FINAL REPORT

PROJECT NO. A–2132

94/183 GHz MULTICHANNEL RADIOMETER FOR CONVAIR FLIGHTS

By

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Prepared For

GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland 20771
Contract NAS5–24480

January, 1979

GEORGIA INSTITUTE OF TECHNOLOGY

Engineering Experiment Station

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16. Abstract

A multichannel 94/183 GHz radiometer was designed, built, and installed on the NASA Convair 990 research aircraft to take data for hurricane penetration flights, SEASAT-A underflights for measuring rain and water vapor, and Nimbus-G underflights for new sea ice signatures and sea surface temperature data (94 GHz only). The radiometer utilized IF frequencies of 1, 5, and 8.75 GHz about the peak of the atmospheric water vapor absorption line, centered at 183.3 GHz, to gather data needed to determine the shape of the water molecule line. Another portion of the radiometer operated at 94 GHz and obtained data on the sea brightness temperature, sea ice signatures, and on areas of rain near the ocean surface.

The radiometer used a multiple lens antenna/temperature calibration technique using 3 lenses and corrugated feed horns at 94 GHz and 183 GHz. Alignment of the feed beams at 94 GHz and 183 GHz was accomplished using a 45° oriented reflecting surface which permitted simultaneous viewing of the feeds on alternate cycles of the chopping intervals. This technique is referred to as the "super chopper" concept. A microstrip multiplexer was used in the 183.3 GHz portion of the radiometer. A split block mixer at 183 GHz was designed to allow wider IF bandwidths.

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FOREWORD

This final report was prepared by the Electromagnetics Laboratory of the Engineering Experiment Station, Georgia Institute of Technology under Contract NAS5-24480. The contract was initiated by the Applications Directorate of NASA Goddard Space Flight Center, Greenbelt, Maryland. The contract was administered by J. L. King of the Earth Observations Systems Division.

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PREFACE

The primary objective of this program was to design, build, and flight test a multichannel 94/183 GHz radiometer on the NASA Convair 990 aircraft. The flight data taken by the radiometer was in support of Project Storm Fury (hurricane flights), SEASAT-A satellite underflight program over the Gulf of Alaska, and Nimbus-G satellite underflight program over the Greenland Sea, the Norwegian Sea, and the Pacific Ocean. Components from the 183 GHz radiometer used on NASA Contract NAS5-23603 (refer to Georgia Tech Final Technical Report A-1866) were augmented by adding a nominal 8.75 GHz IF channel. The new 94 GHz RF portion of the radiometer used a nominal 2.3 GHz IF channel. Both the 94 GHz and 183 GHz lens feeds used corrugated conical horns designed to provide low sidelobe antenna patterns. Alignment of the feed beams at 94 GHz and 183 GHz was accomplished using a 45° oriented reflecting surface which permitted simultaneous viewing of the feeds on alternate cycles of the chopping intervals. This concept is referred to as the "super chopper" concept. The lens focal lengths were modified to accommodate the super chopper blade.

Major new components of the radiometer include: a mixer at 183 GHz designed to allow wider IF bandwidths and constructed using a split block technique, a mixer at 94 GHz utilizing a GaAs Schottky barrier diode mounted in a Sharpless-type mount, a four-port microstrip triplexer with the capability of allowing dc bias to be applied to the 183 GHz mixer diode, a tuned LO injection cavity at 94 GHz, low-noise, high gain amplifiers at 2 GHz and 8.75 GHz, super chopper blade for simultaneous chopping at 94 GHz and 183 GHz, and expanded microprocessor control and display of the data collected.

The purpose for constructing the multichannel 94/183 GHz radiometer was to measure the atmospheric attenuation due to water vapor absorption near the water vapor absorption line centered at 183.35 GHz. The 8.75 GHz IF channel provides additional data to aid in determining the shape of the water vapor absorption line. The 94 GHz RF portion of the

radiometer yields data on the brightness temperature of the sea and the atmosphere in those cases where the radiometer can see to ground level, and in the areas of precipitation where the radiometer sees the cold cosmic background scattered by the raindrops.

Installation of the radiometer onboard the NASA Convair 990 was completed on 26 June 1978 at the NASA Ames Research Center at Moffett Field, California. Engineering test checkout flights were completed on 30 June 1978. Artic flights in the vicinity of Fairbanks, Alaska took place from 11 July to 13 July 1978, for a total of 16 flight hours. Hurricane flight support was provided on Hurricane Cora with deployment of the Convair out of Puerto Rico and on Hurricane Rosa with deployment from San Diego, California.

SEASAT-A underflights were performed out of Seattle, Washington, during the time span of 10 September to 21 September. The measurements for water vapor and rain cell detection were performed over the Gulf of Alaska.

Nimbus-G underflight program was initiated on 25 October and ended on 19 November. Test sites for performing sea surface temperature, new sea ice and snow signature measurements, and near-surface winds include the Artic Ocean, Greenland Sea, Greenland Test Sites, Norwegian Sea/Ocean Polar Front, Pacific Ocean, and Gulf of Alaska. Only the 94 GHz radiometer was used for the Nimbus-G underflight program.

The radiometer system was removed from the Convair 990 the week of 20 November and returned to Georgia Tech.

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1.0 INTRODUCTION

The flight geometry of the 94/183 GHz radiometer is illustrated in Figure 1. Two beam angles for viewing the scene are shown. The sky view is at 15° upwards from a level flight position of the aircraft. The earth view is a downward view of 45° achieved using an external deflector. The beamwidth of the scene being viewed is 2.5° at 183 GHz and 5.0° at 94 GHz. Figures 2 and 3 show the chopping scheme used to view the scene alternately between the 94 GHz feed and the 183 GHz feed using a dielectric lens and a rotating chopper. Figure 2 shows the scene viewed by the 94 GHz feed horn while the 183 GHz feed views the reference load. Rotating the chopper blade one slot position as shown in Figure 3 results in the 183 GHz feed horn viewing the scene and the 94 GHz feed horn viewing the reference.

A block diagram of the 94/183 GHz multichannel radiometer is shown in Figure 4. The scene is chopped at a 200 Hz rate using the super chopper concept described above. In the 94 GHz case, the signal is mixed with a klystron local oscillator and down-converted to a 2.32 GHz IF. In the 183 GHz case, the signal is mixed with a solid state doubler driven by the klystron LO and then down-converted to IF's at 1, 5, and 8.75 GHz. These three IF channels are triplexed, amplified, and then filtered. Following amplification, the signals are video detected and then routed to video amplifiers. The video amplifiers are low noise, high gain devices having bandpass responses tailored for each channel. The video outputs are synchronously detected using phase sensitive detectors. The microcomputer digitizes the outputs of the phase sensitive detectors, controls the storage of data from all four channels onto the cartridge tape recorder, performs periodic automatic calibration and converts voltage readings to temperature data. The data recorded are proportional to the apparent brightness temperature for each channel.

Figure 5 shows the radiometer channel allocation along the water vapor absorption line centered at 183.35 GHz. Simultaneous measurements

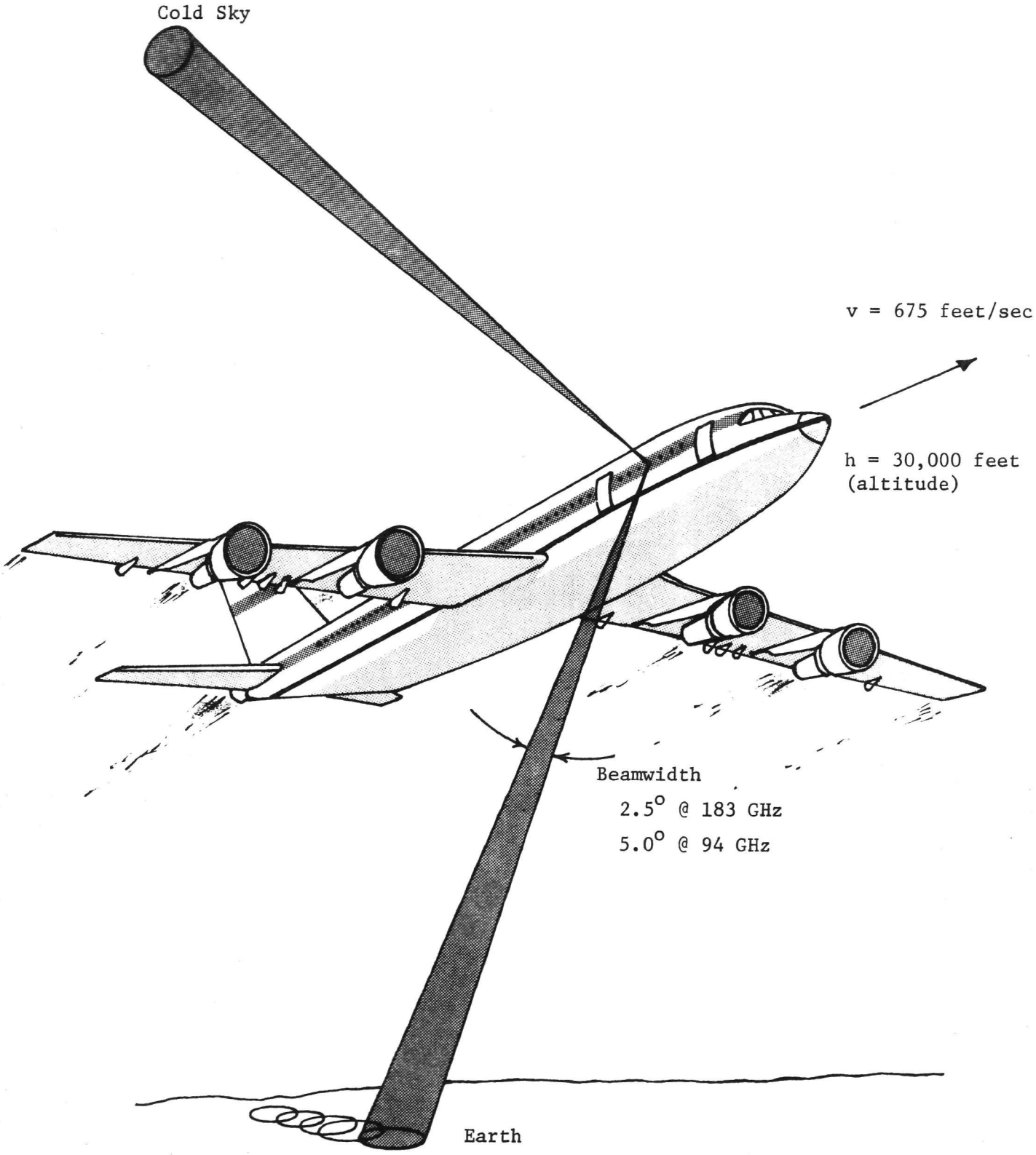

Figure 1. CV 990 Aircraft - Radiometer Flight Geometry.

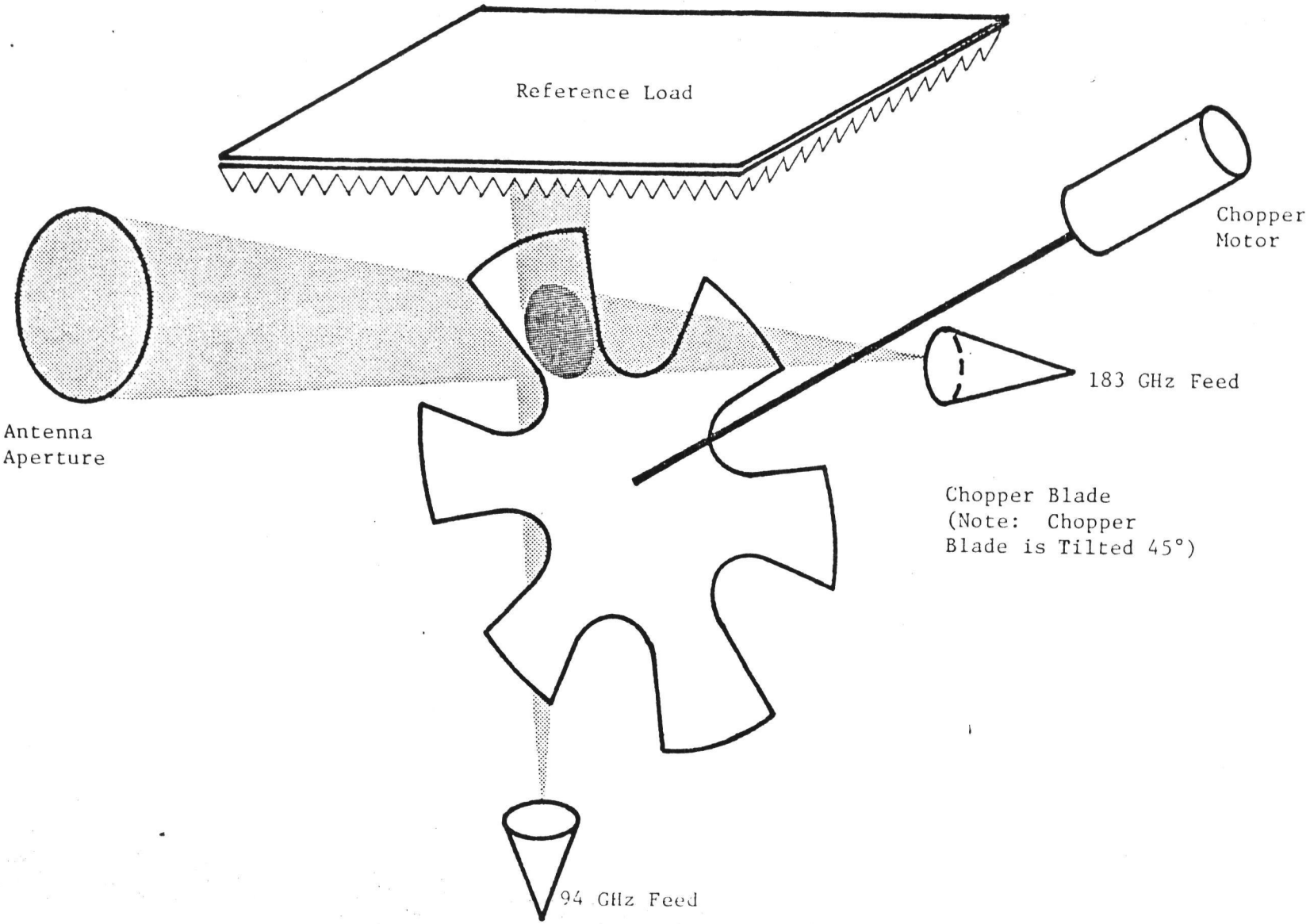

Figure 2. Super-Chopper Concept - Shown Reflecting To Antenna At 94 GHz and Reflecting Into Reference Load at 183 GHz.

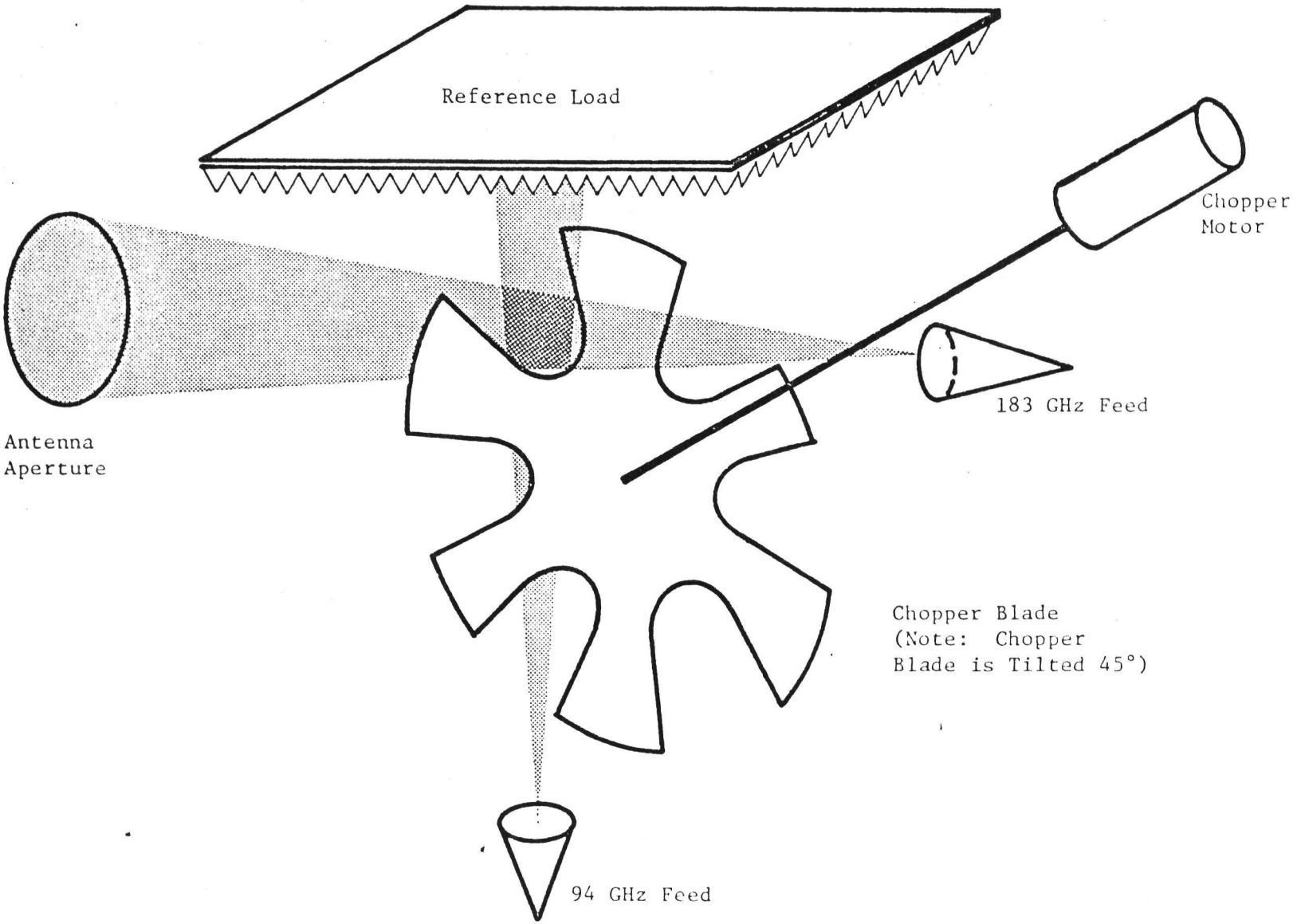

Figure 3. Super-Chopper - Shown Transmitting To Reference Load at 94 GHz and Transmitting to Antenna at 183 GHz.

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at three channels provide a more accurate estimate of water vapor concentration by determining the shape of the absorption line over a $\pm$ 10.5 GHz portion of the spectrum. Figure 5 also illustrates the low atmospheric attenuation at 91.675 GHz. The 94 GHz portion of the radiometer yields data on the brightness temperature of the sea and on areas of precipitation near the ocean surface.

The 94/183 GHz radiometer consists of a front-end assembly designed to mount in a Convair 990 passenger window and a console of rack mountable electronics assembled in a Convair 990 equipment rack. The power supplies and associated interface electronics between the front-end and the console are packaged in a separate chassis mounted in an aircraft low-boy rack. Figure 6 is a view of the front-end showing the "super chopper" blade housing with the hot reference load mounted directly above. Figure 7 shows the control console which contains the data processing equipment used to process and display the data measured by the radiometer. On the rear of the microcomputer system panel are the connections required to send analog data to the ADDAS computer and serial link data to the Goddard computer. All connections between the various modules were made with multi-conductor shielded cables using "MS" type connectors. This was done to insure reliable connections and also to facilitate the installation and removal of equipment.

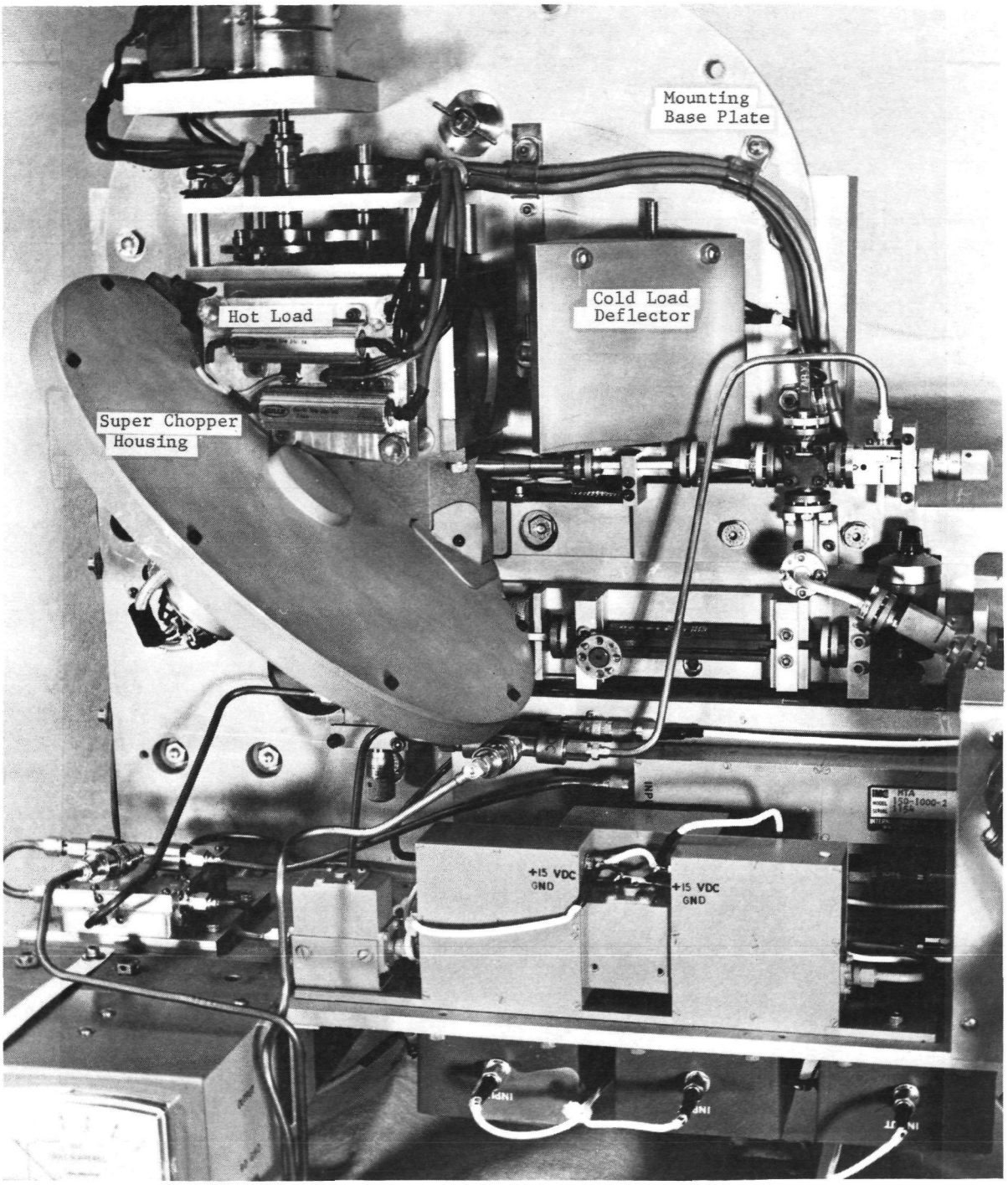

Figure 6. 94/183 GHz Radiometer (Window Mounted Components).

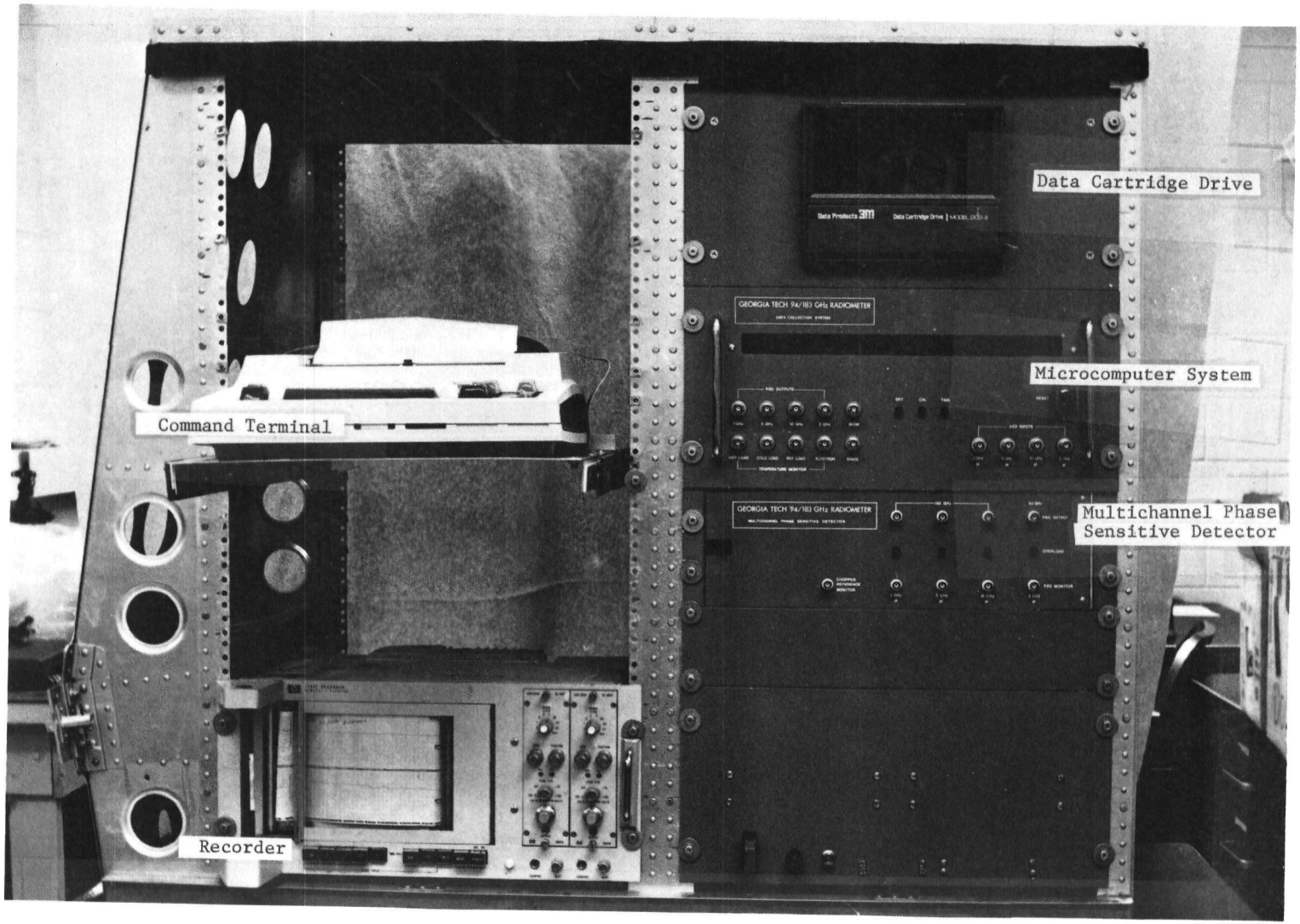

Figure 7. 94/183 GHz Radiometer (Rack Mounted Components).

2.0 RADIOMETER COMPONENTS

2.1 Front-End System

The radiometer front-end uses three 2.0 inch diameter lenses as follows: one for viewing the scene, one for viewing the hot load, and one for viewing the cold load. These lenses are of a f/1.767 design using a single refracting structure having a grooved anti-reflection flat surface toward the scene and a spherically curved surface toward the focus. Further details are contained in the Georgia Tech Final Technical Report A-1866, Section 2.1.

The 94 GHz and 183 GHz feed horns are corrugated conical horns having symmetric far-field patterns, small sidelobes and backlobes. Figures 8, 9, and 10 are antenna patterns for the 183 GHz feed horn and 94 GHz feed horn, respectively. The feed horns and lenses are mounted in a housing illustrated in Section 2.1 of the Final Technical Report A-1866. This housing contains the Geneva mechanism reflector used to select the scene, hot load, or cold load. The hot and cold loads are manufactured from cast lossy dielectric materials having machined grooves at the Brewster angle of the dielectric. As reported in Report A-1866, the cold load is heat sunk to the aircraft skin producing a temperature of 260°K in flight. The hot load is heated to a temperature of 340°K using two power resistors as heating elements.

Figure 11 shows the antenna mechanism with attached hot load mounted above the super chopper housing. The 183 GHz mixer shown is of split block construction with a low-pass filter structure having a roll-off near 14 GHz. A tuneable cavity provides LO injection at 183 GHz. The 94 GHz mixer shown in Figure 11 is a single-ended mixer design using a GaAs Schottky barrier diode. The LO injection diplexer is a directional filter providing low RF losses in the signal path and in the local oscillator path. Figure 12 is measured data on the insertion loss of the 94 GHz directional filter.

The microstrip triplexer is a three port device with IF outputs at 1, 5, and 8.75 GHz. It was designed to pass dc bias current through the 1 GHz port to the 183 GHz mixer diode. Figure 13 depicts the layout concept for the triplexer. The package is mounted on the front-end as shown in Figure 11.

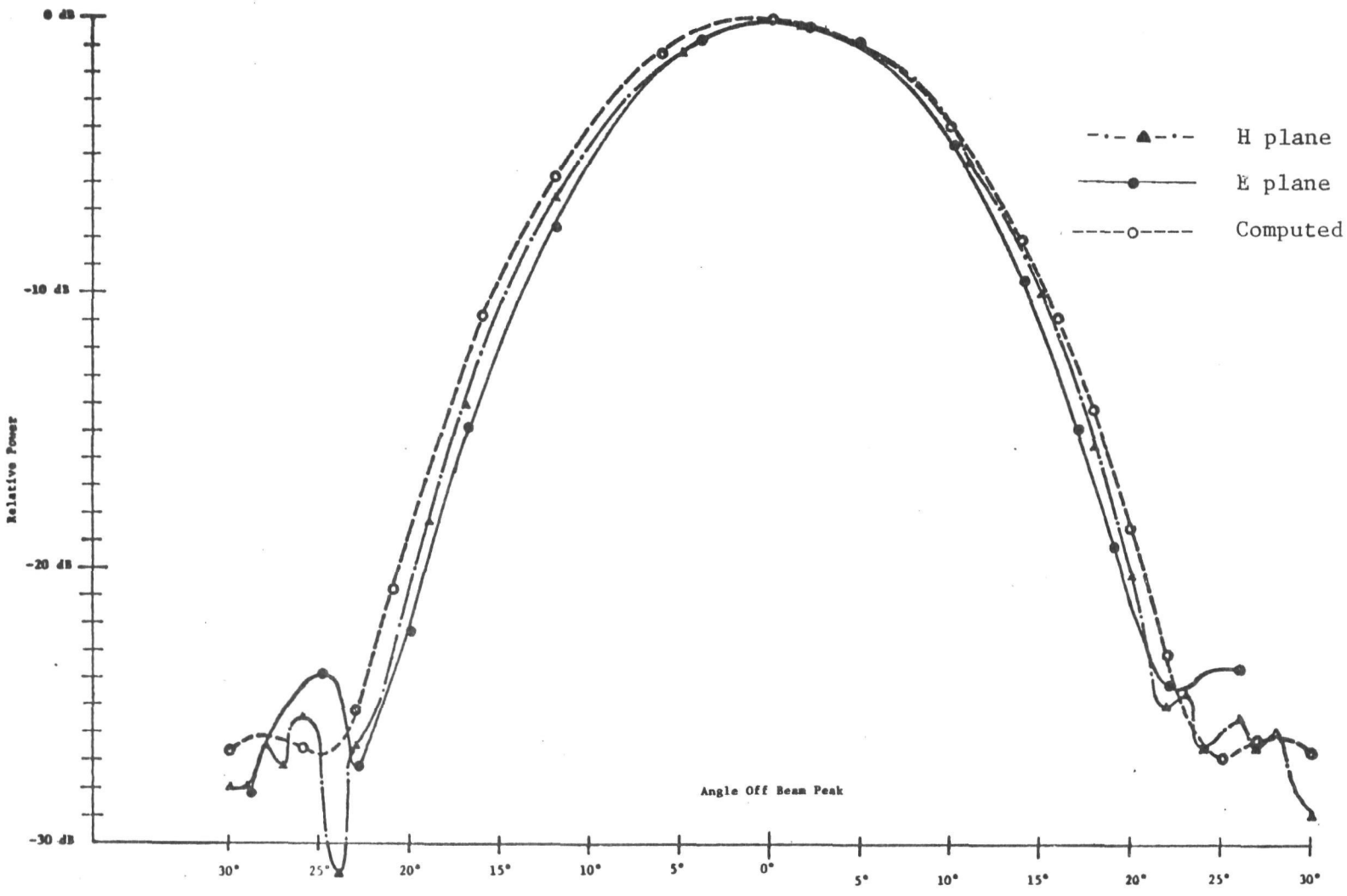

Figure 8. Measured and Calculated 180 GHz Feed Horn Antenna Pattern.

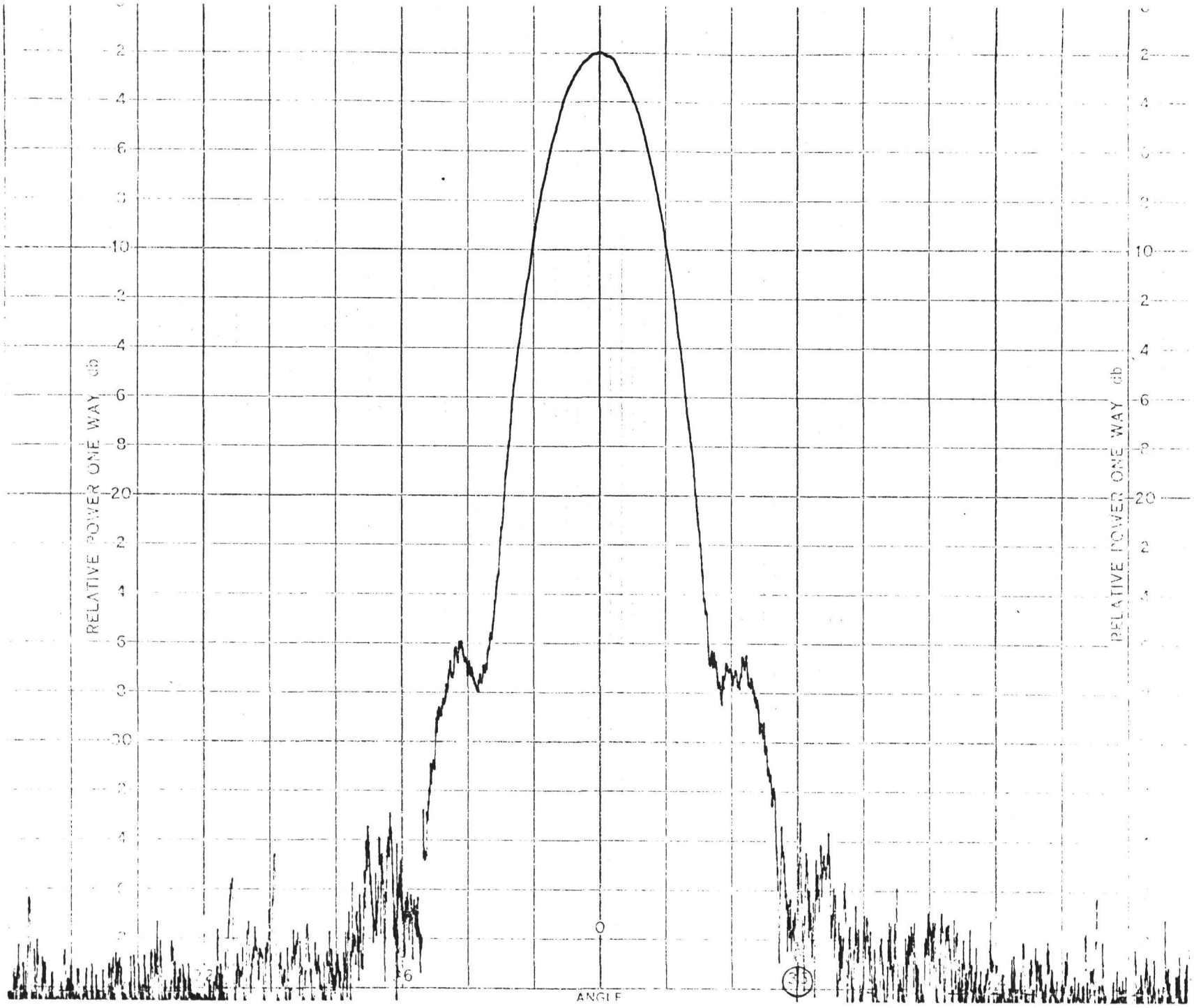

Figure 9. Corrugated Horn Pattern, E-Plane (94.5 GHz).

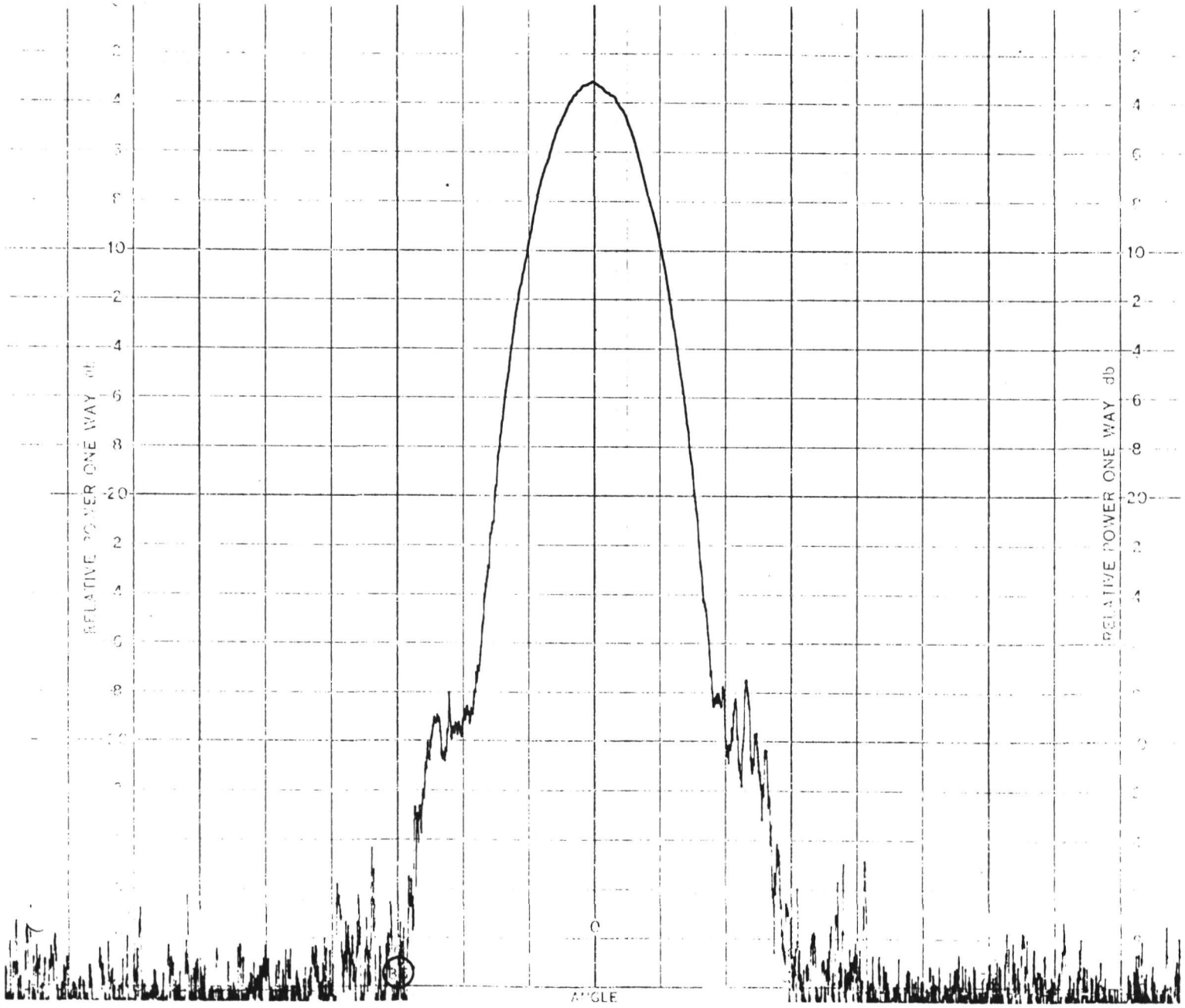

Figure 10. Corrugated Horn Pattern, H-Plane (94.5 GHz).

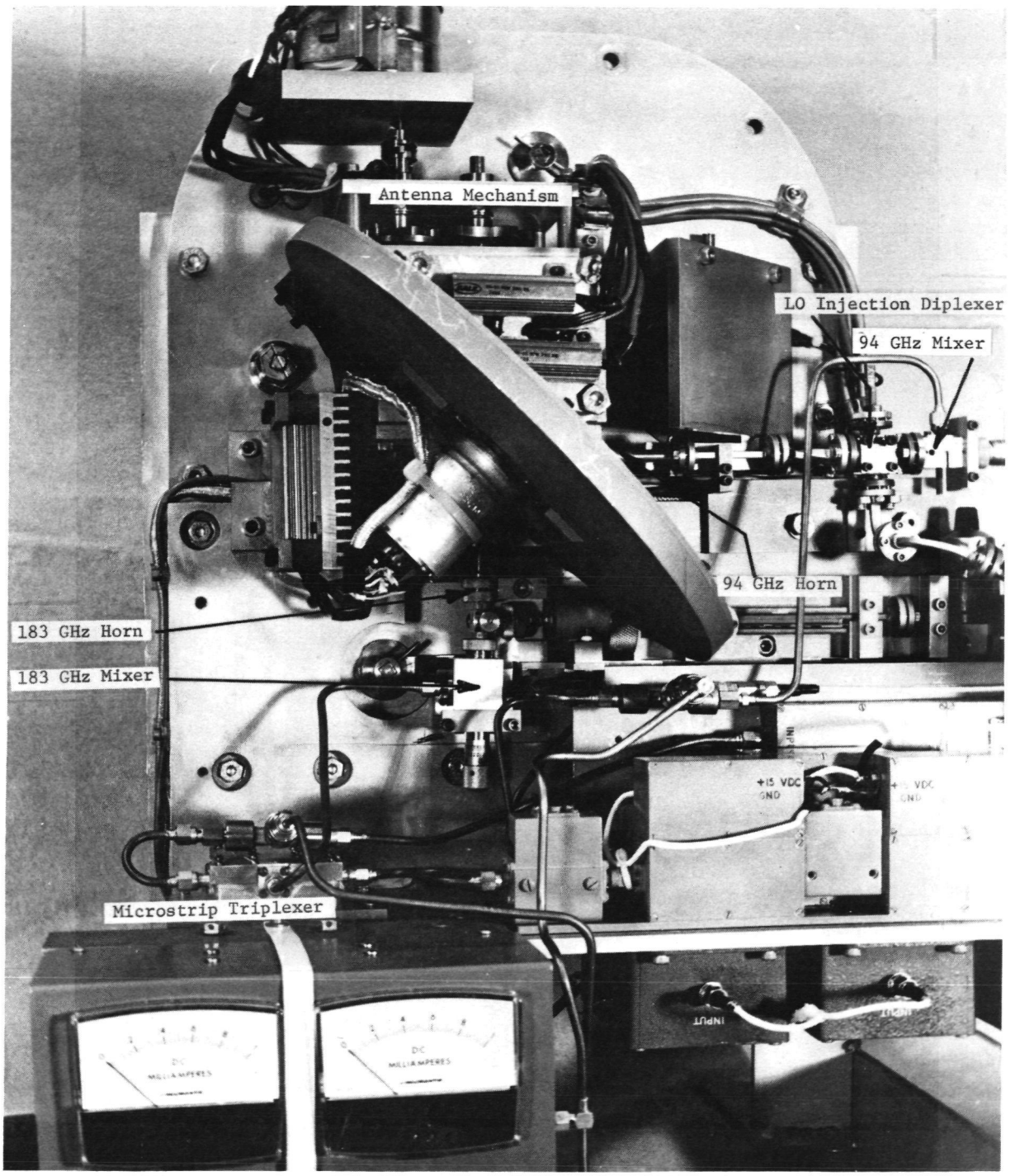

Figure 11. 94/183 GHz Radiometer (Showing Major Components).

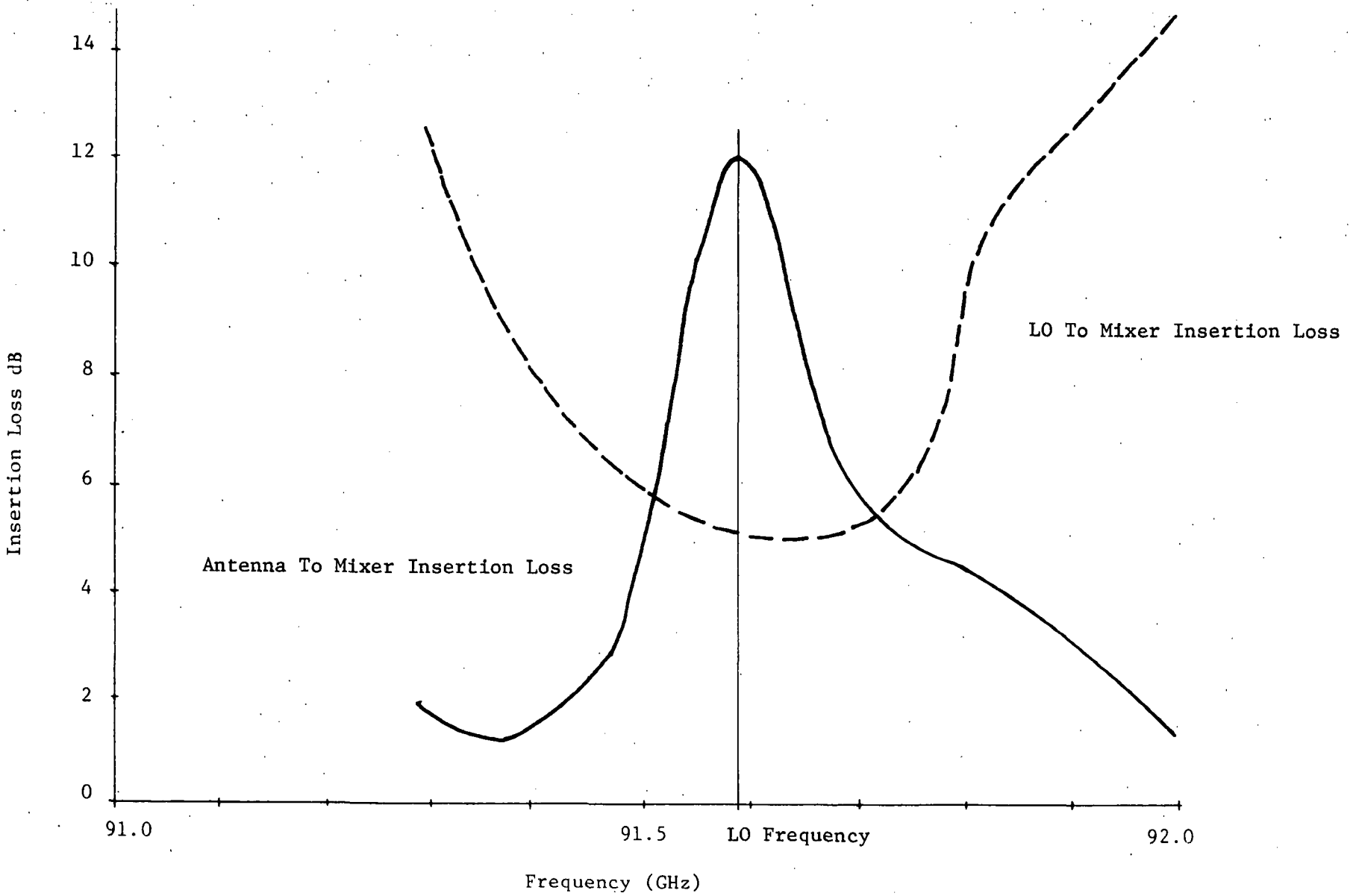

Figure 12. Insertion Loss Measured From LO to Mixer (Dotted Line) and Mixer to Antenna (Solid Line) of 91.65 GHz Directional Filter. Less than 0.5 dB loss at signal sidebands of 88.8 to 89.8 GHz and 93.5 to 94.5 GHz.

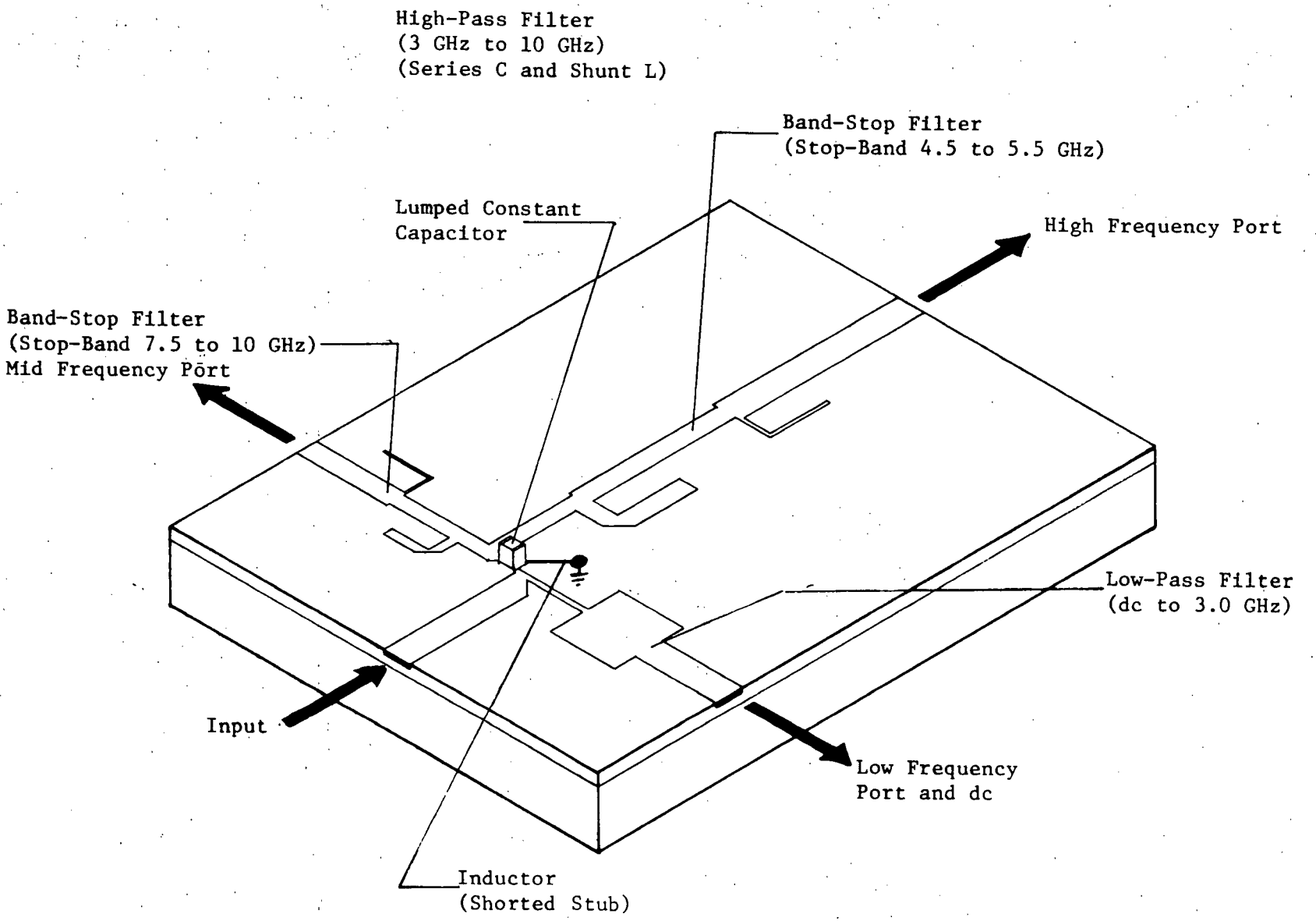

Figure 13. Microstrip Triplexer (With dc Port).

Four IF amplifiers were used to produce channels at 1, 5, and 8.75 GHz removed from the RF frequency of 183 GHz and at 2 GHz removed from the RF frequency of 94 GHz. The microstrip triplexer couples the 183 GHz mixer to the 1, 5, and 8.75 GHz IF amplifiers. Bandpass filters follow the outputs of the 1 and 5 GHz amplifiers. A cavity filter follows the 8.75 GHz IF amplifier's output. The 2 GHz IF amplifier is preceded and followed by separate bandpass filters. The purpose of the filters is to provide the desired frequency response for each channel. Figures 14 through 17 are measured gain versus frequency plots for all four IF channels.

A tunnel diode detector at each filtered IF amplifier's output is used to detect the chopped noise signal from the scene. Since the maximum change in the detector's output is in the order of millivolts, a video amplifier with high gain and low noise characteristics is required prior to synchronous detection. The video amplifier will boost the signal to the nominal 0 to 10 volt range. Figure 18 is a plot of the video amplifier's gain versus frequency.

2.2 Interface System

The front-end of the radiometer is interconnected to the rack-mounted data processor with the interface system. The interface system consists of the following: linear thermistor amplifiers, chopper reference signal generator, Geneva mechanism logic circuit, and ac/dc power supplies.

The thermistor amplifiers convert the resistance of thermo-linear thermistors mounted on the hot load, cold load, reference load, and klystron into a dc voltage proportional to the temperature of the load being measured. The chopper reference is a TTL signal output operating at approximately 200 Hz frequency. The chopper itself has an upper limit of 600 Hz. This signal is an input to the phase sensitive detectors to be described later. The Geneva mechanism circuit accepts a start command from the data processor and sends the 115 Vac signal used to energize the motor driving the calibration reflector.

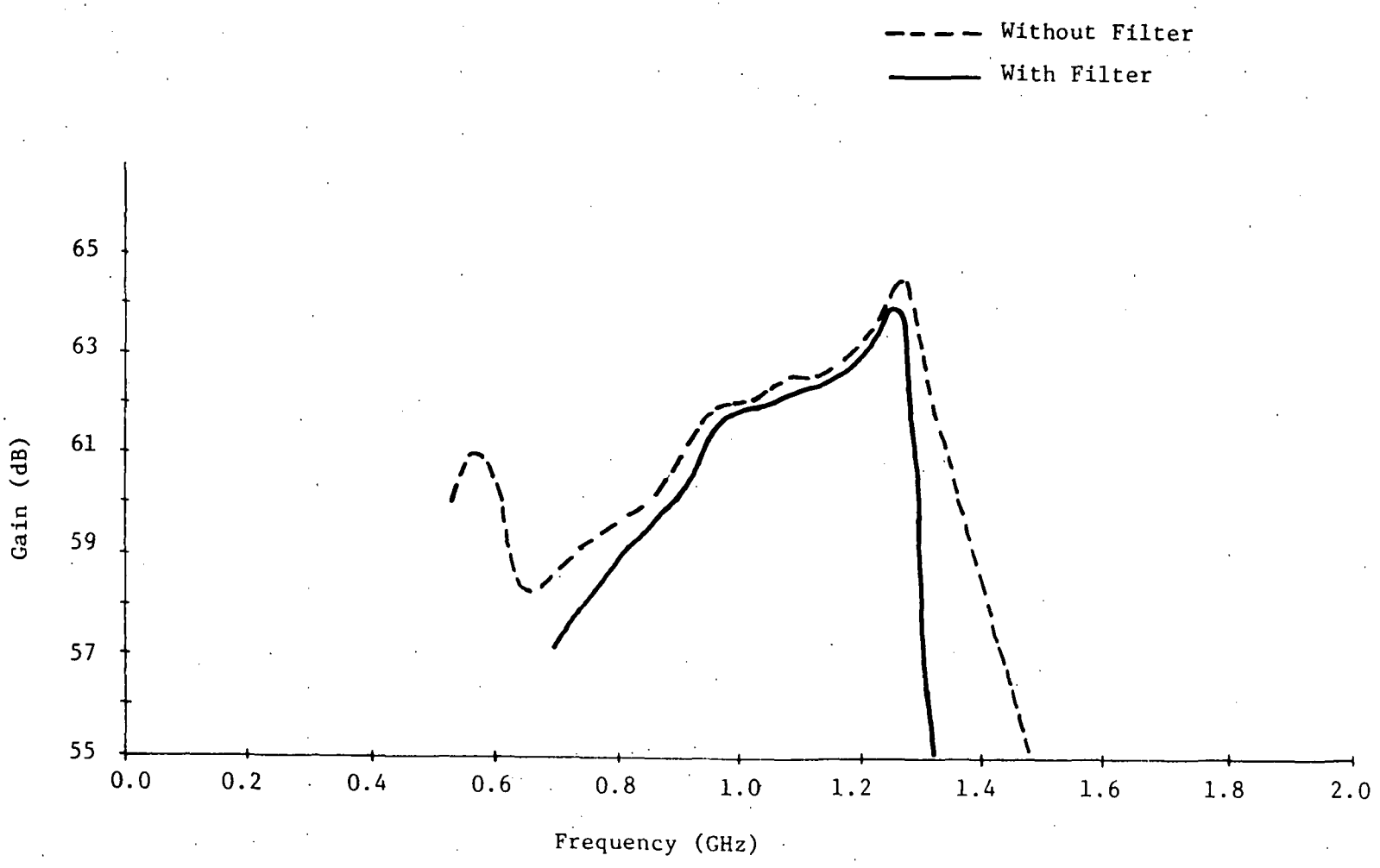

Figure 14. Measured Gain Versus Frequency of 1 GHz IF Amplifier.

