATOR/TRANSMITTER PERFORMANCE MONITOR DEMODULATOR TESTS (BB-IF-BB)
2.6.1	Linearity and Group Delay
2.6.2	Baseband Frequency Response and Envelope Delay
2.6.3	Noise Power Ratio NPR/TPR
2.6.4	Video Test
2.6.4.1	Insertion Gain
2.6.4.2	Continuous Random Noise (S/N)
2.6.4.3	Periodic Noise
2.6.4.4	Differential Gain
2.6.4.5	Differential Phase
2.6.4.6	Field and Line Time Linear Waveform Distortion
2.6.4.7	Short Time Waveform Distortion
2.6.4.8	Synchronizing Signal Distortion
2.6.5	TV Sound Tests
2.7	RECEIVER PERFORMANCE MONITOR MODULATOR AND RECEIVER #1 TESTS

2.7.1	Baseband Frequency Response and Envelope Delay
2.7.2	Noise Power Ratio (NPR/TPR)
2.7.3	Video Tests
2.7.3.1	Insertion Gain and Stability
2.7.3.2	Continuous Random Noise (S/N)
2.7.3.3	Periodic Noise
2.7.3.4	Differential Gain
2.7.3.5	Differential Phase
2.7.3.6	Field and Line Time Linear Waveform Distortion
2.7.3.7	Short Time Waveform Distortion
2.7.3.8	Synchronizing Signal Distortion
2.7.4	Linearity and Group Delay
2.8	RECEIVER PERFORMANCE MONITOR MODULATOR/RECEIVER #2
2.8.1	Baseband Frequency Response and Envelope Delay
2.8.2	Noise Power Ratio (NPR/TPR)
2.8.3	Linearity and Group Delay
2.9	L-BAND TRANSMITTER TESTS
2.9.1	Gain Linearity (70 MHz-RF)
2.9.2	Instantaneous Bandwidth and Amplitude Flatness (70 MHz-RF)
2.9.3	Spectrum Analysis (70 MHz-RF)
2.9.4	Amplitude Linearity (70 MHz-RF)
2.9.5	Gain Linearity (70 MHz-RF-70 MHz)
2.9.6	Instantaneous Bandwidth, Amplitude Flatness and Group Delay (70 MHz-RF-70 MHz)
2.9.7	Short Term Frequency Stability (70 MHz-RF-70 MHz)
2.9.8	Amplitude Linearity (70 MHz-RF-70 MHz)
2.9.9	Group Delay, Linearity (BB-RF-BB)
2.9.10	Noise Power Ratio (NPR/TPR) (BB-RF-BB)
2.10	S-BAND TRANSMITTER TESTS
2.10.1	Gain Linearity (70 MHz-RF)
2.10.2	Instantaneous Bandwidth and Amplitude Flatness (70 MHz-RF)
2.10.3	Spectrum Analysis (70 MHz-RF)
2.10.4	Amplitude Linearity (70 MHz-RF)
2.10.5	Gain Linearity (70 MHz-RF-70 MHz)

2.10.6	Instantaneous Bandwidth, Amplitude Flatness and Group Delay (70 MHz-RF-70 MHz)
2.10.7	Short Term Frequency Stability (70 MHz-RF-70 MHz)
2.10.8	Amplitude Linearity (70 MHz-RF-70 MHz)
2.10.9	Group Delay, Linearity (BB-RF-BB)
2.10.10	Baseband Frequency Response and Envelope Delay (BB-RF-BB)
2.10.11	Noise Power Ratio (NPR/TPR) (BB-RF-BB)
2.11	C-BAND TRANSMITTER TESTS
2.11.1	Gain Linearity (70 MHz-RF)
2.11.2	Instantaneous Bandwidth and Amplitude Flatness (70 MHz-RF)
2.11.3	Spectrum Analysis (70 MHz-RF)
2.11.4	Amplitude Linearity (70 MHz-RF)
2.11.5	Gain Linearity (70 MHz-RF-70 MHz)
2.11.6	Instantaneous Bandwidth, Amplitude Flatness and Group Delay (70 MHz-RF-70 MHz)
2.11.7	Short Term Frequency Stability (70 MHz-RF-70 MHz)
2.11.8	Amplitude Linearity (70 MHz-RF-70 MHz)
2.11.9	Group Delay, Linearity (BB-RF-BB)
2.11.10	Baseband Frequency Response and Envelope Delay (BB-RF-BB)
2.11.11	Noise Power Ratio (NPR/TPR)
2.11.12	Video Test (BB-RF-BB)
2.11.12.1	Continuous Random Noise
2.11.12.2	Periodic Noise
2.11.12.3	Differential Gain and Phase
2.11.13	TV Sound Tests
2.12	L-BAND RECEIVER TESTS
2.12.1	Instantaneous Bandwidth and Amplitude Flatness (RF-70 MHz)
2.12.2	Gain Linearity, Spectrum Analysis and Image Rejection Test (RF-70 MHz)
2.12.3	Amplitude Linearity (RF-70 MHz)
2.12.4	Gain Linearity, Instantaneous Bandwidth, Amplitude Flatness and Group Delay (70 MHz-RF-70 MHz)
2.12.5	Receiver/System Noise Temperature (RF-70 MHz)
2.12.6	Short Term Frequency Stability (70 MHz-RF-70 MHz)
2.12.7	Amplitude Linearity (70 MHz-RF-70 MHz)