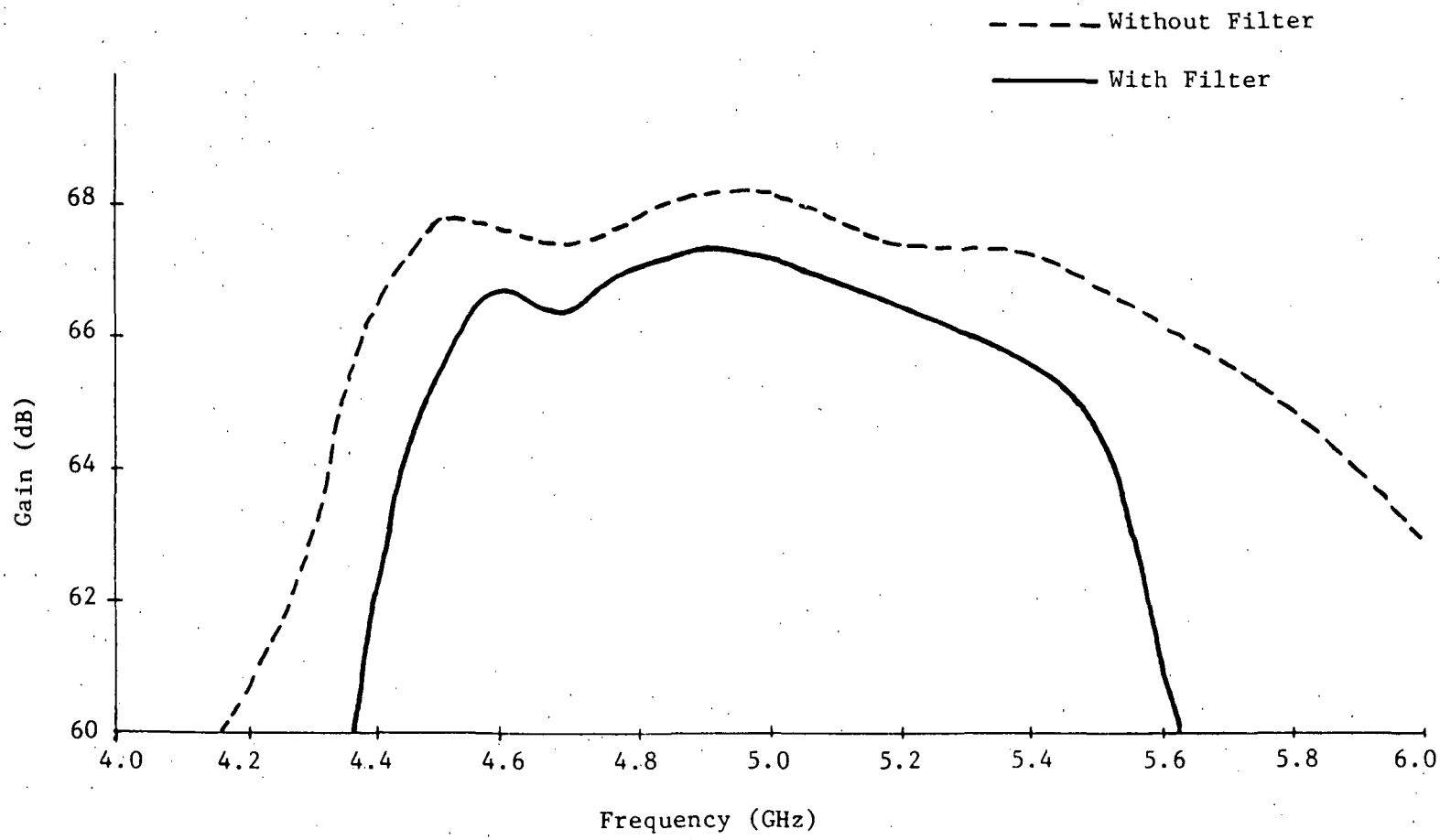

Figure 15. Measured Frequency Response of 5 GHz IF Amplifier.

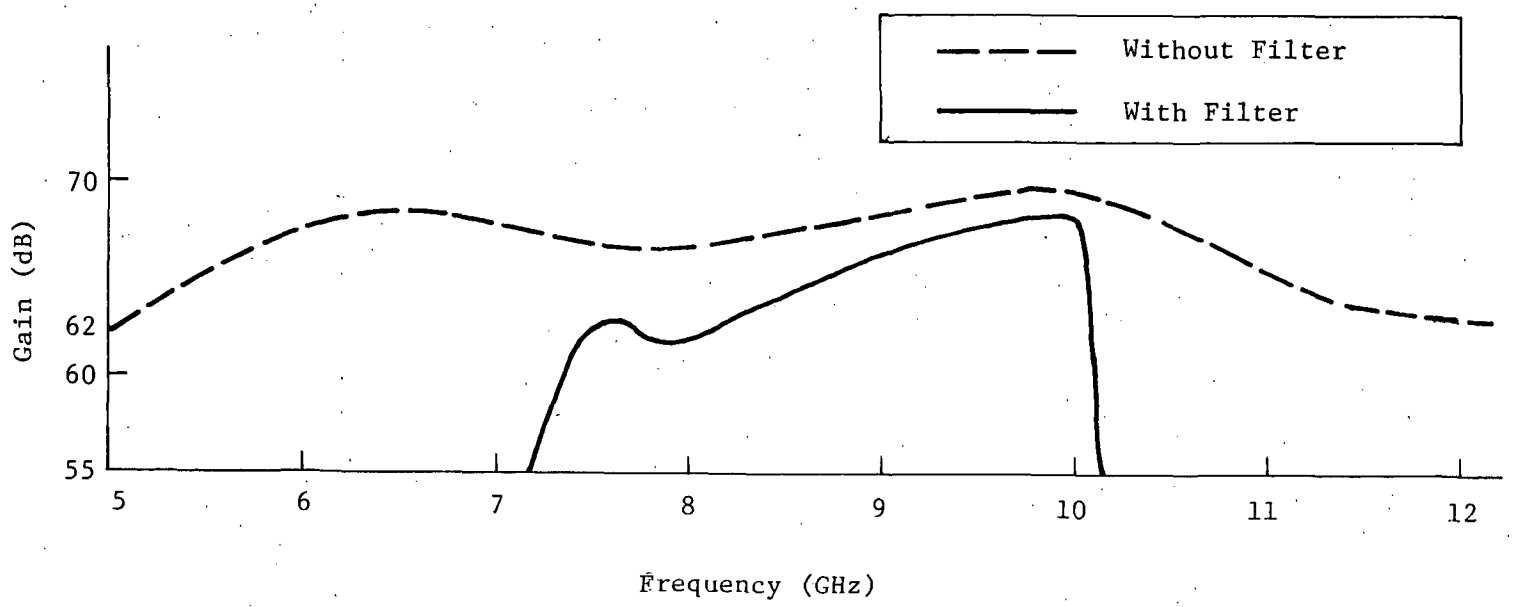

Figure 16. Measured Gain versus Frequency of 10 GHz IF Amplifier (183 GHz Channel).

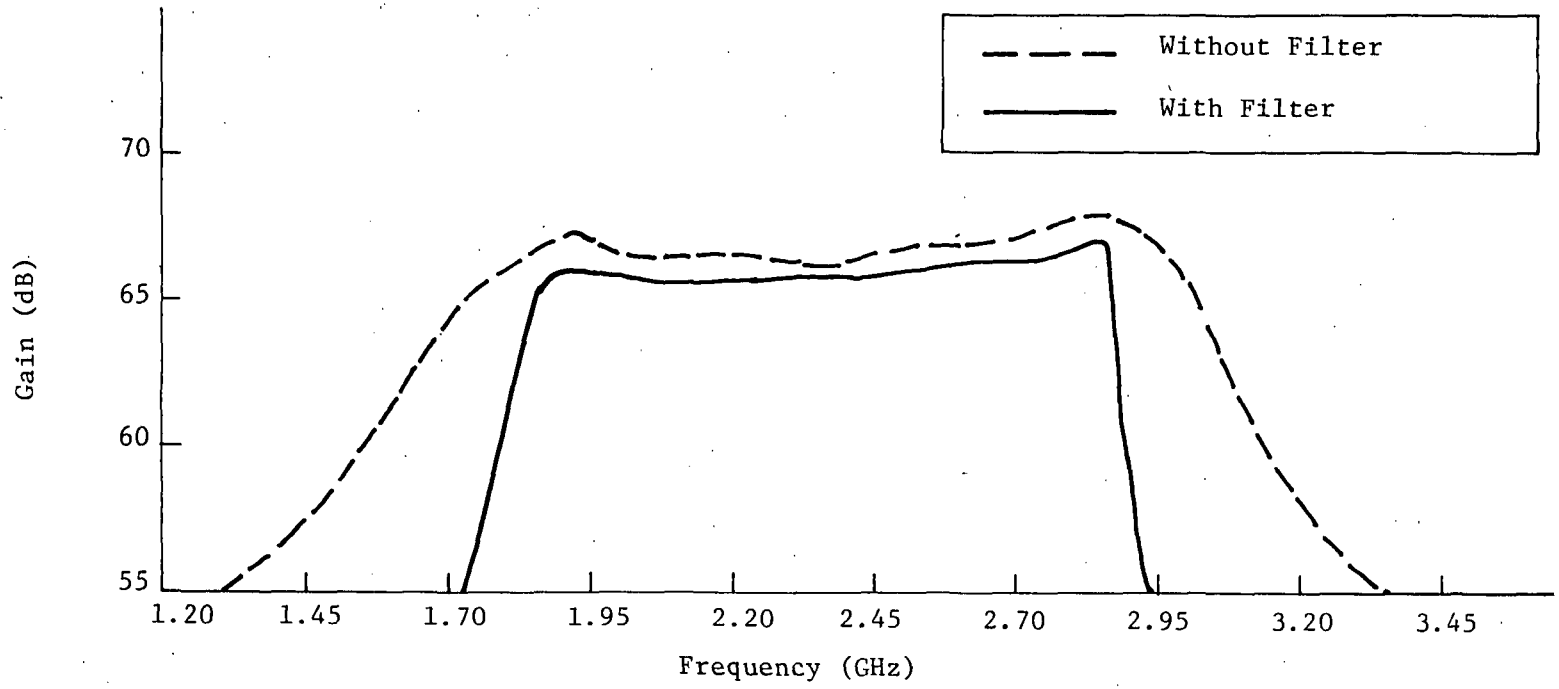

Figure 17. Measured Gain versus Frequency of 2.3 GHz IF Amplifier (94 GHz Channel).

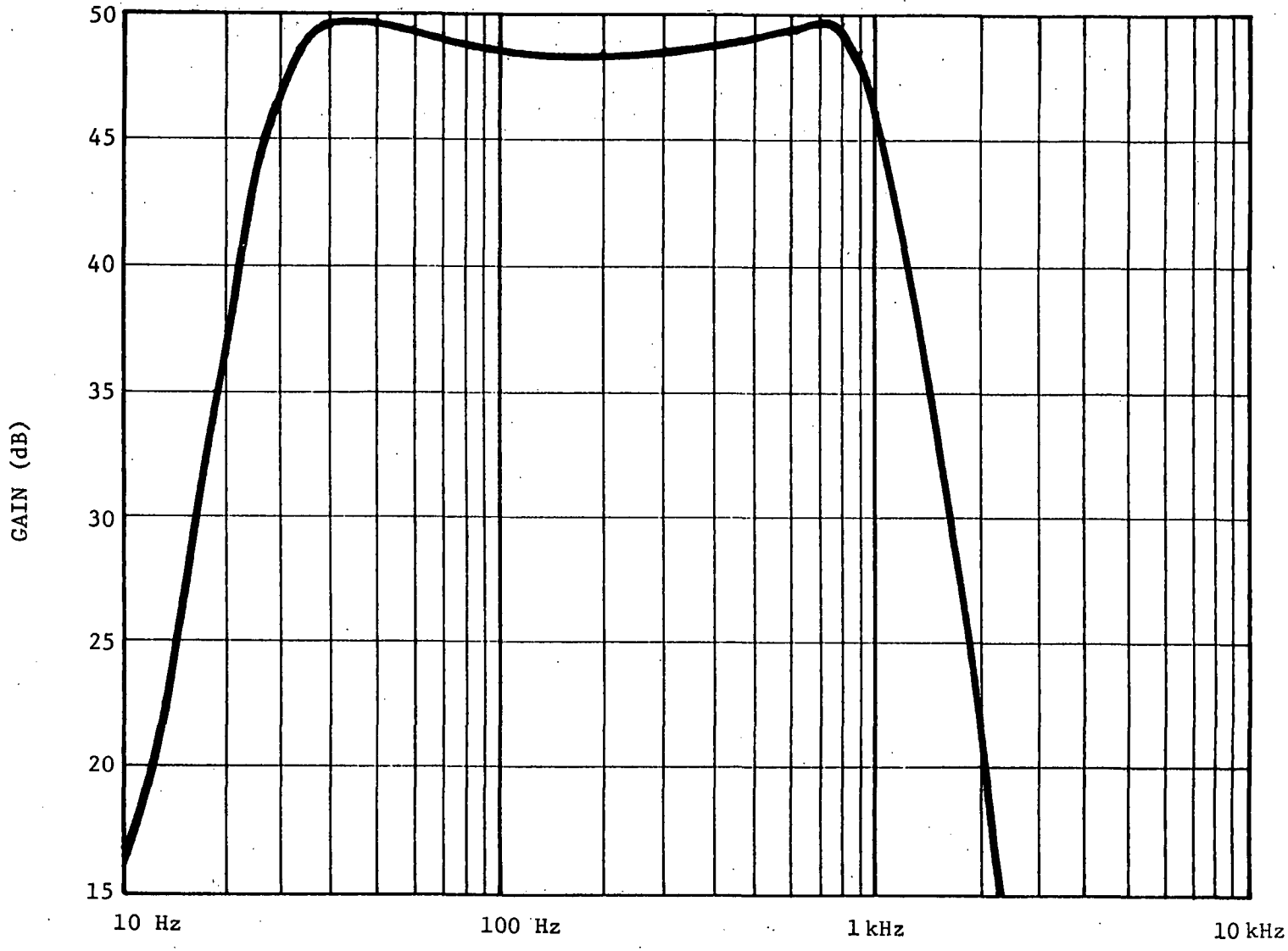

Figure 18. Video Amplifier Frequency Response.

Power supplies generate the necessary dc voltages required by the IF amplifiers (+ 15, and + 12 Vdc), the video amplifiers (± 15 Vdc), and the super chopper motor (+ 24 Vdc). Figure 19 is a photograph of the interconnect box containing the interface electronics and power supplies. This system was installed in the low-boy rack beneath the window mounted radiometer front-end.

2.3 Data Processing System

The data processing system (see Section 1.0, Figure 7) collects data during flight and stores data for future analysis if desired. The outputs from the video amplifiers described in Section 2.1 are fed to the four channel phase sensitive detector panel. Each phase sensitive channel consists of Evans Instruments Models 4110 and 4114 phase sensitive detector and phase control unit, respectively. The Model 4110 consists of a variable gain ac amplifier, bandpass filter, multiplier, integrator, and low gain dc amplifier stage. The bandpass filter center frequency is 200 Hz, i.e. chopping frequency. The integration time constant is 250 msec as derived later on in this section. The chopper reference from the interconnect box drives the Model 4114 phase control unit. The Model 4114 output is a square wave shifted in phase up to 180°. This reference signal is multiplied with the radiometer signal in the Model 4110 phase sensitive detector. The output of the Model 4110 is a dc voltage which is proportional to the scene temperature.

A multichannel A/D converter is used to sample the sources of data, such as the outputs of the phase sensitive detectors. The microcomputer is used to record the data from the A/D converter. There are nine primary sources of data that are recorded from the radiometer. These are the four phase sensitive detector outputs which correspond to brightness temperatures in the three 183 GHz and one 94 GHz channels and five temperature sensor outputs. In addition, several housekeeping parameters such as time, date and flight number are recorded periodically for identification of data. Table 1 summarizes all data sources, their size in bits and how often they are recorded.

Figure 19. 94/183 GHz Radiometer Interface Electronics Package.

TABLE 1

94/183 GHz CONVAIR 990 RADIOMETER DATA SOURCES

DATA SOURCE	DESIGNATION	SIZE (BITS)	RECORDING INTERVAL
PSD OUTPUTS:			
183 GHz Channel 1	PSD1	12	$\tau/2$
183 GHz Channel 2	PSD2	12	$\tau/2$
183 GHz Channel 3	PSD3	12	$\tau/2$
94 GHz	PSD4	12	$\tau/2$
TEMPERATURES:			
Hot Load	HTLD	12	1 per Frame
Cold Load	COLD	12	1 per Frame
Reference Load	RFLD	12	1 per Frame
Klystron	KLYS	12	1 per Frame
Spare	SPRE	12	1 per Frame
HOUSEKEEPING DATA:			
Radiometer Input Source (Hot Load, Sky, etc)	FTYP	8	1 per Frame
Time (GMT)	TIME	24	1 per Frame
Date (GMT)	DATE	24	1 per Frame
Flight No.	FLNO	8	1 per Frame

The four primary data sources are obviously the four radiometer outputs, PSD1-PSD4, which are outputs from the four phase sensitive detectors (PSD) and correspond directly to brightness temperatures. In order to satisfy the Nyquist-rate sampling, these outputs should be sampled at least once every $\tau/2$ seconds where τ is the integration time of the phase sensitive detector. τ is chosen to yield an acceptable ΔT_{min} within the constraints of the relative "speed" of the observed phenomenon. Even if τ is shorter than the integration time required for the desired ΔT_{min}, post flight integration with a longer τ is possible if the data are sampled and recorded at $\leq \tau/2$. There are some transient phenomenon associated with cloud layers close to the aircraft that produce radiometer signatures at 183 GHz of less than one second. In addition, the 94 GHz channel was viewing the ground where relatively rapid temperature variations were observed from altitudes up to 30,000 feet. Some ground temperature variations were also noted at 183 GHz.

It is desirable to use as short an integration time as possible consistent with a practical recording capacity from the cartridge tape recorder. The load temperature and housekeeping data are relatively slow changing data and were not recorded as often as the radiometer data. Since the ASCII cartridge tape standard specifies a maximum record length of 2048 bytes*, it was convenient to record the load temperature and housekeeping data once per record. Thus, each tape record has 108 bits or roughly 14 bytes of "overhead" leaving 2030 bytes for data. Each tape cartridge has a capacity of 2.8 megabytes. After allowing for starting and stopping delays and inter-record gaps (IRG) 1200 blocks were recorded on a cartridge. Thus approximately 2.436 megabytes were available for recording the four radiometer channels on each cartridge. Since each radiometer data word is 12 bits (see Table 1) 48 bits or 6 bytes are required for all four channels. Since it was

*It is desireable to use the longest record possible since this makes more efficient use of tape by minimizing the number of the starts and stops required.

desired to limit the data recorded to one flight per cartridge and the longest flight did not exceed 7 hours, a recording (data collecting) rate of 16 samples per second suffices. This corresponds to sampling all four channels every 62 ms. Therefore, per Nyquist-rate criteria, $\tau \geq$ 124 ms for the integration time. For all Convair Flights the phase sensitive detector integration time (τ) was 250 ms.

Operation of the microcomputer is controlled from the computer terminal mounted in the aircraft rack. Table 2 is a summary of the operating system commands to the terminal. Appendix A is a listing of the microcomputer operating system software. Appendix B includes electronic schematics of the Data Processing System.

2.4 Packaging Concept

Refer to Final Report A-1866, Section 2.7, in regard to the packaging and mounting of the front-end radiometer to the aircraft window. Drawing No. 1 of Final Report A-1866 shows the heavy aluminum window plate with the radiometer components mounted. Appendix C includes the mechanical drawings of all new parts fabricated at Georgia Tech for the radiometer.

Refer to Appendix C of Final Report A-1866 for the radiometer sub-assemblies carried over to the 94/183 GHz radiometer.

TABLE 2

COMPUTER TERMINAL COMMANDS

TYPED COMMAND	OPERATION
Load	Sets new tape at load point prior to data run
Unload	Resets old tape to load point prior to tape removal
Stop	Stops tape immediately
Forward	Tape advances at normal rate
Fastfor	Tape advances at faster rate
Reverse	Tape reverses at normal rate
Rewind	Tape reverses at faster rate
Read	Reads tape contents onto system memory
Write	Writes system memory contents onto tape
Track	Sets the track number (four per tape)
Data On	Starts data collection on tape
DAta Off	Stops data collection on tape
Out	Switches radiometer to viewing outside (scene)
Hot	Switches radiometer to viewing hot load
Cold	Switches radiometer to viewing cold load
Calibrate	Perform manual calibration between hot and cold load
Status	Terminal prints out status of radiometer system
Set Cal	Select calibration interval in minutes (01 to 99)
Print Cal	Terminal prints out gain and offset for each channel
Disp Hot	Display hot load temperature(°K)on computer display
Disp Cold	" cold " " " " " "
Disp Ref	" reference " " " " " "
Disp Klys	" Klystron " " " " "
Disp 183	" 1,5,& 10 GHz " " " " "
Disp 94	" 2 GHz " " " " "
Avg 183	Display averaged (10 samples/sec) 1,5 & 10 GHz temperatures(°)
Avg 94	Display averaged (10 samples/sec) 2 GHz temperatures(°)
Print Volts	Terminal prints out analog-to-digital converter inputs i.e., 1 GHz, 5 GHz, 10 GHz 2 GHz, Hot Load, Cold Load, Ref Load, Klystron, Spare Thermister
Time	Display time of day, last date block stored, time remaining to next calibration, and data collection status
Set Time	Sets time of day, flight number, and day of year
View	Terminal prints out radiometer viewing port i.e., outside, cold load, or hot load
Init	Display "Ga Tech Radiometer"
Tape	Display tape drive status i.e., track and block number
Print L	Terminal prints out in °K the hot load, cold load, Ref load, klystron, and spare thermistor load
Print R	Terminal prints out in °K the 1 GHz, 5 GHz, 10 GHz, and 2 GHz radiometer temperatures.

3.0 OPERATION OF THE RADIOMETER

Initial warm-up and system check-out occurred prior to takeoff before each Convair flight. This included turning on the klystron power supply and the chopper motor power supply for stabilization. A tape cartridge was installed in the recorder in preparation for data collection. After takeoff, the operator used the computer terminal to start the data collection process. Figure 20 shows a typical terminal command and response operation for setting the time of day. The terminal responds with: Ga. Tech Millimeter Radiometer, link to GSFC status, flight number (00), day (0000), and time (00:00:00). In order to set the flight number, day, and time, the operator types "set time" as shown. The terminal responds by asking the question "flight number?". The operator responded with "01" for that particular flight. Similarly "0179" was entered for the day and 210225 for the time in hours, minutes, and seconds. By typing "Time" the data display panel verifies that the time of day was entered as shown. The radiometer can be calibrated either manually or automatically. By typing "Calibrate", the computer terminal responds as shown. Calibration data includes the gain and offset for each radiometer channel. In order to calibrate automatically, the operator selects a calibration interval (in one minute increments). Usually the calibration cycle was set for two minutes minimum to five minutes maximum. In addition the radiometer stores data on the tape cartridge recorder if the command "Data On" is entered.

Figure 21 demonstrates the "System Status" feature of the data collection system. Features include Data Collection (Ga. Tech tape recorder) On or Off, link to GSFC (Goddard Interdata Computer) On or Off, and Ga. Tech recorder tape drive status. Load temperatures (°K) and radiometer temperatures (°K) are provided. For this status printout the radiometer is viewing the ground, i.e. 45° downward from a level flight position of the aircraft. By typing "Data ON", the system responds as shown providing the time (22:02:28) at which the radiometer begins storing flight data. One block of data is stored every 25

```
GA. TECH MILLIMETER RADIOMETER
CONVAIR 990 VER. 2.0

?LINK TO GSFC ON
FLIGHT NO.   00 DAY 0 0000   TIME 00:00:00
SET TIME
FLIGHT NO.  ?
?01
DAY ?
?0179
TIME ?
?210225

?TIME

?CALIBRATE

FLIGHT NO.   01 DAY 0179   TIME 21:03:14

HOT LOAD - COLD LOAD =037.96
CALIBRATION DATA
            GAIN (DEG/VOLT)     OFFSET (DEG)
183/1 GHZ    040.83              -010.22
183/5 GHZ    043.86              -041.99
183/10 GHZ   060.29              -176.02
94 GHZ       063.06              -196.44
```

Figure 20. Command Sequence for Setting Time of Day and Manual Calibration.

```
?
GA. TECH MILLIMETER RADIOMETER
SYSTEM STATUS


FLIGHT NO.  01 DAY 0179  TIME 22:02:00
DATA COLLECTION OFF
LINK TO GSFC OFF
TAPE DRIVE STATUS: TRACK 00 BLOCK 0036

HOT LOAD TEMP   COLD LOAD TEMP   REF. LOAD TEMP   KLYSTRON TEMP
337.55          271.94           300.66           309.95

RADIOMETER TEMPERATURES
183/1 GHZ  183/5 GHZ  183/10 GHZ  94 GHZ
269.37      273.71      277.37      200.23
RADIOMETER IS VIEWING GROUND
DATA ON
DATA COLLECTION ON
FLIGHT NO.  01 DAY 0179  TIME 22:02:28

?DISP 94
```

Figure 21. Radiometer System Status Printout.

seconds and immediately transferred to Goddard's Interdata Computer. For the hurricane and SEASAT-A underflight programs, three IF channels at 183 GHz and one IF channel at 94 GHz were transferred to Goddard every 25 seconds. For the Nimbus-G underflight program, only the 94 GHz channel was transferred to Goddard every 100 seconds.

In addition to the radiometer's own data storage system, NASA Ames and NASA Goddard recorded data from the Georgia Tech Radiometer. The NASA Ames Airborne Digital Data Acquisition System (ADDAS) continuously monitored the following analog voltages from the radiometer and recorded them on magnetic tape at 0.1 second intervals:

GTO: Output voltage from PSD which is proportional to scene temperature at 1 GHz IF channel

GT1: Same as GTO for 5 GHz IF channel

GT2: Same as GTO for 10 GHz IF channel

GT3: Same as GTO for 2 GHz IF channel

and at 1.0 second intervals:

HL: Output voltage from linear thermistor amplifier which is proportional to hot load temperature

CL: Same as HL for cold load temperature

RL: Same as HL for reference load temperature

KL: Same as HL for klystron tube temperature

SL: Same as HL for spare

GTO-GT3 were displayed, in degrees Kelvin, on the CRT located above the instrument rack. ADDAS also monitored an "automatic calibrate" digital signal used to update the gain (deg/volt) and offset (deg) constants shown in Figure 20. This provided accurate data required for the plots shown in Section 4.2 and 4.3, SEASAT-A and Nimbus-G satellites underflight programs.

4.0 FLIGHT EXPERIMENTS

4.1 Hurricane Cora Penetration Flight

The attached plots were made by the NASA-Ames Airborne Digital Data Acquisition System (ADDAS) from data taken with the Georgia Tech 94/183 GHz radiometer onboard the NASA Convair 990 aircraft while deployed to Hurricane Cora. Preliminary data from the first hurricane penetration have indicated that the 94 GHz channel is capable of detecting rainfall. Figure 22 is representative of the phenomenon detected when the Convair flew over an area of heavy rainfall and is due to the colder cosmic background sky temperature scattered by the rain drops.

The data plotted in this figure are from top to bottom: 183 GHz (1 GHz IF), 183 GHz (5 GHz IF), 183 GHz (8.75 GHz IF), 94 GHz, pressure altitude, and IR surface temperature. The triangular peaks at 3 minute intervals are portions of the radiometer's automatic calibration cycle. The scales for the brightness temperatures are in degrees Kelvin but are not absolute.

The event at 16:51 UT shows the passage of the plane over a rain cell that was also detected by weather radar and Goddard's Electronically Scanned Microwave Radiometer (ESMR). The temperature drop was the greatest at 94 GHz and slightly less in the 183 GHz channels as would be expected due to the differing atmospheric attenuations. Similar events are shown in Figure 23 at 18:27 UT and at 18:38 UT in Figure 24. Figures 25 and 26 show effects from multiple rain cells and passage from overcast to clear areas.

A spiral descent profile is shown in Figure 27. RFI from ground radar caused the noise in the 10 GHz data. This plot was sampled at a 2 second rate and thus shows the calibration cycles better.

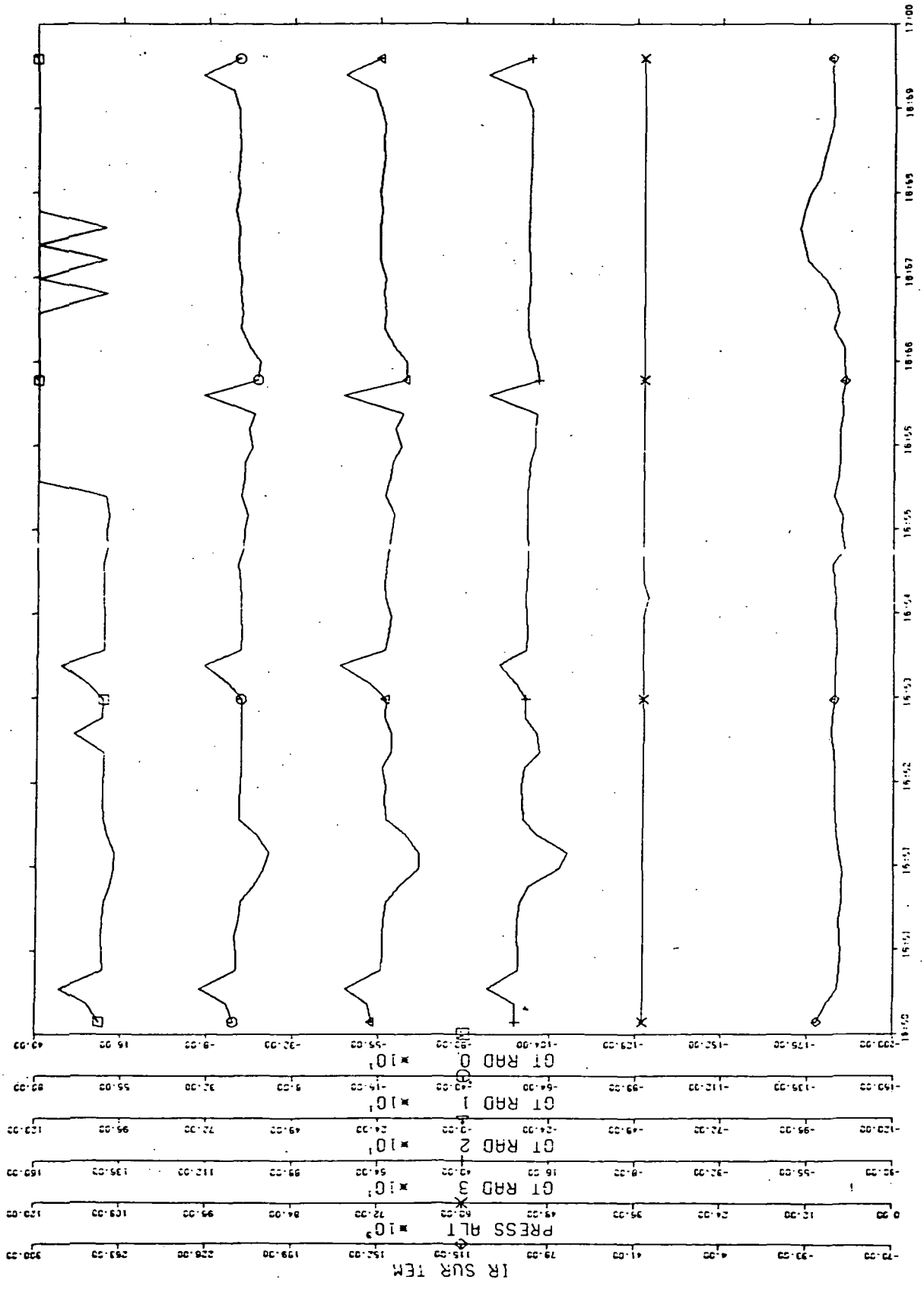

Figure 22. Time UT SMHP '78 Flight 7 - Cora: Convair Over Raincell Area and 94/183 GHz Radiometer Looking Down.

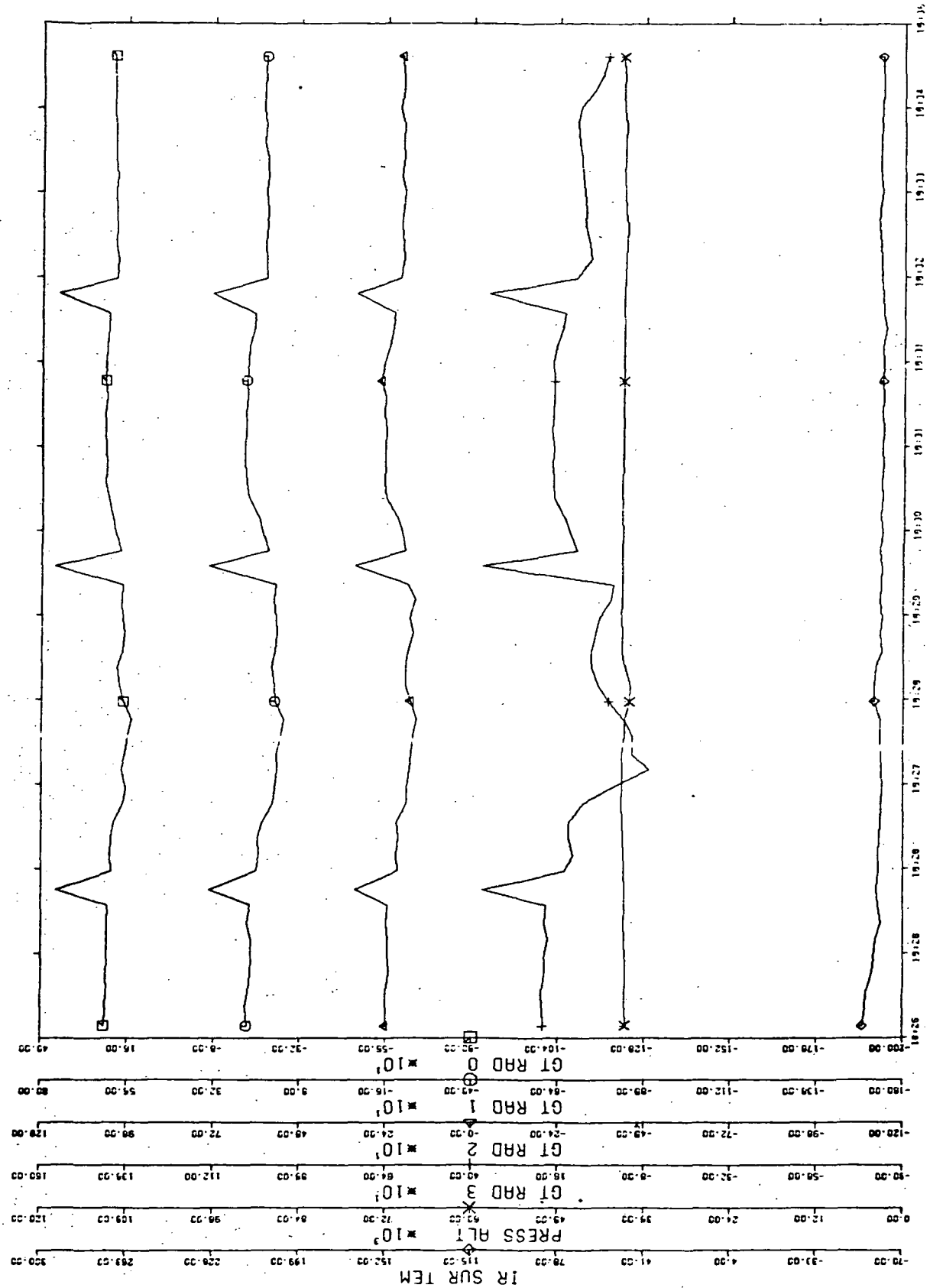

Figure 23. Time UT.SMHP '78 Flight 7 - Cora: Raincell detected at 18:27 UT.

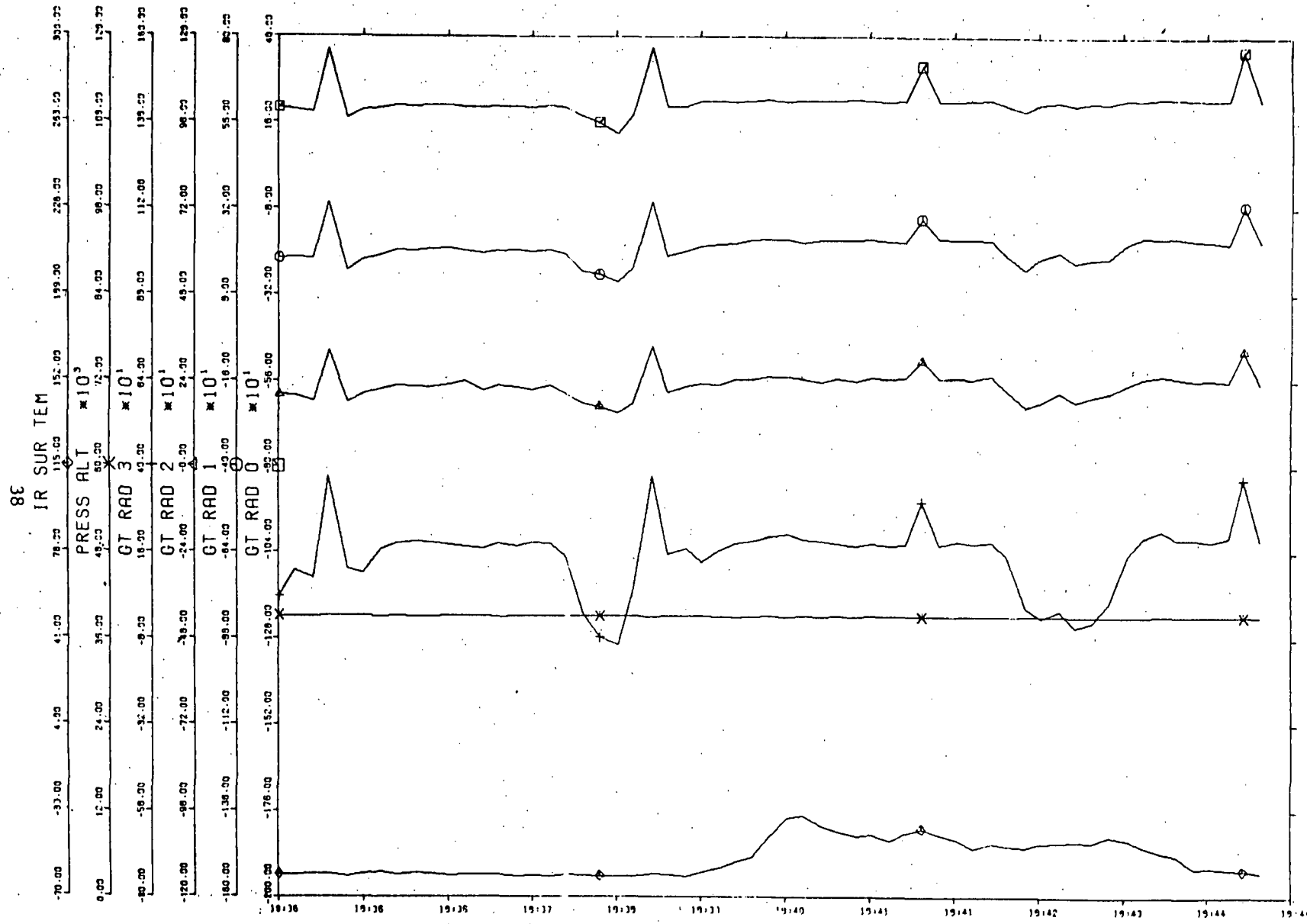

Figure 24. Time UT SMHP '78 Flight 7 - Cora: Raincell detected at 18:38 UT.

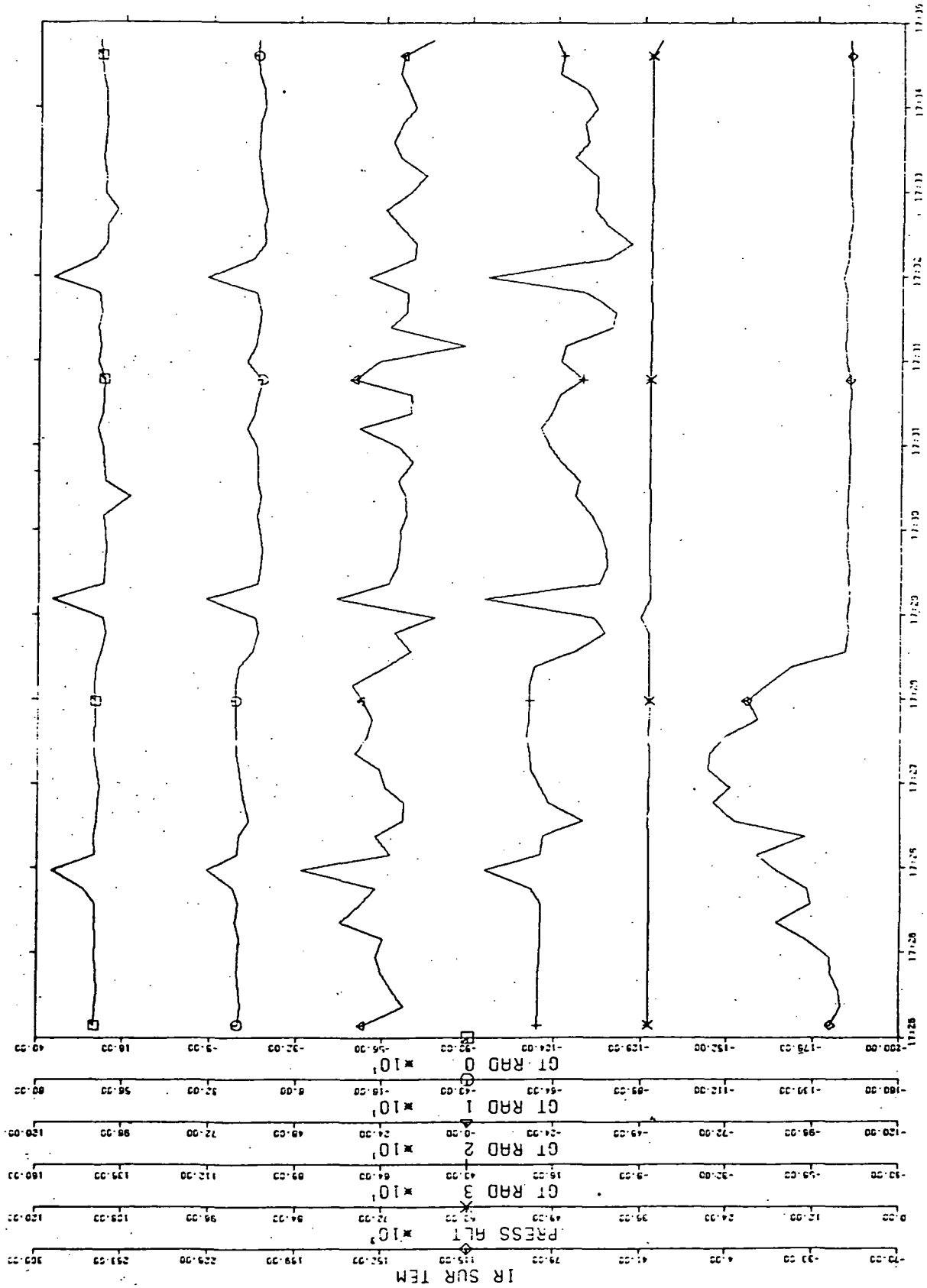

Figure 25. Time UT SMHP '78 Flight - Cora: Multiple Raincells measured as Convair Flies Through Overcast Region.

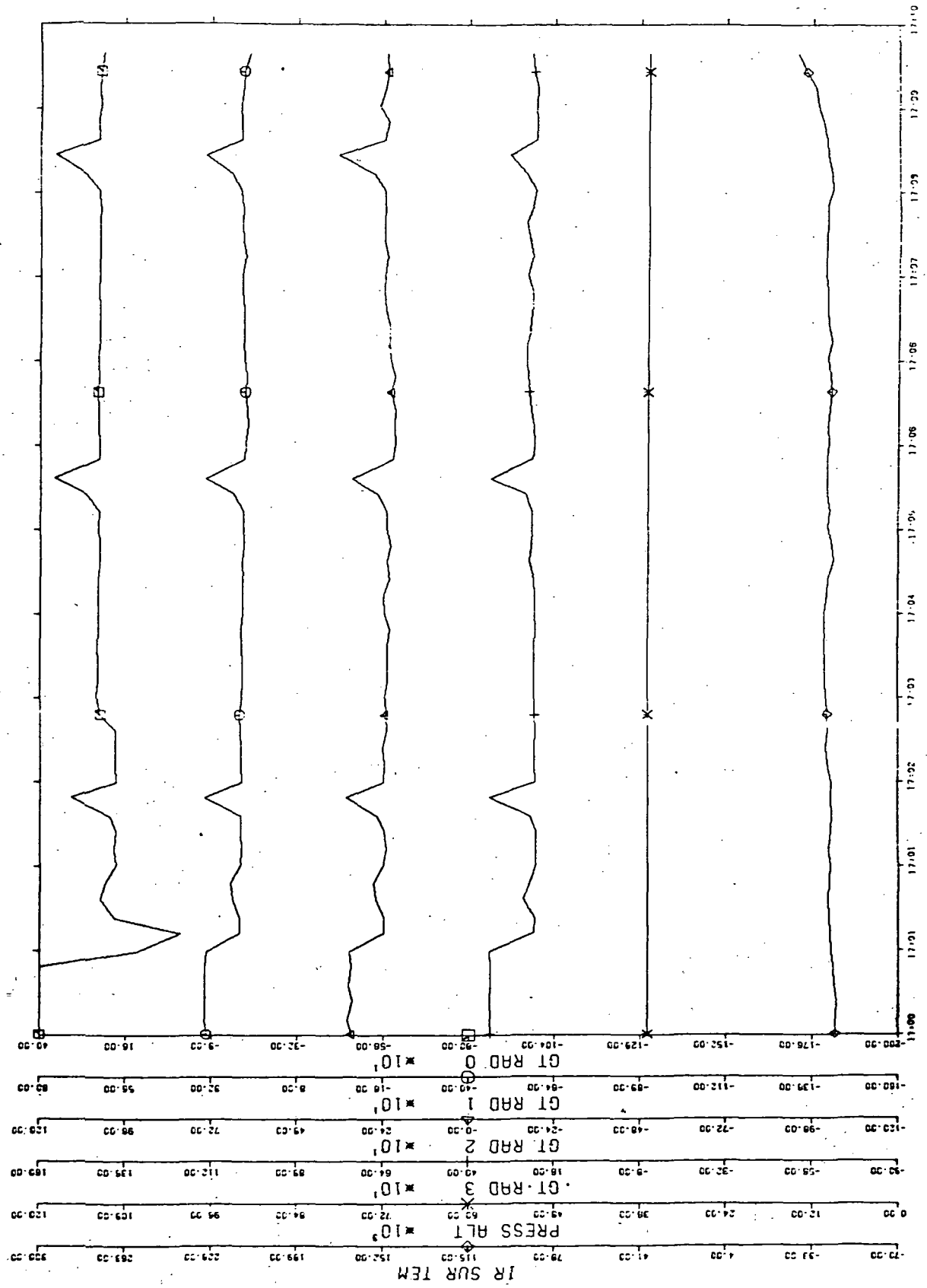

Figure 26. Time UT SMHP '78 Flight - Cora: Temperature Drop In All Four Radiometer Channels at 17:01 UT.

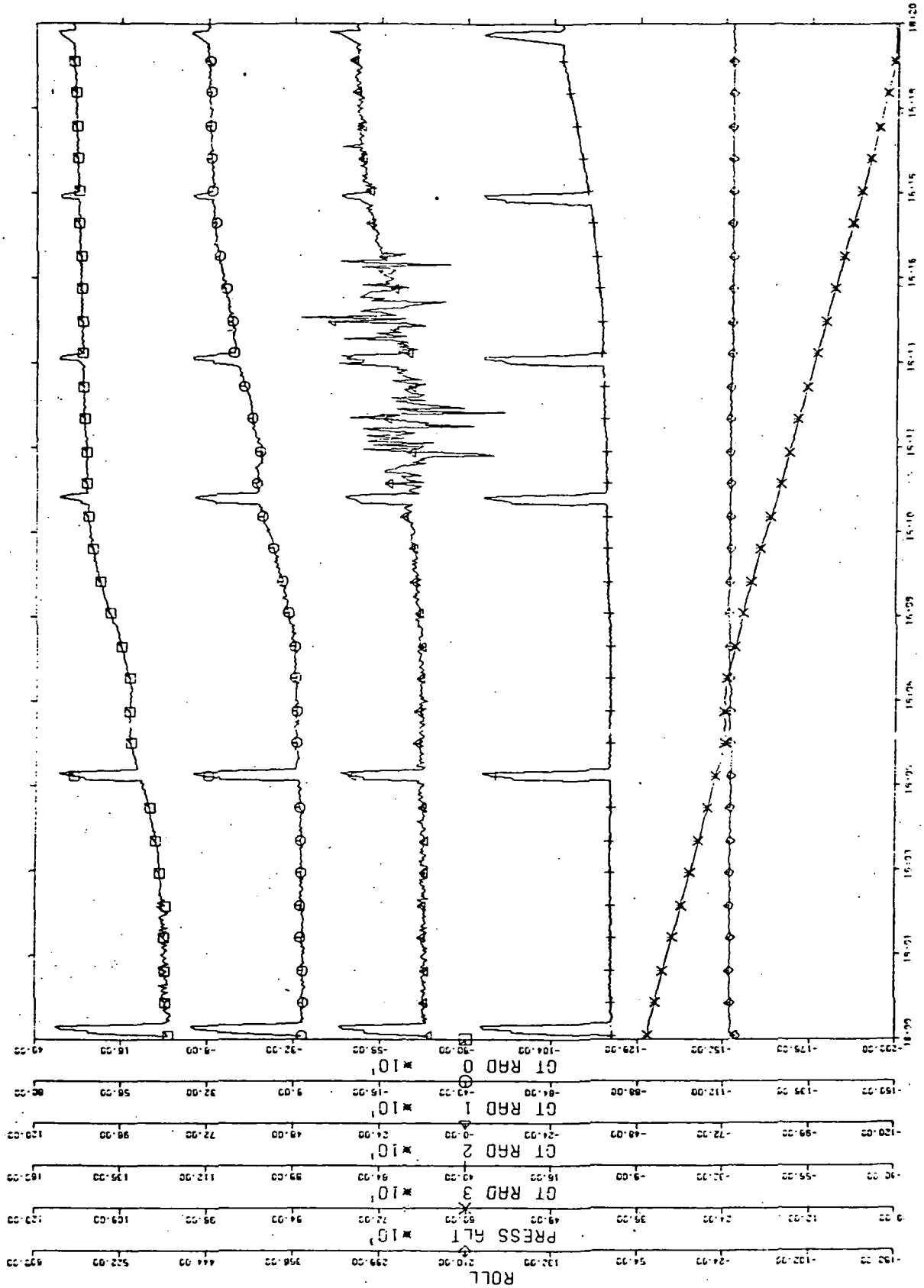

Figure 27. Time UT SMHP '78 Flight 8 (Day 225): Spiral Descent With 30° Left Roll Angle. Note Radar Interference At GT RAD 2 (10 GHz IF Channel).

4.2 SEASAT-A Satellite Underflights (Gulf of Alaska)

Appendix D describes the SEASAT-A Gulf of Alaska Experiment Plan including the CV-990 underflights (Phase III).

ADDAS plots are included for data taken during SEASAT-A underflights. The scales for the brightness temperatures, GT RAD 0 (1 GHz IF), GT RAD 1 (5 GHz IF), GT RAD 2 (10 GHz IF), and GT RAD 3 (2 GHz IF) are in degrees Kelvin and are absolute because ADDAS was provided an auto-calibrate signal with each calibration cycle. This signal was used by ADDAS to update the gain and offset constants discussed in Section 3.0, operation of the radiometer.

Figure 28 is a plot of data taken with the radiometer looking up (15° above the horizon), where the aircraft was flying at an altitude of 1,000 feet over the Gulf of Alaska. Weather radar detected clusters of rain cells above the aircraft during the time duration of this data plot. The top three tracks are 183 GHz (1 GHz IF), 183 GHz (5 GHz IF), and 183 GHz (10 GHz IF). The absolute temperature for these channels was 280°K up to and including time 7:10. This represents an upper limit imposed by the temperature of the lower atmosphere. However, the 94 GHz, represented by the fourth track down from the top, shows an increase in temperature with a jump of 100°K at the event time 7:10. This event coincided with the aircraft flying under a rain cell as detected by Goddard's electronically scanned microwave radiometer. This sudden jump in temperature is possibly due to the overlying rain cell absorbing radiation and re-radiating at its internal temperature, thus causing an increase in the brightness temperature desired.

Figure 29 is a data plot beginning fifteen minutes later where once again multiple rain cells were detected by weather radar. The 94 GHz channel varifies this with numerous peaks over the time span shown. A calibration cycle occurred at approximately 7:35 UT as indicated by peaks on all four radiometer channels.

Figure 30 is a spiral descent profile plotted from another SEASAT-A underflight. A manual calibration was performed at 22:52 UT with automatic calibration cycles following at 22:54 UT and 22:59 UT. Notice the increase in brightness temperatures on all three 183 GHz channels as the aircraft descends. The radiometer was looking up during the left spiral descent with the aircraft banked at a roll angle of about -30 degrees.

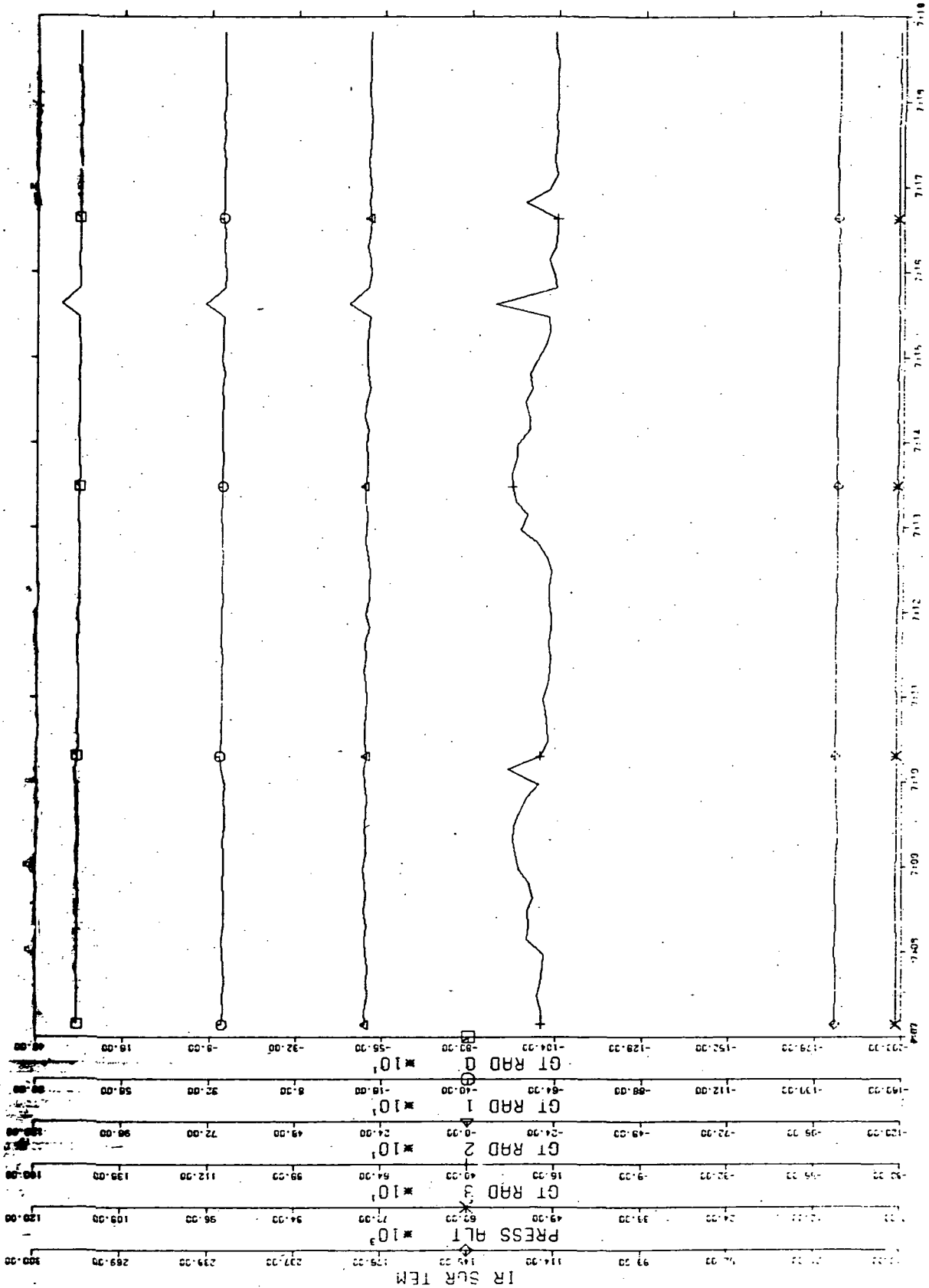

Figure 28. Time UT SMHP '78 Flight 13 (Plot 2): Convair Under Raincell Area and 94/183 GHz Radiometer is Looking Up.

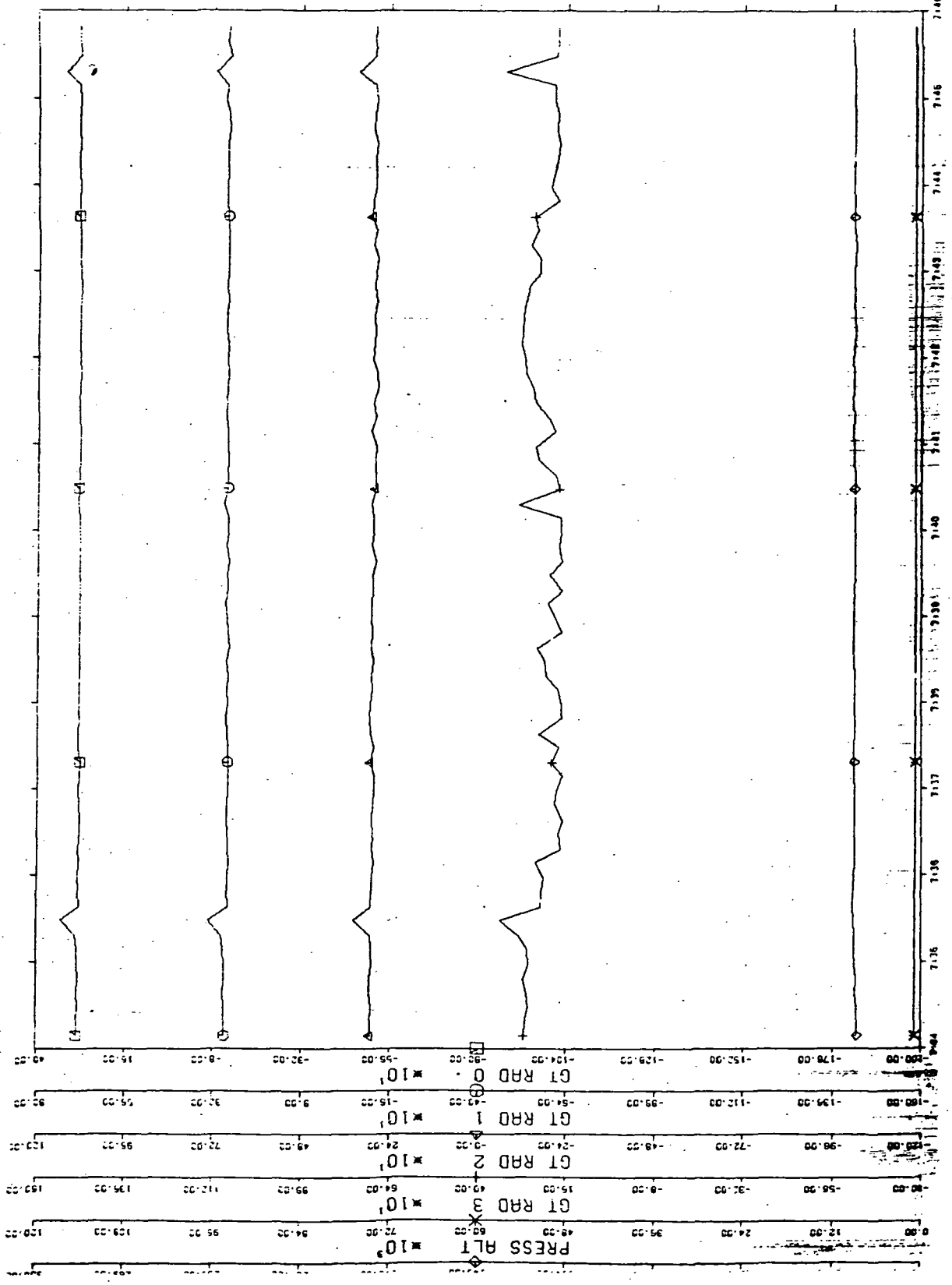

Figure 29. Time UT SMHP '78 Flight 13 (Plot 2): Multiple Raincells Detected By GT RAD 3 (94 GHz).

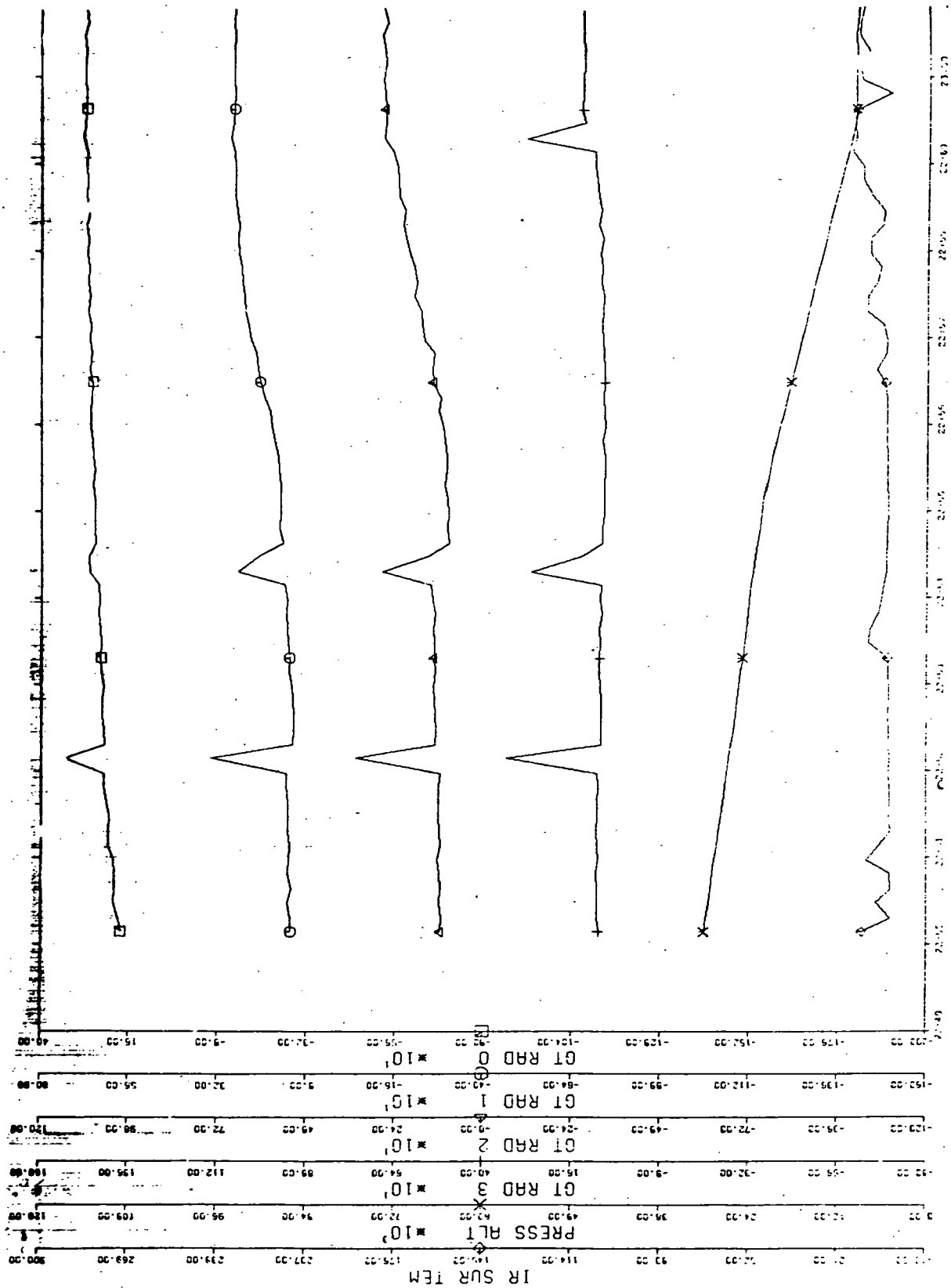

Figure 30. Time UT SMHP '78 Flight 12A (Plot 2): Radiometer Looking Up As Convair Performs Descent. Note Increase In Temperature On All Three 183 GHz Channels (Upper Three Traces).

4.3 NIMBUS-G Satellite Underflights (Artic Ocean, Greenland Sea, Norwegian Sea, Gulf of Alaska, Pacific Ocean)

Only the 94 GHz portion of the radiometer was used during the Nimbus-G satellite underflight program. Measurements of interest include first-year thin ice, multiyear ice, sheet ice, sea surface temperature (SST), and near-surface winds (NSW). A detailed description of each data set performed is included in Appendix E, Fall 1978 Nimbus-G Mission.

ADDAS plots illustrate the type data measured under varying flight conditions. Figure 31 is a plot provided by ADDAS for Flight 5 (Day 301) which was a Thule, Greenland local flight over northern Greenland ice cap regions. Visual observations onboard the Convair reported a large region of broken ice in the sea during the time span of 17:00 to 18:30. The ADDAS plot is of twelve minutes duration beginning at time UT 18:24. During these peaks the 94 GHz radiometer was looking down at sea water which is reflecting the cold sky. The warmer temperature of approximately 220°K was measured over ice which has a lower reflectivity than water, thus less reflection of cold sky off the sea ice.

The peaks occurring at time UT 18:29 and 18:34 are calibration cycle times for the 94 GHz radiometer. Figure 32 is another plot taken during a wing-over maneuver where the 94 GHz is looking up at 15° above the horizon. During this time the Convair is maintaining a roll angle of approximately -30°. A negative roll angle signifies a left roll angle. Observe that after the calibration cycle at time 10:07:59, the 94 GHz measures a cold sky temperature of approximately 30°K. However, as the Convair comes out of the left roll angle, the 94 GHz temperature increases as the radiometer upward viewing angle decreases. Toward the end of the plot, the Convair goes back into a left roll angle and the radiometer temperature drops accordingly.

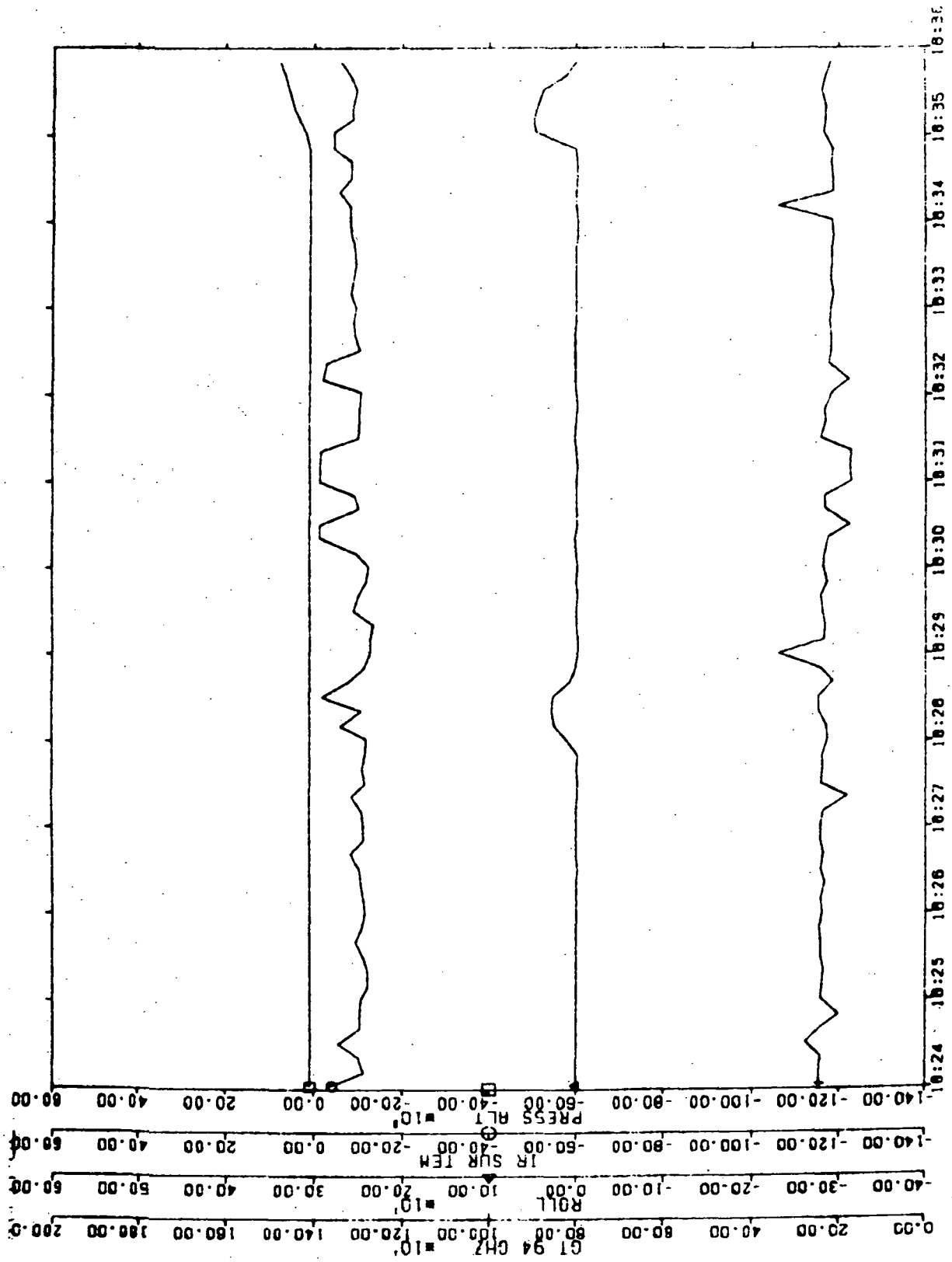

Figure 31. Time UT Day 301 Flight 99 Nimbus G: Convair Flying 500 Feet Above Sea Level Over Ice Cap Regions. Note Negative Peaks Over Open Water Seen By 94 GHz (Bottom Trace).

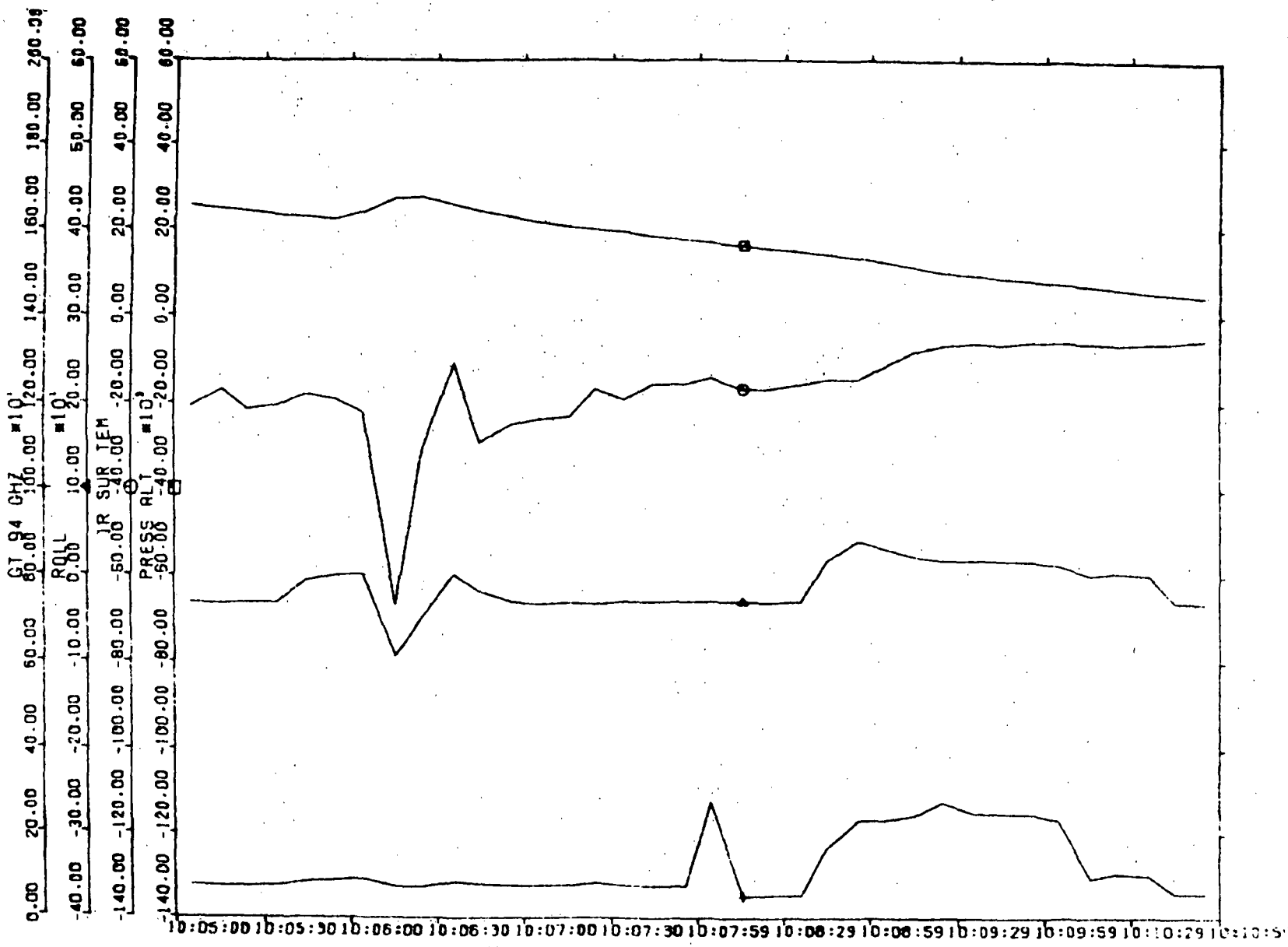

Figure 32. Time UT Day 307 Flight 9 Nimbus G: Convair Performs 90° Left Bank Wingover. 94 GHz Radiometer measures 30°K Looking Up.

APPENDIX A

OPERATING SYSTEM SOFTWARE

```
Tektronix      M6800 ASM V3.1  BOOTSTRAP                        Page     1

00002                          SECTION   BOOTSTRAP,ABSOLUTE
00003                  ;PERIPHERAL ASSIGNMENTS
00004                  ;
00005      8404        PIA2AD    EQU     8404H         ;TAPE DRIVE STATUS
00006      8405        PIA2AC    EQU     8405H         ;TR0 (TRACK SET BIT)
00007      8406        PIA2BD    EQU     8406H         ;TAPE CONTROL
00008      8407        PIA2BC    EQU     8407H         ;TR1 ON CB2
00009                  ;
00010                  ;
00011                  ;ACIAS, SSDA AND APU
00012                  ;
00013      8408        ACIA1C    EQU     8408H         ;CONTROL CONSOLE
00014      8409        ACIA1D    EQU     8409H         ;XMIT AND RCV INTERRUPTS
00015      8808        ACIA2C    EQU     8808H         ;AUX SERIAL INTERFACE
00016      8809        ACIA2D    EQU     8809H         ;XMIT AND RCV INTERRUPTS
00017      8804        SSDAC     EQU     8804H         ;SSDA STATUS/CONTROL1 REGISTERS
00018      8805        SSDAD     EQU     8805H         ;SSDA DATA/CONTROL2,CONTROL3,SYNC CODE REGS.
00019      FE07        WINTEK    EQU     0FE07H        ;WINTEK START ADDRESS
00020      FD36        INCH      EQU     0FD36H         ;WINTEK INPUT ROUTINE
00021      FD80        OUTCH     EQU     0FD80H       ;WINTEK OUTPUT
00022      FDA6        CRLF      EQU     0FDA6H
00023      FD7A        OUT4HS    EQU     0FD7AH
00024      FD7C        OUT2HS    EQU     0FD7CH        ;OUTPUT 2 HEX FROM X
00025      FD92        OUTHEX    EQU     0FD92H        ;OUTPUT HEX FROM A
00026      FD45        INHEX     EQU     0FD45H        ;GET SINGLE HEX IN A
00027      FC64        IN2HEX    EQU     0FC64H        ;GET HEX ANIN A AND B
00028                  ;CONSTANTS
00029      0080        CRCPH     EQU     80H            ;CRC POLY MS BYTE
00030      0041        CRCPL     EQU     41H            ;CRC POLY LS BYTE
00031      0004        LOADCODE  EQU     04H           ;TAPE CONTROL CODES
00032      0006        STOPCODE  EQU     06H
00033      0008        FORCODE   EQU     08H
00034      000A        FFOWCODE  EQU     0AH
00035      000C        REVCODE   EQU     0CH
00036      000E        REWCODE   EQU     0EH
00037                  ;
00038      0000                  ORG     0
00039                  ;TEMPORARY VARIABLES AND POINTERS FOR TAPE ROUTINES
00040                  ;
00041 0000 0002        BYCOUNT   BLOCK   2             ;TEMP BYTE COUNTER FOR TREAD/TWRITE
00042 0002 0002        XTEMP1    BLOCK   2             ;TEMPORARY X REGISTER STORAGE
00043 0004 0002        XTEMP2    BLOCK   2             ;   "
00044 0006 0002        XTEMP3    BLOCK   2             ;   "
00045 0008 0002        XTEMP4    BLOCK   2             ;   "
00046 000A 0001        CRCH      BLOCK   1
00047 000B 0001        CRCL      BLOCK   1             ;CRC CODE FOR TAPE
00048 000C 0002        BUFPNT    BLOCK   2             ;TEMP FOR DECODE
00049 000E 0001        TRACKN    BLOCK   1
00050 000F 0002        BLKNUM    BLOCK   2
00051 0011 0001        BLOCKS    BLOCK   1             ;BLOCK COUNTER FOR TREAD AND TWRITE
00052 0012 0001        F.RDWR    BLOCK   1             ;READ/WRITE FLAG
00053                  ;
00054      F800                  ORG     0F800H
```

```
00055                   ;
00056                   ;SET UP PIA2--TAPE DRIVE STATUS/CONTROL
00057                   ;
00058 F800 0F                   SEI
00059 F801 8E03E9               LDS     #03E9H
00060 F804 CE8400               LDX     #8400H
00061 F807 6F05         INIT2   CLR     5,X             ;CLEAR CONTROL REGISTERS
00062 F809 6F07                 CLR     7,X             ;  "       "
00063 F80B 6F04                 CLR     4,X             ;A-SIDE FOR ALL INPUTS
00064 F80D 863F                 LDA A   #3FH            ;B-SIDE FOR 2 INXS (PB7,PB6) AND 6 OUTS (PB0-PB5)
00065 F80F A706                 STA A   6,X
00066 F811 863C                 LDA A   #3CH            ;ENABLE CA2 AND CB2 FOR TRACK CONTROL OUTPUTS
00067 F813 A705                 STA A   5,X
00068 F815 A707                 STA A   7,X
00069 F817 8636                 LDA A   #36H            ;ISSUE STOP COMMAND TO TAPE AND SET
00070 F819 A706                 STA A 6,X               ;SET WRN=WDR=1
00071                   ;
00072                   ;PROGRAM SSDA FOR TAPE DRIVE I/O
00073                   ;
00074 F81B 8603         INIT7   LDA A   #3              ;RESET XMTR AND RCVR
00075 F81D B78804               STA A   SSDAC           ;STORE IN CONTROL 1
00076 F820 860B                 LDA A   #0BH            ;DISABLE RCVR SYNC
00077 F822 B78804               STA A   SSDAC           ;ACCESS CONTROL 2
00078 F825 865D                 LDA A   #5DH            ;8 BIT WORD, 1 BYTE XFER AND TX SYNC ON UNDERFLOW
00079 F827 B78805               STA A   SSDAD           ;STORE IN CONTROL 2
00080 F82A 864B                 LDA A   #4BH            ;ACCESS CONTROL 3
00081 F82C B78804               STA A   SSDAC           ;
00082 F82F 860E                 LDA A   #0EH            ;SET CTUF=CTS=1 AND 1 SYNC MODE
00083 F831 B78805               STA A   SSDAD
00084 F834 868B                 LDA A   #8BH            ;ACCESS SSYNC CODE REGISTER
00085 F836 B78804               STA A   SSDAC
00086 F839 8601                 LDA A   #1              ;SET SYNC CODE REGISTER TO 01
00087 F83B B78805               STA A   SSDAD
00088 F83E 86C8                 LDA A   #0C8H           ;ACCESS XMIT FIFO AND CLR RESET BITS
00089 F840 B78804               STA A   SSDAC
00090                   ;
00091                   ;MAIN COMMAND LOOP
00092                   ;
00093 F843 BDF8D6       START   JSR     LOAD            ;LOAD CART
00094 F846 BDFDA6               JSR     CRLF
00095 F849 CEFB6B       START1  LDX     #RDYMSG         ;PRINT PROMPT
00096 F84C BDF8CB               JSR     STRNGOUT
00097 F84F BDFDA6               JSR     CRLF
00098 F852 BDFD36               JSR     INCH            ;GET COMMAND
00099 F855 8142                 CMP A   #"B"
00100 F857 260F                 BNE     NOTB
00101 F859 4F                   CLR A
00102 F85A BDF954               JSR     TRACK
00103 F85D 8604                 LDA A   #4              ;ASSUME NORMAL BOOT HERE
00104 F85F CE1000               LDX     #1000H          ;START ADDRESS
00105 F862 BDFA3B               JSR     TREAD           ;READ IN PROGRAM
00106 F865 7E1000               JMP     1000H           ;GO TO IT
00107                   ;
```

```
00108                    ;
00109 F868 8152    NOTB  CMP A  #"R"          ;R FOR READ
00110 F86A 2605          BNE    NOTR
00111 F86C BDF881        JSR    READ
00112 F86F 20D8          BRA    START1
00113 F871 8157    NOTR  CMP A  #"W"          ;W FOR WRITE
00114 F873 2605          BNE    NOTW
00115 F875 BDF886        JSR    WRITE        ;GO WRITE
00116 F878 20CF          BRA    START1
00117 F87A 8120    NOTW  CMP A  #20H          ;IS IT A SPACE?
00118 F87C 26C5          BNE    START
00119 F87E 7EFE07        JMP    WINTEK
00120                    ;
00121                    ;
00122 F881 7F0012  READ  CLR    F.RDWR        ;CLEAR READ/WRITE FLAG
00123 F884 2004          BRA    TRACKSET
00124 F886 86FF    WRITE LDA A  #0FFH         ;SET READ/WRITE FLAG
00125 F888 9712          STA A  F.RDWR
00126                    ;
00127 F88A BDFDA6  TRACKSET JSR  CRLF
00128 F88D CEFB21        LDX    #TRKMSG       ;ASK FOR TRACK
00129 F890 8D39          BSR    STRNGOUT
00130 F892 BDFD45        JSR    INHEX         ;WAIT FOR TRACK ENTRY
00131 F895 C103          CMP B  #3            ;VALID TRACK?
00132 F897 22F1          BHI    TRACKSET
00133 F899 17            TBA
00134 F89A BDF954        JSR    TRACK         ;SET TRACK
00135 F89D BDFDA6        JSR    CRLF
00136 F8A0 CEFB47  RDWR  LDX    #STRTMSG      ;ASK FOR START ADDRESS
00137 F8A3 BDF8CB        JSR    STRNGOUT
00138 F8A6 BDFD45        JSR    INHEX
00139 F8A9 D702          STA B  XTEMP1
00140 F8AB BDFD45        JSR    INHEX
00141 F8AE D703          STA B  XTEMP1+1
00142 F8B0 BDFDA6        JSR    CRLF
00143 F8B3 CEFB29  RDWR1 LDX    #BLKMSG       ;ASK FOR BLOCKS
00144 F8B6 BDF8CB        JSR    STRNGOUT
00145 F8B9 BDFD45        JSR    INHEX
00146 F8BC 17            TBA
00147 F8BD DE02          LDX    XTEMP1
00148 F8BF D612          LDA B  F.RDWR
00149 F8C1 2604          BNE    RDWR2
00150 F8C3 BDFA38        JSR    TREAD
00151 F8C6 39            RTS
00152 F8C7 BDF973  RDWR2 JSR    TWRITE
00153 F8CA 39            RTS
00154                    ;
00155                    ;
00156 F8CB A600    STRNGOUT LDA A  0,X
00157 F8CD 08            INX
00158 F8CE BDFD80        JSR    OUTCH
00159 F8D1 8104          CMP A  #4
00160 F8D3 26F6          BNE    STRNGOUT
```

```
00161 F8D5 39                   RTS
00162                   ;
00163                   ;TAPE DRIVE CONTROL SUBROUTINES
00164                   ;
00165                   ;
00166                   ;TAPE MOTION COMMANDS.  USE BY DATA COLLECTION SOFTWARE
00167                   ;AND UTILITY COMMANDS.
00168                   ;
00169                   ;LOAD CART
00170                   ;
00171 F8D6 B68404       LOAD    LDA A   PIA2AD          ;GET STATUS
00172 F8D9 8430                 AND A   #30H            ;CHECK IF ALREADY LOADED
00173 F8DB 2712                 BEQ     LOAD2
00174 F8DD 8110                 CMP A   #10H            ;CHECK IF STAUTS=0
00175 F8DF 2708                 BEQ     LOAD1           ;YES, STAYTUS OK, LOAD CART
00176 F8E1 CEFB5A               LDX     #MESSNR         ;TURN ON NOT READY MESSAGE
00177 F8E4 BDF8CB               JSR     STRNGOUT
00178 F8E7 2006                 BRA     LOAD2
00179 F8E9 8D0D         LOAD1   BSR     STOP            ;STOP TAPE IF MOVING
00180 F8EB 8604                 LDA A   #LOADCODE       ;GET LOAD CODE
00181 F8ED 8D23                 BSR     TCMND           ;ISSUE COMMAND
00182 F8EF 4F           LOAD2   CLR A
00183 F8F0 970F                 STA A   BLKNUM          ;CLEAR BLOCK NUMBER
00184 F8F2 9710                 STA A   BLKNUM+1
00185 F8F4 BDF908               JSR     REWIND
00186 F8F7 39                   RTS
00187                   ;
00188                   ;STOP TAPE
00189 F8F8 8606         STOP    LDA A   #STOPCODE       ;GET STOP CODE
00190 F8FA 2016                 BRA     TCMND
00191                   ;
00192                   ;MOVE TAPE FORWARD
00193 F8FC 8608         FORWD   LDA A   #FORCODE
00194 F8FE 2012                 BRA     TCMND
00195                   ;
00196                   ;FAST FORWARD
00197 F900 860A         FFORWD  LDA A   #FFOWCODE
00198 F902 200E                 BRA     TCMND
00199                   ;
00200                   ;REVERSE
00201 F904 860C         REVERSE LDA A   #REVCODE
00202 F906 200A                 BRA     TCMND
00203                   ;
00204                   ;REWIND
00205 F908 860E         REWIND  LDA A   #REWCODE
00206 F90A 7F000F               CLR     BLKNUM
00207 F90D 7F0010               CLR     BLKNUM+1
00208 F910 2000                 BRA     TCMND
00209                   ;
00210                   ;PULSE PROPER TAPE CONTROL LINE
00211                   ;
00212 F912 F68406       TCMND   LDA B   PIA2BD          ;GET OLD CONTROL WORD
00213 F915 C4F0                 AND B   #0F0H           ;MASK OF LS HALF
```

```
00214 F917 1B                ABA                    ;ADD IN NEW COMMAND
00215 F918 B78406            STA A  PIA2BD          ;PUT OUT NEW COMMAND
00216 F91B 84F0              AND A  #0F0H           ;CLEAR COMMAND
00217 F91D B78406            STA A  PIA2BD
00218 F920 39                RTS
00219                   ;
00220                   ;
00221                   ;UNLOAD CART FOR REMOVAL
00222                   ;
00223 F921 8DD5         UNLOAD  BSR    STOP            ; STOP TAPE IF MOVING
00224 F923 8604                 LDA A  #LOADCODE
00225 F925 8DEB                 BSR    TCMND
00226 F927 8604                 LDA A  #LOADCODE       ;ISSUE TWO LOAD PULSES
00227 F929 8DE7                 BSR    TCMND
00228 F92B 39                   RTS
00229                   ;
00230                   ;
00231                   ;
00232                   ;TAPE STATUS MONITOR. CHECKS TAPE STATUS BITS ON PIA2A
00233                   ;TO DETERMINE APPROPRIATE STATUS.
00234                   ;
00235 F92C B68404       CKRDY   LDA A  PIA2AD          ;GET STATUS
00236 F92F 8430                 AND A  #30H            ;CHECK RDY AND ST BITS
00237 F931 2709                 BEQ    CKRDY1
00238 F933 CEFB5A               LDX    #MESSNR         ;TURN ON NOT READY MSG
00239 F936 BDF8CB               JSR    STRNGOUT
00240 F939 7EF843               JMP    START            ;RETURN TO MAIN PROGRAM
00241 F93C 39           CKRDY1  RTS
00242                   ;
00243                   ;
00244 F93D B68404       CKLOAD  LDA A  PIA2AD          ;GET STATUS
00245 F940 8402                 AND A  #02H            ;SEE IF TAPE AT LOAD POINT
00246 F942 39                   RTS
00247                   ;
00248                   ;CHECK IF WRITE PROTECT IS ON
00249 F943 B68406       CKFP    LDA A  PIA2BD          ;GET FP AND TM BITS
00250 F946 8440                 AND A  #40H            ;CHECK BIT 6
00251 F948 2609                 BNE    CKFP1           ;NOT PROTECTED
00252 F94A CEFB32               LDX    #FPMSG          ;TURN ON FILE PROTECT MESSAGE
00253 F94D BDF8CB               JSR    STRNGOUT
00254 F950 7EF843               JMP    START
00255 F953 39           CKFP1   RTS
00256                   ;
00257                   ;
00258                   ;SET TRACK NO. FROM CONTENTS OF A
00259                   ;A MAY BE =0,1,2,3
00260 F954 8103         TRACK   CMP A  #3              ;SEE IF ALLOWABLE VALUE
00261 F956 221A                 BHI    TRACK3          ;NOPE, RETURN
00262 F958 970E                 STA A  TRACKN          ;UPDATE TRACK NO.
00263 F95A F68405               LDA B  PIA2AC          ;GET TR0 CONTROL WORD
00264 F95D 8D0C                 BSR    TRACK2          ;SET OR CLEAR TRACK BIT AS REQUIRED
00265 F95F F78405               STA B  PIA2AC          ;REPLACE TR0
00266 F962 F68407               LDA B  PIA2BC          ;GET TR1 BIT
```

```
00267 F965 8D04              BSR    TRACK2      ;DO SAME FOR TR1
00268 F967 F78407            STA B  PIA2BC
00269 F96A 39                RTS
00270 F96B CA38      TRACK2  ORA B  #38H        ;CLEAR TRACK BIT
00271 F96D 44                LSR A               ;CHECK DESIRED TRACK NO.
00272 F96E 2402              BCC    TRACK3
00273 F970 C4F7              AND B  #0F7H
00274 F972 39        TRACK3  RTS
00275                ;
00276                ;
00277                ;
00278                ;TAPE WRITE ROUTINE
00279                ;WRITES 2048 BYTES TO TAPE.  STARTING ADDRESS OF BLOCK IN X.
00280                ;
00281 F973 9711      TWRITE  STA A  BLOCKS      ;SAVE NO. OF BLOCKS TO WRITE
00282 F975 BDF92C            JSR    CKRDY      ;SEE IF DRIVE READY FOR WRITE
00283 F978 BDF943            JSR    CKFP       ;SEE IF FP SET
00284 F97B 8620      TWRITES LDA A  #20H
00285 F97D B78406            STA A  PIA2BD     ;SET WRN=0
00286 F980 8680              LDA A  #80H        ;ACCESS SYNC CODE REGISTER
00287 F982 B78804            STA A  SSDAC
00288 F985 4F                CLR A
00289 F986 B78805            STA A  SSDAD      ;SET SYNC CODE TO 00
00290 F989 C6C0              LDA B  #0C0H      ;ACESS XMIT FIFO
00291 F98B F78804            STA B  SSDAC
00292 F98E B78805            STA A  SSDAD      ;ZERO OUT FIFO
00293 F991 B78805            STA A  SSDAD
00294 F994 B78805            STA A  SSDAD
00295 F997 BDFAC0            JSR    CRC        ;COMPUTE CRC FOR BLOCK
00296 F99A BDF93D            JSR    CKLOAD     ;SEE IF AT LOAD POINT (A=FF IF TRUE)
00297 F99D 36                PSH A             ;SAVE LOAD STATUS
00298 F99E BDF8FC            JSR    FORWD      ;START DRIVE
00299 F9A1 32                PUL A             ;GET LOAD STATUS BACK
00300 F9A2 4D                TST A             ;TEST LOAD FLAG
00301 F9A3 2605              BNE    TWRITE1    ;BYPASS 1 SEC DELAY
00302 F9A5 8601              LDA A  #1
00303 F9A7 BDFB0D            JSR    SECDLY     ;DELAY 1 SEC
00304 F9AA 862F      TWRITE1 LDA A  #47        ;47 MS IRG DELAY
00305 F9AC BDFB04            JSR    MSDLY
00306 F9AF DF02              STX    XTEMP1     ;SAVE BLOCK POINTER
00307 F9B1 CE0800            LDX    #0800H     ;2048 BYTE COUNT
00308 F9B4 DF00              STX    BYCOUNT
00309 F9B6 DE02              LDX    XTEMP1     ;RETREIVE POINTER
00310 F9B8 4F                CLR A
00311 F9B9 B78406            STA A  PIA2BD     ;SET WDR=0
00312 F9BC 8D68              BSR    WRTBYT     ;PAD WITH A FEW ZEROS
00313 F9BE 8D66              BSR    WRTBYT     ;WRITE A FEW ZEROS FOR SPACING
00314 F9C0 8D64              BSR    WRTBYT
00315 F9C2 8D62              BSR    WRTBYT
00316 F9C4 8655              LDA A  #55H       ;SYNC BYTE
00317 F9C6 8D5E              BSR    WRTBYT
00318 F9C8 4F                CLR A             ;WRITE PREAMBLE
00319 F9C9 8D5B              BSR    WRTBYT
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00320 F9CB 8601              LDA A  #1
00321 F9CD 8D57              BSR    WRTBYT
00322 F9CF A600       TWRITE2 LDA A  0,X          ;GET BYTE FROM BLOCK
00323 F9D1 8D53              BSR    WRTBYT        ;SEND BYTE TO SSDA
00324 F9D3 08                INX                  ;INCREMENT BYTE POINTER
00325 F9D4 DF02              STX    XTEMP1        ;SAVE BYTE POINTER
00326 F9D6 DE00              LDX    BYCOUNT       ;GET BYTE COUNTER
00327 F9D8 09                DEX                  ;DECREMENT BYTE COUNTER
00328 F9D9 2706              BEQ    TWRITE3       ;DONE
00329 F9DB DF00              STX    BYCOUNT       ;SAVE COUNT
00330 F9DD DE02              LDX    XTEMP1        ;RETREIVE POINTER
00331 F9DF 20EE              BRA    TWRITE2       ;DO NEXT BYTE
00332 F9E1 960A       TWRITE3 LDA A  CRCH           ;WRITE CRC ON TAPE
00333 F9E3 8D41              BSR    WRTBYT       ;BYPASS CRC
00334 F9E5 960B              LDA A  CRCL
00335 F9E7 8D3D              BSR    WRTBYT
00336 F9E9 8680              LDA A  #80H          ;WIRTE POSTAMBLE
00337 F9EB 8D39              BSR    WRTBYT
00338 F9ED 4F                CLR A
00339 F9EE 8D36              BSR    WRTBYT
00340 F9F0 B68804     TWRITE4 LDA A  SSDAC         ;CHECK TUF FLAG
00341 F9F3 8510              BIT A  #10H          ;MASK OF TUF BIT
00342 F9F5 27F9              BEQ    TWRITE4       ;WAIT UNTILL XMIT FIFO IS EMPTY
00343 F9F7 8640              LDA A  #40H          ;RESET TUF FLAG
00344 F9F9 B78804            STA A  SSDAC         ;ACCESS CONTROL 3
00345 F9FC 860E              LDA A  #0EH
00346 F9FE B78805            STA A  SSDAD
00347 FA01 8620              LDA A  #20H          ;SET WDR=1
00348 FA03 B78406            STA A  PIA2BD
00349 FA06 861A              LDA A  #26           ;WAIT 26 MS FOR IRG
00350 FA08 BDFB04            JSR    MSDLY
00351 FA0B BDF8F8     TWRITE5 JSR    STOP          ;STOP TAPE
00352 FA0E 8619              LDA A  #25           ;WAIT FOR TAPE TO STOP
00353 FA10 BDFB04            JSR    MSDLY
00354 FA13 BDFA31            JSR    INCBLK        ;INC BLOCK NUMBER
00355 FA16 DE02              LDX    XTEMP1        ;GET DATA POINTER BACK
00356 FA18 7A0011            DEC    BLOCKS        ;DEC BLOCK COUNT
00357 FA1B 2703              BEQ    TWRITE6       ;DONE
00358 FA1D 7EF97B            JMP    TWRITES       ;GO WRITE ANOTHER BLOCK
00359 FA20 8630       TWRITE6 LDA A  #30H          ;SET WRN=WDR=1
00360 FA22 B78406            STA A  PIA2BD
00361 FA25 39                RTS
00362                ;
00363                ;
00364                ;SEND A BYTE TO SSDA
00365                ;
00366 FA26 F68804     WRTBYT  LDA B  SSDAC        ;CHECK TDRA BIT
00367 FA29 54                LSR B
00368 FA2A 54                LSR B
00369 FA2B 24F9              BCC    WRTBYT        ;XMTR STILL BUSY
00370 FA2D B78805            STA A  SSDAD         ;STORE BYTE IN XMIT FIFO
00371 FA30 39                RTS
00372                ;
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00373                   ;INCREMENT 16 BIT BLOCK NUMBER
00374                   ;
00375 FA31 DF04         INCBLK  STX     XTEMP2          ;SAVE X
00376 FA33 DE0F                 LDX     BLKNUM
00377 FA35 08                   INX
00378 FA36 DF0F                 STX     BLKNUM
00379 FA38 DE04                 LDX     XTEMP2
00380 FA3A 39                   RTS
00381                   ;
00382                   ;
00383                   ;
00384                   ;
00385                   ;TREAD.  READS 2048 BYTES FROM NEXT BLOCK ON TAPE
00386                   ;TO MEMORY STARTING AT LOCATION IN X.  COMPARES CRCS
00387                   ;AND RETURNS A=0 IF THEY MATCH
00388                   ;
00389                   ;
00390 FA3B 9711         TREAD   STA A   BLOCKS          ;SAVE BLOCK COUNT
00391 FA3D DF04         TREAD11 STX     XTEMP2          ;SAVE FILE POINTER
00392 FA3F BDF92C               JSR     CKRDY           ;SEE IF DRIVE READY
00393 FA42 BDF8FC               JSR     FORWD           ;START TAPE FORWARD
00394 FA45 8619                 LDA A   #25             ;WAIT 25 MS FOR TAPE TO SPEED UP
00395 FA47 BDFB04               JSR     MSDLY
00396 FA4A 8601                 LDA A   #1              ;RESET SSDA RCVR
00397 FA4C B78804               STA A   SSDAC
00398 FA4F 8688                 LDA A   #88H            ;DISABLE SYNC , ACCESS SYNC CODE REG
00399 FA51 B78804               STA A   SSDAC
00400 FA54 8655                 LDA A   #55H
00401 FA56 B78805               STA A   SSDAD           ;SET SYNC CODE=55
00402 FA59 B68404       TREAD12 LDA A   PIA2AD          ;CHECK GAP BIT
00403 FA5C 48                   ASL A
00404 FA5D 2AFA                 BPL     TREAD12         ;WAIT FOR GAP BEFORE TRYING TO READ
00405 FA5F 4F                   CLR A
00406 FA60 B78804               STA A   SSDAC           ;ENABLE RCVR SYNC
00407 FA63 8D51         TREAD1  BSR     RDBYTE          ;WAIT FOR FOR FIRST BYTE FOLLOWING FIRST SYNC
00408 FA65 8101                 CMP A   #1              ;CHECK FOR SECOND PREAMBLE BYTE
00409 FA67 26FA                 BNE     TREAD1          ;NOT THERE, TRY AGAIN
00410 FA69 DF02                 STX     XTEMP1          ;SAVE POINTER
00411 FA6B CE0800               LDX     #0800H          ;BYTE COUNT
00412 FA6E DF00                 STX     BYCOUNT
00413 FA70 DE02                 LDX     XTEMP1          ;GET POINTER
00414 FA72 8D42         TREAD2  BSR     RDBYTE          ;GET A BYTE
00415 FA74 A700                 STA A   0,X             ;PUT IT IN MEMORY
00416 FA76 08                   INX                     ;INCREMENT MEMORY POINTER
00417 FA77 DF02                 STX     XTEMP1          ;SAVE POINTER
00418 FA79 DE00                 LDX     BYCOUNT
00419 FA7B 09                   DEX                     ;DECREMENT BYTE COUNT
00420 FA7C 2706                 BEQ     TREAD3          ;DONE, GET CRC
00421 FA7E DF00                 STX     BYCOUNT         ;SAVE COUNT
00422 FA80 DE02                 LDX     XTEMP1          ;GET POINTER BACK
00423 FA82 20EE                 BRA     TREAD2          ;GET ANOTHER BYTE
00424 FA84 8D30         TREAD3  BSR     RDBYTE          ;GET FIRST CRC BYTE
00425 FA86 36                   PSH A                   ;SAVE IT
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00426 FA87 8D2D              BSR    RDBYTE        ;GET NEXT CRC BYTE
00427 FA89 36                PSH A                ;SAVE IT
00428 FA8A 862B              LDA A  #43
00429 FA8C BDFB04            JSR    MSDLY         ;WAIT 43 MS FOR IRG
00430 FA8F BDF8F8            JSR    STOP          ;STOP TAPE
00431 FA92 DE04              LDX    XTEMP2        ;RETREIVE POINTER
00432 FA94 BDFAC0            JSR    CRC           ;COMPUTE CRC ON NEW DATA
00433 FA97 32                PUL A                ;GET CRC BACK
00434 FA98 33                PUL B
00435 FA99 900B              SUB A  CRCL          ;COMPARE LS BYTE
00436 FA9B 2604              BNE    TREAD4
00437 FA9D D00A              SUB B  CRCH
00438 FA9F 2708              BEQ    TREAD45
00439 FAA1 CEFB71      TREAD4  LDX    #CRCMSG       ;CRC ERROR MESSAGE
00440 FAA4 BDF8CB            JSR    STRNGOUT
00441 FAA7 200C              BRA    TREAD5
00442 FAA9 BDFA31      TREAD45 JSR    INCBLK        ;INCREMENT BLOCK NUMBER
00443 FAAC 7A0011            DEC    BLOCKS        ;DECREMENT BLOCK COUNTER
00444 FAAF 2704              BEQ    TREAD5        ;DONE
00445 FAB1 DE02              LDX    XTEMP1        ;GET DATA POINTER
00446 FAB3 2088              BRA    TREAD11       ;GO READ ANOTHER BLOCK
00447 FAB5 39          TREAD5  RTS
00448                        ;
00449                        ;
00450                        ;READ A BYTE FROM SSDA FIFO AND COMPUTE CRC
00451 FAB6 B68804      RDBYTE  LDA A  SSDAC         ;CHECK RDA FLAG
00452 FAB9 44                LSR A
00453 FABA 24FA              BCC    RDBYTE        ;WAIT FOR RDA=1
00454 FABC B68805            LDA A  SSDAD         ;GET A  BYTE FROM FIFO
00455 FABF 39                RTS
00456                        ;
00457                        ;COMPUTE A 16 BIT CRC CHECK CODE FROM A 2048 BYTE BUFFER
00458                        ;POINTED TO BY X.  RETURNS CRC IN CRCH AND CRCL
00459 FAC0 7F000A      CRC     CLR    CRCH          ;CLEAR CRC IN NEEDED
00460 FAC3 7F000B              CLR    CRCL
00461 FAC6 DF06        CRC1    STX    XTEMP3        ;SAVE POINTER
00462 FAC8 DF04                STX    XTEMP2        ;SAVE X THRU SUBROUTINE
00463 FACA CE0800              LDX    #0800H        ;BYTE COUNT
00464 FACD DF00        CRC2    STX    BYCOUNT       ;SAVE I
00465 FACF DE06                LDX    XTEMP3
00466 FAD1 A600                LDA A  0,X           ;GET CHARACTER
00467 FAD3 8D0B                BSR    CRCC           ;COMPUTE CRC
00468 FAD5 08                  INX
00469 FAD6 DF06                STX    XTEMP3
00470 FAD8 DE00                LDX    BYCOUNT       ;GET COUNT
00471 FADA 09                  DEX
00472 FADB 26F0                BNE    CRC2
00473 FADD DE04                LDX    XTEMP2        ;RETREIVE POINTER
00474                        ;
00475 FADF 39                  RTS
00476                        ;
00477                        ;DO CRC ONE BYTE AT A TIME
00478 FAE0 970C        CRCC    STA A  BUFPNT
```

```
00479 FAE2 8680              LDA A  #80H          ;MASK
00480 FAE4 78000B    CRCC1   ASL    CRCL
00481 FAE7 79000A            ROL    CRCH
00482 FAEA 950C              BIT A  BUFPNT
00483 FAEC 2704              BEQ    CRCC2
00484 FAEE 2510              BCS    NOCHANGE
00485 FAF0 2002              BRA    CHANGE
00486 FAF2 240C      CRCC2   BCC    NOCHANGE
00487 FAF4 C641      CHANGE  LDA B  #CRCPL
00488 FAF6 D80B              EOR B    CRCL
00489 FAF8 D70B              STA B  CRCL
00490 FAFA C630              LDA B  #CRCPH
00491 FAFC D80A              EOR B  CRCH
00492 FAFE D70A              STA B  CRCH
00493 FB00 44        NOCHANGE LSR A
00494 FB01 26E1              BNE    CRCC1
00495 FB03 39                RTS
00496                ;
00497                ;
00498                ;DELAY ROUTINES
00499 FB04 C6A5      MSDLY   LDA B  #0A5H
00500 FB06 5A        MSDLY1  DEC B
00501 FB07 26FD              BNE    MSDLY1
00502 FB09 4A                DEC A
00503 FB0A 26F8              BNE    MSDLY
00504 FB0C 39                RTS
00505                ;
00506                ;DELAY A SECONDS
00507 FB0D 36        SECDLY  PSH A                ;SAVE A
00508 FB0E 86FF              LDA A  #0FFH
00509 FB10 8DF2              BSR    MSDLY
00510 FB12 86FF              LDA A  #0FFH
00511 FB14 8DEE              BSR    MSDLY
00512 FB16 86FF              LDA A  #0FFH
00513                ;       BSR    MSDLY
00514 FB18 86FF              LDA A  #0FFH
00515 FB1A 8DE8              BSR    MSDLY
00516 FB1C 32                PUL A
00517 FB1D 4A                DEC A
00518 FB1E 26ED              BNE    SECDLY
00519 FB20 39                RTS
00520                ;
00521                ;ASCII MESSAGES
00522 FB21 54524143  TRKMSG  ASCII    "TRACK? "
00522 FB25 483F20
00523 FB28 04                BYTE    4
00524 FB29 424C4F43  BLKMSG  ASCII    "BLOCKS? "
00524 FB2D 48533F20
00525 FB31 04                BYTE    4
00526 FB32 54415045  FPMSG   ASCII    "TAPE WRITE PROTECTED"
00526 FB36 20575249
00526 FB3A 54452050
00526 FB3E 524F5445
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00526 FB42 43544544
00527 FB46 04                    BYTE    4
00528 FB47 53544152   STRTMSG   ASCII    "STARTING ADDRESS? "
00528 FB4B 54494E47
00528 FB4F 20414444
00528 FB53 52455353
00528 FB57 3F20
00529 FB59 04                    BYTE    4
00530 FB5A 44524956   MESSNR    ASCII    "DRIVE NOT READY!"
00530 FB5E 45204E4F
00530 FB62 54205245
00530 FB66 41445921
00531 FB6A 04                    BYTE    4
00532 FB6B 52454144   RDYMSG    ASCII   "READY"
00532 FB6F 59
00533 FB70 04                    BYTE   4
00534 FB71 43524320   CRCMSG    ASCII    "CRC ERROR!!!"
00534 FB75 4552524F
00534 FB79 52212121
00535 FB7D 04                    BYTE    4
00536
```

Scalars

ACIA1C - 8408	ACIA1D - 8409	ACIA2C - 8808	ACIA2D - 8809	CRCPH -- 0080
CRCPL -- 0041	CRLF --- FDA6	FFOWCODE 000A	FORCODE 0008	IN2HEX - FC64
INCH --- FD36	INHEX -- FD45	LOADCODE 0004	OUT2HS - FD7C	OUT4HS - FD7A
OUTCH -- FD80	OUTHEX - FD92	PIA2AC - 8405	PIA2AD - 8404	PIA2BC - 8407
PIA2BD - 8406	REVCODE 000C	REWCODE 000E	SSDAC -- 8804	SSDAD -- 8805
STOPCODE 0006	WINTEK - FE07			

BOOTSTRA Section [illegible]solute (FB7E)

BLKMSG - FB29	BLKNUM - 000F	BLOCKS - 0011	BUFPNT - 000C	BYCOUNT 0000
CHANGE - FAF4	CKFP --- F943	CKFP1 -- F953	CKLOAD - F93D	CKRDY -- F92C
CKRDY1 - F93C	CRC ---- FAC0	CRC1 --- FAC6	CRC2 --- FACD	CRCC --- FAE0
CRCC1 -- FAE4	CRCC2 -- FAF2	CRCH --- 000A	CRCL --- 000B	CRCMSG - FB71
F.RDWR - 0012	FFORWD - F900	FORWD -- F8FC	FPMSG -- FB32	INCBLK - FA31
INIT2 -- F807	INIT7 -- F81B	LOAD --- F8D6	LOAD1 -- F8E9	LOAD2 -- F8EF
MESSNR - FB5A	MSDLY -- FB04	MSDLY1 - FB06	NOCHANGE FB00	NOTB --- F868
NOTR --- F871	NOTW --- F87A	RDBYTE - FAB6	RDWR --- F8A0	RDWR1 -- F8B3
RDWR2 -- F8C7	RDYMSG - FB6B	READ --- F881	REVERSE F904	REWIND - F908
SECDLY - FB0D	START -- F843	START1 - F849	STOP --- F8F8	STRNGOUT F8CB
STRTMSG FB47	TCMND -- F912	TRACK -- F954	TRACK2 - F96B	TRACK3 - F972
TRACKN - 000E	TRACKSET F88A	TREAD -- FA3B	TREAD1 - FA63	TREAD11 FA3D
TREAD12 FA59	TREAD2 - FA72	TREAD3 - FA84	TREAD4 - FAA1	TREAD45 FAA9
TREAD5 - FAB5	TRKMSG - FB21	TWRITE - F973	TWRITE1 F9AA	TWRITE2 F9CF
TWRITE3 F9E1	TWRITE4 F9F0	TWRITE5 FA0B	TWRITE6 FA20	TWRITES F97B
UNLOAD - F921	WRITE -- F886	WRTBYT - FA26	XTEMP1 - 0002	XTEMP2 - 0004
XTEMP3 - 0006	XTEMP4 - 0008			