2.16.1 Baseband Frequency Response (BB-RF-BB)

2.16.2 Noise Power Ratio (NPR/TPR) (BB-RF-BB)

2.16.3 Short Term Frequency Stability (BB-RF-BB)

PHASE III
SYSTEM TESTS

3.1	BASEBAND BACK-TO-BACK LOOP
3.1.1	Frequency Response
3.1.2	NPR/TPR
3.1.3	Video Tests:
3.1.3.1	Continuous Random Noise
3.1.3.2	Periodic Noise
3.1.3.3	Differential Gain and Phase
3.1.4	Audio Channel Tests
3.2	IF LOOP
3.2.1	Group Delay & Linearity
3.2.2	Baseband Frequency Response and Envelope Delay
3.2.3	NPR/TPR
3.2.4	Video Tests
3.2.4.1	Continuous Random Noise
3.2.4.2	Periodic Noise
3.2.4.3	Differential Gain and Phase
3.2.5	Audio Channel Tests
3.3	L-BAND SYSTEM TESTS
	BB-RF-BB
3.3.1	Group Delay & Linearity
3.3.2	Freq. Response & Envelope Delay
3.3.3	NPR/TPR
	70 MHz-RF-70 MHz
3.3.4	Gain Linearity
3.3.5	Inst. Bandwidth, Amplitude Flatness & Group Delay
3.3.6	Short Term Freq. Stability
3.3.7	Amplitude Linearity
3.4	S-BAND SYSTEM TESTS
3.4.1	Group Delay & Linearity
3.4.2	Freq. Response & Envelope Delay
3.4.3	NPR/TPR

PHASE IV

4.1	COLLIMATION TOWER CROSS-STRAP MODE TESTS
4.1.1	L to C-Band Cross-Strap Tests via Collimation Tower
4.1.1.1	Gain Linearity
4.1.1.2	Instantaneous Bandwidth, Amplitude Flatness and Group Delay
4.1.1.3	Short Term Frequency Stability
4.1.1.4	Amplitude Linearity
4.1.1.5	IF Spectrum Analysis
4.1.2	C to L-Band Cross-Strap Test via Collimation Tower
4.1.2.1	Gain Linearity
4.1.2.2	Instantaneous Bandwidth, Amplitude Flatness, and Group Delay
4.1.2.3	Short Term Frequency Stability
4.1.2.4	Amplitude Linearity
4.1.2.5	IF Spectrum Analysis
4.1.3	S to C-Band Cross-Strap Tests via Collimation Tower
4.1.3.1	Gain Linearity
4.1.3.2	Instantaneous Bandwidth, Amplitude Flatness, and Group Delay
4.1.3.3	Short Term Frequency Stability
4.1.3.4	Amplitude Linearity
4.1.3.5	IF Spectrum Analysis
4.1.4	C to S-Band Cross-Strap Tests via Collimation Tower
4.1.4.1	Gain Linearity
4.1.4.2	Instantaneous Bandwidth, Amplitude Flatness and Group Delay
4.1.4.3	Short Term Frequency Stability
4.1.4.4	Amplitude Linearity
4.1.4.5	IF Spectrum Analysis
4.2	SPACECRAFT UNIQUE TESTS
4.2.1	C-Band Command Link Test
4.2.2	L-Band P.A. Broad Band Response
4.2.3	PCM Error Rate Test
4.2.4	Spacecraft Verification Tests - TBD
4.3	EXPERIMENTER UNIQUE TESTS
4.3.1	VHRR

4.3.1.1	VHRR - IF Bandwidth, Amplitude Flatness and Group Delay
4.3.1.2	VHRR - Baseband Frequency Response
4.3.1.3	VHRR - Three Tone Intermodulation
4.3.2	PLACE
4.3.2.1	L-Band Transmitter Output Variation Capability and Low Level Amplitude Stability
4.3.2.2	Long Term Frequency Stability
4.3.3	TRUST
4.3.3.1	Audio Subcarrier Intermodulation Test
4.3.4	RFI (ROSMAN ONLY)
4.3.4.1	RFI Waveguide Loss
4.3.4.2	Paramp and Waveguide Run Long Term Amplitude Stability
4.3.4.3	Test Cable Loss (74-84 MHz)
4.3.4.4	RFI NPR Test
4.3.5	Data Relay Experiment
4.3.5.1	Instantaneous Bandwidth, Amplitude Flatness and Group Delay (ROSMAN ONLY)
4.3.5.2	Modulator Tests (ROSMAN ONLY)
4.3.5.3	VSWR of Interface with Nimbus Simulator (ROSMAN & MOJAVE)
4.4	SPECIAL TESTS
4.4.1	Radio Frequency Interference Tests (Rosman)
4.4.2	Radio Frequency Interference Tests (Mojave)
4.4.3	Off-Station Radio Frequency Interference Tests (Rosman)
4.4.4	Off-Station Radio Frequency Interference Tests (Mojave)