536 Source Line[illegible] 536 Assembled Lines 13221 Bytes available

>>> N[illegible] assembly errors detected <<<

ADDRESS AND VARIABLE ASSIGNMENTS

```
00004                           SECTION    CONVAIR,ABSOLUTE
00005                   ;*****************************************************
00006                   ;**********************RADIOM*************************
00007                   ;DATA COLLECTION, CONTROL AND ANALYSIS SYSTEM FOR
00008                   ;A MULTI-CHANNEL MILLIMETER RADIOMETER FOR THE NASA
00009                   ;CONVAIR 990 RESEARCH AIRCRAFT  THIS EFFORT WAS
00010                   ;SUPPORTED BY GEORGIA TECH CONTRACTS A-1902 AND A-2132
00011                   ;*****************************************************
00012                   ;Written by Jim Stratigos,Rob Bird and John Cook
00013                   ;*****************************************************
00014                   ;
00015                   ;PERIPHERAL ASSIGNMENTS
00016                   ;
00017   8400            PIA1AD   EQU    8400H       ;A/D MS 8 BITS
00018   8401            PIA1AC   EQU    8401H       ;A/D START CONVERSION (SC) AND END CONV  (E0C)
00019   8402            PIA1BD   EQU    8402H       ;A/D LS 4 BITS (PB0-PB3) AND MUX   ADR  (PB4-PB7)
00020   8403            PIA1BC   EQU    8403H       ;NO HANDSHAKES
00021   8404            PIA2AD   EQU    8404H       ;TAPE DRIVE STATUS
00022   8405            PIA2AC   EQU    8405H       ;TR0 (TRACK SET BIT)
00023   8406            PIA2BD   EQU    8406H       ;TAPE CONTROL
00024   8407            PIA2BC   EQU    8407H       ;TR1 ON CB2
00025   8800            PIA3AD   EQU    8800H       ;DISPLAY DATA AND CONTROL
00026   8801            PIA3AC   EQU    8801H       ;DISPLAY RESET AND UPDATE (CA1,CA2)
00027   8802            PIA3BD   EQU    8802H       ;IRIGB IN, CLUTCH CNTRL   , AND REFLECTOR SENSE
00028   8803            PIA3BC   EQU    8803H       ;100 MS (CB1) AND 1 SEC (CB2) INTERRUPTS
00029                   ;
00030                   ;
00031                   ;ACIAS, SSDA AND APU
00032                   ;
00033   8408            ACIA1C   EQU    8408H       ;CONTROL CONSOLE
00034   8409            ACIA1D   EQU    8409H       ;XMIT AND RCV INTERRUPTS
00035   8808            ACIA2C   EQU    8808H       ;AUX SERIAL INTERFACE
00036   8809            ACIA2D   EQU    8809H       ;XMIT AND RCV INTERRUPTS
00037   8804            SSDAC    EQU    8804H       ;SSDA STATUS/CONTROL1 REGISTERS
00038   8805            SSDAD    EQU    8805H       ;SSDA DATA/CONTROL2,CONTROL3,SYNC CODE REGS.
00039   880C            APUDATA  EQU    880CH       ;FLOATING PT       PROC    DATA
00040   880D            APUSTAT  EQU    880DH       ;     "    "    "    STATUS/COMMAND
00041                   ;
00042                   ;EXTERNAL EQUATES
00043   03F7            IRQV     EQU    03F7H       ;WINTEK IRQ VECTOR
00044   03FD            NMIV     EQU    03FDH        ;WINTEK NMI VECTOR
00045                   ;
00046                   ;
00047                   ;CONSTANTS
00048   0080            CRCPH    EQU    80H          ;CRC POLY MS BYTE
00049   0041            CRCPL    EQU    41H          ;CRC POLY LS BYTE
00050   0004            LOADCODE EQU    04H         ;TAPE CONTROL CODES
00051   0006            STOPCODE EQU    06H
00052   0008            FORCODE  EQU    08H
00053   000A            FFOWCODE EQU    0AH
00054   000C            REVCODE  EQU    0CH
00055   000E            REWCODE  EQU    0EH
```

```
                      ;
                      ;
                      ;RAM VARIABLES ON PAGE 0
                      ;
          0000                  ORG     0
                      ;
                      ;
                      ;INPUT/OUTPUT BUFFERS
                      ;
                      ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                      ;SYSTEM STATUS VARIABLES
                      ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                      ;
0000 0001             TRACKN   BLOCK  1             ;CURRENT TRACK NUMBER
0001 0002             BLKNUM   BLOCK  2             ;CURRENT BLOCK NUMBER
0003 0002             FRAMTYPE BLOCK  2             ;FRAME TYPE IDENTIFIER, INDICATES POSITION OF REFLECTORS
0005 0001             RFLPOS   BLOCK  1             ;REFLECTOR POSITION INDICATOR
                      ;
                      ;REAL TIME CLOCK DATA FROM 100 MS INTERNAL CLOCK
                      ;
0006 0001             FLIGHT   BLOCK  1             ;FLIGHT NUMBER (BCD)
0007 0001             DAYS.HI  BLOCK  1             ;REAL TIME CLOCK DAY
0008 0001             DAYS.LO  BLOCK  1             ;    "
0009 0001             HOURS    BLOCK  1             ;REAL TIME CLOCK
000A 0001             MINUTES  BLOCK  1             ;  "
000B 0001             SECONDS  BLOCK  1             ;  "
                      ;CLOCK DATA FROM IRIGB TIME CODE
                      ;
000C 0001             IRIGFLT  BLOCK  1             ;IRIGB FLIGHT NUMBER (BCD)
000D 0001             IRIGDAYH BLOCK  1             ;IRIGB DAYS MS DIGIT (BCD)
000E 0001             IRIGDAYL BLOCK  1             ;  "    "  LS   "
000F 0001             IRIGHOUR BLOCK  1             ;    "  HOURS
0010 0001             IRIGMIN  BLOCK  1             ;   "  MINUTES
0011 0001             IRIGSEC  BLOCK  1             ;   "  SECONDS
                      ;
                      ;BCD TEMPERATURE DATA FROM RADIOMETER CHANNELS
                      ;
0012 0005             CH0TEMP  BLOCK  5             ;BCD TEMPERATURE OF 183 GHZ CHANNEL (DEG. KELVIN)
0017 0005             CH1TEMP  BLOCK  5             ; "       "      "  188  "     "     "     "
001C 0005             CH2TEMP  BLOCK  5             ; "       "      "  193  "     "     "     "
0021 0005             CH3TEMP  BLOCK  5             ; "       "      "  94   "     "     "     "
                      ;
                      ;THERMISTOR TEMPERATURES
                      ;
0026 0005             HTLDTEMP BLOCK  5             ;BCD TEMPERATUREE OF HOT LOAD
002B 0005             COLDTEMP BLOCK  5             ;BCD TEMPERATURE OF COLD LOAD
0030 0005             RELDTEMP BLOCK  5             ;BCD TEMPERATURE OF REFERENCE LOAD
0035 0005             KLYSTEMP BLOCK  5             ;BCD TEMPERATURE OF KLYSTRON
003A 0005             SPRETEMP BLOCK  5             ;BCD TEMPERATURE OF SPARE
                      ;
                      ;32 BIT HOT AND COLD LOAD TEMPS
003F 0004             HTTEMP32 BLOCK  4
```

```
00108 0043 0004       CDTEMP32 BLOCK  4
00109 0047 0004       HTCD32   BLOCK  4            ;HOT-COLD TEMP
00110                 ;
00111 004B 0004       CH0VAVG   BLOCK  4           ;AVERAGE OF LAST 10 CH0 SAMPLES (32 BIT9 VOLTS
00112 004F 0004       CH1VAVG   BLOCK  4           ;AVERAGE OF LAST 10 CH1 SAMPLES
00113 0053 0004       CH2VAVG   BLOCK  4           ;AVERAGE OF LAST 10 CH2 SAMPLES
00114 0057 0004       CH3VAVG   BLOCK  4           ;AVERAGE OF LAST 10 CH3 SAMPLES
00115                 ;
00116 005B 0005       CH0TAVG  BLOCK  5           ;CH0 AVERAGE TEMP IN BCD
00117 0060 0005       CH1TAVG  BLOCK  5           ;
00118 0065 0005       CH2TAVG  BLOCK  5
00119 006A 0005       CH3TAVG  BLOCK  5
00120                 ;
00121                 ;     12-BIT DATA FROM RADIOMETER ADC CHANNELS 0-8 (UPDATED EVERY SECOND).
00122 006F 0002       ADC0      BLOCK  2            ;RADIOMETER CHANNEL 0
00123 0071 0002       ADC1      BLOCK  2            ;RADIOMETER CHANNEL 1
00124 0073 0002       ADC2      BLOCK  2            ;RADIOMETER CHANNEL 2
00125 0075 0002       ADC3      BLOCK  2            ;RADIOMETER CHANNEL 3
00126 0077 0002       ADC4     BLOCK  2            ;CHANNEL 4 DATA (HOT LOAD)
00127 0079 0002       ADC5     BLOCK  2            ;CHANNEL 5 DATA (COLD LOAD)
00128 007B 0002       ADC6     BLOCK  2            ;CHANNEL 6 DATA (REFERENCE LOAD)
00129 007D 0002       ADC7     BLOCK  2            ;CHANNEL 7 DATA (KLYSTRON)
00130 007F 0002       ADC8     BLOCK  2            ;CHANNEL 8 DATA (SPARE)
00131                 ;    TEMPORARY VARIABLES FOR FLOATING POINT CALCULATIONS
00132                 ;
00133                 ;     TEMPORARY VARIABLE STORAGE.
00134 0081 0002       SAM10AVG  BLOCK  2            ;HOLDS RUNNING TOTAL OF TEN SAMPLE AVERAGE
00135 0083 0004       TEMP32    BLOCK  4            ;TEMPORARY SPACE FOR FLT-PT.  TEMPERATURES
00136 0087 0001       SAVEA     BLOCK  1            ;ACCUMULATOR A
00137 0088 0001       SAVEB     BLOCK  1            ;ACCUMULATOR B
00138 0089 0001       TEMPA     BLOCK  1            ;ACCUMULATOR A
00139 008A 0001       TEMPB     BLOCK  1            ;ACCUMULATOR B
00140 008B 0002       TEMPX     BLOCK  2            ;REGISTER X
00141 008D 0002       SAVEX     BLOCK  2            ;REGISTER X
00142 008F 0002       SAVEX1    BLOCK  2            ;REGISTER X
00143 0091 0002       SAVEX2    BLOCK  2            ;REGISTER X
00144 0093 0002       SAVEX3    BLOCK  2            ;REGISTER X
00145 0095 0002       SAVEX4    BLOCK  2            ;REGISTER X
00146 0097 0001       APUSTS    BLOCK  1            ;STATUS OF LAST APU CALCULATION
00147 0098 0001       ENTRYA    BLOCK  1            ;HOLDS PARTIALLY PACKED BCD NUMBER
00148 0099 0001       ENTRYB    BLOCK  1            ;HOLDS PARTIALLY PACKED BCD NUMBER
00149 009A 0002       INTREG    BLOCK  2            ;HOLDS INTEGER PART OF FLOATING-PT NUMBER
00150 009C 0004       FPT32     BLOCK  4            ;HOLDS CURRENT FLOATING-POINT NUMBER
00151                 ;
00152                 ;
00153                 ;FLAGS: FF=SET AND 00=CLEAR
00154                 ;
00155 00A0 0001       F.CMND    BLOCK  1            ;COMMAND PRESENT FLAG FOR INBUFF
00156 00A1 0001       F.NUMBR   BLOCK  1            ;NUMBER PRESENT FLAG
00157 00A2 0001       F.5MIN    BLOCK  1            ;5 MINUTE FLAG FOR IRIGB READ
00158 00A3 0001       F.BADTIM  BLOCK  1            ;BAD TIME FLAG FOR IRIGB
00159 00A4 0001       F.CALTIM  BLOCK  1            ;CALIBRATE TIME FLAG
```

ADDRESS AND VARIABLE ASSIGNMENTS

```
00160 00A5 0001       F.NUBLOC BLOCK  1          ;TAPE DATA BLOCK READY FLAG
00161 00A6 0001       F.DATA   BLOCK  1          ;DATA COLLECTION ON/OFF FLAG WHILE WRITING ON TAPE
00162 00A7 0001       F.XMIT   BLOCK  1          ;TRANSMIT BUFFER FLAG
00163 00A8 0001       F.FULBLK BLOCK  1          ;INDICATES DATA BUFFER IS FULL
00164 00A9 0001       F.STATUS BLOCK  1          ;INDICATES WHEN TO PRINT OUT AUTOMATIC STATUS DATA
00165 00AA 0001       F.COLLEC BLOCK  1          ;DATA COLLECTION ENABLE FLAG
00166 00AB 0001       F.GSFC   BLOCK  1          ;GODDARD UP/DOWN FLAG
00167                 ;
00168                 ;TEMPORARY VARIABLES AND POINTERS FOR TAPE ROUTINES
00169                 ;
00170 00AC 0002       BYCOUNT  BLOCK  2          ;TEMP BYTE COUNTER FOR TREAD/TWRITE
00171 00AE 0002       XTEMP1   BLOCK  2          ;TEMPORARY X REGISTER STORAGE
00172 00B0 0002       XTEMP2   BLOCK  2          ;  "
00173 00B2 0002       XTEMP3   BLOCK  2          ;  "
00174 00B4 0002       XTEMP4   BLOCK  2          ;  "
00175 00B6 0001       CRCH     BLOCK  1
00176 00B7 0001       CRCL     BLOCK  1          ;CRC CODE FOR TAPE
00177 00B8 0002       BUFPNT   BLOCK  2          ;TEMP FOR DECODE
00178 00BA 0002       TABPNT   BLOCK  2          ; "
00179 00BC 0002       BTEMP    BLOCK  2          ; "
00180 00BE 0002       CBUFF    BLOCK  2          ;TEMPORARY POINTER FOR INBUFF
00181 00C0 0001       BLOCKS   BLOCK  1          ;BLOCK COUNTER FOR TREAD AND TWRITE
00182 00C1 0002       NEXSTATE BLOCK  2          ;STATE POINTER FOR NUMBER INPUT
00183 00C3 0002       NEXTDISP BLOCK  2          ;DISPLAY BUFFER POINTER
00184 00C5 0002       DISPADR  BLOCK  2          ;DISPLAY DRIVER ROUTINE POINTER
00185 00C7 0002       HEXPTR   BLOCK  2          ;POINTER TO HEX DATA FOR DEBUGGING
00186 00C9 0001       CTSCNTR  BLOCK  1          ;COUNTER FOR TIMEOUT ON CTS FROM GODDARD
00187 00CA 0001       TCNT     BLOCK  1
00188 00CB 0001       FCNT     BLOCK  1
00189 00CC 0001       SKIPSGN  BLOCK  1
00190 00CD 0002       BLKCNT   BLOCK  2
00191 00CF 0001       GSFCTO   BLOCK  1          ;GODDARD TIME OUT INTERVAL IN MS
00192                 ;
00193                 ;IRQ AND NMI SERVICE ROUTINE VARIABLE STORAGE
00194                 ;
00195 00D0 0002       IRQT1    BLOCK  2
00196 00D2 0002       IRQT2    BLOCK  2
00197                 ;
00198 00D4 0001       NMI.F0   BLOCK  1          ;IRIGB FLAG
00199 00D5 0002       NMI.F1   BLOCK  2
00200 00D7 0001       RTC.CNTR BLOCK  1          ;100 MS COUNTER FOR IRIGB READ
00201 00D8 0001       RTC.STAT BLOCK  1          ;RTC STATUS
00202 00D9 0001       MSCNTR   BLOCK  1          ;RTC MS COUNTER
00203 00DA 0001       STATCNTR BLOCK  1          ;TIMER FOR STATUS PRINTOUT
00204 00DB 0001       STATTIME BLOCK  1          ;TIME INTERVAL FOR STATUS
00205 00DC 0001       CAL.CNTR BLOCK  1          ;CALIBRATION INTERVAL COUNTER
00206 00DD 0001       CAL.TIME BLOCK  1          ;CALIBRATION INTERVAL IN MINUTES
00207 00DE 0002       DATAPNTR BLOCK  2          ;POINTER TO NEXT AVAILABLE TAPE BUFFER LOCATION
00208 00E0 0001       NMI.TMP1 BLOCK  1
00209 00E1 0002       NEWCHAR  BLOCK  2          ;OUTPUT CHARACTER BUFFER PNTR.
00210 00E3 0002       NEXTCHAR BLOCK  2          ;BUFFER POINTER FOR OUTCH
00211 00E5 0002       LASTCHAR BLOCK  2          ; "       "       "     "
```

ADDRESS AND VARIABLE ASSIGNMENTS

```
00212 00E7 0002       BLOCKEND BLOCK  2           ;  "
00213 00E9 0002       AVGPTR   BLOCK  2           ;POINTER TO AVERAGE BUFFER
00214                  ;
00215 00EB 0050       AVGBUFF  BLOCK  80          ;BUFFER FOR AVERAGING
00216                  ;
00217                  ;
00218                  ;RADIOMETER CALIBRATION CONSTANTS (32 BIT FLOATING POINT)
00219                  ;SET TO NOMINAL VALUES OF 40 DEG/VOLT AND -10 DEG OFFSET FOR TESTING
00220                  ;
00221 013B 06A0       CH0GAIN  WORD   06A0H       ;183 GHZ GAIN IN DEG. K/VOLT
00222 013D 0000                WORD   0000H
00223 013F 0000       CH0OFST  WORD   0000H       ;  "   "  OFFSET IN DEG. K
00224 0141 0000                WORD   0000H
00225 0143 06A0       CH1GAIN  WORD   06A0H       ;188 GHZ GAIN
00226 0145 0000                WORD   0000H
00227 0147 0000       CH1OFST  WORD   0000H       ;  "   "  OFFSET
00228 0149 0000                WORD   0000H
00229 014B 06A0       CH2GAIN  WORD   06A0H       ;193 GHZ GAIN
00230 014D 0000                WORD   0000H
00231 014F 0000       CH2OFST  WORD   0000H       ;  "   "  OFFSET
00232 0151 0000                WORD   0000H
00233 0153 06A0       CH3GAIN  WORD   06A0H       ;94 GHZ GAIN
00234 0155 0000                WORD   0000H
00235 0157 0000       CH3OFST  WORD   0000H       ;"   "  OFFSET
00236 0159 0000                WORD   0000H
00237                  ;
00238 015B 0064       XMITBUF  BLOCK  100         ;TRANSMITT BUFFER
```

INITIALIZATION

```
00241                   ;PERIPHERAL INITIALIZATION
00242        1000               ORG    1000H
00243 1000 01           INIT1      NOP                 ;FIX FOR SEI INSTRUCTION
00244 1001 0F                      SEI
00245 1002 8E4000                  LDS    #4000H
00246 1005 CE0000                  LDX    #0           ;POINT TO START OF RAM
00247 1008 6F00         INIT11     CLR    0,X          ;CLEAR IT
00248 100A 08                      INX
00249 100B 8C0200                  CPX    #0200H       ;DONE?
00250 100E 26F8                    BNE    INIT11
00251                   ;
00252 1010 CE2903                  LDX    #CBUFFER     ;INIT BUFFER POINTER
00253 1013 DFBE                    STX    CBUFF
00254 1015 CE015B                  LDX    #XMITBUF     ;INITIALIZE OUTCHAR POINTER
00255 1018 DFE3                    STX    NEXTCHAR
00256 101A CE28EF                  LDX    #DISPLY      ;INIT DISP BUFFER POINTER
00257 101D DFC3                    STX    NEXTDISP
00258 101F DFD0                    STX    IRQT1        ;INIT DISPLAY ISR POINTER
00259 1021 BD15AE                  JSR    CLRDISP      ;BLANK DISPLAY
00260 1024 CE1C0B                  LDX    #INITMS      ;INITIALIZE DISPLAY DRIVER
00261 1027 DFC5                    STX    DISPADR
00262 1029 CE00EB                  LDX    #AVGBUFF     ;INIT AVERAGE BUFFER
00263 102C DFE9                    STX    AVGPTR
00264 102E 8605                    LDA A  #5
00265 1030 97DD                    STA A  CAL. TIME    ;INIT CAL TIMER TO 5 MINUTES
00266 1032 97DC                    STA A  CAL. CNTR    ;INIT CAL COUNTER
00267 1034 860A                    LDA A  #10
00268 1036 97DA                    STA A    STATCNTR   ;INIT STATUS TIMER
00269 1038 97DB                    STA A    STATTIME   ;STORAGE FOR STATUS TIME
00270 103A 8619                    LDA A  #25          ;SET GODDARD CTS TIME OUT TIMER
00271 103C 97C9                    STA A  CTSCNTR
00272 103E 97CF                    STA A  GSFCTO       ;SET TIME OUT TIMER
00273 1040 CE06A0                  LDX    #06A0H       ;INIT RADIOMETER GAINS TO 40 DEG/VOLT
00274 1043 FF013B                  STX    CH0GAIN
00275 1046 FF0143                  STX    CH1GAIN
00276 1049 FF014B                  STX    CH2GAIN
00277 104C FF0153                  STX    CH3GAIN
00278 104F CE84A0                  LDX    #84A0H       ;INIT OFFSETS TO -10 DEGREES
00279 1052 FF013F                  STX    CH0OFST
00280 1055 FF0147                  STX    CH1OFST
00281 1058 FF014F                  STX    CH2OFST
00282 105B FF0157                  STX    CH3OFST
00283                   ;
00284                   ;SET UP PIA1--A/D CONTROL
00285                   ;
00286 105E CE8400       INIT2      LDX    #8400H       ;PIA BASI ADDRESS
00287 1061 6F01                    CLR    1,X          ;CLEAR CONTROL REGISTERS
00288 1063 6F03                    CLR    3,X          ;  "       "         "
00289 1065 6F00                    CLR    0,X          ;A-SIDE FOR ALL INPUTS
00290 1067 86F0                    LDA A  #0F0H        ;B-SIDE FOR 4 INS (PB0-PB3) AND
00291 1069 A702                    STA A  2,X          ;4 OUTS (PB4-PB7)
00292 106B 863C                    LDA A  #3CH         ;HANDSHAKE WIT EOC AND CA1 AND SC ON CA2
```

```
INITIALIZATION

00293 106D A701              STA A  1,X
00294 106F 8604              LDA A  #4
00295 1071 A703              STA A  3,X          ;NO HANDSHAKES ON B SIDE
00296                        ;
00297                        ;SET UP PIA2--TAPE DRIVE STATUS/CONTROL
00298                        ;
00299 1073 6F05      INIT3   CLR    5,X          ;CLEAR CONTROL REGISTERS
00300 1075 6F07              CLR    7,X          ;  "       "
00301 1077 6F04              CLR    4,X          ;A-SIDE FOR ALL INPUTS
00302 1079 863F              LDA A  #3FH         ;B-SIDE FOR 2 INXS (PB7,PB6) AND 6 OUTS (PB0-PB5)
00303 107B A706              STA A  6,X
00304 107D 863C              LDA A  #3CH         ;ENABLE CA2 AND CB2 FOR TRACK CONTROL OUTPUTS
00305 107F A705              STA A  5,X
00306 1081 A707              STA A  7,X
00307 1083 8636              LDA A  #36H         ;ISSUE STOP COMMAND TO TAPE AND SET
00308 1085 A706              STA A  6,X          ;WRN=WDR=1
00309                        ;
00310                        ;SET UP IRQ AND NMI POINTERS
00311 1087 867E      INIT31  LDA A  #7EH         ;STORE JUMP CODE
00312 1089 B703F7            STA A  IRQV
00313 108C CE20D4            LDX    #IRQ.ISR
00314 108F FF03F8            STX    IRQV+1
00315 1092 B703FD            STA A  NMIV
00316 1095 CE1E77            LDX    #NMI.ISR
00317 1098 FF03FE            STX    NMIV+1
00318                        ;
00319                        ;
00320                        ;SET UP PIA3--DISPLAY/REFLECTOR CONTROL/TIME CODE
00321                        ;
00322 109B CE8800    INIT4   LDX    #8800H       ;BASE ADDRESS
00323 109E 6F01              CLR    1,X          ;CLEAR CONTROL REGISTERS
00324 10A0 6F03              CLR    3,X          ;  "       "       "
00325 10A2 86FF              LDA A  #0FFH        ;A-SIDE FOR ALL OUTPUTS
00326 10A4 A700              STA A  0,X          ;
00327 10A6 8630              LDA A  #30H         ;B-SIDE FOR 2 OUTS (PB4,PB5) AND 6 INS
00328 10A8 A702              STA A  2,X
00329 10AA 863D              LDA A  #3DH         ;ENABLE IRQ ON CA1 NEG EDGE AND SET CA2 HIGH
00330 10AC A701              STA A  1,X
00331 10AE 860D              LDA A  #0DH         ;SET CB1 AND CB2 FOR INTRPTS ON NEG EDGE FOR RTCS
00332 10B0 A703              STA A  3,X
00333 10B2 86FF              LDA A  #0FFH        ;BLANK DISPLAY
00334 10B4 A700              STA A  0,X
00335 10B6 A702              STA A  2,X          ;DISABLE CLUTCH
00336                        ;
00337                        ;SET UP ACIA1--CONSOLE RS232--PORT 0
00338                        ;
00339 10B8 8603      INIT5   LDA A  #3           ;RESET CODE
00340 10BA B78408            STA A  ACIA1C       ;RESET ACIA
00341 10BD 8685              LDA A  #085H        ;SET UP ACIA FOR 7 DATA BITS, EVEN PARITY, 2 STOP BITS
00342 10BF B78408            STA A  ACIA1C       ;ENABLE RCVR INTERRUPTS ONLY INITIALLY
00343                        ;
00344                        ;SET UP ACIA2--REMOTE RS232--PORT 1
```

INITIALIZATION

```
00345                    ;
00346 10C2 8603  INIT6   LDA A  #3          ;RESET ACIA
00347 10C4 B78808        STA A  ACIA2C
00348 10C7 8611          LDA A  #11H        ;SET UP ACIA FOR 8 DATA BITS, 2 STOP BITS, NO INTRPTS
00349 10C9 B78808        STA A  ACIA2C
00350                    ;
00351                    ;
00352                    ;PROGRAM SSDA FOR TAPE DRIVE I/O
00353                    ;
00354 10CC 8603  INIT7   LDA A  #3          ;RESET XMTR AND RCVR
00355 10CE B78804        STA A  SSDAC       ;STORE IN CONTROL 1
00356 10D1 860B          LDA A  #0BH         ;DISABLE RCVR SYNC
00357 10D3 B78804        STA A  SSDAC       ;ACCESS CONTROL 2
00358 10D6 865D          LDA A  #5DH        ;8 BIT WORD, 1 BYTE XFER AND TX SYNC ON UNDERFLOW
00359 10D8 B78805        STA A  SSDAD       ;STORE IN CONTROL 2
00360 10DB 864B          LDA A  #4BH        ;ACCESS CONTROL 3
00361 10DD B78804        STA A  SSDAC       ;
00362 10E0 860E          LDA A  #0EH        ;SET CTUF=CTS=1 AND 1 SYNC MODE
00363 10E2 B78805        STA A  SSDAD
00364 10E5 868B          LDA A  #8BH        ;ACCESS SSYNC CODE REGISTER
00365 10E7 B78804        STA A  SSDAC
00366 10EA 8601          LDA A  #1         ;SET SYNC CODE REGISTER TO 01
00367 10EC B78805        STA A  SSDAD
00368 10EF 86C8          LDA A  #0C8H        ;ACCESS XMIT FIFO AND CLR RESET BITS
00369 10F1 B78804        STA A  SSDAC
00370                    ;
00371 10F4 86C8          LDA A  #200
00372 10F6 BD1666        JSR    MSDLY       ;WAIT FOR THINGS TO WARM UP
00373 10F9 BD1A18        JSR    CRLF
00374 10FC CE253F        LDX    #RADMSG
00375 10FF BD1DF4        JSR    STRNGOUT
00376 1102 CE26D7        LDX    #CONMSG
00377 1105 BD1DF4        JSR    STRNGOUT
00378 1108 01    RESTART NOP                ;SOFT RESTART ENTRY
00379 1109 0E            CLI
00380 110A 7E1683        JMP    MAINLOOP
00381                    ;
```

```
00384                   ;
00385                   ;INTERRUPT DRIVEN ACIA INPUT ROUTINE FOR CONSOLE.
00386                   ;FILLS CBUFFER WITH DATA FROM CONSOLE UNTILL CARRIAGE
00387                   ;RETURN IS RCVD.  THEN SENDS OUT LINE FEED AND SETS F.CMND
00388                   ;FLAG.
00389 110D DEBE       INBUFF   LDX    CBUFF          ;NEXT BUFFER LOCATION
00390 110F B68409               LDA A  ACIA1D         ;GET CHARACTER
00391 1112 B78409               STA A  ACIA1D         ;ECHO
00392 1115 4D                   TST A
00393 1116 273C                 BEQ    INBUFF6        ;IGNORE NULLS
00394 1118 810A                 CMP A  #0AH           ;WAS IT A LINE FEED?
00395 111A 2738                 BEQ    INBUFF6        ;IGNORE IT
00396 111C 811B                 CMP A  #1BH           ;ESCAPE CHARACTER?
00397 111E 260E                 BNE    INBUFF1        ;NO
00398 1120 CE250B               LDX    #DELMSG        ;PRINT "DEL"
00399 1123 BD1DF4               JSR    STRNGOUT          ;PRINT MESSAGE
00400 1126 7F00A0               CLR    F.CMND
00401 1129 7F00A1               CLR    F.NUMBR
00402 112C 2021                 BRA    INBUFF4        ;RETURN
00403 112E 810D       INBUFF1   CMP A  #0DH          ;CARRIAGE RETURN
00404 1130 2716                 BEQ    INBUFF3        ;YES
00405 1132 8108                 CMP A  #8             ;BACKSPACE?
00406 1134 2608                 BNE    INBUFF2        ;PROCESS CHARACTER
00407 1136 8C2903               CPX    #CBUFFER       ;WAS IT FIRST CHARACTER?
00408 1139 2719                 BEQ    INBUFF6        ;YES,DONT BACKSPACE
00409 113B 09                   DEX                   ;BACH UP POINTER
00410 113C 2014                 BRA    INBUFF5        ;RETURN
00411 113E 8C2913     INBUFF2   CPX    #CBUFFER+16    ;END OF BUFFER
00412 1141 2705                 BEQ    INBUFF3        ;BUFFER FULL, TERMINATE
00413 1143 A700                 STA A  0,X            ;PUT CHARACTER IN BUFFER
00414 1145 08                   INX                   ;BUMP POINTER
00415 1146 200A                 BRA    INBUFF5
00416 1148 8604       INBUFF3   LDA A  #4             ;BUFFER TERMINATOR
00417 114A A700                 STA A  0,X
00418 114C 7A00A0               DEC    F.CMND         ;SET COMMAND READY FLAG
00419 114F CE2903     INBUFF4   LDX    #CBUFFER       ;INIT BUFFER POINTER
00420 1152 DFBE       INBUFF5   STX    CBUFF          ;SAVE POINTER
00421 1154 39         INBUFF6   RTS
00422                   ;
00423                   ;
00424                   ;
00425                   ;DECODES COMMAND IN CBUFFER VIA COMMAND TABLE WHEN F.CMND FLAG
00426                   ;IS SET BY INBUFF.  JUMPS TO APPROPRIATE ROUTINE IF COMMAND FOUND
00427                   ;PRINTS ERROR MESSAGE IF COMMAND NOT FOUND
00428                   ;
00429 1155 BD1A1F     DECODE   JSR    LFEED          ;SEND OFUT LINE FEED
00430 1158 CE2903               LDX    #CBUFFER       ;POINTER TO BUFFER
00431 115B A600       DECODE1   LDA A  0,X            ;GET CHARACTER FROM BUFFER
00432 115D 8120                 CMP A  #20H           ;IS IT A SPACE?
00433 115F 2603                 BNE    DECODE11        ;NO
00434 1161 08                   INX                   ;SKIP SPACE
00435 1162 20F7                 BRA    DECODE1
```

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00436 1164 DFBC       DECODE11 STX    BTEMP          ;SAVE POINTER TO FIRST COMMAND CHAR.
00437 1166 DFB8                STX    BUFPNT        ;COMMAND PARSING POINTER
00438 1168 CE2727              LDX    #CMDTABLE     ;POINTER TO COMMAND TABLE
00439 116B DFBA       DECODE2  STX    TABPNT        ;SAVE POINTER
00440 116D 6D00                TST    0,X           ;IS IT A NULL?
00441 116F 2723                BEQ    DECODE4       ;COMMAD FOU?ND?
00442 1171 A100                CMP A  0,X           ;COMPARE CHARACTERS
00443 1173 260C                BNE    DECODE3       ;ARE THEY EQUAL?
00444 1175 DEB8                LDX    BUFPNT        ;RESTORE POINTER
00445 1177 08                  INX                  ;BUMP IT
00446 1178 A600       DECODE21 LDA A  0,X           ;GET NEXT CHAR
00447 117A DFB8                STX    BUFPNT                ;SAVE POINTER
00448 117C DEBA                LDX    TABPNT        ;GET TABLE POINTER
00449 117E 08                  INX                  ;BUMP IT
00450 117F 20EA                BRA    DECODE2
00451 1181 08         DECODE3  INX                  ;BUMP POINTER
00452 1182 6D00                TST    0,X           ;IS IT A NULL
00453 1184 26FB                BNE    DECODE3       ;MOVE TO NEXT COMMAND
00454 1186 08                  INX                  ;BUMP TABLE POINTER 3 TIMES
00455 1187 08                  INX
00456 1188 08                  INX
00457 1189 6D00                TST    0,X           ;TABLE END?
00458 118B 270E                BEQ    DECERR        ;RETURN WITH ERROR
00459 118D 09                  DEX
00460 118E DFBA                STX    TABPNT
00461 1190 DEBC                LDX    BTEMP         ;GET POINTER TO FIRST BUFFER CHAR.
00462 1192 20E4                BRA    DECODE21      ;REPEAT
00463 1194 08         DECODE4  INX                  ;POINT TO COMMAND ADDRESS
00464 1195 EE00                LDX    0,X           ;GET ADDRES
00465 1197 AD00                JSR    0,X           ;GO DO COMMAND
00466 1199 2006                BRA    DECODE5
00467 119B CE2457     DECERR   LDX    #SYNMSG       ;PRINT ERROR MESSAGE
00468 119E BD1DF4              JSR    STRNGOUT
00469 11A1 7F00A0     DECODE5  CLR    F.CMND        ;CLEAR FLAG
00470 11A4 39                  RTS
00471                 ;
00472                 ;
00473                 ;CONVERT TWO CHARACTERS IN CBUFFER INTO A SINGLE HEX BYTE IN A
00474                 ;SETS CARRY AS ERROR CONDITION IF NON-HEX CHARACTER FOUND OR IF MORE
00475                 ;THAN TWO CHARACTERS IN BUFFER.
00476                 ;
00477 11A5 CE2903     INBYTE   LDX    #CBUFFER      ;POIINTER TO INPUT BUFFER
00478 11A8 A600       INBYTE1  LDA A  0,X           ;GET A CHARACTER
00479 11AA 08                  INX
00480 11AB 8120                CMP A  #20H          ;SKIP SPACES
00481 11AD 27F9                BEQ    INBYTE1
00482 11AF 8D14                BSR    TESTHEX       ;CONVERT TO HEX DIGIT AND TEST IF GOOD
00483 11B1 2510                BCS    INBYTE2       ;ERROR EXIT
00484 11B3 48                  ASL A                ;SHIFT TO MS NIBBLE
00485 11B4 48                  ASL A
00486 11B5 48                  ASL A
00487 11B6 48                  ASL A
```

```
00488 11B7 16                TAB
00489 11B8 A600              LDA A  0,X          ;GET NEXT CHARACTER
00490 11BA 08                INX
00491 11BB 8D08              BSR    TESTHEX
00492 11BD 2504              BCS    INBYTE2       ;ERROR EXIT
00493 11BF 1B                ABA                  ;FORM COMPLETE BYTE
00494 11C0 0C                CLC
00495 11C1 2001              BRA    INBYTE3
00496 11C3 0D        INBYTE2 SEC                  ;ERROR CONDITION
00497 11C4 39        INBYTE3 RTS
00498                        ;
00499                        ;CONVERT ASCII CHARACTER IN A TO HEX NIBBLE. SET CARRY IF NOT HEX.
00500                        ;
00501 11C5 8030      TESTHEX SUB A  #30H          ;REMOVE ASCII BIAS
00502 11C7 2B10              BMI    NOTHEX        ;CHARACTER LESS THAN 30H?
00503 11C9 8109              CMP A  #09H          ;GREATER THAN 9?
00504 11CB 2F0A              BLE    YESHEX        ;ALREADY PROPER HEX
00505 11CD 8111              CMP A  #11H          ;WAS IT LESS THAN AN "A"?
00506 11CF 2B08              BMI    NOTHEX
00507 11D1 8116              CMP A  #16H          ;GREATER THAN F?
00508 11D3 2E04              BGT    NOTHEX
00509 11D5 8007              SUB A  #07H          ;SUBTRACT LETTER BIAS FOR A-F
00510 11D7 0C        YESHEX  CLC
00511 11D8 39                RTS
00512 11D9 0D        NOTHEX  SEC
00513 11DA 39                RTS
00514                        ;
00515                        ;
00516                        ;
00517                        ;GET 2 BYTE NUMBER FROM CBUFFER AND PLACE RESULT IN X.
00518                        ;CARRY SET IF A NON-HEX DIGIT FOUND OR IF THERE ARE NOT EXACTLY
00519                        ;FOUR CHARACTERS IN BUFFER.
00520                        ;
00521 11DB CE2903    IN2BYTES LDX   #CBUFFER     ;POINTER TO INPUT BUFFER
00522 11DE 8DC8              BSR    INBYTE1       ;CONVERT FIRST TWO CHARS TO HEX
00523 11E0 2511              BCS    IN2BYTE2      ;ERROR EXIT
00524 11E2 97AE              STA A  XTEMP1        ;SAVE RESULT
00525 11E4 8DC2              BSR    INBYTE1       ;GET NEXT BYTE
00526 11E6 25DB              BCS    INBYTE2
00527 11E8 97AF              STA A  XTEMP1+1
00528 11EA A600              LDA A  0,X           ;LOOK FOR 04
00529 11EC 8104              CMP A  #4
00530 11EE 2603              BNE    IN2BYTE2      ;ERROR EXIT IF NOT FOUND
00531 11F0 0C                CLC
00532 11F1 2001              BRA    IN2BYTE3
00533 11F3 0D        IN2BYTE2  SEC
00534 11F4 DEAE      IN2BYTE3 LDX   XTEMP1        ;GET 2 BYTES IN X
00535 11F6 39                RTS
00536                        ;
00537                        ;
```

```
00540                   ;
00541                   ;TAPE DRIVE CONTROL SUBROUTINES
00542                   ;
00543                   ;
00544                   ;TAPE MOTION COMMANDS.  USE BY DATA COLLECTION SOFTWARE
00545                   ;AND UTILITY COMMANDS.
00546                   ;
00547                   ;LOAD CART
00548                   ;
00549 11F7 B68404       LOAD      LDA A  PIA2AD        ;GET STATUS
00550 11FA 8430                   AND A  #30H          ;CHECK IF ALREADY LOADED
00551 11FC 2717                   BEQ    LOAD2
00552 11FE 8110                   CMP A  #10H          ;CHECK IF STAUTS=0
00553 1200 2708                   BEQ    LOAD1         ;YES, STAYTUS OK, LOAD CART
00554 1202 CE242C                 LDX    #MESSNR       ;TURN ON NOT READY MESSAGE
00555 1205 BD1DF4                 JSR    STRNGOUT
00556 1208 200B                   BRA    LOAD2
00557 120A 8D0A         LOAD1     BSR    STOP          ;STOP TAPE IF MOVING
00558 120C 8604                   LDA A  #LOADCODE     ;GET LOAD CODE
00559 120E 8D20                   BSR    TCMND         ;ISSUE COMMAND
00560 1210 4F                     CLR A
00561 1211 9701                   STA A  BLKNUM        ;CLEAR BLOCK NUMBER
00562 1213 9702                   STA A  BLKNUM+1
00563 1215 39           LOAD2     RTS
00564                   ;
00565                   ;STOP TAPE
00566 1216 8606         STOP      LDA A  #STOPCODE     ;GET STOP CODE
00567 1218 2016                   BRA    TCMND
00568                   ;
00569                   ;MOVE TAPE FORWARD
00570 121A 8608         FORWD     LDA A  #FORCODE
00571 121C 2012                   BRA    TCMND
00572                   ;
00573                   ;FAST FORWARD
00574 121E 860A         FFORWD    LDA A  #FFOWCODE
00575 1220 200E                   BRA    TCMND
00576                   ;
00577                   ;REVERSE
00578 1222 860C         REVERSE   LDA A  #REVCODE
00579 1224 200A                   BRA    TCMND
00580                   ;
00581                   ;REWIND
00582 1226 860E         REWIND    LDA A  #REWCODE
00583 1228 7F0001                 CLR    BLKNUM
00584 122B 7F0002                 CLR    BLKNUM+1
00585 122E 2000                   BRA    TCMND
00586                   ;
00587                   ;PULSE PROPER TAPE CONTROL LINE
00588                   ;
00589 1230 F68406       TCMND     LDA B  PIA2BD        ;GET OLD CONTROL WORD
00590 1233 C4F0                   AND B  #0F0H         ;MASK OF LS HALF
00591 1235 1B                     ABA                  ;ADD IN NEW COMMAND
```

```
00592 1236 B78406              STA A  PIA2BD        ;PUT OUT NEW COMMAND
00593 1239 84F0                AND A  #0F0H         ;CLEAR COMMAND
00594 123B B78406              STA A  PIA2BD
00595 123E 39                  RTS
00596                  ;
00597                  ;
00598                  ;UNLOAD CART FOR REMOVAL
00599                  ;
00600 123F 8DD5        UNLOAD  BSR    STOP          ; STOP TAPE IF MOVING
00601 1241 8604                LDA A  #LOADCODE
00602 1243 8DEB                BSR    TCMND
00603 1245 8604                LDA A  #LOADCODE     ;ISSUE TWO LOAD PULSES
00604 1247 8DE7                BSR    TCMND
00605 1249 39                  RTS
00606                  ;
00607                  ;
00608                  ;
00609                  ;TAPE STATUS MONITOR. CHECKS TAPE STATUS BITS ON PIA2A
00610                  ;TO DETERMINE APPROPRIATE STATUS.
00611                  ;RETURNS TO ROUTINE ONE LEVEL LOWER ON STACK IF ERROR
00612                  ;
00613 124A B68404      CKRDY   LDA A  PIA2AD        ;GET STATUS
00614 124D 8430                AND A  #30H          ;CHECK RDY AND ST BITS
00615 124F 2605                BNE    CKRDY1
00616 1251 B68406              LDA A  PIA2BD     ;CHECK TAPE MOTION BIT
00617 1254 2B08                BMI    CKRDY2        ;NOT MOVING
00618 1256 CE242C      CKRDY1  LDX    #MESSNR       ;TURN ON NOT READY MSG
00619 1259 BD1DF4              JSR    STRNGOUT
00620 125C 31                  INS                  ;POP STACK
00621 125D 31                  INS
00622 125E 39          CKRDY2  RTS
00623                  ;
00624                  ;
00625 125F B68404      CKLOAD  LDA A  PIA2AD        ;GET STATUS
00626 1262 8402                AND A  #02H          ;SEE IF TAPE AT LOAD POINT
00627 1264 39                  RTS
00628                  ;
00629                  ;CHECK IF WRITE PROTECT IS ON
00630 1265 B68406      CKFP    LDA A  PIA2BD        ;GET FP AND TM BITS
00631 1268 8440                AND A  #40H          ;CHECK BIT 6
00632 126A 2606                BNE    CKFP1         ;NOT PROTECTED
00633 126C CE2518              LDX    #FPMSG        ;TURN ON FILE PROTECT MESSAGE
00634 126F BD1DF4              JSR    STRNGOUT
00635 1272 39          CKFP1   RTS
00636                  ;
00637                  ;
00638                  ;SET TRACK NO. FROM CONTENTS OF A
00639                  ;A MAY BE =0,1,2,3
00640 1273 8103        TRACK   CMP A  #3            ;SEE IF ALLOWABLE VALUE
00641 1275 221A                BHI    TRACK3        ;NOPE,RETURN
00642 1277 9700                STA A  TRACKN        ;UPDATE TRACK NO.
00643 1279 F68405              LDA B  PIA2AC        ;GET TR0 CONTROL WORD
```

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00644 127C 8D0C              BSR    TRACK2       ;SET OR CLEAR TRACK BIT AS REQUIRED
00645 127E F78405            STA B  PIA2AC       ;REPLACE TR0
00646 1281 F68407            LDA B  PIA2BC       ;GET TR1 BIT
00647 1284 8D04              BSR    TRACK2       ;DO SAME FOR TR1
00648 1286 F78407            STA B  PIA2BC
00649 1289 39                RTS
00650 128A CA38       TRACK2 ORA B  #38H         ;CLEAR TRACK BIT
00651 128C 44                LSR A               ;CHECK DESIRED TRACK NO.
00652 128D 2402              BCC    TRACK3
00653 128F C4F7              AND B  #0F7H        ;SET TRACK BIT
00654 1291 39         TRACK3 RTS                 ;DONE
00655                        ;
00656                        ;
00657                        ;WRITE MEMORY TO TAPE . ASKS FOR STARTING ADDRESS AND
00658                        ;NUMBER OF 2K BYTE BLOCKS.  USES STATE POINTER "NEXSTATE"
00659                        ;TO FETCH NUMBER VIA INBUFF AND JUMP FROM MAINPROGRAM
00660 1292 CE24B      WRITE  LDX    #STRTMSG     ;ASK FOR START ADDRESS
00661 1295 BD1DF      WRITE  JSR    STRNGNOC     ;PRINT WITH NO CR
00662 1298 7A00A      WRITE  DEC    F.NUMBR      ;SET NUMBER FLAG
00663 129B CE12A      WRITE  LDX    #WRITE1      ;GET ADDRESS OF NEXT INSTRUCTION
00664 129E DFC1              STX    NEXSTATE
00665 12A0 2031              BRA    WRITE5       ;GO BACK AND RETURN HERE WITH NUMBER IN CBUFF
00666 12A2 BD11D      WRITE1 JSR    IN2BYTES     ;CONVERT ASCII IN CBUFFER TO HEX
00667 12A5 2408              BCC    WRITE2       ;GO ON IF NO ERROR
00668 12A7 CE247      WRITE  LDX    #NUMERR      ;PRINT ERROR MESSAGE
00669 12AA BD1DF      WRITE  JSR    STRNGOUT
00670 12AD 20E3              BRA    WRITE        ;TRY AGAIN
00671 12AF DFB4       WRITE2 STX    XTEMP4        ;SAVE ADDRESS
00672 12B1 CE248      WRITE22 LDX   #BLKSMSG     ;ASK FOR NUMBER OF BLOCKS
00673 12B4 BD1DF      WRITE  JSR    STRNGNOC
00674 12B7 7A00A      WRITE  DEC    F.NUMBR      ;SET NUMBER FLAG
00675 12BA CE12C      WRITE  LDX    #WRITE3      ;SET STATE POINTER
00676 12BD DFC1              STX    NEXSTATE
00677 12BF 2012              BRA    WRITE5
00678 12C1 BD11A      WRITE3 JSR    INBYTE       ;GET BLOCK COUNT
00679 12C4 2408              BCC    WRITE4       ;SKIP OF NO ERROR
00680 12C6 CE247      WRITE  LDX    #NUMERR
00681 12C9 BD1DF      WRITE  JSR    STRNGOUT
00682 12CC 20E3              BRA    WRITE22
00683 12CE DEB4       WRITE4 LDX    XTEMP4       ;GET START ADDRESS BACK
00684 12D0 BD141      WRITE  JSR    TWRITE       ;GO WRITE BLOCKS
00685 12D3 39         WRITE5 RTS
00686                        ;
00687                        ;READ BLOCKS FROM TAPE TO MEMORY STARTING AT CURRENT BLOCK
00688                        ;
00689 12D4 CE24B      READ   LDX    #STRTMSG     ;ASK FOR START ADDRESS
00690 12D7 BD1DF      READ   JSR    STRNGNOC
00691 12DA 7A00A      READ   DEC    F.NUMBR      ;SET NUMBER FLAG
00692 12DD CE12E      READ   LDX    #READ1
00693 12E0 DFC1              STX    NEXSTATE
00694 12E2 2031              BRA    READ5
00695 12E4 BD11D      READ1  JSR    IN2BYTES     ;CONVERT TO HEX
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00696 12E7 2408              BCC    READ2          ;SKIP IF NO ERROR
00697 12E9 CE247D            LDX    #NUMERR
00698 12EC BD1DF4            JSR    STRNGOUT
00699 12EF 20E3              BRA    READ           ;TRY AGAIN
00700 12F1 DFB4      READ2   STX    XTEMP4         ;SAVE ADDRESS
00701 12F3 CE248C    READ22  LDX    #BLKSMSG       ;ASK FOR NUMBER OF BLOCKS
00702 12F6 BD1DFF            JSR    STRNGNOC
00703 12F9 7A00A1            DEC    F.NUMBR        ;SET NUMBER FLAG
00704 12FC CE1303            LDX    #READ3
00705 12FF DFC1              STX    NEXSTATE
00706 1301 2012              BRA    READ5
00707 1303 BD11A5    READ3   JSR    INBYTE         ;CONVERT TO HEX
00708 1306 2408              BCC    READ4
00709 1308 CE247D            LDX    #NUMERR
00710 130B BD1DF4            JSR    STRNGOUT
00711 130E 20E3              BRA    READ22
00712 1310 DEB4      READ4   LDX    XTEMP4
00713 1312 BD14E4            JSR    TREAD
00714 1315 39        READ5   RTS
00715                        ;
00716                        ;
00717                        ;MOVE CART TO DESIRED BLOCK AND TRACK
00718                        ;CHECKS FOR CART READY FIRST
00719                        ;ALSO CHECKS FOR VALID BLOCK AND TRACK NUMBERS
00720 1316 BD124A    SEEK    JSR    CKRDY          ;SEE IF CART IS READY
00721 1319 CE24FB            LDX    #TRACKMSG      ;ASK FOR TRACK NUMBER
00722 131C BD1DFF            JSR    STRNGNOC       ;PRINT WITH NO CR
00723 131F 7A00A1            DEC    F.NUMBR        ;SET NUMBER FLAG
00724 1322 CE1329            LDX    #SEEK1
00725 1325 DFC1              STX    NEXSTATE       ;SET STATE POINTER
00726 1327 2014              BRA    SEEK5
00727 1329 BD11A5    SEEK1   JSR    INBYTE         ;GET BYTE FROM CBUFFER
00728 132C 2408              BCC    SEEK2          ;SKIP IF NO ERROR
00729 132E CE247D    SEEK11  LDX    #NUMERR        ;PRINT ERROR MESSAGE
00730 1331 BD1DF4            JSR    STRNGOUT
00731 1334 20E0              BRA    SEEK           ;TRY AGAIN
00732 1336 8103      SEEK2   CMP A  #3             ;CHECK FOR VALID TRACK NO
00733 1338 22F4              BHI    SEEK11         ;TRY AGAIN IF INVALID NUMBER
00734 133A BD1273            JSR    TRACK          ;GO SET TRACK NUMBER
00735 133D 39        SEEK5   RTS                   ;STOP HERE TILL NEXT ROUTINE IS WRITTEN!
00736                        ;THIS ROUTINE MOVES TAPE TO DESIRED BLOCK NUMBER STARTING AT PRESENT
00737                        ;BLOCK.  ASSUMES PRESENT BLOCK NUMBER IS IN BLKNUM AND THAT MAX BLOCK
00738                        ;NUMBER IS 0130.
00739                        ;WILL STOP TAPE IF GAP LONGER THAN 47 MS IS FOUND
00740                        ;
00741 133E BD124A    FBLOCK  JSR    CKRDY          ;SEE IF DRIVE IS READY
00742 1341 7F00CC            CLR    SKIPSGN
00743 1344 7F00CA            CLR    TCNT
00744 1347 7F00CB            CLR    FCNT
00745 134A CE24C6            LDX    #BLOCKMSG
00746 134D BD1DFF            JSR    STRNGNOC
00747 1350 7A00A1            DEC    F.NUMBR
```

```
00748 1353 CE135:          LDX    #BLOCK1
00749 1356 DFC1            STX    NEXSTATE
00750 1358 39              RTS
00751 1359 BD11D:  BLOCK1  JSR    IN2BYTES     ;GET BLOCK NUMBER IN X
00752 135C 2408            BCC    BLOCK2       ;SKIP IF NO ERROR
00753 135E CE246:  BLOCK11 LDX    #BKERMSG     ;PRINT ERROR MSG
00754 1361 BD1DF4          JSR    STRNGOUT
00755 1364 20D8            BRA    FBLOCK
00756 1366 96AE    BLOCK2  LDA A  XTEMP1       ;GET MS BYTE OF DESIRED BLOCK
00757 1368 8102            CMP A  #2
00758 136A 2CF2            BGE    BLOCK11
00759 136C DFCD            STX    BLKCNT        ;SAVE X
00760 136E 96CE            LDA A  BLKCNT+1     ;SUBRTACT DESIRED FROM PRESENT BLOCK
00761 1370 9002            SUB A  BLKNUM+1
0  62 1372 D6CD            LDA B  BLKCNT
0  63 1374 D201            SBC B  BLKNUM
0  64 1376 2409            BCC    SKIPPOS      ;POSITIVE SKIP
0  65 1378 43      SKIPNEG COM A               ;CONVERT BACK TO SIGN MAG
0  66 1379 53              COM B
0  67 137A 8B01            ADD A  #1
0  68 137C C900            ADC B  #0
0  69 137E 7A00C(          DEC    SKIPSGN      ;SET FOR NEG SKIP
0  70 1381 D7CD    SKIPPOS STA B  BLKCNT
0  71 1383 97CE            STA A  BLKCNT+1
0  72 1385 DECD    SKIP1   LDX    BLKCNT
0  73 1387 09              DEX
0  74 1388 DFCD            STX    BLKCNT
0  75 138A 8CFFFF          CPX    #0FFFFH      ;MINUS?
0  76 138D 276A            BEQ    SKIPS3
0  77 138F 8C000(          CPX    #0
0  78 1392 273A            BEQ    SKIPS        ;SKIP SLOW
0  79 1394 96CC            LDA A  SKIPSGN
0  80 1396 2B05            BMI    SKIP1B
0  81 1398 BD14D:          JSR    INCBLK
0  82 139B 2003            BRA    SKIPF        ;SKIP FAST
0  83 139D BD141:  SKIP1B  JSR    DECBLK
0  84 13A0 8D58    SKIPF   BSR    FAST
0  85 13A2 B6840:          LDA A  PIA2AD       ;CHECK GAP BIT
0  86 13A5 48              ASL A
0  87 13A6 2A16            BPL    SKIPG        ;IN GAP
0  88 13A8 96CB            LDA A  FCNT         ;BLOCK TIMER
0  89 13AA 22F4            BHI    SKIPF        ;ALREADY CHECKED TIMER
0  90 13AC 8106            CMP A  #6
0  91 13AE 2309            BLS    SKIPF1
0  92 13B0 7F00C(          CLR    TCNT
0  93 13B3 86FF            LDA A  #0FFH
0  94 13B5 97CB            STA A  FCNT
0  95 13B7 20CC            BRA    SKIP1
0  96 13B9 7C00C(  SKIPF1  INC    FCNT
0  97 13BC 20E2            BRA    SKIPF
0  98 13BE 96CA    SKIPG   LDA A  TCNT
0  99 13C0 81C8            CMP A  #200
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TAPE CONTROL ROUTINES

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00800 13C2 2305              BLS    SKIPG1
00801 13C4 7F00CB            CLR    FCNT
00802 13C7 20D7              BRA    SKIPF
00803 13C9 7C00CA     SKIPG1 INC    TCNT
00804 13CC 20D2              BRA    SKIPF
00805 13CE 96CC       SKIPS  LDA A  SKIPSGN      ;WHICH WAY?
00806 13D0 2A05              BPL    SKIPSPL
00807 13D2 BD1412            JSR    DECBLK
00808 13D5 2003              BRA    SKIPS11
00809 13D7 BD14DA     SKIPSPL JSR    INCBLK
00810 13DA BD1216     SKIPS11 JSR    STOP
00811 13DD 8628              LDA A  #40
00812 13DF BD1666            JSR    MSDLY
00813 13E2 BD1406            JSR    SLOW
00814 13E5 B68404     SKIPS1 LDA A  PIA2AD
00815 13E8 48                ASL A
00816 13E9 2AFA              BPL    SKIPS1
00817 13EB B68404     SKIPS2 LDA A  PIA2AD
00818 13EE 48                ASL A
00819 13EF 2BFA              BMI    SKIPS2
00820 13F1 861A              LDA A  #26
00821 13F3 BD1666            JSR    MSDLY
00822 13F6 BD1216            JSR    STOP
00823 13F9 39         SKIPS3 RTS
00824                        ;
00825                        ;
00826                        ;SET FASTFORWARD IF SKIPSGN IS POS OR REWIND IF NEG
00827 13FA 96CC       FAST   LDA A  SKIPSGN
00828 13FC 2A04              BPL    GOFORWD
00829 13FE BD1226            JSR    REWIND
00830 1401 39                RTS
00831 1402 BD121E     GOFORWD JSR    FFORWD
00832 1405 39                RTS
00833                        ;
00834                        ;SET FORWARD IF SKIPSGN IS POS OR REVERSE IF NEG
00835 1406 96CC       SLOW   LDA A  SKIPSGN
00836 1408 2A04              BPL    GOFOR
00837 140A BD1222            JSR    REVERSE
00838 140D 39                RTS
00839 140E BD121A     GOFOR  JSR    FORWD
00840 1411 39                RTS
00841                        ;
00842                        ;
00843                        ;DECREMENT BLOCK COUNTER
00844 1412 DFB0       DECBLK STX    XTEMP2
00845 1414 DE01              LDX    BLKNUM
00846 1416 09                DEX
00847 1417 DF01              STX    BLKNUM
00848 1419 DEB0              LDX    XTEMP2
00849 141B 39                RTS
00850                        ;
00851                        ;
```

```
00852                   ;TAPE WRITE ROUTINE
00853                   ;WRITES 2048 BYTES TO TAPE.  STARTING ADDRESS OF BLOCK IN X.
00854                   ;
00855 141C 97C0        TWRITE  STA A  BLOCKS       ;SAVE NO. OF BLOCKS TO WRITE
00856 141E BD124F               JSR    CKRDY      ;SEE IF DRIVE READY FOR WRITE
00857 1421 BD1265               JSR    CKFP       ;SEE IF FP SET
00858 1424 8620        TWRITES  LDA A  #20H
00859 1426 B78406               STA A  PIA2BD      ;SET WRN=0
00860 1429 8680                 LDA A  #80H         ;ACCESS SYNC CODE REGISTER
00861 142B B78804               STA A  SSDAC
00862 142E 4F                   CLR A
00863 142F B78805               STA A  SSDAD       ;SET SYNC CODE TO 00
00864 1432 C6C0                 LDA B  #0C0H       ;ACESS XMIT FIFO
00865 1434 F78804               STA B  SSDAC
00866 1437 B78805               STA A  SSDAD       ;ZERO OUT FIFO
00867 143A B78805               STA A  SSDAD
00868 143D B78805               STA A  SSDAD
00869 1440 BD156A               JSR    CRC         ;COMPUTE CRC FOR BLOCK
00870 1443 BD125D               JSR    CKLOAD      ;SEE IF AT LOAD POINT (A=FF IF TRUE)
00871 1446 36                   PSH A              ;SAVE LOAD STATUS
00872 1447 BD121F               JSR    FORWD       ;START DRIVE
00873 144A 32                   PUL A              ;GET LOAD STATUS BACK
00874 144B 4D                   TST A              ;TEST LOAD FLAG
00875 144C 2605                 BNE    TWRITE1     ;BYPASS 1 SEC DELAY
00876 144E 8601                 LDA A  #1
00877 1450 BD1668               JSR    SECDLY      ;DELAY 1 SEC
00878 1453 862F        TWRITE1  LDA A  #47          ;47 MS IRG DELAY
00879 1455 BD1666               JSR    MSDLY
00880 1458 DFAE                 STX    XTEMP1      ;SAVE BLOCK POINTER
00881 145A CE0800               LDX    #0800H      ;2048 BYTE COUNT
00882 145D DFAC                 STX    BYCOUNT
00883 145F DEAE                 LDX    XTEMP1      ;RETREIVE POINTER
00884 1461 4F                   CLR A
00885 1462 B78406               STA A  PIA2BD      ;SET WDR=0
00886 1465 8D68                 BSR    WRTBYT      ;PAD WITH A FEW ZEROS
00887 1467 8D66                 BSR    WRTBYT      ;WRITE A FEW ZEROS FOR SPACING
00888 1469 8D64                 BSR    WRTBYT
00889 146B 8D62                 BSR    WRTBYT
00890 146D 8655                 LDA A  #55H        ;WRITE SYNC BYTE
00891 146F 8D5E                 BSR    WRTBYT
00892 1471 4F                   CLR A              ;WRITE PREAMBLE (0001)
00893 1472 8D5B                 BSR    WRTBYT
00894 1474 8601                 LDA A  #1          ;SECOND BYTE OF PREAMBLE
00895 1476 8D57                 BSR    WRTBYT
00896 1478 A600        TWRITE2  LDA A  0,X         ;GET BYTE FROM BLOCK
00897 147A 8D53                 BSR    WRTBYT      ;SEND BYTE TO SSDA
00898 147C 08                   INX                ;INCREMENT BYTE POINTER
00899 147D DFAE                 STX    XTEMP1      ;SAVE BYTE POINTER
00900 147F DEAC                 LDX    BYCOUNT     ;GET BYTE COUNTER
00901 1481 09                   DEX                ;DECREMENT BYTE COUNTER
00902 1482 2706                 BEQ    TWRITE3     ;DONE
00903 1484 DFAC                 STX    BYCOUNT     ;SAVE COUNT
```

```
00904 1486 DEAE                LDX    XTEMP1        ;RETREIVE POINTER
00905 1488 20EE                BRA    TWRITE2       ;DO NEXT BYTE
00906 148A 96B6       TWRITE3  LDA A  CRCH           ;WRITE CRC ON TAPE
00907 148C 8D41                BSR    WRTBYT        ;BYPASS CRC
00908 148E 96B7                LDA A  CRCL
00909 1490 8D3D                BSR    WRTBYT
00910 1492 8680                LDA A  #80H          ;WIRTE POSTAMBLE
00911 1494 8D39                BSR    WRTBYT
00912 1496 4F                  CLR A
00913 1497 8D36                BSR    WRTBYT
00914 1499 B68804     TWRITE4  LDA A  SSDAC         ;CHECK TUF FLAG
00915 149C 8510                BIT A  #10H          ;MASK OF TUF BIT
00916 149E 27F9                BEQ    TWRITE4       ;WAIT UNTILL XMIT FIFO IS EMPTY
00917 14A0 8640                LDA A  #40H          ;RESET TUF FLAG
00918 14A2 B78804              STA A  SSDAC         ;ACCESS CONTROL 3
00919 14A5 860E                LDA A  #0EH
00920 14A7 B78805              STA A  SSDAD
00921 14AA 8620                LDA A  #20H          ;SET WDR=1
00922 14AC B78406              STA A  PIA2BD
00923 14AF 861A                LDA A  #26           ;WAIT 26 MS FOR IRG
00924 14B1 BD1666              JSR    MSDLY
00925 14B4 BD1216     TWRITE5  JSR    STOP          ;STOP TAPE
00926 14B7 8619                LDA A  #25           ;WAIT FOR TAPE TO STOP
00927 14B9 BD1666              JSR    MSDLY
00928 14BC BD14DA              JSR    INCBLK        ;INC BLOCK NUMBER
00929 14BF DEAE                LDX    XTEMP1        ;GET DATA POINTER BACK
00930 14C1 7A00C0              DEC    BLOCKS        ;DEC BLOCK COUNT
00931 14C4 2703                BEQ    TWRITE6       ;DONE
00932 14C6 7E1424              JMP    TWRITE5       ;GO WRITE ANOTHER BLOCK
00933 14C9 8630       TWRITE6  LDA A  #30H          ;SET WRN=WDR=1
00934 14CB B78406              STA A  PIA2BD
00935 14CE 39                  RTS
00936                 ;
00937                 ;
00938                 ;SEND A BYTE TO SSDA
00939                 ;
00940 14CF F68804     WRTBYT   LDA B  SSDAC         ;CHECK TDRA BIT
00941 14D2 54                  LSR B
00942 14D3 54                  LSR B
00943 14D4 24F9                BCC    WRTBYT        ;XMTR STILL BUSY
00944 14D6 B78805              STA A  SSDAD         ;STORE BYTE IN XMIT FIFO
00945 14D9 39                  RTS
00946                 ;
00947                 ;INCREMENT 16 BIT BLOCK NUMBER
00948                 ;
00949 14DA DFB0       INCBLK   STX    XTEMP2        ;SAVE X
00950 14DC DE01                LDX    BLKNUM
00951 14DE 08                  INX
00952 14DF DF01                STX    BLKNUM
00953 14E1 DEB0                LDX    XTEMP2
00954 14E3 39                  RTS
00955                 ;
```

```
00956                    ;
00957                    ;
00958                    ;
00959                    ;TREAD.  READS 2048 BYTES FROM NEXT BLOCK ON TAPE
00960                    ;TO MEMORY STARTING AT LOCATION IN X.  COMPARES CRCS
00961                    ;AND RETURNS A=0 IF THEY MATCH
00962                    ;
00963                    ;
00964 14E4 97C0    TREAD    STA A  BLOCKS      ;SAVE BLOCK COUNT
00965 14E6 DFB0    TREAD11  STX    XTEMP2      ;SAVE FILE POINTER
00966 14E8 BD124A          JSR    CKRDY       ;SEE IF DRIVE READY
00967 14EB BD121A          JSR    FORWD       ;START TAPE FORWARD
00968 14EE 8619            LDA A  #25         ;WAIT 25 MS FOR TAPE TO SPEED UP
00969 14F0 BD1666          JSR    MSDLY
00970 14F3 8601            LDA A  #1          ;RESET SSDA RCVR
00971 14F5 B78804          STA A  SSDAC
00972 14F8 8688            LDA A  #88H        ;DISABLE SYNC , ACCESS SYNC CODE REG
00973 14FA B78804          STA A  SSDAC
00974 14FD 8655            LDA A  #55H
00975 14FF B78805          STA A  SSDAD       ;SET SYNC CODE=55
00976 1502 B68404  TREAD12  LDA A  PIA2AD      ;CHECK GAP BIT
00977 1505 48              ASL A
00978 1506 2AFA            BPL    TREAD12     ;WAIT FOR GAP BEFORE TRYING TO READ
00979 1508 4F              CLR A
00980 1509 B78804          STA A  SSDAC       ;ENABLE RCVR SYNC
00981 150C 8D52    TREAD1   BSR    RDBYTE      ;WAIT FOR FOR FIRST BYTE FOLLOWING FIRST SYNC
00982 150E 8101            CMP A  #1          ;CHECK FOR SECOND PREAMBLE BYTE
00983 1510 26FA            BNE    TREAD1      ;NOT THERE, TRY AGAIN
00984 1512 DFAE            STX    XTEMP1      ;SAVE POINTER
00985 1514 CE0800          LDX    #0800H      ;BYTE COUNT
00986 1517 DFAC            STX    BYCOUNT
00987 1519 DEAE            LDX    XTEMP1      ;GET POINTER
00988 151B 8D43    TREAD2   BSR    RDBYTE      ;GET A BYTE
00989 151D A700            STA A  0,X         ;PUT IT IN MEMORY
00990 151F 08              INX                ;INCREMENT MEMORY POINTER
00991 1520 DFAE            STX    XTEMP1      ;SAVE POINTER
00992 1522 DEAC            LDX    BYCOUNT
00993 1524 09              DEX                ;DECREMENT BYTE COUNT
00994 1525 2706            BEQ    TREAD3      ;DONE, GET CRC
00995 1527 DFAC            STX    BYCOUNT     ;SAVE COUNT
00996 1529 DEAE            LDX    XTEMP1      ;GET POINTER BACK
00997 152B 20EE            BRA    TREAD2      ;GET ANOTHER BYTE
00998 152D 8D31    TREAD3   BSR    RDBYTE      ;GET FIRST CRC BYTE
00999 152F 36              PSH A              ;SAVE IT
01000 1530 8D2E            BSR    RDBYTE      ;GET NEXT CRC BYTE
01001 1532 36              PSH A              ;SAVE IT
01002 1533 862B            LDA A  #43
01003 1535 BD1666          JSR    MSDLY       ;WAIT 43 MS FOR IRG
01004 1538 BD1216          JSR    STOP        ;STOP TAPE
01005 153B DEB0            LDX    XTEMP2      ;RETREIVE POINTER
01006 153D BD156A          JSR    CRC         ;COMPUTE CRC STARTING WITH OLD CRC
01007 1540 32              PUL A              ;COMPARE NEW CRC WITH ONE FROM TAPE
```

```
01008 1541 33                PUL B
01009 1542 90B7              SUB A  CRCL          ;COMPARE LS BYTE
01010 1544 2604              BNE    TREAD4
01011 1546 D0B6              SUB B  CRCH          ;COMPARE MS BYTE
01012 1548 2709              BEQ    TREAD45
01013 154A CE249A  TREAD4    LDX    #CRCMSG       ;PRINT ERROR MESSAGE
01014 154D BD1DFF            JSR    STRNGNOC
01015 1550 7E1C31            JMP    TAPE1         ;REPORT BLOCK AND TRACK NO.
01016 1553 BD14DA  TREAD45   JSR    INCBLK        ;INCREMENT BLOCK NUMBER
01017 1556 7A00C6            DEC    BLOCKS        ;DECREMENT BLOCK COUNTER
01018 1559 2704              BEQ    TREAD5        ;DONE
01019 155B DEAE              LDX    XTEMP1        ;GET DATA POINTER
01020 155D 2087              BRA    TREAD11       ;GO READ ANOTHER BLOCK
01021 155F 39      TREAD5    RTS
01022                        ;
01023                        ;
01024                        ;READ A BYTE FROM SSDA FIFO AND COMPUTE CRC
01025 1560 B68804  RDBYTE    LDA A  SSDAC         ;CHECK RDA FLAG
01026 1563 44                LSR A
01027 1564 24FA              BCC    RDBYTE        ;WAIT FOR RDA=1
01028 1566 B68805            LDA A  SSDAD         ;GET A  BYTE FROM FIFO
01029 1569 39                RTS
01030                        ;
01031                        ;COMPUTE A 16 BIT CRC CHECK CODE FROM A 2048 BYTE BUFFER
01032                        ;POINTED TO BY X.   RETURNS CRC IN CRCH AND CRCL
01033 156A 7F00B6  CRC       CLR    CRCH          ;CLEAR CRC IN NEEDED
01034 156D 7F00B7            CLR    CRCL
01035 1570 DFB2    CRC1      STX    XTEMP3        ;SAVE POINTER
01036 1572 DFB0              STX    XTEMP2        ;SAVE X THRU SUBROUTINE
01037 1574 CE0800            LDX    #0800H        ;BYTE COUNT
01038 1577 DFAC    CRC2      STX    BYCOUNT       ;SAVE I
01039 1579 DEB2              LDX    XTEMP3
01040 157B A600              LDA A  0,X           ;GET CHARACTER
01041 157D 8D0B              BSR    CRCC           ;COMPUTE CRC
01042 157F 08                INX
01043 1580 DFB2              STX    XTEMP3
01044 1582 DEAC              LDX    BYCOUNT       ;GET COUNT
01045 1584 09                DEX
01046 1585 26F0              BNE    CRC2
01047 1587 DEB0              LDX    XTEMP2        ;RETREIVE POINTER
01048 1589 39                RTS
01049                        ;
01050                        ;DO CRC ONE BYTE AT A TIME
01051 158A 9789    CRCC      STA A  TEMPA
01052 158C 8680              LDA A  #80H          ;MASK
01053 158E 7800B7  CRCC1     ASL    CRCL
01054 1591 7900B6            ROL    CRCH
01055 1594 9589              BIT A  TEMPA
01056 1596 2704              BEQ    CRCC2
01057 1598 2510              BCS    NOCHANGE
01058 159A 2002              BRA    CHANGE
01059 159C 240C    CRCC2     BCC    NOCHANGE
```

```
01060 159E C641       CHANGE   LDA B  #CRCPL
01061 15A0 D8B7                EOR B    CRCL
01062 15A2 D7B7                STA B  CRCL
01063 15A4 C630                LDA B  #CRCPH
01064 15A6 D8B6                EOR B  CRCH
01065 15A8 D7B6                STA B  CRCH
01066 15AA 44         NOCHANGE LSR A
01067 15AB 26E1                BNE    CRCC1
01068 15AD 39                  RTS
```

```
01071                   ;
01072                   ;FILL DISPLAY WITH BLANKS
01073 15AE CE28EF       CLRDISP  LDX    #DISPLY
01074 15B1 DFC3                  STX    NEXTDISP      ;INIT DISP OPOINTER
01075 15B3 8620                  LDA A  #20H          ;BLANK CODE
01076 15B5 A700         CLRDISP1 STA A  0,X
01077 15B7 08                    INX
01078 15B8 8C2903                CPX    #DISPLY+20 ;DONE?
01079 15BB 26F8                  BNE    CLRDISP1
01080 15BD 39                    RTS
01081                   ;PUT BCD TEMPERATURE POINTED TO BY X IN NEXT 5 DISPLAY LOCATIONS
01082                   ;ONLY PUTS 3 DIGITS TO LEFT AND 1 TO RIGHT OF DECIMAL.   ASSUMES
01083                   ;4 BYTE PLUS SIGN PACKED BCD FORMAT
01084 15BE A601         DISPTEMP LDA A  1,X          ;GET MS DIGITS
01085 15C0 BD1612                JSR    DISPHR       ;PUT LS DIGIT IN DISPLAY
01086 15C3 A602                  LDA A  2,X
01087 15C5 BD1605                JSR    DISPHEX
01088 15C8 862E                  LDA A  #". "
01089 15CA BD15F1                JSR    DISPCHAR
01090 15CD A603                  LDA A  3,X
01091 15CF BD160C                JSR    DISPHL
01092 15D2 39                    RTS
01093                   ;
01094                   ;PUT STRING IN DISPLAY BUFFER BEGINNING AT FIRST DISPLAY POSITION.
01095                   ;LOOKS FOR 04 AS TERMINATOR
01096 15D3 DFB0         DISPSTNG STX    XTEMP2       ;SAVE MESSAGE POINTER
01097 15D5 CE28EF                LDX    #DISPLY      ;INIT DISP POINTER
01098 15D8 DFC3                  STX    NEXTDISP
01099 15DA DEB0                  LDX    XTEMP2       ;GET MESSAGE POINTER BACK
01100                   ;
01101                   ;PUT STRING IN DISPLAY BUFFER BEGINNING AT NEXT DISPLAY LOCATION
01102                   ;STORED IN NEXTDISP
01103 15DC DFB0         DISPNEXT STX    XTEMP2       ;SAVE MESSAGE POINTER
01104 15DE A600                  LDA A  0,X          ;GET CHAR
01105 15E0 8104                  CMP A  #04H         ;DONE?
01106 15E2 2707                  BEQ    DISP2
01107 15E4 8D0B                  BSR    DISPCHAR     ;PUT CHAR IN BUFFER
01108 15E6 DEB0                  LDX    XTEMP2       ;GET MESSAGE POINTER BACK
01109 15E8 08                    INX
01110 15E9 20F1                  BRA    DISPNEXT
01111 15EB 39           DISP2    RTS
01112                   ;PUT A SPACE IN DISPLAY BUFFER
01113 15EC 8620         DISPSPC  LDA A  #20H
01114 15EE 8D01                  BSR    DISPCHAR
01115 15F0 39                    RTS
01116                   ;
01117                   ;
01118                   ;
01119                   ;PUT SINGLE CHARACTER IN DISPLAY BUFFER AT CURRENT BUFFER
01120                   ;POSITION AS INDICATED BY DISPNEXT.  RESETS POINTER WHEN FULL.
01121 15F1 DFAE         DISPCHAR STX    XTEMP1
01122 15F3 DEC3                  LDX     NEXTDISP    ;GET BUFFER POINTER
```

MISC UTILITY ROUTINES AND I/O

```
01123 15F5 A700           STA A  0,X          ;PUT CHAR IN BUFFER
01124 15F7 08             INX
01125 15F8 8C2903         CPX    #DISPLY+20
01126 15FB 2603           BNE    DISPCH1
01127 15FD CE28EF         LDX    #DISPLY
01128 1600 DFC3   DISPCH1 STX    NEXTDISP
01129 1602 DEAE           LDX    XTEMP1
01130 1604 39             RTS
01131                     ;
01132                     ;
01133                     ;CONVERT NUMBER IN A INTO 2 HEX DIGITS AND PUT IN DISBUFF
01134 1605 36             DISPHEX  PSH A              ;SAVE CHARACTER
01135 1606 8D04           BSR    DISPHL       ;OUTPUT LEFT DIGIT
01136 1608 32             PUL A
01137 1609 8D07           BSR    DISPHR       ;OUTPUT RIGHT DIGIT
01138 160B 39             RTS
01139                     ;
01140 160C 44             DISPHL   LSR A
01141 160D 44             LSR A
01142 160E 44             LSR A
01143 160F 44             LSR A
01144 1610 2002           BRA    DISPH1
01145 1612 840F           DISPHR   AND A  #0FH
01146 1614 810A           DISPH1   CMP A  #0AH
01147 1616 2502           BCS    DISPH2
01148 1618 8B07           ADD A  #07H
01149 161A 8B30           DISPH2   ADD A  #30H
01150 161C 20D3           BRA    DISPCHAR
01151                     ;
01152                     ;
01153                     ;
01154                     ;PUT A/D CHANNELS IN DISPLAY IN HEX FOR TESTING
01155                     ;CHANNELS 0-3:
01156 161E CE006F         TESTADR  LDX    #ADC0        ;POINTER TO CHANEL 0 DATA
01157 1621 C604           LDA B  #4
01158 1623 2005           BRA    TESTAD
01159                     ;
01160                     ;CHANNELS 4-8
01161 1625 CE0077         TESTADL  LDX    #ADC4
01162 1628 C605           LDA B  #5
01163                     ;
01164 162A DFB0           TESTAD   STX    XTEMP2       ;SAVE X
01165 162C CE28EF         LDX    #DISPLY
01166 162F DFC3           STX    NEXTDISP
01167 1631 DEB0           LDX    XTEMP2
01168 1633 A600           NEXTCH   LDA A  0,X          ;GET BYTE
01169 1635 8DDB           BSR    DISPHR       ;PUT OUT LS DIGIT
01170 1637 A601           LDA A  1,X
01171 1639 8DCA           BSR    DISPHEX      ;PUT OUT NEXT 2 DIGITS
01172 163B BD15EC         JSR    DISPSPC      ;PUT OUT A SPACE
01173 163E 08             INX
01174 163F 08             INX
```

MISC UTILITY ROUTINES AND I/O

```
1165 1640 5A                DEC B
1166 1641 26F0              BNE     NEXTCH
1167 1643 39                RTS
1168                    ;
1169                    ;PUT HEX DATA FROM MEMORY IN DISPLAY FOR DEBUGGING
1170                    ;MEMORY POINTER "HEXPTR" IS SET BY "SETHEX"
1171 1644 CE28EF    PUTHEX  LDX     #DISPLY         ;INIT DISP PTR
1172 1647 DFC3              STX     NEXTDISP
1173 1649 96C7              LDA A   HEXPTR          ;DISPLAY POINTER
1174 164B BD1605            JSR     DISPHEX
1175 164E 96C8              LDA A   HEXPTR+1
1176 1650 BD1605            JSR     DISPHEX
1177 1653 863D              LDA A   #"="            ;DISPLAY EQUALS
1178 1655 BD15F1            JSR     DISPCHAR
1179 1658 DEC7              LDX     HEXPTR          ;GET PTR
1180 165A C607              LDA B   #7              ;COUNTER FOR 7 BYTES
1181 165C A600      PUTHEX1 LDA A   0,X
1182 165E 08                INX
1183 165F BD1605            JSR     DISPHEX
1184 1662 5A                DEC B
1185 1663 26F7              BNE     PUTHEX1
1186 1665 39                RTS
1187                    ;
1188                    ;
1189                    ;
1190                    ;DELAY ROUTINES
1191 1666 C6A5      MSDLY   LDA B   #0A5H
1192 1668 5A        MSDLY1  DEC B
1193 1669 26FD              BNE     MSDLY1
1194 166B 4A                DEC A
1195 166C 26F8              BNE     MSDLY
1196 166E 39                RTS
1197                    ;
1198                    ;DELAY A SECONDS
1199 166F 36        SECDLY  PSH A               ;SAVE A
1200 1670 86FF              LDA A   #0FFH
1201 1672 8DF2              BSR     MSDLY
1202 1674 86FF              LDA A   #0FFH
1203 1676 8DEE              BSR     MSDLY
1204 1678 86FF              LDA A   #0FFH
1205                    ;       BSR     MSDLY
1206 167A 86FF              LDA A   #0FFH
1207 167C 8DE8              BSR     MSDLY
1208 167E 32                PUL A
1209 167F 4A                DEC A
1210 1680 26ED              BNE     SECDLY
1211 1682 39                RTS
1212                    ;
```

```
01224                    ;MAINLOOP
01225 1683 BD1A18        MAINLOOP JSR    CRLF          ;SEND CRLF
01226 1686 863F                   LDA A  #3FH           ;PROMPT
01227 1688 BD1DED                 JSR    OUTCH
01228 168B BD19EA        MAIN1    JSR    TESTGSFC      ;TEST SERIAL PORT 1 CTS
01229 168E 96A9                   LDA A  F.STATUS      ;CHECK STATUS PRINTOUT FLAG
01230 1690 2A06                   BPL    MAIN2
01231 1692 BD1D60                 JSR    STATUS
01232 1695 7F00A9                 CLR    F.STATUS
01233 1698 96A0          MAIN2    LDA A  F.CMND        ;CHECK FOR PENDING COMMAND
01234 169A 2A18                   BPL    NOCMND
01235 169C 96A1                   LDA A  F.NUMBR       ;IS IT A NUMBER?
01236 169E 2A0F                   BPL    NONUMBR
01237 16A0 BD1A18                 JSR    CRLF          ;NUMBER ACKNOWLEDGED
01238 16A3 7F00A1                 CLR    F.NUMBR       ;CLEAR FLAGS
01239 16A6 7F00A0                 CLR    F.CMND
01240 16A9 DEC1                   LDX    NEXSTATE      ;GET ADDRESS OF WHERE NUMBER IS WANTED
01241 16AB AD00                   JSR    0,X           ;GO THERE
01242 16AD 20D4                   BRA    MAINLOOP
01243 16AF BD1155        NONUMBR  JSR    DECODE        ;DECODE COMMAND
01244 16B2 20CF                   BRA    MAINLOOP      ;GO BACK AND CHECK FLAGS
01245 16B4 96A8          NOCMND   LDA A  F.FULBLK      ;BLOCK READY TO BE WRITTEN?
01246 16B6 2A27                   BPL    NOCAL
01247 16B8 8601                   LDA A  #1            ;WRITE 1 BLOCK
01248 16BA CE3000                 LDX    #DATABUFF
01249 16BD BD141C                 JSR    TWRITE
01250 16C0 96B6                   LDA A  CRCH          ;SEND CRC OF LAST BLOCK TO GODDARD
01251 16C2 BD1E42                 JSR    OUTGSFC
01252 16C5 96B7                   LDA A  CRCL
01253 16C7 BD1E42                 JSR    OUTGSFC
01254 16CA BD171A                 JSR    FTYPE         ;CALCULATE FRAME TYPE OF NEXT FRAME
01255 16CD 7F00A8                 CLR    F.FULBLK      ;CLEAR BLOCK FULL FLAG
01256 16D0 7A00A6                 DEC    F.DATA        ;TURN DATA COLLECTION BACK ON
01257 16D3 8D19                   BSR    CKEW          ;CHECK FOR TAPE EARLY WARNING BIT
01258 16D5 96A4          NOTFULL  LDA A  F.CALTIM      ;TIME TO CALIBRATE?
01259 16D7 2A06                   BPL    NOCAL
01260 16D9 BD172A                 JSR    CALIBRTE      ;RUN CAL AND CALC GAINS
01261 16DC 7F00A4                 CLR    F.CALTIM      ;CLEAR CAL FLAG
01262 16DF DEC5          NOCAL    LDX    DISPADR       ;FILL DISPLAY BUFFER WITH COMMANDED DATA
01263 16E1 AD00                   JSR    0,X
01264 16E3 BD221A                 JSR    LOADTEMP      ;CALCULATE LOAD TEMPS
01265 16E6 BD21A9                 JSR    RADTEMP       ;CALCULATE RAD TEMPS
01266 16E9 BD21DD                 JSR    RADAVG0       ;CALC AVERAGE TEMPS
01267 16EC 209D                   BRA    MAIN1
01268                    ;
01269                    ;CHECK TAP EARLY WARNING BIT TO SEE IF END OF TRACK NEAR
01270 16EE B68404        CKEW     LDA A  PIA2AD        ;GET EW BIT
01271 16F1 44                     LSR A
01272 16F2 2519                   BCS    NOTEW         ;NOT EW YET
01273 16F4 9600                   LDA A  TRACKN        ;GET TRACK NO.
01274 16F6 8103                   CMP A  #3            ;LAST RTRACK?
01275 16F8 2714                   BEQ    TAPEDONE
```

```
01276 16FA 4C                INC A                ;NEXT TRACK
01277 16FB BD1273            JSR    TRACK
01278 16FE BD1226            JSR    REWIND
01279 1701 CE271C            LDX    #NEWMSG       ;PRINT NEW TRACK MESSAGE
01280 1704 BD1DF4            JSR    STRNGOUT
01281 1707 BD1C2B            JSR    TAPE
01282 170A BD1CFF            JSR    WHERE         ;PRINT OUT TIME OF NEW TRACK START
01283 170D 39          NOTEW RTS
01284 170E BD123F      TAPEDONE JSR  UNLOAD        ;UNLOAD TAPE
01285 1711 CE1C12            LDX    #TAPEWARN
01286 1714 DFC5              STX    DISPADR       ;PRINT TAPE WARNING MESSAGE
01287 1716 BD1910            JSR    HALT          ;STOP DATA COLLECTION
01288 1719 39                RTS
01289                  ;
01290                  ;
01291                  ;CREATE FRAME TYPE BYTE
01292                  ;BITS 0,1 ARE INTERNAL LOAD POS
01293                  ;BIT 5 IS HIHG FOR SKY, LOW FOR GROUND
01294                  ;BIT 7 IS HIGH FOR CAL FRAME
01295 171A 9605        FTYPE LDA A  RFLPOS         ;GET LOAD STATUS
01296 171C F68802            LDA B  PIA3BD         ;CHECK SKY/GROUND BIT
01297 171F C440              AND B  #40H           ;MASK OFF BIT
01298 1721 1B                ABA
01299 1722 D6A4              LDA B  F.CALTIME
01300 1724 C480              AND B  #80H
01301 1726 1B                ABA
01302 1727 9703              STA A  FRAMTYPE
01303 1729 39                RTS
01304                  ;
```

```
                      ;
                      ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                      ;
                      ;MOVE CALIBRATION REFLECTOR TO COLD AND HOT LOAD POSITIONS AND
                      ;CALCULATE GAIN AND OFFSETS FOR ALL 4 CHANELS
172A BD1A5B           CALIBRTE JSR    COLD          ;MOVE TO COLD LOAD
172D 8606                      LDA A  #6            ;WAIT 2 SECONDS
172F BD166F                    JSR    SECDLY
1732 BD18B3                    JSR    AVERAGE       ;AVERAGE COLD LOAD SAMPLES
1735 BD1A6F                    JSR    HOT
1738 8606                      LDA A  #6            ;WAIT 2 SEC
173A BD166F                    JSR    SECDLY
                      ;CALCULATE 183/1 GHZ CAL DATA
                      ;
173D BD18E1           CAL0     JSR    AVERAGE0      ;AVERAGE HOT LOAD SAMPLES AND LEAVE AT TOS
1740 CE013B                    LDX    #CH0GAIN      ;PTR TO GAIN/OFFSET CONSTANTS
1743 DF8D                      STX    SAVEX
1745 CE004B                    LDX    #CH0VAVG      ;PTR TO COLD LOAD AVERAGE
1748 BD182C                    JSR    CALCGAIN      ;CALCULATE GAIN AND OFFSET
                      ;
                      ;CALCULATE 183/5 GHZ CAL DATA
                      ;
174B BD18E8           CAL1     JSR    AVERAGE1     ;AVERAGE HOT LOAD DATA
174E CE0143                    LDX    #CH1GAIN
1751 DF8D                      STX    SAVEX
1753 CE004F                    LDX    #CH1VAVG
1756 BD182C                    JSR    CALCGAIN
                      ;
                      ;CALCULATE 183/10 GHZ CAL DATA
                      ;
1759 BD18EF           CAL2     JSR    AVERAGE2
175C CE014B                    LDX    #CH2GAIN
175F DF8D                      STX    SAVEX
1761 CE0053                    LDX    #CH2VAVG
1764 BD182C                    JSR    CALCGAIN
                      ;
                      ;CALCULATE 94 GHZ CAL DATA
                      ;
1767 BD18F6           CAL3     JSR    AVERAGE3
176A CE0153                    LDX    #CH3GAIN
176D DF8D                      STX    SAVEX
176F CE0057                    LDX    #CH3VAVG
1772 BD182C                    JSR    CALCGAIN
                      ;
                      ;DONE WITH CAL, NOW  RETURN TO OUTSIDE AND PRINT RESULTS
1775 BD1A25                    JSR    OUTSIDE       ;MOVE REFLECTOR BACK OUTSIDE
                      ;PRINT GAIN AND OFFSETS
1778 BD1CFF           PRINTCAL JSR    WHERE
177B BD1A18                    JSR    CRLF
177E CE25E6                    LDX    #HOTMSG1      ;PRINT OUT HOT/COLD LOAD TEMP DIFF
1781 BD10FF                    JSR    STRNGNOC
1784 862D                      LDA A  #"-"
```

CALIBRATION ROUTINES

```
01359 1786 BD1DED               JSR    OUTCH
01360 1789 BD1DCD               JSR    OUTSPACE
01361 178C CE25F0               LDX    #COLDMSG1
01362 178F BD1DFF               JSR    STRNGNOC
01363 1792 863D                 LDA A  #"="
01364 1794 BD1DED               JSR    OUTCH
01365 1797 CE0047               LDX    #HTCD32
01366 179A BD1813               JSR    PRINT32
01367 179D BD1A18               JSR    CRLF
01368 17A0 CE2680               LDX    #CALMSG1
01369 17A3 BD1DF4               JSR    STRNGOUT
01370 17A6 CE263E               LDX    #MSG183
01371 17A9 BD1DFF               JSR    STRNGNOC
01372 17AC BD1DBC               JSR    OUT2SPC
01373 17AF CE0136               LDX    #CH0GAIN
01374 17B2 BD1813               JSR    PRINT32       ;PRINT 32 BIT NUMBER IN BCD
01375 17B5 BD1DB4               JSR    OUT10SPC
01376 17B8 CE013F               LDX    #CH0OFST
01377 17BB BD1813               JSR    PRINT32
01378 17BE BD1A18               JSR    CRLF
01379 17C1 CE2649               LDX    #MSG188
01380 17C4 BD1DFF               JSR    STRNGNOC
01381 17C7 BD1DBC               JSR    OUT2SPC
01382 17CA CE0143               LDX    #CH1GAIN
01383 17CD BD1813               JSR    PRINT32
01384 17D0 BD1DB4               JSR    OUT10SPC
01385 17D3 CE0147               LDX    #CH1OFST
01386 17D6 BD1813               JSR    PRINT32
01387 17D9 BD1A18               JSR    CRLF
01388 17DC CE2654               LDX    #MSG193
01389 17DF BD1DFF               JSR    STRNGNOC
01390 17E2 BD1DCD               JSR    OUTSPACE
01391 17E5 CE014B               LDX    #CH2GAIN
01392 17E8 BD1813               JSR    PRINT32
01393 17EB BD1DB4               JSR    OUT10SPC
01394 17EE CE014F               LDX    #CH2OFST
01395 17F1 BD1813               JSR    PRINT32
01396 17F4 BD1A18               JSR    CRLF
01397 17F7 CE2660               LDX    #MSG94
01398 17FA BD1DFF               JSR    STRNGNOC
01399 17FD BD1DCD               JSR    OUTSPACE
01400 1800 CE0153               LDX    #CH3GAIN
01401 1803 BD1813               JSR    PRINT32
01402 1806 BD1DB4               JSR    OUT10SPC
01403 1809 CE0157               LDX    #CH3OFST
01404 180C BD1813               JSR    PRINT32
01405 180F BD1A18               JSR    CRLF
01406 1812 39                   RTS
01407                    ;
01408                    ;
01409                    ;PRINT 32 BIT NUMBER AT X IN BCD
01410 1813 DF8D          PRINT32 STX    SAVEX
```

```
01411 1815 EE00              LDX    0,X
01412 1817 DF9C              STX    FPT32          ;MOVE DAT A TO FPT32
01413 1819 DE8D              LDX    SAVEX
01414 181B EE02              LDX    2,X
01415 181D DF9E              STX    FPT32+2
01416 181F CE003A            LDX    #SPRETEMP      ;TEMP BCD STORAGE
01417 1822 BD228C            JSR    FPTBCD
01418 1825 CE003A            LDX    #SPRETEMP
01419 1828 BD1D42            JSR    OUTTEMP
01420 182B 39                RTS
01421                  ;
01422                  ;
01423                  ;CALCULATE RADIOMETER GAIN AND OFFSET
01424                  ;CALL WITH X AT AVERAGE OF COLD LOAD SAMPLES (32 BIT VOLTS)
01425                  ;SAVEX WITH POINTER TO WHERE GAIN AND OFFSET SHOULD GO AND
01426                  ;AVERAGE HOT LOAD VOLTAGE AT TOS IN APU
01427 182C DF8F        CALCGAIN STX    SAVEX1         ;SAVE X
01428 182E 8D44                 BSR    DIFHC          ;CALCULATE HOT AND COLD LOAD TEMP AND DIFFERENCE
01429 1830 DE8F                 LDX    SAVEX1         ;SAVE POINTER
01430 1832 C604                 LDA B  #4             ;PUSH COLD AVG ON STACK
01431 1834 BD2393               JSR    PUSH
01432 1837 BD23C2               JSR    FSUB           ;HOTAVG-COLDAVG
01433 183A CE0047               LDX    #HTCD32        ;GET TEMP DIFF
01434 183D C604                 LDA B  #4
01435 183F BD2393               JSR    PUSH           ;PUSH TEMP DIFF ON STACK
01436 1842 BD23E9               JSR    XCHF           ;EXCHANGE
01437 1845 BD23D2               JSR    FDIV           ;(HOT TEMP-COLD TEMP)/(HOTAVG-COLDAVG)
01438 1848 BD23F1               JSR    PTOF           ;COPY TOS TO NOS
01439 184B DE8D                 LDX    SAVEX          ;GET PTR TO GAIN CONSTANT
01440 184D C604                 LDA B  #4             ;PULL OUT GAIN
01441 184F BD23A7               JSR    PULL
01442 1852 DF8D                 STX    SAVEX
01443 1854 DE8F                 LDX    SAVEX1         ;PTR TO COLD AVG
01444 1856 C604                 LDA B  #4
01445 1858 BD2393               JSR    PUSH           ;PUT COLD AVG ON STACK
01446 185B BD23CA               JSR    FMUL           ;(COLDAVG)(GAIN)
01447 185E CE0043               LDX    #CDTEMP32      ;COLD LOAD TEMP 32 BIT
01448 1861 C604                 LDA B  #4
01449 1863 BD2393               JSR    PUSH           ;PUSH COLD LOAD TEMP
01450 1866 BD23E9               JSR    XCHF
01451 1869 BD23C2               JSR    FSUB           ;COLD TEMP-(GAIN)(COLDAVG)
01452 186C DE8D                 LDX    SAVEX          ;POINTER TO OFFSET
01453 186E C604                 LDA B  #4
01454 1870 BD23A7               JSR    PULL
01455 1873 39                   RTS
01456                  ;
01457                  ;
01458                  ;CALCULATE HOT LOAD AND COLD LOAD TEMP AND THEIR DIFFERENCE
01459 1874 9677        DIFHC    LDA A  ADC4           ;HOT LOAD BINARY
01460 1876 D678                 LDA B  ADC4+1
01461 1878 BD2277               JSR    BINVOLTS       ;CONVERT TO VOLTS
01462 187B CE28C7               LDX    #HTLDGAIN
```

```
01463 187E BD2266              JSR    VOLTTEMP
01464 1881 CE003F              LDX    #HTTEMP32     ;PTR TO RESULT
01465 1884 C604                LDA B  #4
01466 1886 BD23A7              JSR    PULL
01467 1889 9679                LDA A  ADC5          ;COLD LOAD BINARY
01468 188B D67A                LDA B  ADC5+1
01469 188D BD2277              JSR    BINVOLTS
01470 1890 CE28CF              LDX    #COLDGAIN
01471 1893 BD2266              JSR    VOLTTEMP
01472 1896 BD23F1              JSR    PTOF          ;COPY TOS TO NOS
01473 1899 CE0043              LDX    #CDTEMP32
01474 189C C604                LDA B  #4
01475 189E BD23A7              JSR    PULL
01476 18A1 CE003F              LDX    #HTTEMP32
01477 18A4 C604                LDA B  #4
01478 18A6 BD2393              JSR    PUSH
01479 18A9 BD23E9              JSR    XCHF
01480 18AC BD23C2              JSR    FSUB          ;HOT TEMP-COLD TEMP
01481 18AF CE0047              LDX    #HTCD32
01482 18B2 C604                LDA B  #4
01483 18B4 BD23A7              JSR    PULL
01484 18B7 39                  RTS
01485                    ;
01486                    ;
01487                    ;AVERAGE 10 SAMPLES FROM CH0-CH3 STORED IN AVGBUFF BY INTERRUPT
01488                    ;SERVICE ROUTINE EVERY 100 MS
01489                    ;PUT RESULT IN CH0VAVG-CH3VAVG
01490 18B8 8D27          AVERAGE  BSR    AVERAGE0      ;AVERAGE CH0 SAMPLES
01491 18BA CE004B                 LDX    #CH0VAVG      ;PTR TO RESULT
01492 18BD C604                   LDA B  #4
01493 18BF BD23A7                 JSR    PULL
01494 18C2 8D24                   BSR    AVERAGE1
01495 18C4 CE004F                 LDX    #CH1VAVG
01496 18C7 C604                   LDA B  #4
01497 18C9 BD23A7                 JSR    PULL
01498 18CC 8D21                   BSR    AVERAGE2
01499 18CE CE0053                 LDX    #CH2VAVG
01500 18D1 C604                   LDA B  #4
01501 18D3 BD23A7                 JSR    PULL
01502 18D6 8D1E                   BSR    AVERAGE3
01503 18D8 C604                   LDA B  #4
01504 18DA CE0057                 LDX    #CH3VAVG
01505 18DD BD23A7                 JSR    PULL
01506 18E0 39                     RTS
01507                    ;
01508                    ;
01509 18E1 CE00EB        AVERAGE0 LDX    #AVGBUFF      ;PTR TO SAMPLES
01510 18E4 BD216E                 JSR    AVG10         ;TAKE AVERAGE
01511 18E7 39                     RTS
01512 18E8 CE00FF        AVERAGE1 LDX    #AVGBUFF+20
01513 18EB BD216E                 JSR    AVG10
01514 18EE 39                     RTS
```

```
01515 18EF CE0113     AVERAGE2 LDX    #AVGBUFF+40
01516 18F2 BD216E              JSR   AVG10
01517 18F5 39                  RTS
01518 18F6 CE0127     AVERAGE3 LDX    #AVGBUFF+60
01519 18F9 BD216E              JSR    AVG10
01520 18FC 39                  RTS
01521                 ;
01522                 ;
01523                 ;
01524                 ;
01525                 ;
01526                 ;TURN DATA COLLECTION ON AND OFF
01527 18FD CE2584     START    LDX    #DATAMSG
01528 1900 BD1DFF              JSR    STRNGNOC
01529 1903 BD1DA8              JSR    PRTON
01530 1906 BD1CFF              JSR    WHERE
01531 1909 BD171A              JSR    FTYPE          ;CALC FRAME TYPE OF FIRST FRAME
01532 190C BD1A25              JSR    OUTSIDE        ;HOME REFLECTOR
01533 190F 86FF                LDA A  #0FFH
01534 1911 97AA                STA A  F.COLLECT
01535 1913 97A6                STA A  F.DATA
01536 1915 97A5                STA A  F.NUBLOC       ;FLAG A NEW BLOCK
01537 1917 39                  RTS
01538                 ;
01539 1918 CE2584     HALT     LDX    #DATAMSG
01540 191B BD1DFF              JSR    STRNGNOC
01541 191E BD1DAD              JSR    PRTOFF
01542 1921 BD1CFF              JSR    WHERE
01543 1924 7F00AA              CLR    F.COLLECT
01544 1927 7F00A6              CLR    F.DATA
01545 192A 39                  RTS
01546                 ;
01547                 ;SET CALIBRATION TIME INTERVAL FROM CONSOLE.
01548                 ;INITIAL VALUE IS 5 MINUTES
01549 192B CE260B     SETCAL   LDX    #CALMSG        ;ASK FOR CAL INTERVAL
01550 192E BD1DFF              JSR    STRNGNOC
01551 1931 7A00A1              DEC    F.NUMBR        ;SET NUMBER REQUEST FLAG
01552 1934 CE193B              LDX    #SETCAL1
01553 1937 DFC1                STX    NEXSTATE
01554 1939 2014                BRA    SETCAL3
01555 193B BD11A5     SETCAL1  JSR    INBYTE         ;CONVERT ASCII TO HEX
01556 193E 2408                BCC    SETCAL2        ;ERROR?
01557 1940 CE247D     SETCAL11 LDX    #NUMERR        ;PRINT ERROR MSG
01558 1943 BD1DF4              JSR    STRNGOUT
01559 1946 20E3                BRA    SETCAL         ;LOOP IF ERROR
01560 1948 4D         SETCAL2  TST A                 ;CHECK FOR ZERO ENTRY
01561 1949 27F5                BEQ    SETCAL11
01562 194B 97DD                STA A  CAL.TIME
01563 194D 97DC                STA A  CAL.CNTR       ;RESET COUNTER
01564 194F 39         SETCAL3  RTS
01565                 ;
01566                 ;SET HEX DEBUG POINTER
```

```
01567 1950 CE24B2     SETHEX  LDX    #STRTMSG
01568 1953 BD1DFF             JSR    STRNGNOC
01569 1956 BD19E5             JSR    OUTQUES
01570 1959 7A00A1             DEC    F.NUMBR
01571 195C CE1962             LDX    #SETHEX1
01572 195F DFC1               STX    NEXSTATE
01573 1961 39                 RTS
01574 1962 BD11DB     SETHEX1 JSR    IN2BYTES
01575 1965 25E9               BCS    SETHEX
01576 1967 DFC7               STX    HEXPTR
01577 1969 39                 RTS
01578                 ;
01579                 ;PRINT FIRST 9 A/D CHANELS IN VOLTS ON CONSOLE
01580                 ;ASSUMES DATA IS IN ADC0-ADC8
01581 196A BD1A18     PRINVOLT JSR   CRLF
01582 196D CE006F             LDX    #ADC0          ;FIRST DATA
01583 1970 DF95       PRINTV1 STX    SAVEX4
01584 1972 A600               LDA A  0,X
01585 1974 E601               LDA B  1,X
01586 1976 CE003A             LDX    #SPRETEMP;     ;TEMP FOR BCD
01587 1979 BD22AB             JSR    VOLTSBCD
01588 197C CE003A             LDX    #SPRETEMP
01589 197F BD1D42             JSR    OUTTEMP
01590 1982 BD1DBC             JSR    OUT2SPC
01591 1985 DE95               LDX    SAVEX4         ;GET POINTER TO DATA BACK
01592 1987 08                 INX
01593 1988 08                 INX
01594 1989 8C0081             CPX    #ADC8+2
01595 198C 26E2               BNE    PRINTV1
01596 198E BD1A18             JSR    CRLF
01597 1991 39                 RTS
01598                 ;
01599                 ;
01600                 ;
01601                 ;SET TIME,DAY AND FLIGHT NUMBER MANUALLY
01602 1992 CE256C     SETTIME LDX    #FLTMSG
01603 1995 BD1DFF             JSR    STRNGNOC
01604 1998 BD19E5             JSR    OUTQUES        ;PRINT QUESTION MARK
01605 199B 7A00A1             DEC    F.NUMBR
01606 199E CE19A5             LDX    #SETT1
01607 19A1 DFC1               STX    NEXSTATE
01608 19A3 203F               BRA    SETT4
01609 19A5 BD11A5     SETT1   JSR    INBYTE
01610 19A8 2502               BCS    SETT2          ;ERROR ?,IGNORE IT
01611 19AA 9706               STA A  FLIGHT
01612 19AC CE2579     SETT2   LDX    #DAYMSG
01613 19AF BD1DFF             JSR    STRNGNOC
01614 19B2 8D31               BSR    OUTQUES
01615 19B4 7A00A1             DEC    F.NUMBR
01616 19B7 CE19BE             LDX    #SETT22
01617 19BA DFC1               STX    NEXSTATE
01618 19BC 2026               BRA    SETT4
```

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01619 19BE BD11DB     SETT22   JSR    IN2BYTES
01620 19C1 2502                BCS    SETT3
01621 19C3 DF07                STX    DAYS.HI
01622 19C5 CE257E     SETT3    LDX    #TIMEMSG
01623 19C8 BD1DFF              JSR    STRNGNOC
01624 19CB 8D18                BSR    OUTQUES
01625 19CD 7A00A1              DEC    F.NUMBR
01626 19D0 CE19D7              LDX    #SETT33
01627 19D3 DFC1                STX    NEXSTATE
01628 19D5 200D                BRA    SETT4
01629 19D7 BD11DB     SETT33   JSR    IN2BYTES
01630 19DA DF09                STX    HOURS
01631 19DC CE2907              LDX    #CBUFFER+4
01632 19DF BD11A3              JSR    INBYTE1
01633 19E2 970B                STA A  SECONDS
01634 19E4 39         SETT4    RTS
01635                 ;
01636                 ;PRINT A QUESTION MARK
01637 19E5 863F       OUTQUES  LDA A  #3FH
01638 19E7 7E1DED              JMP    OUTCH
01639                 ;
01640                 ;
01641                 ;CHECK STATUS OF CTS FLAG SET BY SERIAL PORT 1.
01642                 ;PRINT MESSAGE IF IT CHANGES STATES FROM 00 TO FF
01643 19EA 96AB       TESTGSFC LDA A  F.GSFC        ;WAS IT LOW BEFORE?
01644 19EC 2A14                BPL    GSFCOK        ;YES, DO NOTHING
01645 19EE CE2595              LDX    #LINKMSG      ;PRINT ON MESSAGE
01646 19F1 BD1DFF              JSR    STRNGNOC
01647 19F4 BD1DAD              JSR    PRTOFF
01648 19F7 BD1CFF              JSR    WHERE
01649 19FA 860F                LDA A  #0FH          ;MAKE NON ZERO AND POSITIVE
01650 19FC 97AB                STA A  F.GSFC
01651 19FE 7F00A3              CLR    F.BADTIM
01652 1A01 39                  RTS
01653 1A02 2613       GSFCOK   BNE    GSFCOK1       ;DO NOTHING IF FLAG IS ZERO
01654 1A04 96A3                LDA A  F.BADTIM      ;CHECK PRINT FLAG
01655 1A06 260F                BNE    GSFCOK1
01656 1A08 CE2595              LDX    #LINKMSG
01657 1A0B BD1DFF              JSR    STRNGNOC
01658 1A0E BD1DA8              JSR    PRTON
01659 1A11 BD1CFF              JSR    WHERE
01660 1A14 7A00A3              DEC     F.BADTIM             ;SET PRINT FLAG
01661 1A17 39         GSFCOK1  RTS
01662                 ;
01663                 ;
01664                 ;
01665 1A18 CE2515     CRLF     LDX    #CRLFSTR
01666 1A1B BD1DFF              JSR    STRNGNOC
01667 1A1E 39                  RTS
01668                 ;
01669 1A1F 860A       LFEED    LDA A  #0AH
01670 1A21 BD1DED              JSR    OUTCH
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```
01671 1A24 39                    RTS
01672
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```
01675                   ;
01676                   ;INTERNAL REFLECTOR MOTION CONTROL ROUTINES
01677                   ;
01678                   ;HOME REFLECTOR TO "OUTSIDE" POSITION
01679                   ;
01680 1A25 B68802       OUTSIDE  LDA A  PIA3BD        ;TEST SENSE SWITCH
01681 1A28 2A04                  BPL    POSOK         ;ALREADY HOME
01682 1A2A 8D16                  BSR    CLTCHON       ;TURN CLUTCH ON
01683 1A2C 20F7                  BRA    OUTSIDE       ;LOOP TILL DONE
01684 1A2E 8D09         POSOK    BSR    CLTCHOFF      ;TURN CLUTCH OFF
01685 1A30 7F0005                CLR    RFLPOS        ;CLEAR REFLECTOR POSITION FLAG
01686 1A33 86FF                  LDA A  #0FFH          ;WAIT FOR CLUTCH TO DISENGAGE
01687 1A35 BD1666                JSR    MSDLY
01688 1A38 39                    RTS
01689                   ;
01690                   ;
01691                   ;TURN CLUTCH OFF
01692 1A39 8620         CLTCHOFF LDA A  #20H          ;SET PB5=1
01693 1A3B BA8802                ORA A  PIA3BD
01694 1A3E B78802                STA A  PIA3BD
01695 1A41 39                    RTS
01696                   ;
01697                   ;TURN CLUTCH ON
01698 1A42 86DF         CLTCHON  LDA A  #0DFH         ;SET PB5=0
01699 1A44 B48802                AND A  PIA3BD
01700 1A47 B78802                STA A  PIA3BD
01701 1A4A 39                    RTS
01702                   ;
01703                   ;
01704                   ;PULSE CLUTCH ON FOR 1/4 SEC
01705 1A4B 8DF5         PULSE    BSR    CLTCHON       ;TURN CLUTCH ON
01706 1A4D 8619                  LDA A  #25           ;DELAY 25  MS
01707 1A4F BD1666                JSR    MSDLY
01708 1A52 8DE5                  BSR    CLTCHOFF      ;TURN CLUTCH OFF
01709 1A54 8632                  LDA A  #50
01710 1A56 BD1666                JSR    MSDLY
01711 1A59 39                    RTS
01712                   ;
01713                   ;
01714                   ;MOVE REFLECTOR TO COLD LOAD
01715 1A5A 9605         COLD     LDA A  RFLPOS        ;CHECK CURRENT POSITION
01716 1A5C 2604                  BNE    COLD1         ;AT OUTSIDE?
01717 1A5E 8DEB                  BSR    PULSE         ;MOVE TO COLD LOAD
01718 1A60 2008                  BRA    COLD2
01719 1A62 8101         COLD1    CMP A  #1            ;ALREADY AT COLD POS?
01720 1A64 2704                  BEQ    COLD2         ;YES
01721 1A66 8DBD                  BSR    OUTSIDE
01722 1A68 8DE1                  BSR    PULSE
01723 1A6A 8601         COLD2    LDA A  #1
01724 1A6C 9705                  STA A  RFLPOS        ;UPDATE REFLECTOR POSITION FLAG
01725 1A6E 39                    RTS
01726                   ;
```

REFLECTOR CONTROL ROUTINES

```
01727                   ;MOVE TO HOT LOAD
01728 1A6F 9605         HOT     LDA A   RFLPOS
01729 1A71 260B                 BNE     HOT1            ;IS IT HOME?
01730 1A73 8DD6                 BSR     PULSE           ;MOVE IT TO COLD LOAD
01731 1A75 8601                 LDA A   #1              ;WAIT 1 SEC FOR IT TO GET THERE
01732 1A77 BD166F               JSR     SECDLY
01733 1A7A 8DCF                 BSR     PULSE           ;MOVE TO HOT LOAD
01734 1A7C 2006                 BRA     HOT2
01735 1A7E 8102         HOT1    CMP A   #2              ;IS IT ALREADY THERE?
01736 1A80 2702                 BEQ     HOT2
01737 1A82 8DC7                 BSR     PULSE           ;MOVE IT TO HOT LOAD
01738 1A84 8602         HOT2    LDA A   #2              ;UPDATE FLAG
01739 1A86 9705                 STA A   RFLPOS
01740 1A88 39                   RTS
01741                   ;
01742                   ;DETERMINES WHAT THE RADIOMETER IS VIEWING FROM THE EXTERNAL
01743                   ;REFELCTOR POSITION SWITCH AND RFLPOS STATUS BYTE FOR THE CALIBRATION
01744                   ;REFLECTOR
01745 1A89 CE261C       VIEW    LDX     #RADMSG2
01746 1A8C BD1DFF               JSR     STRNGNOC
01747 1A8F 9605                 LDA A   RFLPOS          ;CHECK INT. REFL POS
01748 1A91 2720                 BEQ     VIEW1           ;LOOKING OUT?
01749 1A93 8101                 CMP A   #1              ;COLD LOAD?
01750 1A95 2608                 BNE     NOTCOLD
01751 1A97 CE25F0               LDX     #COLDMSG1
01752 1A9A BD1DF4               JSR     STRNGOUT
01753 1A9D 2029                 BRA     VIEW3
01754 1A9F 8102         NOTCOLD CMP A   #2
01755 1AA1 2608                 BNE     NOTHOT
01756 1AA3 CE25E6               LDX     #HOTMSG1
01757 1AA6 BD1DF4               JSR     STRNGOUT
01758 1AA9 201D                 BRA     VIEW3
01759 1AAB CE2701       NOTHOT  LDX     #RFLERR
01760 1AAE BD1DF4               JSR     STRNGOUT
01761 1AB1 2015                 BRA     VIEW3
01762 1AB3 B68802       VIEW1   LDA A   PIA3BD          ;CHECK SKY/GROUND SWITCH
01763 1AB6 8540                 BIT A   #40H
01764 1AB8 2708                 BEQ     VIEW2           ;IS IT GROUND?
01765 1ABA CE2633               LDX     #SKYMSG
01766 1ABD BD1DF4               JSR     STRNGOUT        ;PRINT "SKY"
01767 1AC0 2006                 BRA     VIEW3
01768 1AC2 CE2637       VIEW2   LDX     #GNDMSG
01769 1AC5 BD1DF4               JSR     STRNGOUT
01770 1AC8 39           VIEW3   RTS
01771                   ;
01772                   ;
```

```
01775                   ;
01776                   ;PUT ADDRESS OF DISPLAY ROUTINE IN DISPADR
01777 1AC9 CE1C0B      INIT     LDX    #INITMS
01778 1ACC 203A                 BRA    SETADR
01779 1ACE CE1B0E      SETCOLD  LDX    #DISPCOLD
01780 1AD1 2035                 BRA    SETADR
01781 1AD3 CE1B1B      SETHOT   LDX    #DISPHOT
01782 1AD6 2030                 BRA    SETADR
01783 1AD8 CE1B35      SETREF   LDX    #DISPREF
01784 1ADB 202B                 BRA    SETADR
01785 1ADD CE1B28      SETKLYS  LDX    #DISPKLYS
01786 1AE0 2026                 BRA    SETADR
01787 1AE2 CE1B42      SET183   LDX    #DISP183
01788 1AE5 2021                 BRA    SETADR
01789 1AE7 CE1B63      SET94    LDX    #DISP94
01790 1AEA 201C                 BRA    SETADR
01791 1AEC CE1B81      SET183A  LDX    #DISP183A
01792 1AEF 2017                 BRA    SETADR
01793 1AF1 CE1BA2      SET94A   LDX    #DISP94A
01794 1AF4 2012                 BRA    SETADR
01795 1AF6 CE1BC0      DISTIME  LDX    #TESTIME
01796 1AF9 200D                 BRA    SETADR
01797 1AFB CE161E      TEST1    LDX    #TESTADR
01798 1AFE 2008                 BRA    SETADR
01799 1B00 CE1625      TEST2    LDX    #TESTADL
01800 1B03 2003                 BRA    SETADR
01801 1B05 CE1644      TEST3    LDX    #PUTHEX
01802                   ;
01803 1B08 DFC5        SETADR   STX    DISPADR
01804 1B0A BD15AE               JSR    CLRDISP      ;CLEAR OUT OLD DISPLAY MESSAGE
01805 1B0D 39                   RTS
01806                   ;
01807                   ;PUT TEMPERATURES IN DISPLAY
01808                   ;
01809 1B0E CE25C6      DISPCOLD LDX    #COLDMSG
01810 1B11 BD15D3               JSR    DISPSTNG
01811 1B14 CE002B               LDX    #COLDTEMP
01812 1B17 BD15BE               JSR    DISPTEMP
01813 1B1A 39                   RTS
01814                   ;
01815 1B1B CE25B7      DISPHOT LDX    #HOTMSG
01816 1B1E BD15D3               JSR    DISPSTNG
01817 1B21 CE0026               LDX    #HTLDTEMP
01818 1B24 BD15BE               JSR    DISPTEMP
01819 1B27 39                   RTS
01820                   ;
01821 1B28 CE25FB      DISPKLYS LDX    #KLYSMSG
01822 1B2B BD15D3               JSR    DISPSTNG
01823 1B2E CE0035               LDX    #KLYSTEMP
01824 1B31 BD15BE               JSR    DISPTEMP
01825 1B34 39                   RTS
01826                   ;
```

MESSAGE DISPLAY COMMANDS

```
01827 1B35 CE25D6     DISPREF  LDX    #REFMSG
01828 1B38 BD15D3              JSR    DISPSTNG
01829 1B3B CE0030              LDX    #RELDTEMP
01830 1B3E BD15BE              JSR    DISPTEMP
01831 1B41 39                  RTS
01832                  ;
01833 1B42 CE28EF     DISP183  LDX    #DISPLY      ;INTI DISPLAY BUFF
01834 1B45 DFC3                STX    NEXTDISP
01835 1B47 CE0012              LDX    #CH0TEMP     ;DISPLAY ALL 183 GHZ TEMPS
01836 1B4A BD15BE              JSR    DISPTEMP
01837 1B4D BD15EC              JSR    DISPSPC
01838 1B50 CE0017              LDX    #CH1TEMP
01839 1B53 BD15BE              JSR    DISPTEMP
01840 1B56 BD15EC              JSR    DISPSPC
01841 1B59 CE001C              LDX    #CH2TEMP
01842 1B5C BD15BE              JSR    DISPTEMP
01843 1B5F BD15EC              JSR    DISPSPC
01844 1B62 39                  RTS
01845                  ;
01846 1B63 CE2660     DISP94   LDX    #MSG94
01847 1B66 BD15D3              JSR    DISPSTNG
01848 1B69 DEC3                LDX    NEXTDISP     ;BACKUP POINTER
01849 1B6B 09                  DEX
01850 1B6C 09                  DEX
01851 1B6D 09                  DEX
01852 1B6E 09                  DEX
01853 1B6F DFC3                STX    NEXTDISP
01854 1B71 CE25BF              LDX    #TEMPMSG
01855 1B74 BD15DC              JSR    DISPNEXT
01856 1B77 BD15EC              JSR    DISPSPC
01857 1B7A CE0021              LDX    #CH3TEMP
01858 1B7D BD15BE              JSR    DISPTEMP
01859 1B80 39                  RTS
01860                  ;
01861                  ;DISPLAY AVERAGE RAD TEMPS
01862 1B81 CE28EF     DISP183A LDX    #DISPLY
01863 1B84 DFC3                STX    NEXTDISP
01864 1B86 CE005B              LDX    #CH0TAVG
01865 1B89 BD15BE              JSR    DISPTEMP
01866 1B8C BD15EC              JSR    DISPSPC
01867 1B8F CE0060              LDX    #CH1TAVG
01868 1B92 BD15BE              JSR    DISPTEMP
01869 1B95 BD15EC              JSR    DISPSPC
01870 1B98 CE0065              LDX    #CH2TAVG
01871 1B9B BD15BE              JSR    DISPTEMP
01872 1B9E BD15EC              JSR    DISPSPC
01873 1BA1 39                  RTS
01874                  ;
01875                  ;
01876 1BA2 CE2660     DISP94A  LDX    #MSG94
01877 1BA5 BD15D3              JSR    DISPSTNG
01878 1BA8 DEC3                LDX    NEXTDISP
```