HYBRID SUBSYSTEM MEASUREMENTS

Phase I

1.1	TIMING SUBSYSTEM
1.1.1	Frequency and Phase Checks
1.1.1.1	Frequency Measurement and Adjustment Test
1.1.2	Signal Tests
1.1.2.1	Voltage and Waveform Test
1.2	C-BAND SUBSYSTEM
1.2.1	Transmitter Tests
1.2.1.1	Gain Linearity
1.2.2	Receiver Tests
1.2.2.1	RF Gain
1.2.2.2	Gain Linearity
1.2.2.3	Rec. System Noise Temperature
1.2.3	IF-TO-IF Loop Tests
1.2.3.1	Short Term Frequency Stability
1.2.3.2	Instantaneous Bandwidth, Ampl. Flatness, & Group Delay
1.2.4	BB-TO-BB Loop Tests
1.2.4.1	NPR/TPR Measurements
1.2.4.2	Continuous Random Noise (S/N)
1.2.4.3	Differential Gain
1.3	S-BAND SUBSYSTEM
1.3.1	Transmitter Tests
1.3.1.1	Gain Linearity
1.3.2	Receiver Tests
1.3.2.1	RF Gain
1.3.2.2	Gain Linearity
1.3.2.3	Receive System Noise Temperature
1.3.3	IF-TO-IF Loop Tests
1.3.3.1	Short Term Frequency Stability
1.3.3.2	Instantaneous Bandwidth, Ampl. Flatness, & Group Delay
1.3.4	BB-TO-BB Loop Tests
1.3.4.1	NPR/TPR Measurements
1.4	L-BAND SUBSYSTEM
1.4.1	Transmitter Tests

1.4.1.1	Gain Linearity
1.4.2	Receiver Tests
1.4.2.1	RF Gain
1.4.2.2	Gain Linearity
1.4.2.3	Receive System Noise Temperature
1.4.3	IF-TO-IF Loop Tests
1.4.3.1	Short Term Frequency Stability
1.4.3.2	Instantaneous B.W., Ampl. Flatness & Group Delay
1.5	UHF BAND SUBSYSTEM
1.5.1	Receiver Tests
1.5.1.1	RF Gain
1.5.1.2	Gain Linearity
1.5.1.3	Receive System Noise Temperature
1.5.2	IF TO IF Loop Tests (C-UHF)
1.5.2.1	Instantaneous B.W., Amplitude Flatness & Group Delay
1.5.2.2	IF Spectrum Analysis
1.6	21 FOOT ANTENNA SUBSYSTEM
1.6.1	C-Band
1.6.1.1	Transmitting Gain (6150 MHz)
1.6.1.2	Receiving Gain & Vertical Pattern (3950 MHz)
1.7	15 FOOT ANTENNA SUBSYSTEM
1.7.1	S-Band
1.7.1.1	Transmitting Gain (2250 MHz)
1.7.1.2	Receiving Gain & Vertical Pattern (2075 MHz)
1.7.2	L-Band
1.7.2.1	Transmitting Gain (1650 MHz)
1.7.2.2	Receiving Gain & Vertical Pattern (1550 MHz)
1.8	RANGING SUBSYSTEM
1.8.1	C-Band
1.8.1.1	Range Comparison; Hyb. Tml. vs Mojave Sta.

HYBRID SYSTEM NETWORK TESTS

Phase II

2.1	CROSS-STRAP MODE TESTS VIA COLLIMATION TOWER
2.1.1	S-Band to C-Band Mode
2.1.1.1	Gain Linearity
2.1.1.2	Instantaneous B.W., Ampl. Flatness, & Group Delay
2.1.1.3	Short Term Frequency Stability
2.1.2	C-Band to S-Band Mode
2.1.2.1	Gain Linearity
2.1.2.2	Instantaneous B.W., Ampl. Flatness, & Group Delay
2.1.2.3	Short Term Frequency Stability
2.2	S/C UNIQUE TESTS
2.2.1	C-Band Command Test
2.2.2	PCM Error Rate Test
2.3	EXPERIMENTER UNIQUE TESTS
2.3.1	VHRR Experiment
2.3.1.1	Baseband Frequency Response
2.3.1.2	Three Tone Intermod.
2.3.2	Trust Experiment
2.3.2.1	Intermodulation Measurement
2.3.3	TDR&E Experiment
2.3.3.1	Instantaneous B.W., Ampl. Flatness, & Group Delay