```
01879 1BAA 09                DEX
01880 1BAB 09                DEX
01881 1BAC 09                DEX
01882 1BAD 09                DEX
01883 1BAE DFC3              STX     NEXTDISP
01884 1BB0 CE25BF            LDX     #TEMPMSG
01885 1BB3 BD15DC            JSR     DISPNEXT
01886 1BB6 BD15EC            JSR     DISPSPC
01887 1BB9 CE006A            LDX     #CH3TAVG
01888 1BBC BD15BE            JSR     DISPTEMP
01889 1BBF 39                RTS
01890                    ;
01891                    ;
01892                    ;PUT TIME IN DISPLAY
01893 1BC0 CE28EF    TESTIME LDX     #DISPLY      ;RESET DISPLAY BUFFER
01894 1BC3 DFC3              STX     NEXTDISP
01895 1BC5 9601              LDA A   BLKNUM       ;DISPLAY TAPE BLOCK NUMBER
01896 1BC7 BD1605            JSR     DISPHEX
01897 1BCA 9602              LDA A   BLKNUM+1
01898 1BCC BD1605            JSR     DISPHEX
01899 1BCF BD15EC            JSR     DISPSPC
01900 1BD2 9609              LDA A   HOURS
01901 1BD4 BD1605            JSR     DISPHEX
01902 1BD7 C63A              LDA B   #":"
01903 1BD9 17                TBA
01904 1BDA BD15F1            JSR     DISPCHAR
01905 1BDD 960A              LDA A   MINUTES
01906 1BDF BD1605            JSR     DISPHEX
01907 1BE2 17                TBA
01908 1BE3 BD15F1            JSR     DISPCHAR
01909 1BE6 960B              LDA A   SECONDS
01910 1BE8 BD1605            JSR     DISPHEX
01911 1BEB BD15EC            JSR     DISPSPC
01912 1BEE 96DC              LDA A   CAL.CNTR     ;DISPLAY TIME TO CAL
01913 1BF0 BD1605            JSR     DISPHEX
01914 1BF3 BD15EC            JSR     DISPSPC
01915 1BF6 96AA              LDA A   F.COLLECT
01916 1BF8 270A              BEQ     NOTONN       ;PUT ON IN DISPLAY IF DATA ON
01917 1BFA CE2684            LDX     #ONMSG
01918 1BFD BD15DC            JSR     DISPNEXT
01919 1C00 BD15EC            JSR     DISPSPC
01920 1C03 39                RTS
01921 1C04 CE2687    NOTONN  LDX     #OFFMSG
01922 1C07 BD15DC            JSR     DISPNEXT
01923 1C0A 39                RTS
01924                    ;
01925                    ;PUT SIGN ON MESSAGE IN DISPLAY
01926 1C0B CE243C    INITMS  LDX     #INITMSG
01927 1C0E BD15D3            JSR     DISPSTNG
01928 1C11 39                RTS
01929                    ;
01930                    ;FLASH END OF TAPE WARNING MESSAGE IN DISPLAY AND RING BELL ON CONSOLE
```

```
1C12 CE26EC   TAPEWARN LDX    #WNGMSG
1C15 BD15D3            JSR    DISPSTNG
1C18 8607              LDA A  #7          ;BELL
1C1A BD1DED            JSR    OUTCH
1C1D 86C8              LDA A  #200          ;WAIT
1C1F BD1666            JSR    MSDLY
1C22 BD15AE            JSR    CLRDISP
1C25 86C8              LDA A  #200
1C27 BD1666            JSR    MSDLY
1C2A 39                RTS
              ;
              ;
              ;
              ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
              ;STATUS PRINTOUT ROUTINES
              ;
              ;PRINT CURRENT TRACK AND BLOCK NUMBER
1C2B CE25A3   TAPE     LDX    #TAPEMSG
1C2E BD1DFF            JSR    STRNGNOC    ;PRINT MSG WITH NO CR LF
1C31 CE26C9   TAPE1    LDX    #TRKMSG
1C34 BD1DFF            JSR    STRNGNOC
1C37 9600              LDA A  TRACKN      ;GET TRACK NUMBER
1C39 BD1DD4            JSR    OUTHEX
1C3C BD1DCD            JSR    OUTSPACE    ;PRINT A SPACE
1C3F CE26D0            LDX    #BLKMSG
1C42 BD1DFF            JSR    STRNGNOC    ;PRINT "BLOCK"
1C45 CE0001            LDX    #BLKNUM
1C48 BD1DC9            JSR    OUT2HEX
1C4B BD1A18            JSR    CRLF
1C4E 39                RTS
              ;
              ;
              ;PRINT LOAD TEMPS ON CONSOLE
1C4F BD1A18   TEMPL    JSR    CRLF
1C52 CE25B7            LDX    #HOTMSG     ;PRINT "HOT LOAD#
1C55 BD1DFF            JSR    STRNGNOC
1C58 BD1DCD            JSR    OUTSPACE
1C5B BD1DCD            JSR    OUTSPACE
1C5E CE25C6            LDX    #COLDMSG
1C61 BD1DFF            JSR    STRNGNOC
1C64 BD1DCD            JSR    OUTSPACE
1C67 BD1DCD            JSR    OUTSPACE
1C6A CE25D6            LDX    #REFMSG
1C6D BD1DFF            JSR    STRNGNOC
1C70 BD1DCD            JSR    OUTSPACE
1C73 BD1DCD            JSR    OUTSPACE
1C76 CE25FB            LDX    #KLYSMSG
1C79 BD1DFF            JSR    STRNGNOC
1C7C BD1A18            JSR    CRLF
1C7F CE0026            LDX    #HTLDTEMP
1C82 BD1D42            JSR    OUTTEMP
1C85 BD1DB4            JSR    OUT10SPC
```

```
1983 1C88 CE002B              LDX    #COLDTEMP
1984 1C8B BD1D42              JSR    OUTTEMP
1985 1C8E BD1DB4              JSR    OUT10SPC
1986 1C91 CE0030              LDX    #RELDTEMP
1987 1C94 BD1D42              JSR    OUTTEMP
1988 1C97 BD1DB4              JSR    OUT10SPC
1989 1C9A CE0035              LDX    #KLYSTEMP
1990 1C9D BD1D42              JSR    OUTTEMP
1991 1CA0 BD1DB4              JSR    OUT10SPC
1992 1CA3 BD1A18              JSR    CRLF
1993 1CA6 39                  RTS
1994                    ;
1995                    ;
1996                    ;PRINT OUT ALL FOUR RADIOMETER CHANNEL TEMPERATURES
1997 1CA7 BD1A18        TEMPR JSR    CRLF
1998 1CAA CE266C              LDX    #RADMSG3      ;PRINT RADIOMETER MESSAGE
1999 1CAD BD1DF4              JSR    STRNGOUT
2000 1CB0 CE263E              LDX    #MSG183       ;PRINT "183 GHZ"
2001 1CB3 BD1DFF              JSR    STRNGNOC
2002 1CB6 BD1DCD              JSR    OUTSPACE
2003 1CB9 CE2649              LDX    #MSG188
2004 1CBC BD1DFF              JSR    STRNGNOC
2005 1CBF BD1DCD              JSR    OUTSPACE
2006 1CC2 CE2654              LDX    #MSG193
2007 1CC5 BD1DFF              JSR    STRNGNOC
2008 1CC8 BD1DCD              JSR    OUTSPACE
2009 1CCB CE2660              LDX    #MSG94        ;PRINT 94 GHZ TEMP
2010 1CCE BD1DFF              JSR    STRNGNOC
2011 1CD1 BD1DCD              JSR    OUTSPACE
2012 1CD4 BD1A18              JSR    CRLF
2013 1CD7 CE0012              LDX    #CH0TEMP
2014 1CDA BD1D42              JSR    OUTTEMP
2015 1CDD BD1DB8              JSR    OUT6SPC
2016 1CE0 CE0017              LDX    #CH1TEMP
2017 1CE3 BD1D42              JSR    OUTTEMP
2018 1CE6 BD1DB8              JSR    OUT6SPC
2019 1CE9 CE001C              LDX    #CH2TEMP
2020 1CEC BD1D42              JSR    OUTTEMP
2021 1CEF BD1DB8              JSR    OUT6SPC
2022 1CF2 CE0021              LDX    #CH3TEMP
2023 1CF5 BD1D42              JSR    OUTTEMP
2024 1CF8 BD1DCD              JSR    OUTSPACE
2025 1CFB BD1A18              JSR    CRLF
2026 1CFE 39                  RTS
2027                    ;
2028                    ;
2029                    ;
2030                    ;PRINT CURRENT FLIGHT NUMBER, DAY AND TIME
2031 1CFF BD1A18        WHERE JSR    CRLF          ;PRINT CR AND LF
2032 1D02 CE256C              LDX    #FLTMSG       ;PRINT "FLIGHT"
2033 1D05 BD1DFF              JSR    STRNGNOC
2034 1D08 9606                LDA A  FLIGHT
```

MESSAGE DISPLAY COMMANDS

```
02035 1D0A BD1DD4              JSR    OUTHEX
02036 1D0D BD1DCD              JSR    OUTSPACE
02037 1D10 CE2579              LDX    #DAYMSG        ;PRINT "DAY"
02038 1D13 BD1DFF              JSR    STRNGNOC
02039 1D16 CE0007              LDX    #DAYS.HI       ;PRINT DAY
02040 1D19 BD1DC9              JSR    OUT2HEX
02041 1D1C BD1DCD              JSR    OUTSPACE
02042 1D1F CE257E     TIME     LDX    #TIMEMSG       ;PRINT "TIME"
02043 1D22 BD1DFF              JSR    STRNGNOC
02044 1D25 9609                LDA A  HOURS
02045 1D27 BD1DD4              JSR    OUTHEX
02046 1D2A 863A                LDA A  #":"
02047 1D2C BD1DED              JSR    OUTCH          ;PRINT ":"
02048 1D2F 960A                LDA A  MINUTES
02049 1D31 BD1DD4              JSR    OUTHEX
02050 1D34 863A                LDA A  #":"
02051 1D36 BD1DED              JSR    OUTCH
02052 1D39 960B                LDA A  SECONDS
02053 1D3B BD1DD4              JSR    OUTHEX
02054 1D3E BD1A18              JSR    CRLF
02055 1D41 39                  RTS
02056                  ;
02057                  ;
02058                  ;PRINT PACKED BCD NUMBER ON CONSOLE.  ASSUMES FIXED POINT
02059                  ;FORMAT WITH 4 DIGITS TO LEFT AND RIGHT OF DECIMAL POINT.
02060                  ;FIRST BYTE IS SIGN.  CALL WITH X POINTING TO SIGN BYTE.
02061 1D42 A600       OUTTEMP  LDA A  0,X            ;GET SIGN BYTE
02062 1D44 2705                BEQ    OUTPOS         ;BRANCH IF POS
02063 1D46 862D                LDA A  #"-"           ;PRINT A MINUS SIGN
02064 1D48 BD1DED              JSR    OUTCH
02065 1D4B A601       OUTPOS   LDA A  1,X            ;GET MS BYTE
02066 1D4D BD1DE1              JSR    OUTHEXR        ;PRINT IT
02067 1D50 A602                LDA A  2,X
02068 1D52 BD1DD4              JSR    OUTHEX
02069 1D55 862E                LDA A  #"."           ;PRINT DECIMAL PT
02070 1D57 BD1DED              JSR    OUTCH
02071 1D5A A603                LDA A  3,X
02072 1D5C BD1DD4              JSR    OUTHEX
02073 1D5F 39                  RTS
02074                  ;
02075                  ;
02076                  ;PRINT ENTIRE SYSTEM STATUS MESSAGES ON CONSOLE.
02077                  ;NORMALLY CALLED AFTER CAL CYCLE
02078 1D60 BD1A18     STATUS   JSR    CRLF
02079 1D63 CE253F              LDX    #RADMSG        ;PRINT RAD MSG
02080 1D66 BD1DF4              JSR    STRNGOUT
02081 1D69 CE255E              LDX    #RADMSG1
02082 1D6C BD1DF4              JSR    STRNGOUT
02083 1D6F BD1A18              JSR    CRLF
02084 1D72 BD1CFF              JSR    WHERE          ;PRING FLIGHT,DAY AND TIME
02085 1D75 CE2584              LDX    #DATAMSG
02086 1D78 BD1DFF              JSR    STRNGNOC
```

MESSAGE DISPLAY COMMANDS

```
02087 1D7B 96A6              LDA A  F.DATA       ;TEST DATA COLLECTION FLAG
02088 1D7D 2604              BNE    STATUS1      ;IS DATA COLLECTION ON?
02089 1D7F 8D2C              BSR    PRTOFF       ;PRINT "OFF"
02090 1D81 2002              BRA    STATUS2
02091 1D83 8D23      STATUS1 BSR    PRTON        ;PRINT  "ON"
02092 1D85 BD1A18    STATUS2 JSR    CRLF
02093 1D88 CE2595            LDX    #LINKMSG     ;PRINT "LINK TO GSFC"
02094 1D8B BD1DFF            JSR    STRNGNOC
02095 1D8E 96AB              LDA A  F.GSFC
02096 1D90 2604              BNE    STATUS3      ;BRANCH IF FLAG=FF
02097 1D92 8D14              BSR    PRTON        ;PRINT "ON"
02098 1D94 2002              BRA    STATUS4
02099 1D96 8D15      STATUS3 BSR    PRTOFF       ;PRINT "OFF"
02100 1D98 BD1A18    STATUS4 JSR    CRLF
02101 1D9B BD1C2B            JSR    TAPE         ;PRINT TAPE STATUS
02102 1D9E BD1C4F            JSR    TEMPL        ;PRINT LOAD TEMPS
02103 1DA1 BD1CA7            JSR    TEMPR        ;PRINT RADIOMETER TEMPS
02104 1DA4 BD1A89            JSR    VIEW         ;PRINT WHAT RADIOMETER IS VIEWING
02105 1DA7 39                RTS
02106                ;
02107                ;
02108 1DA8 CE2684    PRTON   LDX    #ONMSG
02109 1DAB 2003              BRA    PRT1
02110 1DAD CE2687    PRTOFF  LDX    #OFFMSG
02111 1DB0 BD1DFF    PRT1    JSR    STRNGNOC
02112 1DB3 39                RTS
02113                ;
02114                ;
```

```

                   ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                   ;
                   ;
                   ;
1DB4 C60A          OUT10SPC LDA B  #10
1DB6 2008                   BRA    OUTSPC
1DB8 C606          OUT6SPC  LDA B  #6
1DBA 2004                   BRA    OUTSPC
1DBC C602          OUT2SPC  LDA B  #2
1DBE 2000                   BRA    OUTSPC
1DC0 37            OUTSPC   PSH B
1DC1 BD1DCD                 JSR    OUTSPACE
1DC4 33                     PUL B
1DC5 5A                     DEC B
1DC6 26F8                   BNE    OUTSPC
1DC8 39                     RTS
                   ;
                   ;
                   ;
                   ;PRINT 2 HEX BYTES POINTED TO BY X
1DC9 8D06          OUT2HEX  BSR    THB
                   ;
                   ;PRINT SINGLE HEX BYTE POINTED TO BY X
1DCB 8D04          OUT1HEX  BSR    THB
1DCD 8620          OUTSPACE LDA A  #20H
1DCF 201C                   BRA    OUTCH
                   ;
                   ;PRINT SINGLE HEX BYTE FROM X
                   ;
1DD1 A600          THB      LDA A  0,X
1DD3 08                     INX
                   ;PRINT SINGLE HEX CHARACTER FROM A
1DD4 36            OUTHEX   PSH A
1DD5 8D04                   BSR    OUTHEXL
1DD7 32                     PUL A
1DD8 8D07                   BSR    OUTHEXR
1DDA 39                     RTS
                   ;
1DDB 44            OUTHEXL  LSR A
1DDC 44                     LSR A
1DDD 44                     LSR A
1DDE 44                     LSR A
1DDF 2002                   BRA    THB1
1DE1 840F          OUTHEXR  AND A  #0FH          ;MASK OFF LS PART
1DE3 810A          THB1     CMP A  #0AH
1DE5 2502                   BCS    THB2
1DE7 8B07                   ADD A  #07
1DE9 8B30          THB2     ADD A  #30H          ;MAKE ASCII
1DEB 2000                   BRA    OUTCH
                   ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                   ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
                ;
                ;       ****    OUTCH   ****
                ;
                ;
                ;                               ****   TRANSMIT SINGLE CHARACTER IMMEDIATELY
                ;                               ****   INPUT ASCII IN RA
                ;
                ;
                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

1DED 8D1B       OUTCH   BSR     CHAR.INS        ;PUT CHARACTER ONTO BUFFER
1DEF 8604               LDA A   #04             ;AND SEND AN ETX TO START TRANSMISSION
1DF1 8D17               BSR     CHAR.INS        ;BY WRITING AN ETX TO BUFFER
1DF3 39                 RTS

                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                ;
                ;       ****    STRNGOUT    ****
                ;
                ;
                ;                               ****   PUT STRING POINTED TO BY RX ONTO TRANSMIT BUFFER
                ;                               ****   STRING MUST END WITH AN 04H (ETX)
                ;                               ****   SENDS OUT CR AND LF FOLLOWING STRING
                ;
1DF4 8D09       STRNGOUT BSR    STRNGNOC        ;SEND STRING
1DF6 860D               LDA A   #0DH            ;SEND CARRIAGE RETURN
1DF8 8DF3               BSR     OUTCH
1DFA 860A               LDA A   #0AH            ;SEND LINE FEED
1DFC 8DEF               BSR     OUTCH
1DFE 39                 RTS
                ;
                ;
                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!! !
                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

1DFF A600       STRNGNOC LDA A  0,X             ;GET THE CHARACTER POINTED TO BY RX
1E01 BD1E0A             JSR     CHAR.INS        ;PUT IT INTO TRANSMIT BUFFER ( EVEN IF ETX )
1E04 08                 INX                     ;BUMP THE POINTER
1E05 8104               CMP A   #04             ;SEE IF AN ETX
1E07 26F6               BNE     STRNGNOC        ;IF NOT THEN GET NEXT CHAR
1E09 39                 RTS
                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                ;
                ;       ****    CHAR.INS    ****
                ;
                ;
                ;                               ****  PUTS THE INPUT ASCII CODE INTO TRANSMIT BUFFER
                ;                               ****  INPUT CODE IS IN RA
                ;                               ****  STARTS TRANSMISSION WHEN CODE IS 04H ( ETX )
                ;                               ****  ETX IS NOT PUT INTO BUFFER
```

```
                              ;
                              ;
                              ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                              ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
1E0A DFAE       CHARINS  STX    XTEMP1          ;SAVE THE X REGISTER
1E0C D6A7                LDA B  F.XMIT          ;SEE IF WE ARE ALREADY SENDING A BLOCK FROM THE BUFFER
1E0E 2A0E                BPL    CHARINS2        ;IF WE ARE NOT THEN SKIP
                         ;
                         ;     ****   INSERT WHEN ALREADY TRANSMITTING   ****
                         ;
1E10 8104                CMP A  #04             ;SEE IF ETX
1E12 2707                BEQ    CHARINS1        ;IF SO THEN GO ON AND EXIT
1E14 DEE5                LDX    LASTCHAR        ;IF NO THEN PUT ON AS LAST CHAR IN BUFFER
1E16 08                  INX
1E17 A700                STA A  0,X
1E19 DFE5                STX    LASTCHAR        ;REPLACE THE POINTER
1E1B DEAE       CHARINS1 LDX    XTEMP1            ;REPLACE THE X REGISTER
1E1D 39                  RTS
                         ;
                         ;     ****   INSERT WHEN NOT TRANSMITTING   ****
                         ;
1E1E 8104       CHARINS2 CMP A  #04             ;SEE IF ETX
1E20 2709                BEQ    CHARINS3        ;IF SO THEN SKIP TO SET TRANSMIT FLAG
1E22 DEE3                LDX    NEXTCHAR        ;IF NOT ETX THEN PUT ONTO CURRENT BLOCK
1E24 A700                STA A  0,X
1E26 08                  INX
1E27 DFE3                STX    NEXTCHAR        ;REPLACET THE POINTER
1E29 20F0                BRA    CHARINS1        ;AND EXIT
                         ;
                         ;     ****   END OF STRING. START TRANSMITTING   ****
                         ;
1E2B DEE3       CHARINS3 LDX    NEXTCHAR        ;GET THE ADDRESS OF NEXT FREE CHAR ON BLOCK
1E2D 09                  DEX                    ;POINT IT TO LAST INPUT CHAR
1E2E DFE7                STX    BLOCKEND        ;RESET THE OTHER TWO POINTERS
1E30 DFE5                STX    LASTCHAR
1E32 CE015B              LDX    #XMITBUF        ;NOW RESET THE BLOCK POINTER (CHARS TO BE SENT)
1E35 DFE3                STX    NEXTCHAR
1E37 C6FF                LDA B  #0FFH            ;SET FLAG THAT SAYS WE RARE XMITTING
1E39 D7A7                STA B  F.XMIT
1E3B C6A1                LDA B  #0A1H           ;CAUSE THE ACIA TO BE INTERRUPTING
1E3D F78408              STA B  ACIA1.C
1E40 20D9                BRA    CHARINS1        ;AND EXIT
                ;
                ;SEND BYTE IN A TO SERIAL PORT 1 (ACIA2)
                ;GODDARD COMPUTER LISTENS THERE
1E42 37         OUTGSFC  PSH B                  ;SAVE B
1E43 F68808     OUTGS1   LDA B  ACIA2C          ;CHECK CTS FROM GODDARD
1E46 C508                BIT B  #08H            ;MASK OFF CTS BIT
1E48 260F                BNE    OUTGS2          ;DONT TRY TO SEND OF CTS=1
1E4A 7F00AB              CLR    F.GSFC          ;CLEAR FLAG IF CTS GOES LO
1E4D 7F00C9              CLR    CTSCNTR         ;RESET COUNTER
```

```
====CHARACTER OUTPUT ROUTINES====

02273 1E50 F68808            LDA B  ACIA2C       ;GET ACIA STATUS AGAIN
02274 1E53 54                LSR B
02275 1E54 54                LSR B
02276 1E55 24EC              BCC    OUTGS1       ;LOOP TILL IT IS
02277 1E57 2019              BRA    OUTGS3       ;
02278 1E59 7D00AB     OUTGS2 TST    F.GSFC       ;CHECK FLAG
02279 1E5C 2617              BNE    OUTGS4       ;DONT WAIT IF FLAG IS SET
02280 1E5E 36                PSH A               ;SAVE A
02281 1E5F 8601              LDA A  #1           ;DELAY 1 MS
02282 1E61 BD1666            JSR    MSDLY
02283 1E64 32                PUL A
02284 1E65 7A00C9            DEC    CTSCNTR      ;BUMP COUNTER
02285 1E68 26D9              BNE    OUTGS1       ;TRY TILL COUNTER OVERFLOWS
02286 1E6A C6FF              LDA B  #0FFH        ;SET FLAG NEG AND NON ZERO
02287 1E6C D7AB              STA B  F.GSFC
02288 1E6E D6CF              LDA B  GSFCTO       ;RESET TIME OUT TIMER
02289 1E70 D7C9              STA B  CTSCNTR
02290 1E72 B78809     OUTGS3 STA A  ACIA2D       ;SEND DATA
02291 1E75 33         OUTGS4 PUL B                ;GET B BACK
02292 1E76 39                RTS
02293                 ;
02294                 ;
```

```
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;
                       ;
                       ;                     NMI.ISR
                       ;
                       ;
                       ;      ****   NON MASKABLE INTERRUPT SERVICE ROUTINE    ****
                       ;
                       ;      ****   DATA COLLECTION, REAL TIME CLOCK, IRIGB   ****
                       ;
                       ;
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;
                              MACRO    COUNT      ;****   COUNT CHECKER USED IN "NMI.ISR"   ****

                                                          ;*******************************
                                                          ;***                         ***
                                        LDA A  '2'        ;*** GET THE COUNT VARIABLE ***
                                        ADD A  #1         ;***      INCREMENT IT       ***
                                        DAA               ;***      MAKE IT  BCD       ***
                                        STA A  '2'        ;***   REPLACE THE VARIABLE ***
                                        CMP A  #'1'H      ;***  SEE IF AT RESET VALUE ***
                                        BEQ    '3'        ;***IF SO THEN SKIP TO NEXT ***
                                        JMP    NMI.DATA   ;***   ELSE END COUNT SEQ.   ***
                                                          ;***                         ***
                                                          ;*******************************

                              ENDM
                       ;      ****   DEFINE SYMBOLS FOR A READABLE PROGRAM   ****
                       ;
           880:        IR:   IN EQU   PIA3BD       ;DEFINE THE DATA REGISTER FOR IRIGB INPUTS
           880:        NM.   IA EQU   PIA3BC       ;ADDRESS OF THE PIA FOR BOTH IRIBG AND RTC
                       ;
                       ;      ****   VECTOR TO THE INTERRUPTING CLOCK DRIVER   ****
                       ;
 1E77 B68:03           NM.   SR LDA A  NMI.PIA     ;READ THE PIA TO SEE WHO GAVE NMI
 1E7A 2B6                       BMI    NMI.RTC     ;IF CB1 THEN IT WAS RTC 100 MS
 1E7C 48                        ASL A              ;ELSE TEST FOR CB2 (100-MS RTC PULSE)
 1E7D 2A0                       BPL    NMI.EX0     ;IF CB2 NOT SET THEN WE HAD A FALSE INTERRUPT
 1E7F 200                       BRA    NMI.IRIG    ;IF CB2 THEN IT WAS IRIGB

                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;
                       ;      ****   IRIGB INTERRUPT DRIVER   ****
                       ;
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                       ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
1E81 96A2        NMI.IRIG LDA A  F.5MIN       ;SEE IF 5 MINUTES ARE UP (THAT IS PERIOD OF RTC SYNCH CHECK)
1E83 2B08                 BMI    IRIGB.1      ;IF SO THEN PROCESS IRIGB IRQ
1E85 96D4                 LDA A  NMI.F0       ;TEST IF WE ARE INITIAL ENTRY INTO PROGRAM
1E87 2704                 BEQ    IRIGB.1      ;IF SO THEN PROCESS IRIGB IRQ (GET INITIAL VALUES)
1E89 B68802               LDA A  IRIGB.IN     ;NEITHER CASE VALID, SO RESET IRQ AND EXIT
1E8C 3B          NMI.EX0  RTI                 ;HERE IS AN EXIT POINT
                          ;
                          ;        ****   INPUT THE IRIGB TIME CODE ( TAKES 1 SEC )   ***
                          ;
1E8D BD2061      IRIGB.1  JSR    IRIGBSET     ;GO READ THE CODE
                          ;
                          ;        ****   SEE IF INITIAL ISR ENTRY   ****
                          ;
1E90 96D4                 LDA A  NMI.F0       ;INITIAL ENTRY?
1E92 2609                 BNE    IRIGB.3      ;IF NOT THEN SKIP
1E94 96D5                 LDA A  NMI.F1       ;SEE IF IRIGSET GOT HUNG (IRIGB NONFUNCTIONAL)
1E96 2BF4                 BMI    NMI.EX0      ;IF WE ARE HUNG THEN EXIT WITHOUT TRYING TO INIT THE VALUES
1E98 7300D4      IRIGB.2  COM    NMI.F0       ;WE DID NOT GET HUNG, SO RESET FLAG AND UPDATE
1E9B 2029                 BRA    IRIG.UPD
                          ;
                          ;        ****   TEST IF IRIGB WAS HUNG UP   ****
                          ;
1E9D 96D5        IRIGB.3  LDA A  NMI.F1       ;READ THE "HUNG-UP" FLAG
1E9F 2BEB                 BMI    NMI.EX0      ;IF WE ARE HUNG THEN EXIT ( FLAG IS ALREADY SET )

                          ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                          ;
                          ;    ****   CHECK THE IRIGB AGAINST THE SYSTEM CLOCK   ****
                          ;
                          ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

                          ;
                          ;        ****   FIRST TEST THE SECONDS CLOCK   ****
                          ;
1EA1 9611        IRI      LDA A  IRIGSEC      ;READ THE SECONDS VALUE RETURNED FROM IRIGSET
1EA3 900B                 SUB A  SECONDS      ;FIND THE DIFFERENCE BETWEEN IT AND THE SYS TIME
1EA5 4D                   TST A               ;TAKE THE ABSOLUTE VALUE
1EA6 2A01                 BPL    IRIGB.5      ;IF POS THEN SKIP
1EA8 43                   COM A
1EA9 8101        IRI      CMP A  #1           ;SEE IF WITHIN ERROR
1EAB 2E32                 BGT    IRIG.BAD     ;IF NOT THEN GGOTO FAIL SECTION
                          ;
                          ;        ****   TEST THE MINUTES   ****
                          ;
1EAD 9610                 LDA A  IRIGMIN      ;READ THE MINUTES
1EAF 910A                 CMP A  MINUTES      ;COMPARE TO SYSTEM MINUTES.
1EB1 262C                 BNE    IRIG.BAD
                          ;
                          ;        ****   TEST THE HOURS   ****
                          ;
1EB3 960F                 LDA A  IRIGHOUR
```

```
1EB5 9109                CMP A  HOURS
1EB7 2626                BNE    IRIG.BAD
                         ;
                         ;         ****   TEST THE LSB OF DAYS   ****
                         ;
1EB9 960E                LDA A  IRIGDAYL
1EBB 9108                CMP A  DAYS.LO      ;DAYS TAKE 2 BYTES
1EBD 2620                BNE    IRIG.BAD
                         ;
                         ;        ****   TEST DAYS MSB   ****
                         ;
1EBF 960D                LDA A  IRIGDAYH
1EC1 9107                CMP A  DAYS.HI
1EC3 261A                BNE    IRIG.BAD     ; GOTO HANDLER FOR LOST TIME SYNC
1EC5 3B         NMI.EX1  RTI                 ;SECOND EXIT POINT

                         ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                         ;
                         ;     ****  UPDATE THE SYSTEM POINTERS ON INITIALIZATION  ****
                         ;
                         ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

1EC6 9611       IRIG.UPD LDA A  IRIGSEC
1EC8 970B                STA A  SECONDS
                         ;
1ECA 9610                LDA A  IRIGMIN
1ECC 970A                STA A  MINUTES
                         ;
1ECE 960F                LDA A  IRIGHOUR
1ED0 9709                STA A  HOURS
                         ;
1ED2 960E                LDA A  IRIGDAYL
1ED4 9708                STA A  DAYS.LO      ;LEAST ORDER BYTE OF DAYS
                         ;
1ED6 960D                LDA A  IRIGDAYH
1ED8 9707                STA A  DAYS.HI
                         ;
1EDA 960C                LDA A  IRIGFLT
1EDC 9706                STA A  FLIGHT
                         ;
1EDE 3B         NMI.EX2  RTI                 ;THIRD EXIT POINT

                         ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                         ;
                         ;        ***  ERROR ROUTINE FOR 5-MIN TIME SYNC CHECK   ***
                         ;
                         ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

1EDF 8680       IRIG.BAD LDA A  #80H         ;SET THE "LOST SYNC" FLAG
1EE1 97A3                STA A  F.BADTIM
1EE3 3B         NMI.EX3  RTI
```

```
                          ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                          ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                          ;
                          ;         ****   REAL TIME CLOCK (100 MS) DRIVER  ****
                          ;
                          ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                          ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

1EE4 B68802       NMI.RTC  LDA A  IRIGB.IN      ;CLEAR NMI FLAGS
1EE7 01                    NOP
1EE8 0E                    CLI                  ;ENABLE IRQ FOR DISPALY
1EE9 96D8                  LDA A  RTC.STAT      ;SEE IF WE SHOULD CHECK FOR A HUNG IRIGB
1EEB 260B                  BNE    RTC.SEC1      ;IF NOT THEN SKIP
                           ;
                           ;      ****   TEST IF IRIGB IS HUNG   ****
                           ;
1EED 96D7                  LDA A  RTC.CNTR      ;COUNT UP A TEMPORARY COUNTER
1EEF 4C                    INC A
1EF0 97D7                  STA A  RTC.CNTR      ;SAVE THE NEW VALUE
1EF2 8103                  CMP A  #3            ;SEE IF 300 MS
1EF4 2602                  BNE    RTC.SEC1      ;IF NOT THEN GOTO NEXT SECTION
1EF6 97D8                  STA A  RTC.STAT      ;IF SO THEN MAKE THE STATE VAR NONZERO (IRIGB IS HUNG)
                           ;
                           ;     ****   SECONDS TIMING   ****
                  ;SAMPLE 4 RADIOMETER CHANELS AND PUT DATA IN BUFFER FOR AVERAGING
                  ;DONT DO IT IF TAPE IS WORKING
                  ;
1EF8 96C0         RTC.SEC1 LDA A  BLOCKS        ;SEE IF TAPE IS READING OR WRITING
1EFA 2631                  BNE    RTC.SEC2
1EFC DEE9         FILLBUFF LDX    AVGPTR        ;GET PTR TO NEXT LOCATIONS
1EFE 4F                    CLR A
1EFF BD2035                JSR    GETDATA       ;GET CH0 DATA
1F02 A700                  STA A  0,X           ;PUT IN BUFFER
1F04 E701                  STA B  1,X
1F06 8601                  LDA A  #1            ;CH1
1F08 BD2035                JSR    GETDATA
1F0B A714                  STA A  20,X
1F0D E715                  STA B  21,X
1F0F 8602                  LDA A  #2
1F11 BD2035                JSR    GETDATA
1F14 A728                  STA A  40,X
1F16 E729                  STA B  41,X
1F18 8603                  LDA A  #3
1F1A BD2035                JSR    GETDATA
1F1D A73C                  STA A  60,X
1F1F E73D                  STA B  61,X
1F21 08                    INX
1F22 08                    INX
1F23 8C00FF                CPX    #AVGBUFF+20   ;DONE YET?
1F26 2603                  BNE    FILBUF1
1F28 CE00EB                LDX    #AVGBUFF
1F2B DFE9         FILBUF1  STX    AVGPTR
```

```
02505                    ;
02506                    ;
02507                    ;COUNT SECONDS
02508                    RTC.SEC2  COUNT 10,[ MSCNTR ],[ RTC.SEC ]
      1F2D 96D9      +                   LDA A   MSCNTR        ;*** GET THE COUNT VARIABLE ***
      1F2F 8B01                          ADD A  #1         ;***      INCREMENT IT       ***
      1F31 19                            DAA               ;***      MAKE IT  BCD       ***
      1F32 97D9      +                   STA A   MSCNTR        ;***   REPLACE THE VARIABLE ***
      1F34 8110      +                   CMP A  #10H     ;***  SEE IF AT RESET VALUE ***
      1F36 2703      +                   BEQ     RTC.SEC        ;***IF SO THEN SKIP TO NEXT ***
      1F38 7E1FBE                        JMP    NMI.DATA ;***   ELSE END COUNT SEQ.   ***
02509                    ;
02510 1F3B 7F00D9  RTC.SEC  CLR    MSCNTR       ;RESET THE 100 MS COUNTER
02511                    ;SAMPLE ALL 9 A/D CHANNELS EVERY SECOND FOR DISPLAY PURPOSES
02512                    ;BYPASS THIS ROUTINE DURING TAPE READ OR WRITE (BLOCKS NON ZERO)
02513 1F3E 96C0                    LDA A  BLOCKS
02514 1F40 2617                    BNE    RTC.MIN       ;BRANCH IF BLOCKS NOT ZERO
02515 1F42 CE006F                  LDX    #ADC0         ;POINT TO WHERE DATA GOES
02516 1F45 4F                      CLR A
02517 1F46 C608                    LDA B  #8
02518 1F48 37          GETONE      PSH B
02519 1F49 36                      PSH A
02520 1F4A BD2035                  JSR    GETDATA       ;GET A/D DATA
02521 1F4D A700                    STA A  0,X
02522 1F4F E701                    STA B  1,X
02523 1F51 08                      INX
02524 1F52 08                      INX
02525 1F53 32                      PUL A
02526 1F54 33                      PUL B
02527 1F55 4C                      INC A
02528 1F56 11                      CBA
02529 1F57 23EF                    BLS    GETONE
02530                    ;
02531                    RTC.MIN   COUNT 60,[ SECONDS ],[ RTC.MIN1 ]
      1F59 960B      +                   LDA A   SECONDS       ;*** GET THE COUNT VARIABLE ***
      1F5B 8B01                          ADD A  #1         ;***      INCREMENT IT       ***
      1F5D 19                            DAA               ;***      MAKE IT  BCD       ***
      1F5E 970B      +                   STA A   SECONDS       ;***   REPLACE THE VARIABLE ***
      1F60 8160      +                   CMP A  #60H     ;***  SEE IF AT RESET VALUE ***
      1F62 2703      +                   BEQ     RTC.MIN1       ;***IF SO THEN SKIP TO NEXT ***
      1F64 7E1FBE                        JMP    NMI.DATA ;***   ELSE END COUNT SEQ.   ***
02532                              ;
02533                              ;      ****   MINUTES TIMING   ****
02534                              ;
02535 1F67 7F000B  RTC.MIN1 CLR    SECONDS       ;WE CYCLED A MINUTE, SO RESET SECONDS
02536 1F6A 96DA                    LDA A  STATCNTR      ;CHECK STATUS TIMER
02537 1F6C 8B99                    ADD A  #99H          ;DEC TIMER
02538 1F6E 19                      DAA
02539 1F6F 97DA                    STA A  STATCNTR
02540 1F71 2608                    BNE    RTC.MINS
02541 1F73 96DB                    LDA A  STATTIME      ;RESET COUNTER
02542 1F75 97DA                    STA A  STATCNTR
```

```
1F77 86FF                  LDA A  #0FFH
1F79 97A9                  STA A  F.STATUS
1F7B 96DC        RTC.MINS  LDA A  CAL.CNTR      ;READ THE CALIBRATION COUNTER
1F7D 8B99                  ADD A  #99H          ;BUMP IT
1F7F 19                    DAA                  ;MAKE IT BCD
1F80 97DC                  STA A  CAL.CNTR      ;REPLACE THE COUNTER
1F82 2608                  BNE    RTC.MIN2      ;IF NOT THEN SKIP
1F84 96DD                  LDA A  CAL.TIME      ;RESET CAL COUNTER
1F86 97DC                  STA A  CAL.CNTR
1F88 8680                  LDA A  #80H          ;AND SET FLAG
1F8A 97A4                  STA A  F.CALTIM      ;TO SAY THAT IT IS TIME TO CALIBRATE
                 RTC.MIN2  COUNT 60,[ MINUTES ],[ RTC.HOUR ]
1F8C 960A    +                       LDA A   MINUTES        ;*** GET THE COUNT VARIABLE ***
1F8E 8B01                            ADD A  #1         ;***      INCREMENT IT       ***
1F90 19                              DAA               ;***      MAKE IT  BCD       ***
1F91 970A    +                       STA A   MINUTES       ;***   REPLACE THE VARIABLE ***
1F93 8160    +                       CMP A  #60H    ;***  SEE IF AT RESET VALUE ***
1F95 2703    +                       BEQ     RTC.HOUR       ;***IF SO THEN SKIP TO NEXT ***
1F97 7E1FBE                          JMP    NMI.DATA ;***   ELSE END COUNT SEQ.   ***
                           ;
                           ;      ****   HOURS TIMING   ****
                           ;
1F9A 7F000A      RTC.HOUR  CLR    MINUTES       ;WE GOT ANOTHER HOUR SO RESET MINUTES
                           COUNT    24,[ HOURS ],[ RTC.DAYL ]
1F9D 9609    +                       LDA A   HOURS         ;*** GET THE COUNT VARIABLE ***
1F9F 8B01                            ADD A  #1         ;***      INCREMENT IT       ***
1FA1 19                              DAA               ;***      MAKE IT  BCD       ***
1FA2 9709    +                       STA A   HOURS        ;***   REPLACE THE VARIABLE ***
1FA4 8124    +                       CMP A  #24H    ;***  SEE IF AT RESET VALUE ***
1FA6 2703    +                       BEQ     RTC.DAYL       ;***IF SO THEN SKIP TO NEXT ***
1FA8 7E1FBE                          JMP    NMI.DATA ;***   ELSE END COUNT SEQ.   ***
                           ;
                           ;      ****   DAYS TIMING   ****
                           ;
1FAB 7F0009      RTC.DAYL  CLR    HOURS
1FAE 9608                  LDA A  DAYS.LO       ;BUMP THE DAY COUNT
1FB0 8B01                  ADD A  #1
1FB2 19                    DAA                  ;MAKE IT BCD
1FB3 9708                  STA A  DAYS.LO       ;REPLACE THE COUNT
1FB5 2407                  BCC    NMI.DATA      ;IF NO RIPPLE OUT THEN GET DATA
1FB7 9607                  LDA A  DAYS.HI       ;IF A RIPPLE THEN BUMP THE HIGH DAY COUNT
1FB9 8B01                  ADD A  #1
1FBB 19                    DAA                  ;MAKE IT BCD
1FBC 9707                  STA A  DAYS.HI

                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                 ;
                 ;        ****   REAL TIME CLOCK DATA COLLECTION   ****
                 ;
                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

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02581
02582 1FBE 96AA       NMI.DATA LDA A  F.COLLECT     ;OK TO TAKE DATA?
02583 1FC0 2A57                BPL    NMI.EX4       ;NO, RETURN
02584 1FC2 96A6                LDA A  F.DATA        ;SEE IF WE SHOULD COLLECT ANY DATA
02585 1FC4 2A53                BPL    NMI.EX4       ;IF NOT THEN EXIT FROM THE ISR
02586                          ;
02587                          ;      ****   SEE IF A NEW DATA BLOCK   ****
02588                          ;
02589 1FC6 96A5       NMI.DAT1 LDA A  F.NUBLOC      ;SEE IF WE HAVE A NEW DATA BLOCK
02590 1FC8 2A38                BPL    NMI.DAT2      ;IF NOT THEN SKIP TO NEXT SECTION
02591 1FCA 7F00A5              CLR    F.NUBLOC      ;RESET THE FLAG (IT WILL SOON NOT BE NEW)
02592 1FCD CE3000              LDX    #DATABUFF     ;SET POINTER TO BEGINNING OF DATA BUFFER
02593                  ;SEND HEADER TO GODDARD
02594 1FD0 8647                LDA A  #"G"
02595 1FD2 BD1E4?              JSR    OUTGSFC
02596 1FD5 8654                LDA A  #"T"
02597 1FD7 BD1E4?              JSR    OUTGSFC
02598 1FDA 9601                LDA A  BLKNUM
02599 1FDC D602                LDA B  BLKNUM+1      ;PUT BLKNUMBER IN BUFFER
02600 1FDE 8D3A                BSR    PUTDATA
02601                          ;
02602 1FE0 9607                LDA A  DAYS.HI       ;PUT THE DATE ON THE TAPE
02603 1FE2 D608                LDA B  DAYS.LO       ;   DATE IS 2 BYTES LONG
02604 1FE4 8D34                BSR    PUTDATA       ;PUT THE DATA INTO THE BUFFER
02605                          ;
02606 1FE6 9606                LDA A  FLIGHT        ;NOW SET THE FLIGHT ONTO THE BUFFER
02607 1FE8 D609                LDA B  HOURS         ;AND THE TIME (MS BYTE FIRST)
02608 1FEA 8D2E                BSR    PUTDATA
02609                          ;
02610 1FEC 960A                LDA A  MINUTES
02611 1FEE D60B                LDA B  SECONDS
02612 1FF0 8D28                BSR    PUTDATA
02613                          ;
02614 1FF2 9603                LDA A  FRAMTYPE      ;GET THE TYPE OF FRAME THAT THIS ONE IS
02615 1FF4 BD1E4?              JSR    OUTGSFC       ;SEND DATA TO SERIAL PORT 1
02616 1FF7 A700                STA A  0,X           ;PUT IT INTO BUFFER
02617 1FF9 08                  INX                  ;NEXT FREE ADDRESS
02618                          ;
02619 1FFA 8604                LDA A  #4            ;READ A/D CHANNELS 4 TO 8
02620 1FFC C608                LDA B  #8
02621 1FFE 8D28                BSR    GETSOME       ;READ THESE DATA CHANNELS AND PUT THEM ON THE BUFFER
02622 2000 DFDE                STX    DATAPNTR      ;SAVE THE VALUE OF BYTE POINTER
02623                          ;
02624                          ;      ****   READ THE NORMAL 4 A/D CHANNELS    ****
02625                          ;
02626 2002 DEDE       NMI.DAT2 LDX    DATAPNTR      ;GET POINTER TO THE NEXT FREE BYTES
02627 2004 4F                  CLR A                ;READ FROM CHANNELS 0 TO 3
02628 2005 C603                LDA B  #3
02629 2007 8D1F                BSR    GETSOME
02630 2009 DFDE                STX    DATAPNTR      ;SAVE THE POINTER
02631 200B 8C3803              CPX    #DATABUFF+803H          ;SEE IF WE HAVE A FULL BUFFER
02632 200E 2609                BNE    NMI.EX4       ;IF NOT THEN EXIT
```

```
02633 2010 7F00A6            CLR    F.DATA       ;IF FULL THEN CLEAR THE DATA COLLECTION FLAG
02634 2013 8680              LDA A  #80H         ;AND SET THE FULL BUFFER FLAG
02635 2015 97A8              STA A  F.FULBLK
02636 2017 97A5              STA A  F.NUBLOC     ;SET NEW BLOCK FLAG
02637 2019 3B        NMI.EX4 RTI                 ;EXIT OUT OF ISR
02638                        ;
02639                        ;      ****   PUTDATA: WRITE TWO BYTES TO BUFFER   ****
02640                        ;
02641 201A A700      PUTDATA STA A 0,X
02642 201C BD1E42            JSR    OUTGSFC      ;SEND DATA TO SERIAL PORT 1
02643 201F E701              STA B 1,X           ;WRITE THE TWO BYTES
02644 2021 17                TBA
02645 2022 BD1E42            JSR    OUTGSFC      ;SEND TO SERIAL PORT 1
02646 2025 08                INX
02647 2026 08                INX
02648 2027 39                RTS
02649                        ;
02650                        ;      ****   GETSOME: READ CHANNELS FROM A/D   ****
02651                        ;
02652 2028 37        GETSOME PSH B               ;SAVE END CHANNEL
02653 2029 36                PSH A               ;AND SAVE THE START CHANNEL
02654 202A 8D09      GETSOME1 BSR   GETDATA      ;GET A SINGLE CHANNEL FROM A/D (CHAN. # IN RA)
02655 202C 8DEC              BSR    PUTDATA      ;WRITE THE DATA TO THE BUFFER
02656 202E 32                PUL A               ;NEXT CHANNEL
02657 202F 33                PUL B
02658 2030 4C                INC A
02659 2031 11                CBA                 ;SEE IF THAT IS ALL OF THE CHANNELS
02660 2032 23F4              BLS    GETSOME      ;LOOP IF NOT
02661 2034 39                RTS
02662                        ;
02663                        ;      ****   GETDATA: READ SINGLE DATA CHANNEL FROM A/D   ****
02664                        ;
02665                        ;
02666                        ;                   ****   12 BIT WORD FROM A/D
02667                        ;                   ****   CHANNEL NUMBER IN RA
02668                        ;                   ****   RESULT IN RA (MS BYTE) AND RB (LS BYTE)
02669                        ;
02670                        ;
02671 2035 48        GETDATA ASL A               ;LEFT JUSTIFY THE CHANNEL NUMBER
02672 2036 48                ASL A
02673 2037 48                ASL A
02674 2038 48                ASL A
02675 2039 B7840.            STA A  PIA1BD       ;WRITE THE CHANNEL NUMBER TO THE PIA
02676 203C 8634              LDA A  #34H         ;SET SSTART CONVERSION (SC) TO 0
02677 203E B78401            STA A  PIA1AC       ;BY SETTING CA1 TO A 0
02678 2041 963C              LDA A  #3CH         ;NOW SET SC TO A 1
02679 2043 B7840.            STA A  PIA1AC       ;BY WRITING TO CA1
02680                        ;
02681 2046 B68401    GETDATA1 LDA A  PIA1AC      ;READ THE PIA CONTROL REGISTER FOR END OF CONVERSION
02682 2049 2AFB              BPL    GETDATA1     ;LOOP UNTIL IT IS SET
02683                        ;
02684 204B B6840.            LDA A  PIA1AD       ;NOW READ THE MS 8 BITS
```

```
204E F68402            LDA B  PIA1BD        ;AND GET THE LS 4 BITS
2051 C40F              AND B  #0FH          ;MASK OFF THE CHANNEL NUMBER
2053 D7E0              STA B  NMI.TMP1      ;SAVE THE LS BITS TEMPORARILY
2055 5F                CLR B                ;SHIFT IN THE BOTTOM 4 BITS FROM A
2056 44                LSR A
2057 56                ROR B
2058 44                LSR A
2059 56                ROR B
205A 44                LSR A
205B 56                ROR B
205C 44                LSR A
205D 56                ROR B
205E DAE0              ORA B  NMI.TMP1      ;OR IN THE PREVIOUS BITS
2060 39                RTS                  ;THATS IT, SO EXIT

                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                 ;
                 ;      ****   IRIGBSET   ****
                 ;
                 ;      ****   READS IN CODED IRIGB TIME   ****
                 ;
                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

2061 B68803      IRIGBSET LDA A  NMI.PIA    ;READ THE PIA CONTROL REGISTER
2064 84C7              AND A  #0C7H         ;PRESERVE CB1,CB2, SET CB2 TO INTERRUPT,HI TO LOW, DISABLED
2066 B78803            STA A  NMI.PIA
                       ;
                       ;    ****   READ THE SECONDS   ****
                       ;
2069 8D27              BSR    IRIGBYT1      ;READ A SHORT DATA BYTE (DO NOT SKIP SPACER PULSE)
206B C47F              AND B  #07FH         ;MASK MSB (WHICH IS THE SPACER BIT)
206D D711              STA B  IRIGSEC       ;SAVE IN THE TEMP REGISTER FOR SECONDS
                       ;
                       ;    ****   READ THE MINUTES   ****
                       ;
206F 8D21              BSR    IRIGBYT1      ;READ A SHORT DATA BYTE (NO PRECEDING SPACER PULSE)
2071 C47F              AND B  #07FH         ;MASK MSB TO REMOVE THE SPACER
2073 D710              STA B  IRIGMIN
                       ;
                       ;    ****   READ THE HOUR   ****
                       ;
2075 8D19              BSR    IRIGBYTE      ;READ A FULL BYTE (THERE IS A SPACER PULSE)
2077 C47F              AND B  #07FH         ;FORCE MSB TO 0
2079 D70F              STA B  IRIGHOUR
                       ;
                       ;    ****   READ THE DAY (LOW BYTE)   ****
                       ;
207B 8D13              BSR    IRIGBYTE
207D D70E              STA B  IRIGDAYL
                       ;
```

```
                                ;      ****   READ THE DAY (HIGH BYTE)    ****
                                ;
207F 8D0F                       BSR    IRIGBYTE
2081 D70D                       STA B  IRIGDAYH
                                ;
                                ;      ****   READ THE FLIGHT NUMBER    ****
                                ;
2083 8D0B                       BSR    IRIGBYTE
2085 D70C                       STA B  IRIGFLT
                                ;
                                ;      ****  RESET THE PIA CONTROL    ****
                                ;
2087 B68803                     LDA A  NMI.PIA       ;LOAD THE PIA CONTROL REGISTER
208A 8A0C                       ORA A  #0CH          ;RE-ENABLE THE INTERRUPTS
208C B78803                     STA A  NMI.PIA
208F 39                         RTS                  ;GO BACK TO NMI ROUTINE

                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                     ;
                     ;         ****   IRIGBYTE    ****
                     ;
                     ;         ****   READ 8 BITS FROM IRIGB INTO B REGISTER  ****
                     ;
                     ;         ****   SKIP THE LEADING SPACER PULSE IF CALLED AT "IRIGBYTE"  ****
                     ;
                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

2090 8D12            IRIGBYTE BSR    IRIGBIT       ;SKIP THE SPACE BIT
2092 CE0009          IRIGBYT1 LDX    #09H          ;USE X AS A BIT COUNTER
2095 8D0D            IRIGBYT2 BSR    IRIGBIT       ;READ THE 1/ST DATA BIT (LSB FIRST)
2097 09                       DEX                  ;COUNT DOWN NUMBER OF BITS
2098 8C0004                   CPX    #04           ;5/TH BIT IS NIBBLE SEPARATOR
209B 27F8                     BEQ    IRIGBYT2      ;IF WE ARE THERE THEN SKIP THAT BIT
209D 56                       ROR B                ;ELSE MOVE CARRY INTO B (CARRY WAS THE DATA BIT)
209E 8C0000                   CPX    #0            ;SEE IF ALL DONE
20A1 26F2                     BNE    IRIGBYT2      ;IF NOT THEN LOOP FOR NEXT BIT
20A3 39                       RTS


                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                     ;
                     ;         ****   IRIGBIT    ****
                     ;
                     ;         ****   READS A DATA BIT FROM CODE (SPACER OR NORMAL)   ****
                     ;         ****   EXITS TO CALLING ROUTINE IF HUNG UP   ****
                     ;
                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                     ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
02789 20A4 7D00D5     IRIGBIT  TST    NMI.F1        ;SEE IF WE ARE HUNG UP
02790 20A7 2A01               BPL    IRIGBIT1      ;IF NOT THEN CONTINUE
02791 20A9 39                 RTS
02792 20AA 7F00D8     IRIGBIT1 CLR    RTC.STAT      ;RESET COUNTER TO SEE IF ARE HUNG (TIMING LOOP)
02793 20AD B68802     IRIGBIT2 LDA A  IRIGB.IN      ;READ THE PIA DATA REGISTER
02794 20B0 44                 LSR A                 ;LOOK AT LSB (THE CLOCK INPUT)
02795 20B1 2507               BCS    IRIGBIT3      ;IF WE HAVE IT THEN GO TO NEXT SECTION
02796 20B3 7D00D8             TST    RTC.STAT      ;ELSE SEE IF WE ARE HUNG (200 MS WAIT)
02797 20B6 2617               BNE    IRIGHUNG      ;IF IT GETS COUNTED UP THEN WE ARE HERE TOO LONG
02798 20B8 20F3               BRA    IRIGBIT2      ;IF NOT SET THEN LOOP AND LOOK FOR CLOCK
02799                         ;
02800 20BA 7F00D8     IRIGBIT3 CLR    RTC.STAT      ;START PROCESS OVER TO FIND FALLING CLOCK
02801 20BD B68802     IRIGBIT4 LDA A  IRIGB.IN      ;READ IN THE PIA AGAIN
02802 20C0 44                 LSR A                 ;LOOK AT CLOCK BIT (LSB)
02803 20C1 2407               BCC    IRIGBIT5      ;IF CLOCK HAS FALLEN THEN GOTO NEXT SECTION
02804 20C3 7D00D8             TST    RTC.STAT      ;ELSE LOOK FOR HANG-UP
02805 20C6 2607               BNE    IRIGHUNG
02806 20C8 20F3               BRA    IRIGBIT4      ;LOOP AND LOOK FOR CLOCK FALLING
02807                         ;
02808 20CA 44         IRIGBIT5 LSR A                 ;WE GOT RISING AND FALLING EDGE, SO GET DATA (BIT 1)
02809 20CB 7C00D8             INC    RTC.STAT      ;MAKE RTC.STAT NONZERO SO THAT RTC ISR WILL NOT THINK WE ARE HUNG
02810 20CE 39                 RTS                  ;EXIT WITH DATA BIT IN THE CARRY BIT
02811                         ;
02812 20CF 8680       IRIGHUNG LDA A  #80H          ;SET THE HUNG FLAG
02813 20D1 7D00D5             STA A  NMI.F1
02814 20D3 39                 RTS
```

```
                        ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                        ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                        ;
                        ;
                        ;        ****   IRQ.ISR    ****
                        ;
                        ;
                        ;                              ****   POLLS FOR THE DEVICE THAT ITERRUPTED VIA IRQ LINE
                        ;                              ****   ERROR MESSAGE SENT IF NO IRQ FOUND (COULD HANG 6800)
                        ;                              ****   WINTEK VECTOR TO IRQ.ISR IS AT 03F7H
                        ;                              ****
                        ;                              ****   DEVICES:  CONSOLE ACIA, DBURROUGHS DISPLAY, APU
                        ;
                        ;
                        ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                        ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

                                 ;
                                 ;      ****   DEFINE SOME SYMBOLS TO MAKE ROUTINE READABLE   ****
                                 ;

           8408         ACIA1.C  EQU    ACIA1C        ;ADDRESS OF CONSOLE ACIA CONTROL REGISTER
           8409         ACIA1.D  EQU    ACIA1D        ;ADDRESS OF CONSOLE ACIA DATA REGISTER
           110D         RECEIVER EQU    INBUFF        ;ADDRESS OF RECEIVED CHARACTER PARSER

                        ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                        ;
                        ;        ****   POLLING SEQUENCE   ****
                        ;
                        ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

      20D4 B68408       IRQ.ISR  LDA A  ACIA1.C       ;CHECK THE CONSOLE PORT
      20D7 2A0D                  BPL    IRQ.ISR1      ;IF NOT ACIA THEN SKIP
                                 ;
                                 ;      ****   ACIA POLLING   ****
                                 ;
      20D9 44                    LSR A                ;TEST IF THE RECEIVER IS ACTIVE
      20DA 2405                  BCC    IRQ.ISR0      ;IF NOT THEN TEST FOR TRANSMITTER
      20DC 36                    PSH A                ;OTHERWISE SAVE ACIA REGISTER
      20DD BD110D                JSR    RECEIVER      ;PROCESS THE RECEIVER CHARACTER
      20E0 32                    PUL A
      20E1 44           IRQ.ISR0 LSR A                ;SHIFT OVER TWICE TO TEST THE TRANSMITTER
      20E2 2402                  BCC    IRQ.ISR1      ;IF NOT THE TRANSMITTER THEN SKIP OUT ( SPURIOUS INTERRUPT )
      20E4 8D09                  BSR    TRANSMIT      ;IF TRANSMITTER THEN PROCESS THE NEXT CHAR
                                 ;
                                 ;     ****   DISPLAY POLLING   ****
                                 ;
      20E6 B68801       IRQ.ISR1 LDA A  PIA3AC        ;SEE IF DISPLAY DATA UPDATE FLAG IS SET
      20E9 2A03                  BPL    IRQ.ISR2      ;IF NOT DISPLAY THEN SKIP OUT
      20EB BD2145                JSR    DISPLAY       ;OTHERWISE PROCESS THE DISPLAY INTERRUPT
      20EE 3B           IRQ.ISR2 RTI
                                 ;
```

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                      ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
                      ;
                      ;         ****   TRANSMIT   ****
                      ;
                      ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20EF 96A7    TRANSMIT LDA A  F.XMIT      ;SEE IF WE ARE TRANSMITING ANY CHARS
20F1 2B06             BMI    XMIT1       ;IF WE ARE THEN SKIP TO HANDLER
20F3 8685             LDA A  #85H        ;IF WE ARENT TRANSMITTING, RESET ACIA NOT TO GET ANY MORE IRQS.
20F5 B78408           STA A  ACIA1.C     ;BY STORING THE ABOVE VALUE INTO THE ACIA CONTROL REG.
20F8 39               RTS                ;AND EXIT
                      ;
20F9 DEE3    XMIT1    LDX    NEXTCHAR    ;GET THE POINTER TO NEXT CHAR
20FB A600             LDA A  0,X         ;NOW GET THE CHAR
20FD B78409           STA A  ACIA1.D     ;WRITE THE CHAR TO THE OUTPUT PORT
2100 9CE7             CPX    BLOCKEND    ;SEE IF WE ARE AT END OF TRANMSIT BUFFER
2102 2704             BEQ    XMIT2       ;IF SO THEN RE-ADJUST THE TRANSMIT BUFFER
2104 08               INX                ;IF NOT THEN MOVE TO NEXT CHAR AND EXIT
2105 DFE3             STX    NEXTCHAR    ;SAVE POINTER
2107 39               RTS
                      ;
                      ;     ****    END OF TRANSMIT BLOCK. MOVE BUFFERED CHARS DOWN   ****
                      ;
2108 8685    XMIT2    LDA A  #85H        ;DISABLE TRANMSIT INTERRUPTS FOR A SECOND
210A B78408           STA A  ACIA1.C
210D 9CE5             CPX    LASTCHAR    ;SEE IF END OF BLOCK IS ALSO END OF BUFFER
210F 2726             BEQ    XMIT4       ;IF SO THEN SKIP THE BYTE TRANSFERS
                      ;
2111 CE015B           LDX    #XMITBUF    ;GET ADDRESS OF XMIT BUFFER
2114 DFE3             STX    NEXTCHAR    ;RESET THE OUTPUT CHAR POINTER
2116 DEE7             LDX    BLOCKEND    ;GET ADDRESS OF 1/ST FREE CHAR
2118 08      XMIT3    INX
2119 DFE7             STX    BLOCKEND    ;REPLACE THE POINTER
211B A600             LDA A  0,X         ;GET THE BYTE
211D DEE3             LDX    NEXTCHAR    ;GET POINTER FOR STORAGE
211F A700             STA A  0,X         ;WRITE THE BYTE
2121 08               INX
2122 DFE3             STX    NEXTCHAR    ;REPLACE THE STORAGE POINTER
2124 DEE7             LDX    BLOCKEND
2126 9CE5             CPX    LASTCHAR    ;SEE IF WE HAVE MOVED THEM ALL
2128 26EE             BNE    XMIT3       ;IF NOT THEN LOOP
                      ;
212A DEE3             LDX    NEXTCHAR    ;GET POINTER TO THE LAST CHAR
212C 09               DEX
212D DFE7             STX    BLOCKEND    ;AND RESET THE OTHER TWO POINTERS
212F DFE5             STX    LASTCHAR
2131 CE015B           LDX    #XMITBUF
2134 DFE3             STX    NEXTCHAR
2136 86A1             LDA A  #0A1H       ;RESET THE ACIA FOR INTERRUPTS
2138 B78408           STA A  ACIA1.C
213B 39               RTS
```

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==== IRQ INTERRUPT SERVICE ROUTINE ====

02921                              ;
02922 213C 7F00A7     XMIT4    CLR     F.XMIT        ;WE SEND A WHOLE BUFFER SO EXIT
02923 213F CE015B              LDX     #XMITBUF      ;RESET THE NEWCHAR POINTER
02924 2142 DFE3                STX     NEXTCHAR
02925 2144 39                  RTS
02926                          ;SEND CHARACTER TO DISPLAY WHEN IT INTERRUPTS
02927                          ;RESET AFTER SENDING 20 CHARACTERS
02928 2145 B68800     DISPLAY  LDA A   8800H         ;CLR FLAG
02929 2148 DED0                LDX     IRQT1      ;TEMP
02930 214A 8C2903              CPX     #DISPLY+20
02931 214D 2709                BEQ     STARTUP
02932 214F A600                LDA A   0,X
02933 2151 B78800              STA A   8800H
02934 2154 08                  INX
02935 2155 DFD0                STX     IRQT1
02936 2157 39                  RTS
02937 2158 CE28EF     STARTUP  LDX     #DISPLY
02938 215B A600                LDA A   0,X
02939 215D B78800              STA A   8800H
02940 2160 08                  INX
02941 2161 DFD0                STX     IRQT1
02942 2163 8635       RESET    LDA A   #35H
02943 2165 B78801              STA A 8801H
02944 2168 863D                LDA A #3DH
02945 216A B78801              STA A   8801H
02946 216D 39                  RTS
02947                          ;
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02950                   ;
02951                   ;   FLOATING POINT SUBROUTINES
02952                   ;
02953                   ;
02954                   ;
02955                   ;       "AVERAGE" SUBROUTINE.
02956                   ;       COMPUTATION OF RUNNING AVERAGE OF 10 SUCCESSFUL SAMPLES FROM ADC
02957                   ;       ENTRY:  X REGISTER POINTS TO 1ST ADDRESS OF SAMPLES BUFFER.
02958                   ;       EXIT:   AVERAGE OF 10 SAMPLES IS LEFT AT TOS IN APU.
02959 216E DF8D       AVG10     STX     SAVEX           ;SAVE DATA POINTER
02960 2170 7F0081               CLR     SAM10AVG        ;INITIALIZE RUNNING TOTAL VARIABLE
02961 2173 7F0082               CLR     SAM10AVG+1
02962 2176 C60A                 LDA B   #10             ;SAMPLE COUNT
02963 2178 37         AVG11     PSH  B
02964 2179 A600                 LDA A   0,X             ;GET THE FIRST SAMPLE
02965 217B E601                 LDA B   1,X
02966 217D DB82                 ADD B   SAM10AVG+1      ;ADD SAMPLE TO RUNNING TOTAL
02967 217F 9981                 ADC A   SAM10AVG
02968 2181 9781                 STA A   SAM10AVG        ;UPDATE RUNNING TOTAL
02969 2183 D782                 STA B   SAM10AVG+1
02970 2185 08                   INX                     ;INCREMENT POINTER TO NEXT SAMPLE
02971 2186 08                   INX
02972 2187 33                   PUL B
02973 2188 5A                   DEC B
02974 2189 26ED                 BNE     AVG11           ;BRANCHES UNTIL ALL TEN SAMPLES WERE COMPUTED
02975 218B CE0081               LDX     #SAM10AVG
02976 218E C602                 LDA B   #02H
02977 2190 BD2393               JSR     PUSH            ;PUTS 12-BIT WORD ONTO TOS IN APU
02978 2193 4F                   CLR A                   ;PUSH 2 ZEROS FOR 32 BIT FIXED FORMAT
02979 2194 B7880C               STA A   APUDATA
02980 2197 B7880C               STA A   APUDATA
02981 219A BD23E2               JSR     FLTD            ;CONVERTS 32-BIT FIXED-PT TO 32-BIT FLT-PT FORMAT
02982 219D CE2428               LDX     #FSADCWD        ;GET 32-BIT VALUE OF 4095
02983 21A0 C604                 LDA B   #04H
02984 21A2 BD2393               JSR     PUSH            ;PUTS 32-BIT FLT-PT NUMBER ONTO TOS IN APU
02985 21A5 BD23D2               JSR     FDIV            ;COMPUTES AVERAGE....(SUMMED SAMPLES)/10.0
02986 21A8 39                   RTS
02987                   ;
02988                   ;       "RADTEMP" SUBROUTINE.
02989                   ;       CONVERSION OF ADC CHANNELS 0-3 TO TEMPERATURE (BCD).
02990                   ;       ENTRY:  FOUR 12-BIT NUMBER = "ADC0" THRU "ADC3" (2 BYTE BLOCKS).
02991                   ;       EXIT:   BCD RESULTS = "CH0TEMP" THRU "CH3TEMP" (5 BYTE BLOCKS).
02992 21A9 CE0012     RADTEMP   LDX     #CH0TEMP
02993 21AC DF8F                 STX     SAVEX1          ;SAVE BCD RESULT POINTER
02994 21AE CE013B               LDX     #CH0GAIN        ;GET POINTER FOR CALIBRATION CONSTANTS
02995 21B1 DF91                 STX     SAVEX2          ;SAVE POINTER FOR CALIBRATION CONSTANTS
02996 21B3 CE006F               LDX     #ADC0
02997 21B6 A600       RADTEMP1  LDA A   0,X             ;GET 12-BIT NUMBER FROM ADC
02998 21B8 E601                 LDA B   1,X
02999 21BA 08                   INX                     ;INCREMENT X REG. TO NEXT 12-BIT NUMBER
03000 21BB 08                   INX
03001 21BC DF93                 STX     SAVEX3          ;SAVE THIS POINTER
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03002 21BE DE91              LDX    SAVEX2
03003 21C0 BD2250            JSR    TEMPBCD      ;CONVERT 12-BIT NUMBER TO TEMPERATURE (BCD)
03004 21C3 DE91              LDX    SAVEX2
03005 21C5 C608              LDA B  #08H
03006 21C7 BD224B            JSR    INCRMNTX     ;INCREMENT POINTER TO NEXT CAL. CONSTANT
03007 21CA DF91              STX    SAVEX2
03008 21CC DE8F              LDX    SAVEX1
03009 21CE C605              LDA B  #05H
03010 21D0 BD224B            JSR    INCRMNTX     ;INCREMENTS POINTER TO NEXT LOC. FOR BCD RESULT
03011 21D3 DF8F              STX    SAVEX1
03012 21D5 DE93              LDX    SAVEX3       ;GET DATA POINTER FOR 12-BIT NUMBER
03013 21D7 8C0077            CPX    #ADC0+8      ;ARE ALL OF THE RADIOMETER CHANNELS SAMPLED
03014 21DA 26DA              BNE    RADTEMP1     ;BRANCH IF UNTIL ALL CHANNELS HAVE BEEN CONVERTED
03015 21DC 39                RTS
03016                        ;
03017                        ;CALCULATE BCD TEMPERATURES FOR RADIOMETER CHANNELS USING
03018                        ;AVERAGE VOLTAGES IN CH0VAVG-CH3VAVG AND PUT RESULT IN
03019                        ;CH0TAVG-CH3TAVG
03020 21DD BD18E1  RADAVG0   JSR    AVERAGE0     ;AVERAGE CH0 SAMPLES
03021 21E0 CE013B            LDX    #CH0GAIN
03022 21E3 BD2266            JSR    VOLTTEMP
03023 21E6 CE005B            LDX    #CH0TAVG
03024 21E9 BD229B            JSR    TOSBCD       ;CONVERT TOS TO BCD
03025 21EC BD18E8  RADAVG1   JSR    AVERAGE1
03026 21EF CE0143            LDX    #CH1GAIN
03027 21F2 BD2266            JSR    VOLTTEMP
03028 21F5 CE0060            LDX    #CH1TAVG
03029 21F8 BD229B            JSR    TOSBCD
03030 21FB BD18EF  RADAVG2   JSR    AVERAGE2
03031 21FE CE014B            LDX    #CH2GAIN
03032 2201 BD2266            JSR    VOLTTEMP
03033 2204 CE0065            LDX    #CH2TAVG
03034 2207 BD229B            JSR    TOSBCD
03035 220A BD18F6  RADAVG3   JSR    AVERAGE3
03036 220D CE0153            LDX    #CH3GAIN
03037 2210 BD2266            JSR    VOLTTEMP
03038 2213 CE006A            LDX    #CH3TAVG
03039 2216 BD229B            JSR    TOSBCD
03040 2219 39                RTS
03041                        ;      "LOADTEMP" SUBROUTINE.
03042                        ;      CONVERSION OF ADC CHANNELS 4-8 TO TEMPERATURE (BCD).
03043                        ;      ENTRY:  FIVE 12-BIT NUMBERS = "ADC4" THRU "ADC8".
03044                        ;      EXIT:   BCD RESULTS = "HTLDTEMP" THRU "SPRETEMP" (5 BYTE BLOCKS)
03045 221A CE0026  LOADTEMP  LDX    #HTLDTEMP
03046 221D DF8F              STX    SAVEX1       ;SAVES RESULT POINTER
03047 221F CE28C7            LDX    #HTLDGAIN
03048 2222 DF91              STX    SAVEX2       ;SAVES CAL CONST. POINTER
03049 2224 CE0077            LDX    #ADC4        ;BEGIN CONVERSION AT CHANNEL 4
03050 2227 A600    ALLTEMP1  LDA A  0,X          ;GET 12-BIT NUMBER INTO ACCA,ACCB
03051 2229 E601              LDA B  1,X
03052 222B 08                INX                 ;INCREMENT POINTER TO NEXT 12-BIT NUMBER
03053 222C 08                INX
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03054 222D DF93                 STX     SAVEX3          ;SAVE INCREMENTED POINTER
03055 222F DE91                 LDX     SAVEX2          ;SET DATA POINTER AT APPROPRIATE CAL CONST
03056 2231 8D1D                 BSR     TEMPBCD         ;CONVERT 12-BIT NUMBER TO TEMPERATURE (BCD)
03057 2233 DE91                 LDX     SAVEX2
03058 2235 C608                 LDA B   #08H
03059 2237 8D12                 BSR     INCRMNTX        ;INCREMENTS X REGISTER 8 TIMES TO NEXT CAL CONST
03060 2239 DF91                 STX     SAVEX2          ;SAVES INCREMENTED POINTER
03061 223B DE8F                 LDX     SAVEX1
03062 223D C605                 LDA B   #05H
03063 223F 8D0A                 BSR     INCRMNTX        ;INCREMENTS X REG 5 TIMES TO NEXT RESULT LOCATION
03064 2241 DF8F                 STX     SAVEX1          ;SAVE INCREMENTED POINTER
03065 2243 DE93                 LDX     SAVEX3
03066 2245 8C0081               CPX     #ADC4+10        ;TESTS TO SEE IF CHANNEL 8 HAS BEEN SAMPLED
03067 2248 26DD                 BNE     ALLTEMP1        ;BRANCH UNTIL CHANNEL 8 HAS BEEN CONVERTED
03068 224A 39                   RTS
03069                   ;
03070                   ;       "INCRMNTX" SUBROUTINE.
03071                   ;       INCREMENTS X REGISTER "B" TIMES.
03072                   ;       ENTRY:  X REGISTER CONTAINS POINTER TO BE INCREMENTED.
03073                   ;               ACCB CONTAINS THE VALUE "B".
03074                   ;       EXIT:   X REGISTER CONTAINS NEW UPDATED VALUE.
03075                   ;               ACCB = ZERO, ACCA DOES NOT CHANGE.
03076 224B 08          INCRMNTX INX                    ;INCREMENTS X REGISTER BY ONE
03077 224C 5A                   DEC B                   ;DECREMENTS INCREMENTAL COUNTER
03078 224D 26FC                 BNE     INCRMNTX        ;BRANCH UNTIL ACCB = 0
03079 224F 39                   RTS
03080                   ;
03081                   ;       "TEMPBCD" SUBROUTINE.
03082                   ;       CONVERSION OF 12-BIT ADC WORD TO TEMPERATURE (BCD).
03083                   ;       ENTRY:  ACCA, ACCB CONTAINS 12-BIT NUMBER.
03084                   ;               X REGISTER POINTS TO CALIBRATION CONSTANTS.
03085                   ;               "SAVEX1" POINTS TO LOCATION OF BCD RESULT.
03086                   ;       EXIT:   BCD RESULT IN LOCATION SPECIFIED BY X REGISTER.
03087                   ;               ACCA, ACCB ARE DESTROYED.
03088 2250 DF8D         TEMPBCD  STX    SAVEX           ;SAVES DATA POINTER
03089 2252 BD22??               JSR     BINVOLTS        ;CONVERTS 12-BIT NUMBER TO 32-BIT VOLTAGE
03090 2255 DE8D                 LDX     SAVEX           ;RESETS POINTER TO CAL. CONSTANTS
03091 2257 8D0D                 BSR     VOLTTEMP        ;CONVERT 32-BIT VOLTAGE TO 32-BIT TEMPERATURE
03092 2259 CE00??               LDX     #FPT32
03093 225C C604                 LDA B   #04H
03094 225E BD23??               JSR     PULL            ;REMOVES 32-BIT NUMBER FROM TOS
03095 2261 DE8F                 LDX     SAVEX1          ;X REG. POINTS TO LOCATION OF RESULT (BCD)
03096 2263 8D57                 BSR     FPTBCD          ;CONVERTS 32-BIT FLT-PT. NUMBER TO 5 BYTE BLOCK
03097 2265 39                   RTS
03098                   ;
03099                   ;       "VOLTTEMP" SUBROUTINE
03100                   ;       CONVERSION OF VOLTAGE TO TEMPERATURE.
03101                   ;       ENTRY:  32-BIT FLOATING-POINT VOLTAGE MUST BE ON APU STACK.
03102                   ;               X REGISTER POINTS TO CALIBRATION CONSTANTS.
03103                   ;       EXIT:   32-BIT FLOATING-POINT TEMPERATURE LEFT AT TOS IN APU.
03104 2266 C604         VOLTTEMP LDA B  #04H
03105 2268 BD23??               JSR     PUSH            ;PUSH 4-BYTE FLOATING-POINT NUMBER ON STACK
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03106 226B BD23CA              JSR    FMUL          ;MULT GAIN BY A/D VOLTS
03107 226E C604                LDA B  #04H
03108 2270 BD2393              JSR    PUSH          ;PUSH 4-BYTE FLOATING-POINT NUMBER ON APU STACK
03109 2273 BD23BA              JSR    FADD          ;( GAIN X VOLTAGE ) + OFFSET
03110 2276 39                  RTS
03111                  ;
03112                  ;     "BINVOLTS" SUBROUTINE
03113                  ;     CONVERSION OF 12-BIT A/D WORD TO A VOLTAGE RANGING FROM 0-10V.
03114                  ;     ENTRY:  ACCA, ACCB CONTAINS 12-BIT NUMBER.
03115                  ;     EXIT:   32-BIT FLT-PT. VOLTAGE LEFT AT TOS IN APU.
03116 2277 37          BINVOLTS PSH B                ;SAVES 12-BIT WORD ON STACK
03117 2278 36                   PSH A
03118 2279 CE2424              LDX    #VOLTS10      ;X REG. POINTS TO FULL SCALE VOLTAGE...10V
03119 227C C604                LDA B  #04H
03120 227E BD2393              JSR    PUSH          ;PUSH 4-BYTE FLOATING-POINT NUMBER ON STACK
03121 2281 30                  TSX                  ;X REG. POINTS TO 12-BIT WORD
03122 2282 C602                LDA B  #02H
03123 2284 BD2393              JSR    PUSH          ;PUSH 2-BYTE FIXED-POINT NUMBER ON SAPU STACK
03124 2287 BD23DA              JSR    FLTS          ;CONVERT FIXED-POINT TO FLOATING-POINT BINARY
03125 228A CE2428              LDX    #FSADCWD      ;X REG. POINTS TO FULL SCALE 12-BIT WORD (4095)
03126 228D C604                LDA B  #04H
03127 228F BD2393              JSR    PUSH          ;PUSH 4-BYTE FLOATING-POINT NUMBER ON APU STACK
03128 2292 BD23D2              JSR    FDIV          ;ADCWORD/4095<1.0
03129 2295 BD23CA              JSR    FMUL          ;(ADCWORD/4095)X10VOLTS
03130 2298 31                  INS
03131 2299 31                  INS                  ;CLEAN UP STACK
03132 229A 39                  RTS
03133                  ;
03134                  ;    TOSBCD
03135                  ;    CONVERT NUMBER ON TOS TO BCD AT X
03136 229B DF8F        TOSBCD  STX    SAVEX1
03137 229D CE009C              LDX    #FPT32
03138 22A0 C604                LDA B  #4
03139 22A2 BD23A7              JSR    PULL
03140 22A5 DE8F                LDX    SAVEX1
03141 22A7 BD22BC              JSR    FPTBCD
03142 22AA 39                  RTS
03143                  ;
03144                  ;     "VOLTSBCD" SUBROUTINE.
03145                  ;     CONVERSION OF 12-BIT ADC WORD TO VOLTAGE (BCD).
03146                  ;     ENTRY:  ACCA, ACCB CONTAINS 12-BIT NUMBER.
03147                  ;             X REGISTER POINTS TO LOCATION OF RESULT.
03148                  ;     EXIT:   BCD RESIULT IN LOCATION SPECIFIED BY X REGISTER.
03149                  ;             ACCA, ACCB ARE DESTROYED.
03150 22AB DF8F        VOLTSBCD STX   SAVEX1        ;SAVES DATA POINTER
03151 22AD 8DC8                BSR    BINVOLTS      ;CONVERTS 12-BIT NUMBER TO 32-BIT VOLTAGE
03152 22AF CE009C              LDX    #FPT32
03153 22B2 C604                LDA B  #04H
03154 22B4 BD23A7              JSR    PULL          ;REMOVES 32-BIT NUMBER FROM TOS
03155 22B7 DE8F                LDX    SAVEX1        ;SETS DATA POINTER
03156 22B9 8D01                BSR    FPTBCD        ;CONVERTS 32-BIT NUMBER TO BCD
03157 22BB 39                  RTS
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03158                    ;
03159                    ;      "FPTBCD" SUBROUTINE
03160                    ;      CONVERSION OF 32-BIT FLOATING-POINT NUMBER TO 32-BIT PACKED BCD.
03161                    ;      ROUTINE ASSUMES 32-BIT FLT-PT. NUMBER = "FPT32".
03162                    ;      ENTRY:  X REGISTER POINTS TO LOCATION OF BCD RESULT.
03163                    ;      EXIT:   BCD RESULT SPECIFIED BY X REGISTER.
03164                    ;              ACCA, ACCB ARE DESTROYED.
03165 22BC DF8F    FPTBCD   STX    SAVEX1        ;SAVES RESULT POINTER
03166 22BE 7F009A            CLR    INTREG        ;INITIALIZE INTEGER REGISTERS
03167 22C1 7F009B            CLR    INTREG+1
03168 22C4 6F00              CLR    0,X           ;INTIALIZE BCD SIGN VALUE
03169 22C6 CE009C            LDX    #FPT32        ;SET POINTER TO 32-BIT NUMBER
03170 22C9 A600              LDA A  0,X           ;GET EXPONENT PART OF 32-BIT NUMBER
03171 22CB 2733              BEQ    FPT7          ;DONT SHIFT IF ZERO EXPONENT
03172 22CD 2A07              BPL    FPT1          ;BRANCHES IF 32-BIT NUMBER IS POSITIVE
03173 22CF DE8F              LDX    SAVEX1        ;IT IS NEG, FIX BCD SIGN BYTE TO BE NEGATIVE
03174 22D1 6A00              DEC    0,X           ;SIGN BYTE IS NEGATIVE
03175 22D3 CE009C            LDX    #FPT32        ;RESETS DATA POINTER
03176 22D6 48        FPT1    ASL A                ;CONVERTS 7-BIT 2S COMP. TO 8-BIT 2S COMP
03177 22D7 47                ASR A
03178 22D8 2A0F              BPL    FPT4          ;BRANCHES TO POS. SHIFTING ROUTINE IF 32-BIT=POS
03179 22DA C609              LDA B  #09H          ;INITIALIZES BIT COUNTER
03180 22DC 6401      FPT2    LSR    1,X           ;MOVES BINARY POINT OVER TO THE LEFT
03181 22DE 5A                DEC B                ;DECREMENTS BIT COUNTER
03182 22DF 2603              BNE    FPT3          ;BRANCHES IF UNDERFLOW DOES NOT OCCUR
03183 22E1 0B                SEV                  ;SETS OVERFLOW BIT TO DENOTE AN ERROR
03184 22E2 2030              BRA    FPT8          ;BRANCHES TO END OF ROUTINE
03185 22E4 4C        FPT3    INC A                ;ADJUSTS THE EXPONENT
03186 22E5 26F5              BNE    FPT2          ;BRANCHES THRU LOOP UNLESS BINARY PT IS ADJUSTED
03187 22E7 2017              BRA    FPT7          ;BRANCHES TO CONVERSION PART OF THIS ROUTINE
03188 22E9 C611      FPT4    LDA B  #11H          ;INITIALIZES BIT COUNTER
03189 22EB 6803      FPT5    ASL    3,X           ;BEGIN POSITIVE SHIFTINE ROUTINE
03190 22ED 6902              ROL    2,X           ;ROTATES 3RD BYTE OF 32-BIT NUMBER
03191 22EF 6901              ROL    1,X           ;ROTATES 2ND BYTE OF 32-BIT NUMBER
03192 22F1 79009B            ROL    INTREG+1      ;ROTATES 32-BIT NUMBER INTO INTEGER REGISTER
03193 22F4 79009A            ROL    INTREG
03194 22F7 5A                DEC B                ;DECREMENTS BIT COUNTER
03195 22F8 2603              BNE    FPT6          ;BRANCHES IF OVERFLOW HAS NOT OCCURED
03196 22FA 0B                SEV                  ;SETS OVERFLOW BIT TO DENOTE AN ERROR
03197 22FB 2017              BRA    FPT8          ;BRANCHES TO END OF ROUTINE
03198 22FD 4A        FPT6    DEC A                ;ADJUSTS THE EXPONENT
03199 22FE 26EB              BNE    FPT5          ;BRANCHES THRU LOOP UNLESSS BINARY PT IS ADJUSTED
03200 2300 A601      FPT7    LDA A  1,X           ;GETS BINARY FRACTION IN ACCA
03201 2302 36                PSH A                ;SAVE A
03202 2303 DE8F              LDX    SAVEX1        ;SETS DATA POINTER
03203 2305 08                INX
03204 2306 969A              LDA A  INTREG        ;RETRIEVES THE BINARY INTEGER
03205 2308 D69B              LDA B  INTREG+1
03206 230A 8D09              BSR    BINBCD        ;CONVERT INTEGER PART
03207 230C DE8F              LDX    SAVEX1        ;SETS DATA POINTER
03208 230E 08                INX
03209 230F 08                INX
```

```
                        INX
                        PUL A
                        BSR    BINFPT       ;CONVERT FRACTIONAL PART
2314 39         FPT8    RTS
                ;
                ;       "BINBCD" SUBROUTINE
                ;       BINARY TO PACKED BCD CONVERSION ROUTINE
                ;       REVISION 1.1
                ;       LOAD ACCA, ACCB WITH A 16-BIT BINARY NUMBER.
                ;       LOAD INDEX REG. WITH ADDRESS OF MS BYTE OF
                ;       WHERE PACKED BCD INFORMATION IS TO BE KEPT.
                ;       ROUTINE RETURNS WITH PACKED BCD IN THE
                ;       SPECIFIED MEMORY LOCATION AND ALSO IN ACCA,
                ;       ACCB.  THE LEAST FOUR MS DECIMAL VALUES
                ;       WILL BE CONTAINED IN THE PACKED BCD NUMBER
2315 DF8D       BINBCD  STX    SAVEX        ;SAVE DATA POINTER
2317 CE241A             LDX    #K10K        ;INITIALIZES X REG. FOR 1ST BCD CONVERSION CONST.
231A 7F0098             CLR    ENTRYA       ;INTIALIZES REG. FOR PACKING SUBROUTINE
231D 7F0099             CLR    ENTRYB
2320 7F0087     CVDEC1  CLR    SAVEA        ;CLEAR BCD CONVERSION COUNTER
2323 E001       CVDEC2  SUB B  1,X
2325 A200               SBC A  0,X
2327 2505               BCS    CVDEC5       ;BRANCH IF SUBTACTION PRODUCES OVERFLOW
2329 7C0087             INC    SAVEA        ;DECIMAL CHARACTER BEING BUILT, INCREMENT SAVEA
232C 20F5               BRA    CVDEC2
232E EB01       CVDEC5  ADD B  1,X
2330 A900               ADC A  0,X          ;RESTORES PARTIAL RESULT UPON OVERFLOW
2332 36                 PSH A               ;SAVES ACCA
2333 9687               LDA A  SAVEA        ;GETS BCD CONVERSION COUNTER
2335 8D13               BSR    PACK         ;PACKS NEWLY FORMED BCD CHARACTER
2337 32                 PUL A               ;RESTORES ACCA TO FORMER VALUE
2338 08                 INX
2339 08                 INX                 ;INCREMENTS INDEX REGISTER TO NEXT CONSTANT
233A 8C2424             CPX    #K10K+10     ;TESTS TO SEE LAST CONSTANT HAS BEEN USED
233D 26E1               BNE    CVDEC1       ;BRANCHES IF LAST CHAR HAS NOT BEEN REACHED YET
233F 9698               LDA A  ENTRYA
2341 D699               LDA B  ENTRYB
2343 DE8D               LDX    SAVEX
2345 A700               STA A  0,X
2347 E701               STA B  1,X          ;SAVES 16-BIT PACKED BCD NUMBER
2349 39                 RTS
                ;
                ;       "PACK" SUBROUTINE
                ;       PACKS BINARY NUMBERS INTO BCD FORM
                ;       ACCA SHOULD CONTAIN THE UNPACKED BCD FORM
                ;       ROUTINE DESTROYS CONTENTS OF ACCA.
234A 780099     PACK    ASL    ENTRYB       ;THEN DOES 1-BIT LEFT SHIFT WITH ZERO FILL
234D 790098             ROL    ENTRYA
2350 780099             ASL    ENTRYB
2353 790098             ROL    ENTRYA
2356 780099             ASL    ENTRYB
2359 790098             ROL    ENTRYA
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03262 235C 780099              ASL     ENTRYB
03263 235F 790098              ROL     ENTRYA          ;SHIFTS 16-BIT BINARY INFORMATION OVER ONE CHAR.
03264 2362 9B99                ADD A   ENTRYB          ;ENTRYB LOOKS LIKE "X0"
03265 2364 9799                STA A   ENTRYB          ;PACKS IN ANOTHER UNPACKED BCD FORM
03266 2366 39                  RTS
03267                  ;
03268                  ;       "BINFPT" SUBROUTINE
03269                  ;       CONVERSION OF FRACTIONAL PART OF BINARY NUMBER TO PACKED BCD.
03270                  ;       LOAD FRACTIONAL PART IN ACCA BEFORE EXECUTION.
03271                  ;       ACCB IS USED IN CALCULATION.
03272                  ;       ROUTINE EXITS WITH BCD ANSWER (4 DECIMAL PLACES) IN ACCA,ACCB.
03273 2367 DF8D       BINFPT  STX     SAVEX           ;SAVES DATA POINTER
03274 2369 9787                STA A   SAVEA           ;SAVE FRACTIONAL PART
03275 236B C608                LDA B   #08H
03276 236D D788                STA B   SAVEB           ;SAVE BIT COUNTER
03277 236F CE240A              LDX     #CONST          ;SET POINTER IN ACCX AT FIRST BYTE OF CONSTANTS
03278 2372 4F                  CLR A                   ;INITIALIZES ACCA,ACCB
03279 2373 5F                  CLR B
03280 2374 9789       BIN1     STA A   TEMPA           ;SAVES ACCA TEMPORARILY
03281 2376 780087              ASL     SAVEA           ;LOOK AT NEXT BIT
03282 2379 240A                BCC     BIN2            ;BRANCHES PAST LOOP IF C=0
03283 237B 17                  TBA                     ;PUT ACCUMULATOR B INTO ACCUMULATOR A
03284 237C AB01                ADD A   1,X             ;C=1, ADD IN CONSTANT
03285 237E 19                  DAA
03286 237F 16                  TAB
03287 2380 9689                LDA A   TEMPA           ;RETRIEVE ACCUMULATOR A FROM TEMPORARY STORAGE
03288 2382 A900                ADC A   0,X
03289 2384 19                  DAA
03290 2385 08         BIN2     INX                     ;INCREMENT ACCX TO NEXT CONSTANT
03291 2386 08                  INX
03292 2387 7A0088              DEC     SAVEB           ;DECREMENT BIT COUNTER
03293 238A 26E8                BNE     BIN1            ;BRANCHES THRU LOOP UNTIL 8 BITS ARE SHIFTED
03294 238C DE8D                LDX     SAVEX           ;RETRIEVE DATA POINTER
03295 238E A700                STA A   0,X             ;SAVES 16-BIT PACKED BCD CHARACTER
03296 2390 E701                STA B   1,X
03297 2392 39                  RTS
03298                  ;
03299                  ;       "PUSH" SUBROUTINE
03300                  ;       MOVES B BYTES OF DATA ONTO APU STACK
03301                  ;       LOAD ACCB WITH NUMBER OF BYTES TO BE PLACED ONTO APU STACK
03302                  ;       LOAD ACCX WITH ADDRESS OF MS BYTE OF DATA TO BE PLACED ONTO STACK.
03303                  ;       ROUTINE WILL PLACE BYTES ON APU STACK IN SUCH A MANNER AS TO HAVE
03304                  ;       THE MS BYTE OF DATA AT TOP OF STACK (TOS).
03305                  ;       ROUTINE EXITS WITH ACCX POINTING AT NEXT B BYTES OF DATA.
03306 2393 37         PUSH     PSH B                   ;SAVES THE NUMBER OF BYTES
03307 2394 08         PUSH1    INX                     ;INCREMENTS ACCX TO POINT AT LAST BYTE OF DATA
03308 2395 5A                  DEC B                   ;DECREMENTS BYTE COUNTER
03309 2396 26FC                BNE     PUSH1           ;BRANCHES THRU AGAIN UNTIL LAST BYTE IS REACHED
03310 2398 DF8B                STX     TEMPX           ;SAVES THE MS ADDRESS OF NEXT DATA TO BE PUSHED
03311 239A 33                  PUL B                   ;RETRIEVES THE NUMBER OF BYTES IN DATA
03312 239B 09         PUSH2    DEX                     ;ACCESS NEXT ADDRESS TO PUT ONTO THE APU STACK
03313 239C A600                LDA A   0,X
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03314 239E B78 0C            STA A  APUDATA      ;ENTER THE CURRENT BYTE OF DATA ONTO THE APU STACK
03315 23A1 5A                DEC B               ;DECREMENTS THE BYTE COUNTER
03316 23A2 26F.              BNE    PUSH2        ;BRANCHES THRU UNTIL LS BYTE OF DATA IS ENTERED
03317 23A4 DE8               LDX    TEMPX        ;RETRIEVES THE ADDRESS OF NEXT BATCH OF DATA
03318 23A6 39                RTS
03319                   ;
03320                   ;     "PULL" SUBROUTINE
03321                   ;     REMOVES B BYTES OF DATA FROM STACK.
03322                   ;     LOAD ACCB WITH NUMBER OF BYTES TO BE REMOVED FROM APU STACK.
03323                   ;     LOAD ACCX WITH ADDRESS OF WHERE TOS IS TO BE PLACED.
03324                   ;     ROUTINE WILL PULL BYTES FROM APU STACK AND PLACE THEM INTO
03325                   ;     MEMORY SPECIFIED BY THE ADDRESS IN ACCX.
03326 23A7 B68 0C      PULL     LDA A  APUDATA
03327 23AA A700              STA A  0,X          ;PLACES REMOVED DATA INTO MEMORY AT ACCX
03328 23AC 08                INX                 ;INCREMENTS ACCX TO NEXT MEMORY LOCATION
03329 23AD 5A                DEC B               ;DECREMENTS BYTE COUNTER
03330 23AE 26F7              BNE    PULL         ;BRANCHES THRU UNTIL B BYTES OF DATA ARE REMOVED
03331 23B0 39                RTS
03332                   ;
03333                   ;     "TSTEND" SUBROUTINE
03334                   ;    LOOPS UNTIL END LFLAG FROM APU GOES LOW (ON PA7 OF PIA2)
03335 23B1 B68 04      TSTEND   LDA A  PIA2AD       ;CHECK END FLAG
03336 23B4 2BF.              BMI    TSTEND       ;LOOP TILL LOW
03337 23B6 B68 0D            LDA A  APUSTAT      ;CLEAR FLAG
03338 23B9 39                RTS
03339                   ;
03340                   ;     "FADD" SUBROUTINE
03341                   ;     ADDS TWO 32-BIT FLOATING POINT NUMBERS (B+A).
03342                   ;     BOTH NUMBERS MUST BE ON APU STACK BEFORE EXECUTION OF COMMAND.
03343                   ;     ROUTINE EXITS WHEN APU IS FINISHED.
03344 23B8 C61.        FADD     LDA B  #10H         ;LOADS IN ADD OPCODE
03345 23BC F7 0D             STA B  APUSTAT      ;ISSUES COMMAND TO APU
03346 23BF 8DF.              BSR    TSTEND       ;WAITS UNTIL APU IS FINISHED
03347 23C1 39                RTS
03348                   ;
03349                   ;     "FSUB" SUBROUTINE
03350                   ;     SUBTRACTS TWO 32-BIT FLOATIONG POINT NUMBERS (B-A).
03351                   ;     BOTH NUMBERS MUST BE ON APU STACK BEFORE EXECUTION OF COMMAND.
03352                   ;     ROUTINE EXITS WHEN APU IS FINISHED.
03353 23C2 C611        FSUB     LDA B  #11H         ;LOADS IN SUBTRACT OPCODE
03354 23C4 F7 D              STA B  APUSTAT      ;ISSUES COMMAND TO APU
03355 23C7 8DE               BSR    TSTEND       ;WAITS UNTIL APU IS FINISHED
03356 23C9 39                RTS
03357                   ;
03358                   ;     "FMUL" SUBROUTINE
03359                   ;     MULTIPLIES TWO 32-BIT FLOATING POINT NUMBERS (A*B).
03360                   ;     BOTH NUMBERS MUST BE ON APU STACK BEFORE EXECUTION OF COMMAND.
03361                   ;     ROUTINE EXITS WHEN APU IS FINISHED.
03362 23CA C61         FMUL     LDA B  #12H         ;LOADS IN MULTIPLY OPCODE
03363 23CC F7 D              STA B  APUSTAT      ;ISSUES MULTIPLY COMMAND TO APU
03364 23CF 8DE               BSR    TSTEND       ;WAITS UNTIL APU IS FINISHED
03365 23D1 39                RTS
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03366                   ;
03367                   ;       "FDIV" SUBROUTINE
03368                   ;       DIVIDES TWO 32-BIT FLOATING POINT NUMBERS (B/A).
03369                   ;       BOTH NUMBERS MUST BE ON APU STACK BEFORE EXECUTION OF COMMAND.
03370                   ;       ROUTINE EXITS WHEN APU IS FINISHED.
03371 23D2 C613       FDIV      LDA B   #13H            ;LOADS IN DIVIDE OPCODE
03372 23D4 F7880D               STA B   APUSTAT         ;ISSUES DIVIDE COMMAND TO APU
03373 23D7 8DD8                 BSR     TSTEND          ;WAITS UNTIL APU IS FINISHED
03374 23D9 39                   RTS
03375                   ;
03376                   ;       "FLTS" SUBROUTINE
03377                   ;       CONVERSION OF 16-BIT FIXED PT # TO A 32-BIT FLOATING PT #
03378                   ;       16-BIT FIXED POINT # MUST BE ON APU STACK BEFORE EXECUTION.
03379                   ;       ROUTINE EXITS WHEN APU IS FINISHED.
03380 23DA C61D       FLTS      LDA B   #1DH            ;LOADS IN FLOAT OPCODE
03381 23DC F7880D               STA B   APUSTAT         ;ISSUES COMMAND TO APU
03382 23DF 8DD0                 BSR     TSTEND          ;WAITS UNTIL APU IS FINISHED
03383 23E1 39                   RTS
03384                   ;
03385                   ;     FLOAT A 32 BIT FIXED POINT NUMBER
03386 23E2 C61C       FLTD      LDA B   #1CH
03387 23E4 F7880D               STA B   APUSTAT
03388 23E7 20C8                 BRA     TSTEND
03389                   ;
03390                   ;       "XCHF" SUBROUTINE
03391                   ;       EXCHANGES 32-BIT STACK OPERANDS (TOS AND NOS)
03392                   ;       BOTH NUMBERS MUST ON APU STACK BEFORE EXECUTION BEGINS.
03393                   ;       ROUTINE EXITS WHEN APU IS FINISHED.
03394 23E9 C619       XCHF      LDA B   #19H            ;LOADS IN EXCHANGE COMMAND
03395 23EB F7880D               STA B   APUSTAT         ;ISSUES COMMAND TO APU
03396 23EE 8DC1                 BSR     TSTEND          ;WAITS UNTIL APU IS FINISHED
03397 23F0 39                   RTS
03398                   ;DUPLICATE TOS AT NOS
03399 23F1 C617       PTOF      LDA B   #17H
03400 23F3 F7880D               STA B   APUSTAT
03401 23F6 20B9                 BRA     TSTEND
03402                   ;
03403                   ;POP NOS INTO TOS
03404 23F8 C618       POPF      LDA B   #18H
03405 23FA F7880D               STA B   APUSTAT
03406 23FD 20B2                 BRA     TSTEND
03407                   ;
03408 23FF CE1108     PATCH     LDX     #RESTART
03409 2402 FF03C3               STX     03C3H           ;PUT IN WINTEK PROG CNTR
03410 2405 31                   INS
03411 2406 31                   INS                     ;FIX STACK
03412 2407 7EFE07               JMP     0FE07H          ;GO TO WINTEK
03413                   ;
03414                   ;       TABLE OF BCD CONSTANTS FOR "BINFPT" SUBROUTINE.
03415 240A 5000       CONST   WORD    5000H   ;BIT=-1
03416 240C 2500                 WORD    2500H   ;BIT=-2
03417 240E 1250                 WORD    1250H   ;BIT=-3
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03418 2410 0625              WORD   0625H   ;BIT=-4
03419 2412 0312              WORD   0312H   ;BIT=-5
03420 2414 0156              WORD   0156H   ;BIT=-6
03421 2416 0078              WORD   0078H   ;BIT=-7
03422 2418 0039              WORD   0039H   ;BIT=-8
03423                ;
03424                ;     TABLE OF DECIMAL CONSTANTS FOR "BINBCD" SUBROUTINE.
03425 241A 2710      K10K    WORD   10000    ;FIFTH DECIMAL CHARACTER
03426 241C 03E8              WORD   1000     ;FORTH DECIMAL CHARACTER
03427 241E 0064              WORD   100      ;THIRD DECIMAL CHARACTER
03428 2420 000A              WORD   10       ;SECOND DECIMAL CHARACTER
03429 2422 0001              WORD   1        ;FIRST DECIMAL CHARACTER
03430 2424 04A0      VOLTS10  WORD    04A0H       ;FULL SCALE A/D VOLTAGE (10.000)
03431 2426 0000               WORD    0000H
03432 2428 0CFF      FSADCWD  WORD    0CFFH       ;FULL SCALL A/D WORD (0FFF)
03433 242A 0000               WORD    0000H
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03436                   ;ASCII MESSAGES FOR CONVAIR SOFTWARE AND COMMAND JUMP TABLE.
03437                   ;
03438                   ;
03439 242C 44524956    MESSNR   ASCII  "DRIVE NOT READY"
03439 2430 45204E4F
03439 2434 54205245
03439 2438 41445900
03440 243B 04                    BYTE  4
03441 243C 20474154    INITMSG  ASCII  " GA. TECH RADIOMETER"
03441 2440 2054454B
03441 2444 48205241
03441 2448 44494F4D
03441 244C 45544552
03442 2450 04                    BYTE  4
03443 2451 52454144    RDYMSG   ASCII  "READY"
03443 2455 59
03444 2456 04                    BYTE  4
03445 2457 494E5641    SYNMSG   ASCII  "INVALID COMMAND"
03445 245B 4C494420
03445 245F 434F4D4D
03445 2463 414E4400
03446 2466 04                    BYTE  4
03447 2467 494C4C45    BKERMSG  ASCII    "ILLEGAL BLOCK NUMBER!"
03447 246B 47414C20
03447 246F 424C4F43
03447 2473 4B204E55
03447 2477 4D424552
03447 247B 21
03448 247C 04                    BYTE    4
03449 247D 494E5641    NUMERR   ASCII    "INVALID NUMBER"
03449 2481 4C494420
03449 2485 4E554D42
03449 2489 4552
03450 248B 04                    BYTE    4
03451 248C 4E4F2E20    BLKSMSG  ASCII    "NO. OF BLOCKS"
03451 2490 4F462042
03451 2494 4C4F434B
03451 2498 53
03452 2499 04                    BYTE    4
03453 249A 43524320    CRCMSG   ASCII  "CRC ERROR AT BLOCK    :"
03453 249E 4552524F
03453 24A2 52204154
03453 24A6 20424C4F
03453 24AA 434B2020
03453 24AE 20203A00
03454 24B1 04                    BYTE  4
03455 24B2 20535441    STRTMSG  ASCII  " STARTING ADDRESS? "
03455 24B6 52544E47
03455 24BA 20414444
03455 24BE 52455353
03455 24C2 533F2000
03456 24C5 04                    BYTE  4
```

ASCII MESSAGES

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03457 24C6 20424[illegible]4F   BLOCKMSG ASCII  " BLOCK NUMBER? "
03457 24CA 434B2[illegible]1E
03457 24CE 554D4[illegible]45
03457 24D2 523F2[illegible]
03458 24D5 04                   BYTE  4
03459 24D6 47414[illegible]4E   GAINMSG  ASCII    "GAIN IN DEG/VOLT "
03459 24DA 20494[illegible]20
03459 24DE 44454[illegible]2F
03459 24E2 564F4[illegible]54
03459 24E6 20
03460 24E7 04                   BYTE    4
03461 24E8 4F464[illegible]53   OFSTMSG  ASCII    "OFFSET IN DEGREES "
03461 24EC 45542[illegible]49
03461 24F0 4E204[illegible]45
03461 24F4 47524[illegible]45
03461 24F8 5320
03462 24FA 04                   BYTE    4
03463 24FB 20545[illegible]41   TRACKMSG ASCII  " TRACK NUMBER? "
03463 24FF 434B2[illegible]4E
03463 2503 554D4[illegible]45
03463 2507 523F2[illegible]
03464 250A 04                   BYTE  4
03465 250B 2A2A2[illegible]44   DELMSG   ASCII  "***DEL***"
03465 250F 454C2[illegible]2A
03465 2513 2A
03466 2514 04                   BYTE  4
03467 2515 0D0A         CRLFSTR  WORD 0D0AH
03468 2517 04                   BYTE    4
03469 2518 54415[illegible]45   FPMSG    ASCII  "TAPE IS WRITE PROTECTED"
03469 251C 20495[illegible]20
03469 2520 57524[illegible]54
03469 2524 45205[illegible]52
03469 2528 4F544[illegible]43
03469 252C 5445[illegible]
03470 252F 04                   BYTE  4
03471 2530 41505[illegible]20   APUERMSG ASCII    "APU ERROR!!!!!"
03471 2534 45525[illegible]4F
03471 2538 52212[illegible]21
03471 253C 2121
03472 253E 04                   BYTE    4
03473                           ;
03474 253F 47412[illegible]20   RADMSG   ASCII  "GA  TECH MILLIMETER RADIOMETER"
03474 2543 54454[illegible]48
03474 2547 204D4[illegible]4C
03474 254B 4C494[illegible]45
03474 254F 54455[illegible]20
03474 2553 52414[illegible]49
03474 2557 4F4D4[illegible]54
03474 255B 4552
03475 255D 04                   BYTE    4
03476 255E 53595[illegible]54   RADMSG1  ASCII    "SYSTEM STATUS"
03476 2562 454D2053
```

ASCII MESSAGES

```
03476 2566 54415455
03476 256A 53
03477 256B 04                    BYTE    4
03478 256C 464C4947   FLTMSG    ASCII    "FLIGHT NO.   "
03478 2570 4854204E
03478 2574 4F2E2020
03479 2578 04                   BYTE    4
03480 2579 44415920   DAYMSG    ASCII    "DAY "
03481 257D 04                    BYTE    4
03482 257E 54494D45   TIMEMSG   ASCII    "TIME "
03482 2582 20
03483 2583 04                    BYTE    4
03484 2584 44415441   DATAMSG   ASCII    "DATA COLLECTION "
03484 2588 20434F4C
03484 258C 4C454354
03484 2590 494F4E20
03485 2594 04                    BYTE   4
03486 2595 4C494E4B   LINKMSG   ASCII    "LINK TO GSFC "
03486 2599 20544F20
03486 259D 47534643
03486 25A1 20
03487 25A2 04                    BYTE    4
03488 25A3 54415045   TAPEMSG   ASCII    "TAPE DRIVE STATUS: "
03488 25A7 20445249
03488 25AB 56452053
03488 25AF 54415455
03488 25B3 533A20
03489 25B6 04                    BYTE    4
03490 25B7 484F5420   HOTMSG    ASCII   "HOT LOAD"
03490 25BB 4C4F4144
03491 25BF 2054454D   TEMPMSG   ASCII    " TEMP "
03491 25C3 5020
03492 25C5 04                    BYTE    4
03493 25C6 434F4C44   COLDMSG   ASCII    "COLD LOAD TEMP "
03493 25CA 204C4F41
03493 25CE 44205445
03493 25D2 4D5020
03494 25D5 04                    BYTE    4
03495 25D6 5245462E   REFMSG    ASCII    "REF. LOAD TEMP "
03495 25DA 204C4F41
03495 25DE 44205445
03495 25E2 4D5020
03496 25E5 04                    BYTE    4
03497 25E6 484F5420   HOTMSG1   ASCII    "HOT LOAD "
03497 25EA 4C4F4144
03497 25EE 20
03498 25EF 04                    BYTE    4
03499 25F0 434F4C44   COLDMSG1  ASCII    "COLD LOAD "
03499 25F4 204C4F41
03499 25F8 4420
03500 25FA 04                    BYTE    4
03501 25FB 4B4C5953   KLYSMSG   ASCII    "KLYSTRON TEMP   "
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ASCII MESSAGES

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03501 25FF 54524F4E
03501 2603 20544548
03501 2607 502020
03502 260A 04                    BYTE    4
03503 260B 43414C2E   CALMSG    ASCII    "CAL. INTERVAL ? "
03503 260F 20494E54
03503 2613 45525641
03503 2617 4C203F20
03504 261B 04                   BYTE    4
03505 261C 52414449   RADMSG2   ASCII     "RADIOMETER IS VIEWING "
03505 2620 4F4D4554
03505 2624 45522049
03505 2628 53205649
03505 262C 4557494E
03505 2630 4720
03506 2632 04                    BYTE    4
03507 2633 534B59     SKYMSG    ASCII     "SKY"
03508 2636 04                    BYTE    4
03509 2637 47524F55   GNDMSG    ASCII     "GROUND"
03509 263B 4E44
03510 263D 04                    BYTE    4
03511 263E 3138332F   MSG183    ASCII     "183/1 GHZ "
03511 2642 31204748
03511 2646 5A20
03512 2648 04                    BYTE    4
03513 2649 3138332F   MSG188    ASCII     "183/5 GHZ "
03513 264D 35204748
03513 2651 5A20
03514 2653 04                    BYTE    4
03515 2654 3138332F   MSG193    ASCII     "183/10 GHZ "
03515 2658 31302047
03515 265C 485A20
03516 265F 04                    BYTE    4
03517 2660 39342047   MSG94     ASCII     "94 GHZ      "
03517 2664 485A2020
03517 2668 202020
03518 266B 04                    BYTE    4
03519 266C 52414449   RADMSG3   ASCII     "RADIOMETER TEMPERATURES"
03519 2670 4F4D4554
03519 2674 45522054
03519 2678 454D5045
03519 267C 52415455
03519 2680 524553
03520 2683 04                    BYTE    4
03521 2684 4F4E       ONMSG     ASCII     "ON"
03522 2686 04                    BYTE    4
03523 2687 4F4646     OFFMSG    ASCII     "OFF"
03524 268A 04                    BYTE    4
03525 268B 43414C49   CALMSG1   ASCII     "CALIBRATION DATA"
03525 268F 42524154
03525 2693 494F4E20
03525 2697 44415441
```

ASCII MESSAGES

```
03526 269B 0D0A                WORD    0D0AH
03527 269D 20202020            ASCII    "          GAIN (DEG/VOLT)    OFFSET (DEG)  "
03527 26A1 20202020
03527 26A5 20204741
03527 26A9 494E2028
03527 26AD 4445472F
03527 26B1 564F4C54
03527 26B5 29202020
03527 26B9 204F4646
03527 26BD 53455420
03527 26C1 28444547
03527 26C5 292020
03528 26C8 04                  BYTE    4
03529                  ;
03530 26C9 54524143    TRKMSG  ASCII    "TRACK "
03530 26CD 4B20
03531 26CF 04                  BYTE    4
03532 26D0 424C4F43    BLKMSG  ASCII    "BLOCK "
03532 26D4 4B20
03533 26D6 04                  BYTE    4
03534 26D7 434F4E56    CONMSG  ASCII    "CONVAIR 990 VER.  2.0"
03534 26DB 41495220
03534 26DF 39393020
03534 26E3 5645522E
03534 26E7 20322E30
03535 26EB 04                  BYTE    4
03536 26EC 21212121    WNGMSG  ASCII    "!!!!TAPE WARNING!!!!"
03536 26F0 54415045
03536 26F4 20574152
03536 26F8 4E494E47
03536 26FC 21212121
03537 2700 04                  BYTE    4
03538 2701 5245464C    RFLERR  ASCII    "REFLECTOR POSITION ERROR!!"
03538 2705 4543544F
03538 2709 5220504F
03538 270D 53495449
03538 2711 4F4E2045
03538 2715 52524F52
03538 2719 2121
03539 271B 04                  BYTE    4
03540 271C 4E455720    NEWMSG  ASCII    "NEW TRACK "
03540 2720 54524143
03540 2724 4B20
03541 2726 04                  BYTE    4
03542                  ;
03543                  ;
03544                  ;
03545                  ;
```

```
03548                    ;
03549                    ;COMMAND TABLE
03550                    ;
03551 2727 4C4F4144      CMDTABLE ASCII  "LOAD"
03552 272B 00                     BYTE  0
03553 272C 11F7                   WORD  LOAD
03554 272E 554E4C4F               ASCII  "UNLOAD"
03554 2732 4144
03555 2734 00                     BYTE  0
03556 2735 123F                   WORD  UNLOAD
03557 2737 53544F50               ASCII  "STOP"
03558 273B 00                     BYTE  0
03559 273C 1216                   WORD  STOP
03560 273E 464F5257               ASCII  "FORWARD"
03560 2742 415244
03561 2745 00                     BYTE  0
03562 2746 121A                   WORD  FORWD
03563 2748 46415354               ASCII  "FASTFOR"
03563 274C 464F52
03564 274F 00                     BYTE  0
03565 2750 121E                   WORD  FFORWD
03566 2752 52455645               ASCII  "REVERSE"
03566 2756 525345
03567 2759 00                     BYTE 0
03568 275A 1222                   WORD  REVERSE
03569 275C 52455749               ASCII  "REWIND"
03569 2760 4E44
03570 2762 00                     BYTE  0
03571 2763 1226                   WORD  REWIND
03572 2765 52454144               ASCII  "READ"
03573 2769 00                     BYTE  0
03574 276A 12D4                   WORD  READ
03575 276C 57524954               ASCII  "WRITE"
03575 2770 45
03576 2771 00                     BYTE  0
03577 2772 1292                   WORD  WRITE
03578 2774 54524143               ASCII    "TRACK"
03578 2778 4B
03579 2779 00                     BYTE    0
03580 277A 1316                   WORD    SEEK
03581 277C 424C4F43               ASCII    "BLOCK"
03581 2780 4B
03582 2781 00                     BYTE    0
03583 2782 133E                   WORD    FBLOCK
03584 2784 44415441               ASCII  "DATA ON"
03584 2788 204F4E
03585 278B 00                     BYTE  0
03586 278C 18FD                   WORD  START
03587 278E 44415441               ASCII  "DATA OFF"
03587 2792 204F4646
03588 2796 00                     BYTE 0
03589 2797 1918                   WORD  HALT
```

COMMAND JUMP TABLE

```
03590 2799 4F5554              ASCII    "OUT"
03591 279C 00                  BYTE     0
03592 279D 1A25                WORD     OUTSIDE
03593 279F 484F54              ASCII    "HOT"
03594 27A2 00                  BYTE     0
03595 27A3 1A6F                WORD     HOT
03596 27A5 434F4C44            ASCII    "COLD"
03597 27A9 00                  BYTE     0
03598 27AA 1A5A                WORD     COLD
03599 27AC 43414C49            ASCII    "CALIBRATE"
03599 27B0 42524154
03599 27B4 45
03600 27B5 00                  BYTE     0
03601 27B6 172A                WORD     CALIBRTE
03602 27B8 53544154            ASCII    "STATUS"
03602 27BC 5553
03603 27BE 00                  BYTE     0
03604 27BF 1D60                WORD     STATUS
03605 27C1 53455420            ASCII    "SET CAL"
03605 27C5 43414C
03606 27C8 00                  BYTE     0
03607 27C9 192B                WORD     SETCAL
03608 27CB 5052494E            ASCII    "PRINT CAL"
03608 27CF 54204341
03608 27D3 4C
03609 27D4 00                  BYTE     0
03610 27D5 1778                WORD     PRINTCAL
03611 27D7 44495350            ASCII    "DISP HOT"
03611 27DB 20484F54
03612 27DF 00                  BYTE     0
03613 27E0 1AD3                WORD     SETHOT
03614 27E2 44495350            ASCII    "DISP COLD"
03614 27E6 20434F4C
03614 27EA 44
03615 27EB 00                  BYTE     0
03616 27EC 1ACE                WORD     SETCOLD
03617 27EE 44495350            ASCII    "DISP REF"
03617 27F2 20524546
03618 27F6 00                  BYTE     0
03619 27F7 1AD8                WORD     SETREF
03620 27F9 44495350            ASCII    "DISP KLYS"
03620 27FD 204B4C59
03620 2801 53
03621 2802 00                  BYTE     0
03622 2803 1ADD                WORD     SETKLYS
03623 2805 44495350            ASCII    "DISP 183"
03623 2809 20313833
03624 280D 00                  BYTE     0
03625 280E 1AE2                WORD     SET183
03626 2810 44495350            ASCII    "DISP 94"
03626 2814 203934
03627 2817 00                  BYTE     0
```

COMMAND JUMP TABLE

```
03628 2818 1AE7              WORD    SET94
03629 281A 41564720          ASCII    "AVG 183"
03629 281E 313833
03630 2821 00                BYTE    0
03631 2822 1AEC              WORD    SET183A
03632 2824 41564720          ASCII    "AVG 94"
03632 2828 3934
03633 282A 00                BYTE    0
03634 282B 1AF1              WORD    SET94A
03635 282D 5052494E          ASCII    "PRINT VOLTS"
03635 2831 5420564F
03635 2835 4C5453
03636 2838 00                BYTE    0
03637 2839 196A              WORD    PRINVOLT
03638 283B 54494D45          ASCII    "TIME"
03639 283F 00                BYTE    0
03640 2840 1AF6              WORD    DISTIME
03641 2842 53455420          ASCII    "SET TIME"
03641 2846 54494D45
03642 284A 00                BYTE    0
03643 284B 1992              WORD    SETTIME
03644 284D 56494557          ASCII    "VIEW"
03645 2851 00                BYTE    0
03646 2852 1A89              WORD    VIEW
03647 2854 494E4954          ASCII    "INIT"
03648 2858 00                BYTE    0
03649 2859 1AC9              WORD    INIT
03650 285B 54415045          ASCII    "TAPE"
03651 285F 00                BYTE    0
03652 2860 1C2B              WORD    TAPE
03653 2862 5052494E          ASCII   "PRINT L"
03653 2866 54204C
03654 2869 00                BYTE    0
03655 286A 1C4F              WORD    TEMPL
03656 286C 5052494E          ASCII    "PRINT R"
03656 2870 542052
03657 2873 00                BYTE    0
03658 2874 1CA7              WORD    TEMPR
03659 2876 57484552          ASCII    "WHERE"
03659 287A 45
03660 287B 00                BYTE    0
03661 287C 1CFF              WORD    WHERE
03662 287E 54455354          ASCII    "TEST1"
03662 2882 31
03663 2883 00                BYTE    0
03664 2884 1AFB              WORD    TEST1
03665 2886 54455354          ASCII    "TEST2"
03665 288A 32
03666 288B 00                BYTE    0
03667 288C 1B00              WORD    TEST2
03668 288E 54455354          ASCII    "TEST3"
03668 2892 33
```

```
03669 2893 00                   BYTE    0
03670 2894 1805                 WORD    TEST3
03671 2896 53455420             ASCII    "SET HEX"
03671 289A 484558
03672 289D 00                   BYTE    0
03673 289E 1950                 WORD    SETHEX
03674 28A0 50415443             ASCII    "PATCH"
03674 28A4 48
03675 28A5 00                   BYTE    0
03676 28A6 23FF                 WORD    PATCH
03677 28A8 00                   BYTE  0
03678 28A9 001E                 BLOCK    30          ;SPACE FOR MORE COMMANDS
03679                   ;THERMISTOR CALIBRATION CONSTANTS FOR LOAD TEMPERATURES
03680                   ;
03681 28C7 84A0         HTLDGAIN WORD    84A0H       ;AMP GAIN=-10 DEG/VOLT
03682 28C9 0000                 WORD    0000H
03683 28CB 09BA         HTLDOFST WORD    09BAH       ;OFFSET IS 373 DEGREES
03684 28CD 8000                 WORD    8000H
03685 28CF 84A0         COLDGAIN WORD    84A0H       ;COLD GAIN =-10 DEG/VOLT
03686 28D1 0000                 WORD    0000H
03687 28D3 09A1         COLDOFST WORD    09A1H       ;OFFSET = 323 DEGREES
03688 28D5 8000                 WORD    8000H
03689 28D7 84A0         RELDGAIN WORD    84A0H       ;REF LOAD GAIN =-10 DEG/VOLT
03690 28D9 0000                 WORD    0000H
03691 28DB 09BA         RELDOFST WORD    09BAH       ;REF OFFSET =373 DEGREES
03692 28DD 8000                 WORD    8000H
03693 28DF 84A0         KLYSGAIN WORD    84A0H       ;KYSTRON GAIN =-10 DEG/VOLT
03694 28E1 0000                 WORD    0000H
03695 28E3 09BA         KLYOFST  WORD    09BAH       ;KLYSTRON OFFSET=373 DEGREES
03696 28E5 8000                 WORD    8000H
03697 28E7 84A0         SPREGAIN WORD    84A0H       ;SPARE CHANNEL GAIN =-10 DEG/VOLT
03698 28E9 0000                 WORD    0000H
03699 28EB 09BA         SPREOFST WORD    09BAH
03700 28ED 8000                 WORD    8000H
03701                   ;
03702                   ;
03703 28EF 0014         DISPLY   BLOCK  20          ;PLASMA DISPLAY BUFFER
03704 2903 0014         CBUFFER  BLOCK  20          ;CHARACTER INPUT BUFFER FROM CONSOLE DEVICE
03705                   ;
03706      3000                 ORG    3000H
03707                   ;
03708                   ;
03709                   ;DATA COLLECTION INPUT BUFFER STARTS HERE
03710 3000 0800         DATABUFF BLOCK  2048        ;2048 BYTE BUFFER FOR DATA COLLECTION
03711
```

Strings and Macros

COUNT -- 01E4 M

Scalars

ACIA1.C 8408	ACIA1.D 8409	ACIA1C - 8408	ACIA1D - 8409	ACIA2C - 8808
ACIA2D - 8809	APUDATA 880C	APUSTAT 880D	CRCPH -- 0080	CRCPL -- 0041
FFOWCODE 000A	FORCODE 0008	IRIGB.IN 8802	IRQV --- 03F7	LOADCODE 0004
NMI.PIA 8803	NMIV --- 03FD	PIA1AC - 8401	PIA1AD - 8400	PIA1BC - 8403
PIA1BD - 8402	PIA2AC - 8405	PIA2AD - 8404	PIA2BC - 8407	PIA2BD - 8406
PIA3AC - 8801	PIA3AD - 8800	PIA3BC - 8803	PIA3BD - 8802	REVCODE 000C
REWCODE 000E	SSDAC -- 8804	SSDAD -- 8805	STOPCODE 0006	

CONVAIR Section Absolute (3800)

ADC0 --- 006F	ADC1 --- 0071	ADC2 --- 0073	ADC3 --- 0075	ADC4 --- 0077
ADC5 --- 0079	ADC6 --- 007B	ADC7 --- 007D	ADC8 --- 007F	ALLTEMP1 2227
APUERRMSG 2530	APUSTS - 0097	AVERAGE 18B8	AVERAGE0 18E1	AVERAGE1 18E8
AVERAGE2 18EF	AVERAGE3 18F6	AVG10 -- 216E	AVG11 -- 2178	AVGBUFF 00EB
AVGPTR - 00E9	BIN1 --- 2374	BIN2 --- 2385	BINBCD - 2315	BINFPT - 2367
BINVOLTS 2277	BKERMSG 2467	BLKCNT - 00CD	BLKMSG - 26D0	BLKNUM - 0001
BLKSMSG 248C	BLOCK1 - 1359	BLOCK11 135E	BLOCK2 - 1366	BLOCKEND 00E7
BLOCKMSG 24C6	BLOCKS - 00C0	BTEMP -- 00BC	BUFFNT - 00B8	BYCOUNT 00AC
CAL.CNTR 00DC	CAL.TIME 00DD	CAL0 --- 173D	CAL1 --- 174B	CAL2 --- 1759
CAL3 --- 1767	CALCGAIN 182C	CALIBRTE 172A	CALMSG - 260B	CALMSG1 268B
CBUFF -- 00BE	CBUFFER 2903	CDTEMP32 0043	CH0GAIN 013B	CH0OFST 013F
CH0TAVG 005B	CH0TEMP 0012	CH0VAVG 004B	CH1GAIN 0143	CH1OFST 0147
CH1TAVG 0060	CH1TEMP 0017	CH1VAVG 004F	CH2GAIN 014B	CH2OFST 014F
CH2TAVG 0065	CH2TEMP 001C	CH2VAVG 0053	CH3GAIN 0153	CH3OFST 0157
CH3TAVG 006A	CH3TEMP 0021	CH3VAVG 0057	CHANGE - 159E	CHAR.INS 1E0A
CHARINS1 1E1B	CHARINS2 1E1E	CHARINS3 1E2B	CKEW --- 16EE	CKFP --- 1265
CKFP1 -- 1272	CKLOAD - 125F	CKRDY -- 124A	CKRDY1 - 1256	CKRDY2 - 125E
CLRDISP 15AE	CLRDISP1 15B5	CLTCHOFF 1A39	CLTCHON 1A42	CMDTABLE 2727
COLD --- 1A5A	COLD1 -- 1A62	COLD2 -- 1A6A	COLDGAIN 28CF	COLDMSG 25C6
COLDMSG1 25F0	COLDOFST 28D3	COLDTEMP 002B	CONMSG - 26D7	CONST -- 240A
CRC ---- 156A	CRC1 --- 1570	CRC2 --- 1577	CRCC --- 158A	CRCC1 -- 158E
CRCC2 -- 159C	CRCH --- 00B6	CRCL --- 00B7	CRCMSG - 249A	CRLF --- 1A18
CRLFSTR 2515	CTSCNTR 00C9	CVDEC1 - 2320	CVDEC2 - 2323	CVDEC5 - 232E
DATABUFF 3000	DATAMSG 2584	DATAPNTR 00DE	DAYMSG - 2579	DAYS.HI 0007
DAYS.LO 0008	DECBLK - 1412	DECERR - 119B	DECODE - 1155	DECODE1 115B
DECODE11 1164	DECODE2 116B	DECODE21 1178	DECODE3 1181	DECODE4 1194
DECODE5 11A1	DELMSG - 250B	DIFHC -- 1874	DISP183 1B42	DISP183A 1B81
DISP2 -- 15EB	DISP94 - 1B63	DISP94A 1BA2	DISPADR 00C5	DISPCH1 1600
DISPCHAR 15F1	DISPCOLD 1B0E	DISPH1 - 1614	DISPH2 - 161A	DISPHEX 1605
DISPHL - 160C	DISPHOT 1B1B	DISPHR - 1612	DISPKEYS 1B28	DISPLAY 2145
DISPLY - 28EF	DISPNEXT 15DC	DISPREF 1B35	DISPSPC 15EC	DISPSTNG 15D3
DISPTEMP 15BE	DISTIME 1AF6	ENTRYA - 0098	ENTRYB - 0099	F.5MIN - 00A2
F.BADTIM 00A3	F.CALTIM 00A4	F.CMND - 00A0	F.COLLEC 00AA	F.DATA - 00A6
F.FULBLK 00A8	F.GSFC - 00AB	F.NUBLOC 00A5	F.NUMBR 00A1	F.STATUS 00A9
F.XMIT - 00A7	FADD --- 23BA	FAST --- 13FA	FBLOCK - 133E	FCNT --- 00CB
FDIV --- 23D2	FFORWD - 121E	FILBUF1 1F2B	FILLBUFF 1EFC	FLIGHT - 0006

```
FLTD --- 23E2    FLTMSG - 256C    FLTS --- 23DA    FMUL --- 23CA    FORWD -- 121A
FPMSG -- 2518    FPT1 --- 22D6    FPT2 --- 22DC    FPT3 --- 22E4    FPT32 -- 009C
FPT4 --- 22E9    FPT5 --- 22EB    FPT6 --- 22FD    FPT7 --- 2300    FPT8 --- 2314
FPTBCD - 22BC    FRAMTYPE 0003    FSADCWD  2428    FSUB --- 23C2    FTYPE -- 171A.
GAINMSG  24D6    GETDATA  2035    GETDATA1 2046    GETONE - 1F48    GETSOME  2028
GETSOME1 202A    GNDMSG - 2637    GOFOR -- 140E    GOFORWD  1402    GSFCOK - 1A02
GSFCOK1  1A17    GSFCTO - 00CF    HALT --- 1918    HEXPTR - 00C7    HOT ---- 1A6F
HOT1 --- 1A7E    HOT2 --- 1A84    HOTMSG - 25B7    HOTMSG1  25E6    HOURS -- 0009
HTCD32 - 0047    HTLDGAIN 28C7    HTLDOFST 28CB    HTLDTEMP 0026    HTTEMP32 003F
IN2BYTE2 11F3    IN2BYTE3 11F4    IN2BYTES 11DB    INBUFF - 110D    INBUFF1  112E
INBUFF2  113E    INBUFF3  1148    INBUFF4  114F    INBUFF5  1152    INBUFF6  1154
INBYTE - 11A5    INBYTE1  11A8    INBYTE2  11C3    INBYTE3  11C4    INCBLK - 14DA
INCRMNTX 224B    INIT --- 1AC9    INIT1 -- 1000    INIT11 - 1008    INIT2 -- 105E
INIT3 -- 1073    INIT31 - 1087    INIT4 -- 109B    INIT5 -- 10B8    INIT6 -- 10C2
INIT7 -- 10CC    INITMS - 1C0B    INITMSG  243C    INTREG - 009A    IRIG. BAD 1EDF
IRIG. UPD 1EC6   IRIGB. 1 1E8D    IRIGB. 2 1E98    IRIGB. 3 1E9D    IRIGB. 4 1EA1
IRIGB. 5 1EA9    IRIGBIT  20A4    IRIGBIT1 20AA    IRIGBIT2 20AD    IRIGBIT3 20BA
IRIGBIT4 20BD    IRIGBIT5 20CA    IRIGBSET 2061    IRIGBYT1 2092    IRIGBYT2 2095
IRIGBYTE 2090    IRIGDAYH 000D    IRIGDAYL 000E    IRIGFLT  000C    IRIGHOUR 000F
IRIGHUNG 20CF    IRIGMIN  0010    IRIGSEC  0011    IRQ. ISR 20D4    IRQ. ISR0 20E1
IRQ. ISR1 20E6   IRQ. ISR2 20EE   IRQT1 -- 00D0    IRQT2 -- 00D2    K10K --- 241A
KLYOFST  28E3    KLYSGAIN 28DF    KLYSMSG  25FB    KLYSTEMP 0035    LASTCHAR 00E5
LFEED -- 1A1F    LINKMSG  2595    LOAD --- 11F7    LOAD1 -- 120A    LOAD2 -- 1215
LOADTEMP 221A    MAIN1 -- 168B    MAIN2 -- 1698    MAINLOOP 1683    MESSNR - 242C
MINUTES  000A    MSCNTR - 00D9    MSDLY -- 1666    MSDLY1 - 1668    MSG183 - 263E
MSG188 - 2649    MSG193 - 2654    MSG94 -- 2660    NEWCHAR  00E1    NEWMSG - 271C
NEXSTATE 00C1    NEXTCH - 1633    NEXTCHAR 00E3    NEXTDISP 00C3    NMI. DAT1 1FC6
NMI. DAT2 2002   NMI. DATA 1FBE   NMI. EX0  1E8C    NMI. EX1 1EC5    NMI. EX2  1EDE
NMI. EX3  1EE3   NMI. EX4  2019   NMI. F0 - 00D4    NMI. F1 - 00D5   NMI. IRIG 1E81
NMI. ISR  1E77   NMI. RTC  1EE4   NMI. TMP1 00E0    NOCAL -- 16DF    NOCHANGE 15AA
NOCMND - 16B4    NONUMBR  16AF    NOTCOLD  1A9F    NOTEW -- 170D    NOTFULL  16D5
NOTHEX - 11D9    NOTHOT - 1AAB    NOTONN - 1C04    NUMERR - 247D    OFFMSG - 2687
OFSTMSG  24E8    ONMSG -- 2684    OUT10SPC 1DB4    OUT1HEX  1DCB    OUT2HEX  1DC9
OUT2SPC  1DBC    OUT6SPC  1DB8    OUTCH -- 1DED    OUTGS1 - 1E43    OUTGS2 - 1E59
OUTGS3 - 1E72    OUTGS4 - 1E75    OUTGSFC  1E42    OUTHEX - 1DD4    OUTHEXL  1DDB
OUTHEXR  1DE1    OUTPOS - 1D4B    OUTQUES  19E5    OUTSIDE  1A25    OUTSPACE 1DCD
OUTSPC - 1DC0    OUTTEMP  1D42    PACK --- 234A    PATCH -- 23FF    POFF --- 23F8
POSOK -- 1A2E    PRINT32  1813    PRINTCAL 1778    PRINTV1  1970    PRINVOLT 196A
PRT1 --- 1DB0    PRTOFF - 1DAD    PRTON -- 1DA8    PTOF --- 23F1    PULL --- 23A7
PULSE -- 1A4B    PUSH --- 2393    PUSH1 -- 2394    PUSH2 -- 239B    PUTDATA  201A
PUTHEX - 1644    PUTHEX1  165C    RADAVG0  21DD    RADAVG1  21EC    RADAVG2  21FB
RADAVG3  220A    RADMSG - 253F    RADMSG1  255E    RADMSG2  261C    RADMSG3  266C
RADTEMP  21A9    RADTEMP1 21B6    RDBYTE - 1560    RDYMSG - 2451    READ --- 12D4
READ1 -- 12E4    READ2 -- 12F1    READ22 - 12F3    READ3 -- 1303    READ4 -- 1310
READ5 -- 1315    RECEIVER 110D    REFMSG - 25D6    RELDGAIN 28D7    RELDOFST 28DB
RELDTEMP 0030    RESET -- 2163    RESTART  1108    REVERSE  1222    REWIND - 1226
RFLERR - 2701    RFLPOS - 0005    RTC. CNTR 00D7   RTC. DAYL 1FAB    RTC. HOUR 1F9A
RTC. MIN  1F59   RTC. MIN1 1F67   RTC. MIN2 1F8C   RTC. MINS 1F7B   RTC. SEC  1F3B
RTC. SEC1 1EF8   RTC. SEC2 1F2D   RTC. STAT 00D8   SAM10AVG 0081   SAVEA -- 0087
SAVEB -- 0088    SAVEX -- 008D    SAVEX1 - 008F    SAVEX2 - 0091    SAVEX3 - 0093
SAVEX4 - 0095    SECDLY - 166F    SECONDS  000B    SEEK --- 1316    SEEK1 -- 1329
SEEK11 - 132E    SEEK2 -- 1336    SEEKS -- 133D    SET183 - 1AE2    SET183A  1AEC
SET94 -- 1AE7    SET94A - 1AF1    SETADR - 1B08    SETCAL - 192B    SETCAL1  193B
```

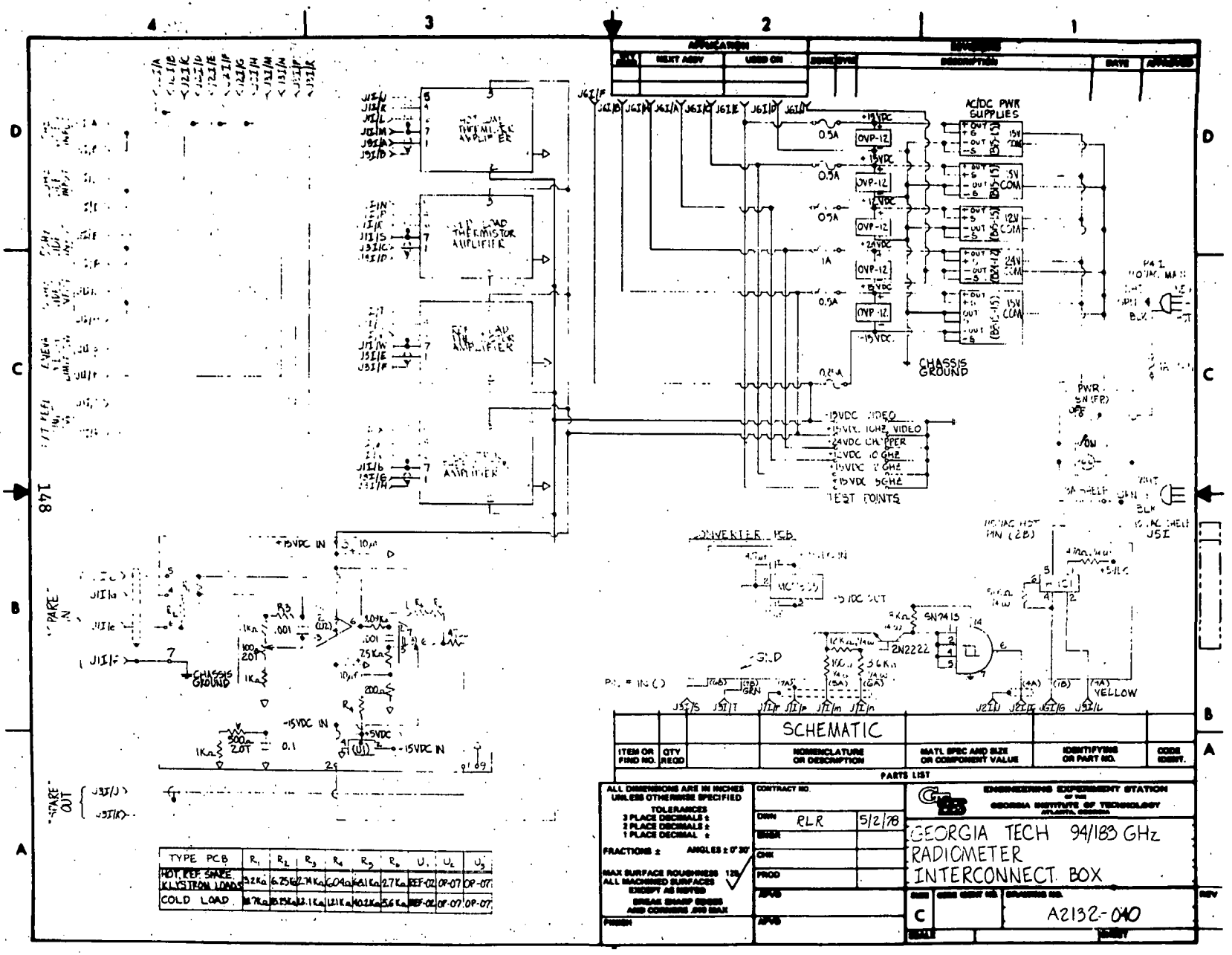
```
SETCAL11 1940   SETCAL2  1948   SETCAL3  194F   SETCOLD  1ACE   SETHEX - 1950
SETHEX1  1962   SETHOT - 1AD3   SETKEYS  1ADD   SETREF - 1AD8   SETT1 -- 19A5
SETT2 -- 19AC   SETT22 - 19BE   SETT3 -- 19C5   SETT33 - 19D7   SETT4 -- 19E4
SETTIME  1992   SKIP1 -- 1385   SKIP1B - 139D   SKIPF -- 13A0   SKIPF1 - 13B9
SKIPG -- 13BE   SKIPG1 - 13C9   SKIPNEG  1378   SKIPPOS  1381   SKIPS -- 13CE
SKIPS1 - 13E5   SKIPS11  13DA   SKIPS2 - 13EB   SKIPS3 - 13F9   SKIPSGN  00CC
SKIPSPL  13D7   SKYMSG - 2633   SLOW --- 1406   SPREGAIN 28E7   SPREOFST 28EB
SPRETEMP 003A   START -- 18FD   STARTUP  2158   STATCNTR 00DA   STATTIME 00DB
STATUS - 1D60   STATUS1  1D83   STATUS2  1D85   STATUS3  1D96   STATUS4  1D98
STOP --- 1216   STRNGNOC 1DFF   STRNGOUT 1DF4   STRTMSG  24B2   SYNMSG - 2457
TABPNT - 008A   TAPE --- 1C2B   TAPE1 -- 1C31   TAPEDONE 170E   TAPEMSG  25A3
TAPEWARN 1C12   TCMND -- 1230   TCNT --- 00CA   TEMP32 - 0083   TEMPA -- 0089
TEMPB -- 008A   TEMPBCD  2250   TEMPL -- 1C4F   TEMPMSG  25BF   TEMPR -- 1CA7
TEMPX -- 008B   TEST1 -- 1AFB   TEST2 -- 1B00   TEST3 -- 1B05   TESTAD - 162A
TESTADL  1625   TESTADR  161E   TESTOSFC 19EA   TESTHEX  11C5   TESTIME  1BC0
THB ---- 1DD1   THB1 --- 1DE3   THB2 --- 1DE9   TIME --- 1D1F   TIMEMSG  257E
TOSBCD - 229B   TRACK -- 1273   TRACK2 - 128A   TRACK3 - 1291   TRACKMSG 24FB
TRACKN - 0000   TRANSMIT 20EF   TREAD -- 14E4   TREAD1 - 150C   TREAD11  14E6
TREAD12  1502   TREAD2 - 151B   TREAD3 - 152D   TREAD4 - 154A   TREAD45  1553
TREAD5 - 155F   TRKMSG - 26C9   TSTEND - 23B1   TWRITE - 141C   TWRITE1  1453
TWRITE2  1478   TWRITE3  148A   TWRITE4  1499   TWRITE5  14B4   TWRITE6  14C9
TWRITES  1424   UNLOAD - 123F   VIEW --- 1A89   VIEW1 -- 1AB3   VIEW2 -- 1AC2
VIEW3 -- 1AC8   VOLTS10  2424   VOLTSBCD 22AB   VOLTTEMP 2266   WHERE -- 1CFF
WNGMSG - 26EC   WRITE -- 1292   WRITE1 - 12A2   WRITE2 - 12AF   WRITE22  12B1
WRITE3 - 12C1   WRITE4 - 12CE   WRITE5 - 12D3   WRTBYT - 14CF   XCHF --- 23E9
XMIT1 -- 20F9   XMIT2 -- 2108   XMIT3 -- 2118   XMIT4 -- 213C   XMITBUF  015B
XTEMP1 - 00AE   XTEMP2 - 00B0   XTEMP3 - 00B2   XTEMP4 - 00B4   YESHEX - 11D7
```

3711 Source Lines 3743 Assembled Lines 5782 Bytes available

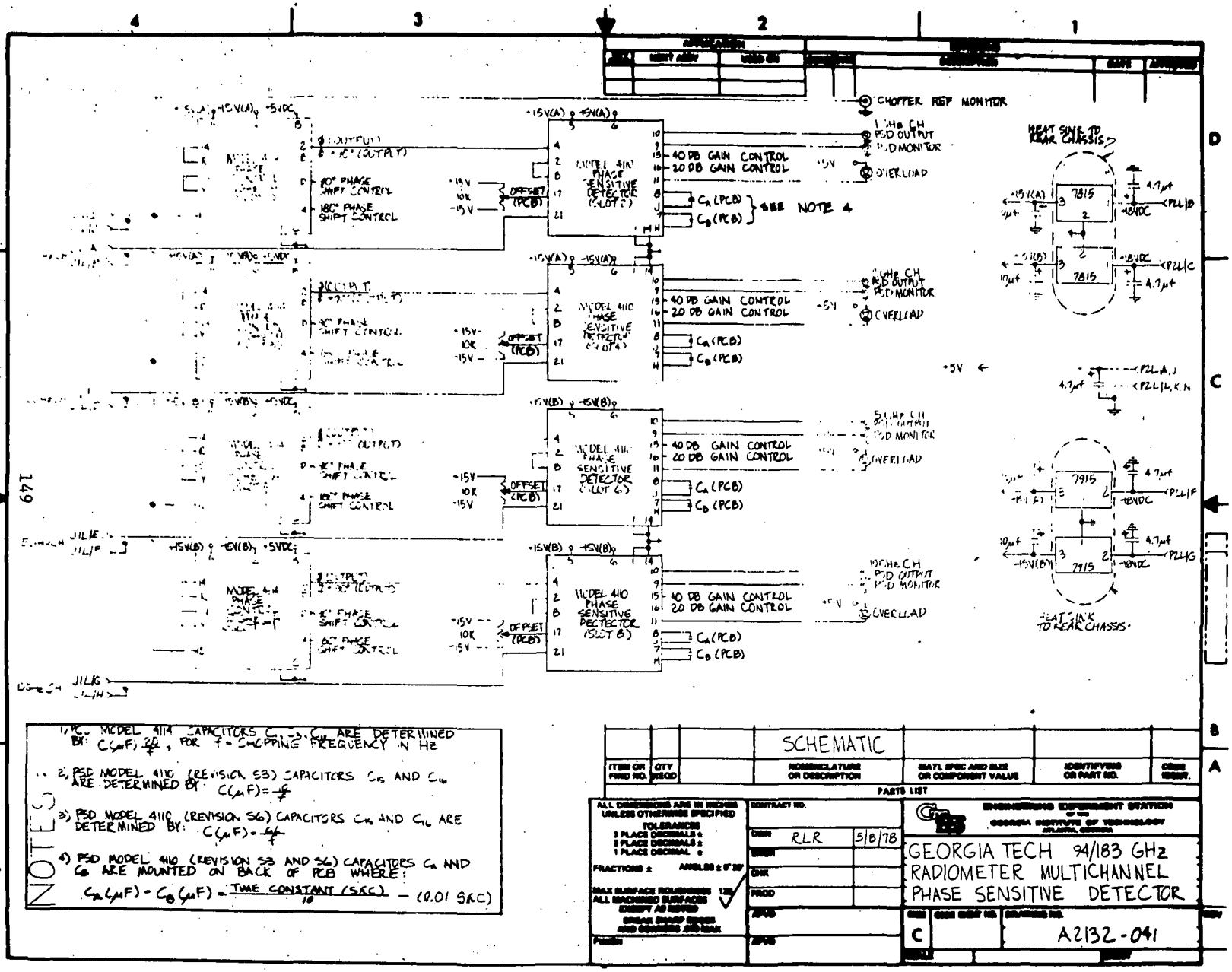
>>> No assembly errors detected <<<

APPENDIX B

ELECTRONIC SCHEMATICS



TYPE PCB	R_1	R_2	R_3	R_4	R_5	R_6	U_1	U_2	U_3
HOT, REF, SHARE, KLYSTRON LOADS	3.2Ka	6.75Ka	2.74Ka	604a	4.61Ka	2.7Ka	REF-02	OP-07	OP-07
COLD LOAD	8.87Ka	15.8Ka	13.1Ka	121Ka	402Ka	5.6Ka	REF-02	OP-07	OP-07



NOTES:

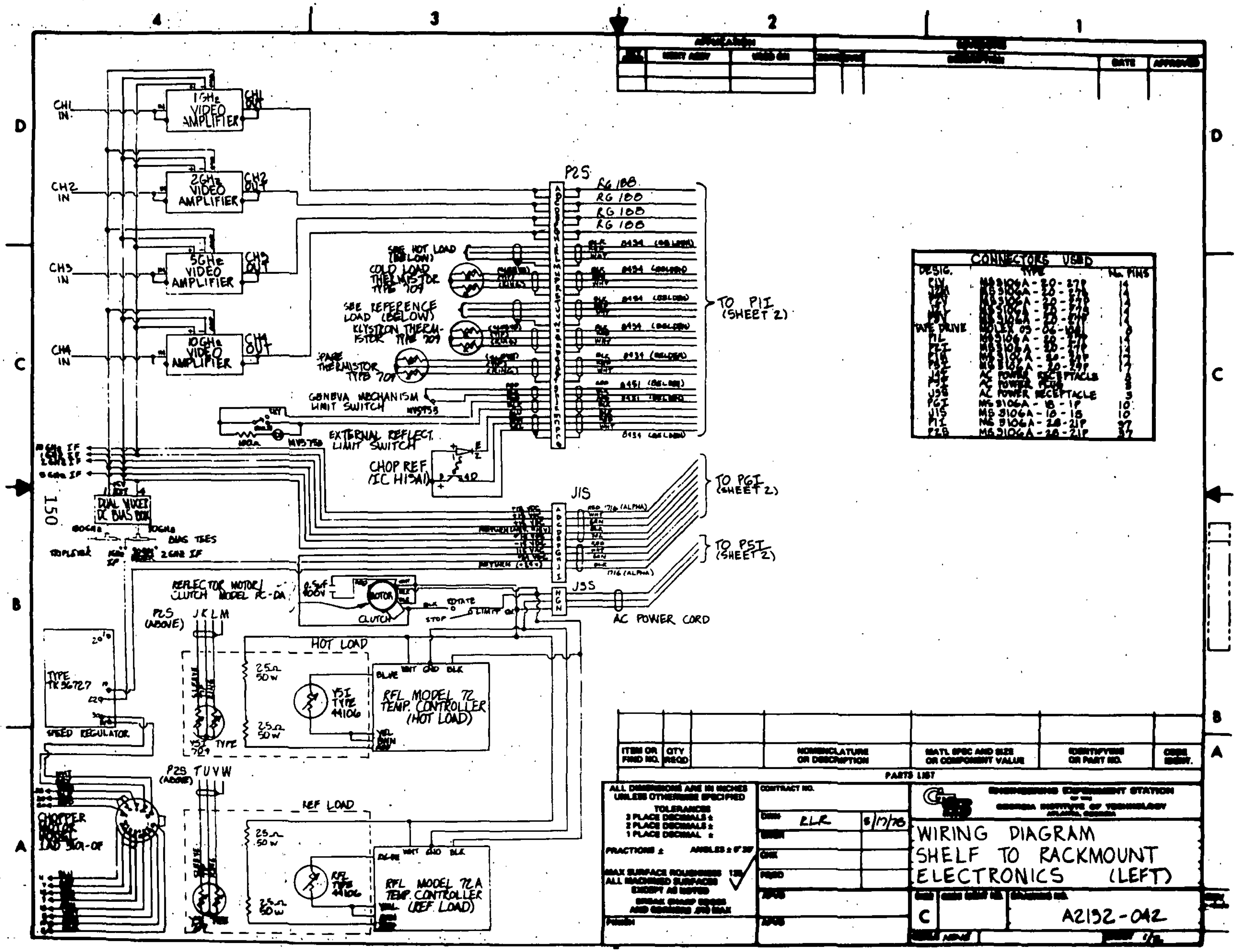
1) PSD MODEL 4110 CAPACITORS C_1, C_2, C_3 ARE DETERMINED BY: $C(\mu F) = \frac{25}{f}$, FOR f = CHOPPING FREQUENCY IN Hz

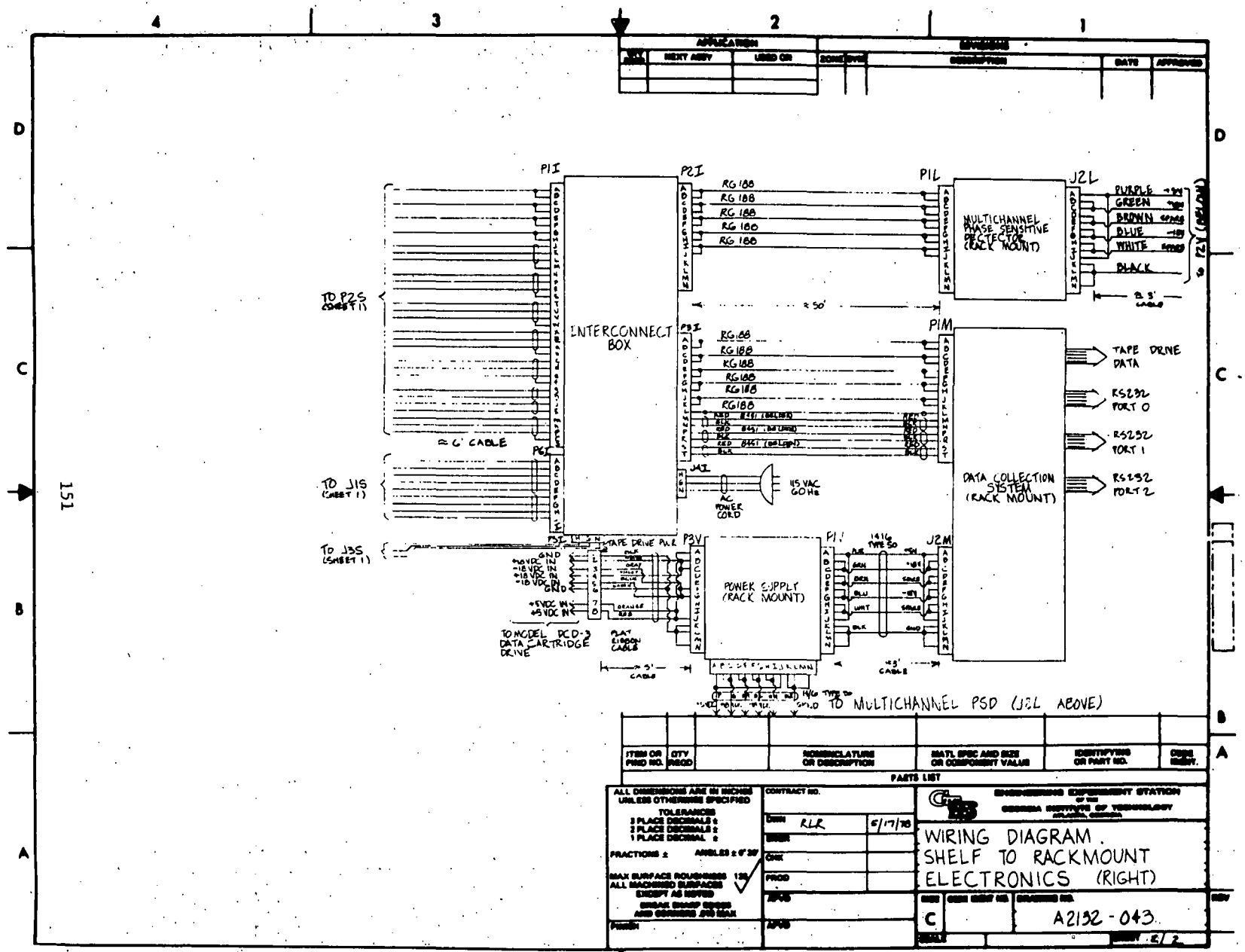
2) PSD MODEL 4110 (REVISION S3) CAPACITORS C_5 AND C_{10} ARE DETERMINED BY: $C(\mu F) = \frac{4}{f}$

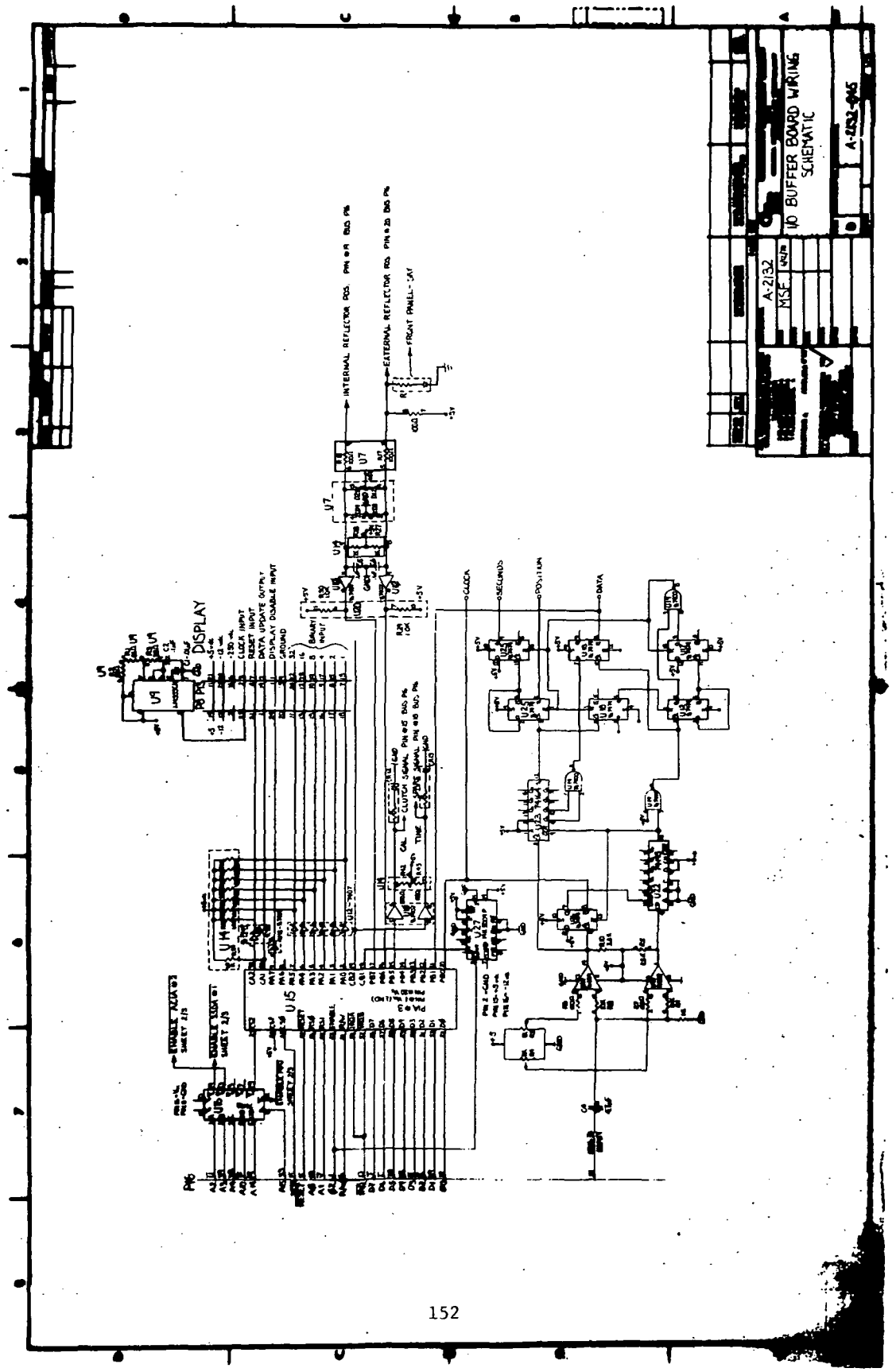
3) PSD MODEL 4110 (REVISION S6) CAPACITORS C_{10} AND C_{11} ARE DETERMINED BY: $C(\mu F) = \frac{64}{f}$

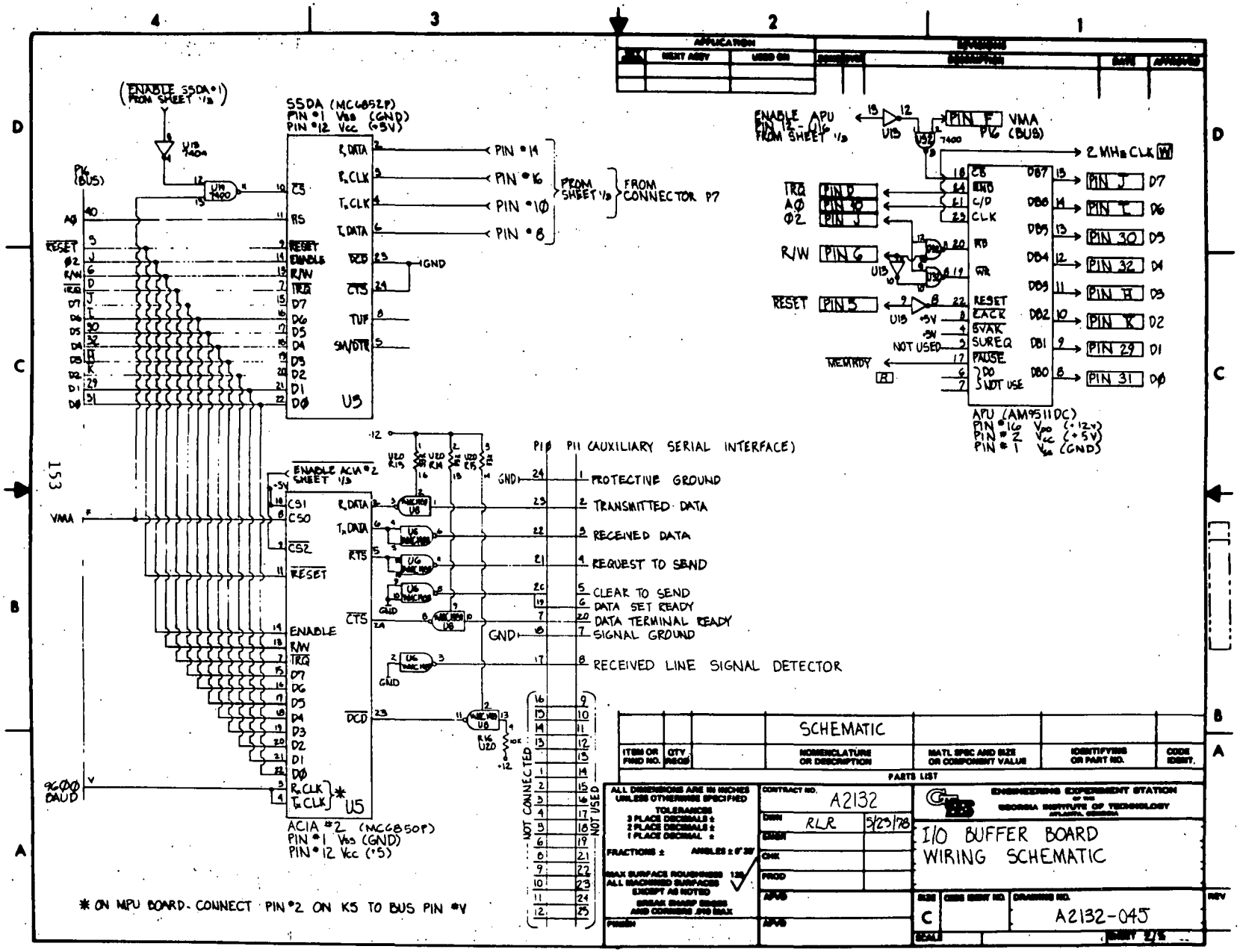
4) PSD MODEL 4110 (REVISION S3 AND S6) CAPACITORS C_8 AND C_9 ARE MOUNTED ON BACK OF PCB WHERE:

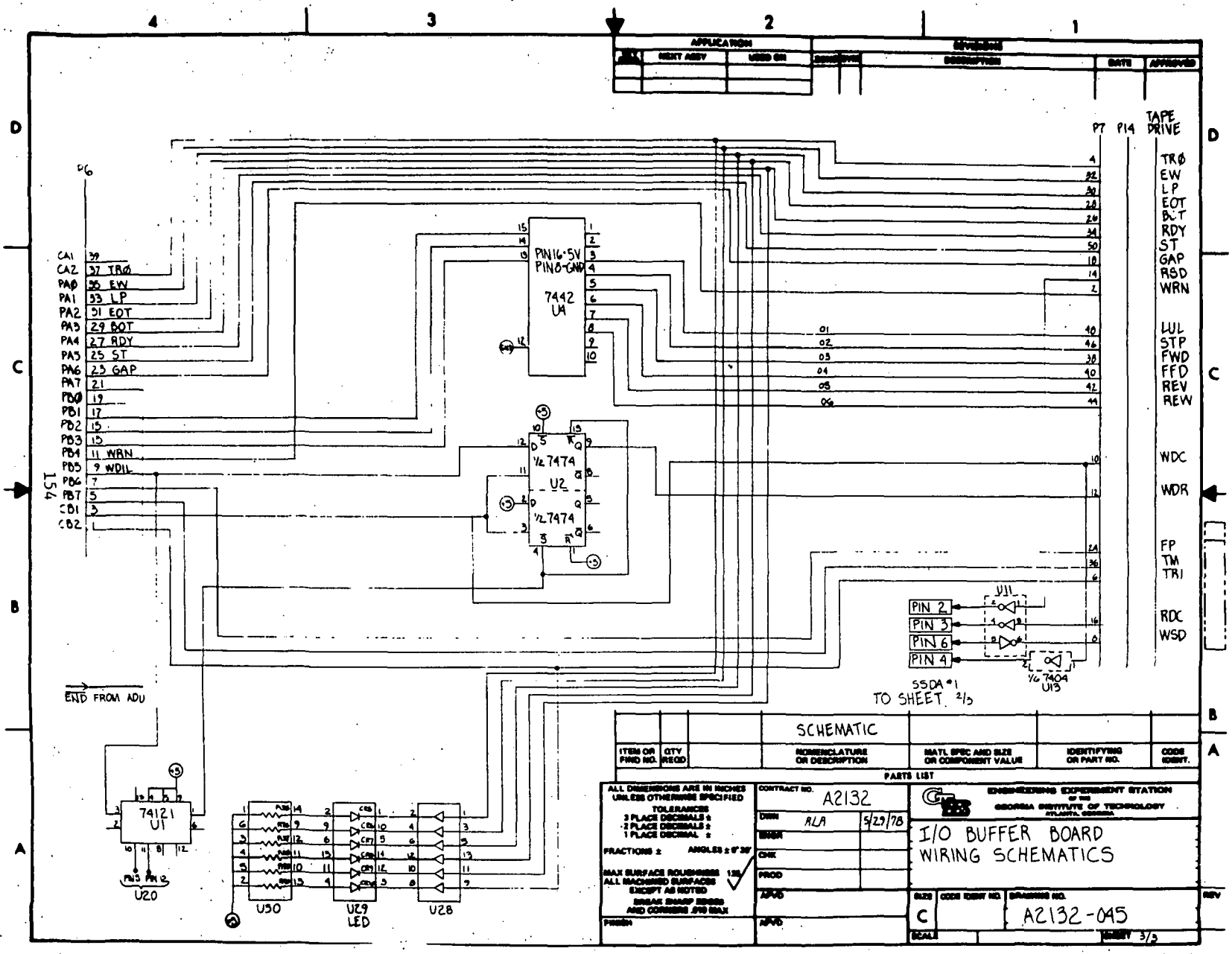
$$C_8(\mu F) = C_9(\mu F) = \frac{\text{TIME CONSTANT (SEC)}}{10} - (0.01\ \text{SEC})$$

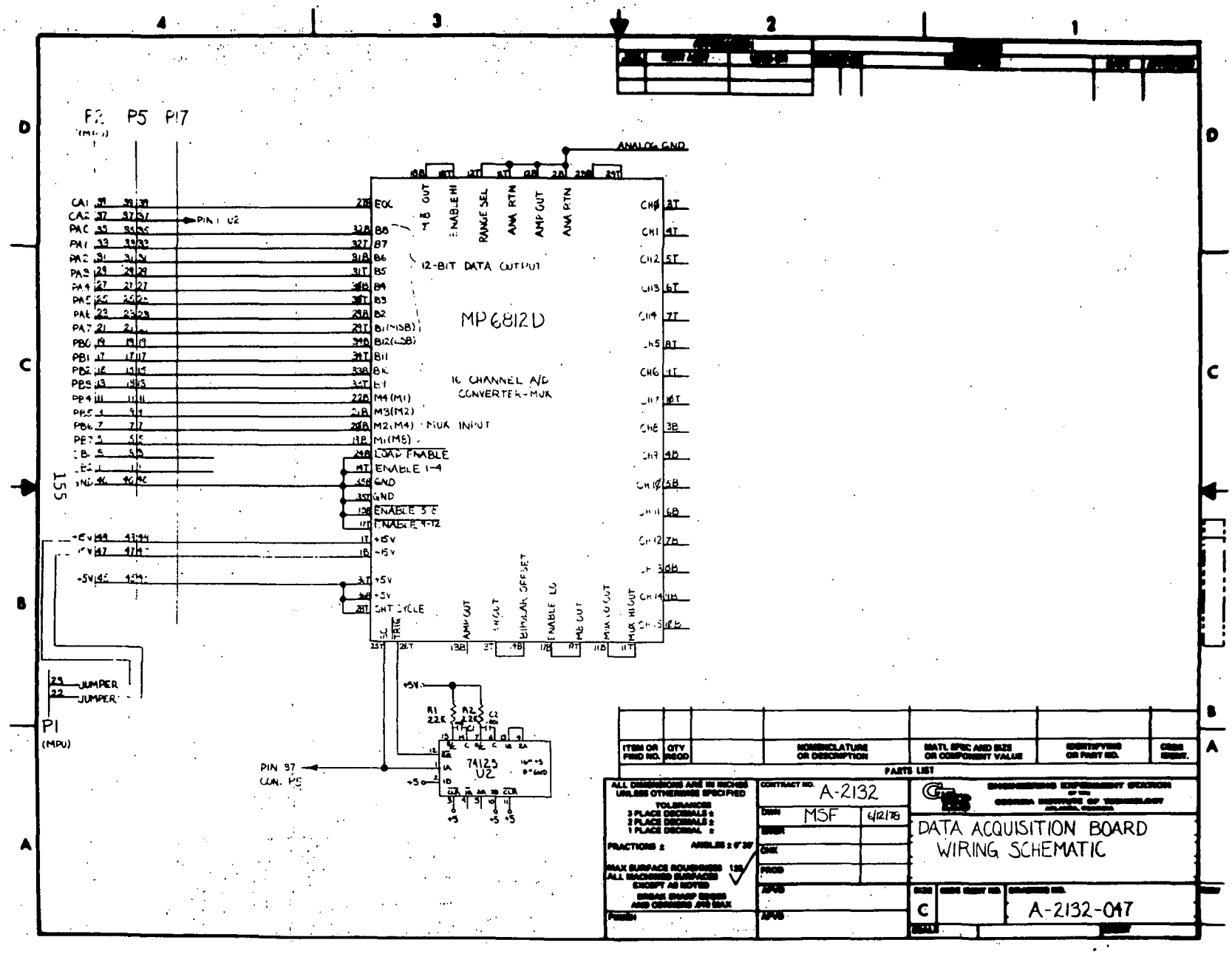

CH1 IN
1GHz VIDEO AMPLIFIER
CH1 OUT
CH2 IN
2GHz VIDEO AMPLIFIER
CH2 OUT
CH3 IN
5GHz VIDEO AMPLIFIER
CH3 OUT
CH4 IN
10GHz VIDEO AMPLIFIER
CH4 OUT
P2S
RG 188
RG 188
RG 188
RG 188
SEE HOT LOAD (BELOW)
COLD LOAD THERMISTOR TYPE 709
SEE REFERENCE LOAD (BELOW)
KLYSTRON THERMISTOR TYPE 709
SPARE THERMISTOR TYPE 709
GENEVA MECHANISM LIMIT SWITCH
EXTERNAL REFLECT. LIMIT SWITCH
CHOP REF (IC H15A1)
TO P1I (SHEET 2)
J1S
TO PGI (SHEET 2)
TO PSI (SHEET 2)
J3S
AC POWER CORD
DUAL MIXER DC BIAS BOX
BIAS TEES
2GHz IF
REFLECTOR MOTOR/ CLUTCH MODEL RC-DA
MOTOR
CLUTCH
ROTATE
STOP
P2S (ABOVE)
J K L M
HOT LOAD
25Ω 50W
YSI TYPE 44106
RFL MODEL 72 TEMP. CONTROLLER (HOT LOAD)
TYPE TK56727
SPEED REGULATOR
P2S (ABOVE)
T U V W
REF LOAD
RFL MODEL 72A TEMP. CONTROLLER (REF. LOAD)
CHOPPER
CONNECTORS USED
DESIG.
TYPE
No. PINS
TAPE DRIVE
AC POWER RECEPTACLE
MS 3106A - 18 - 1P
MS 3106A - 18 - 1S
MS 3106A - 28 - 21P
ITEM OR FIND NO.
QTY REQD
NOMENCLATURE OR DESCRIPTION
MAT'L SPEC AND SIZE OR COMPONENT VALUE
IDENTIFYING OR PART NO.
PARTS LIST
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
TOLERANCES
CONTRACT NO.
RLR
8/17/76
ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY
WIRING DIAGRAM
SHELF TO RACKMOUNT
ELECTRONICS (LEFT)
C
A2132-042


INTERCONNECT BOX
MULTICHANNEL PHASE SENSITIVE DETECTOR (RACK MOUNT)
DATA COLLECTION SYSTEM (RACK MOUNT)
POWER SUPPLY (RACK MOUNT)
RG 188
PURPLE
GREEN
BROWN
BLUE
WHITE
BLACK
TAPE DRIVE DATA
RS232 PORT 0
RS232 PORT 1
RS232 PORT 2
115 VAC 60Hz
AC POWER CORD
≈ 6' CABLE
TO P2S (SHEET 1)
TO J1S (SHEET 1)
TO J3S (SHEET 1)
TO MODEL DCD-3 DATA CARTRIDGE DRIVE
TO MULTICHANNEL PSD (J2L ABOVE)
WIRING DIAGRAM. SHELF TO RACKMOUNT ELECTRONICS (RIGHT)
A2132-043
C
ITEM OR FIND NO.
QTY REQD
NOMENCLATURE OR DESCRIPTION
MATL SPEC AND SIZE OR COMPONENT VALUE
IDENTIFYING OR PART NO.
PARTS LIST
RLR
5/17/78
151


I/O BUFFER BOARD WIRING SCHEMATIC
A-2132
MSF
DISPLAY
INTERNAL REFLECTOR POS.
EXTERNAL REFLECTOR POS.
FRONT PANEL-SAY
CLOCK
DATA
ENABLE KEYS


SSDA (MC6852P)
ACIA #2 (MC6850P)
APU (AM9511DC)
P6 (BUS)
P7 (BUS)
P11 (AUXILIARY SERIAL INTERFACE)
PROTECTIVE GROUND
TRANSMITTED DATA
RECEIVED DATA
REQUEST TO SEND
CLEAR TO SEND
DATA SET READY
DATA TERMINAL READY
SIGNAL GROUND
RECEIVED LINE SIGNAL DETECTOR
NOT CONNECTED
NOT USED
* ON MPU BOARD - CONNECT PIN #2 ON K5 TO BUS PIN #V
SCHEMATIC
I/O BUFFER BOARD
WIRING SCHEMATIC
A2132
A2132-045


4
3
2
1
APPLICATION
NEXT ASSY
USED ON
REVISIONS
DESCRIPTION
DATE
APPROVED
TAPE DRIVE
P7
P14
TRØ
EW
LP
EOT
BOT
RDY
ST
GAP
RSD
WRN
WDC
WDR
FP
TM
TRI
RDC
WSD
PG
CA1 39
CA2 37 TRØ
PAØ 35 EW
PA1 33 LP
PA2 31 EOT
PA3 29 BOT
PA4 27 RDY
PA5 25 ST
PA6 23 GAP
PA7 21
PBØ 19
PB1 17
PB2 15
PB3 13
PB4 11 WRN
PB5 9 WDIL
PB6 7
PB7 5
CB1 3
CB2 1
154
PIN16·5V
PIN8·GND
7442
U4
01
02
03
04
05
06
½ 7474
U2
½ 7474
PIN 2
PIN 3
PIN 6
PIN 4
U11
½ 7404
U13
SSDA*1
TO SHEET 2/3
END FROM ADU
74121
U1
U20
U30
U29
LED
U28
SCHEMATIC
ITEM OR FIND NO.
QTY REQD
NOMENCLATURE OR DESCRIPTION
MATL SPEC AND SIZE OR COMPONENT VALUE
IDENTIFYING OR PART NO.
CODE IDENT.
PARTS LIST
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
TOLERANCES
3 PLACE DECIMALS ±
2 PLACE DECIMALS ±
1 PLACE DECIMAL ±
FRACTIONS ±
ANGLES ± 0° 30'
MAX SURFACE ROUGHNESS ALL MACHINED SURFACES EXCEPT AS NOTED
BREAK SHARP EDGES AND CORNERS .010 MAX
FINISH
CONTRACT NO. A2132
DWN ALA 5/29/78
ENGR
CHK
PROD
APVD
APVD
ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA
I/O BUFFER BOARD
WIRING SCHEMATICS
SIZE C
CODE IDENT NO.
DRAWING NO. A2132-045
REV
SCALE
SHEET 3/3



ITEM OR FIND NO.	QTY PER ASSY	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	CAGE NUMBER

PARTS LIST

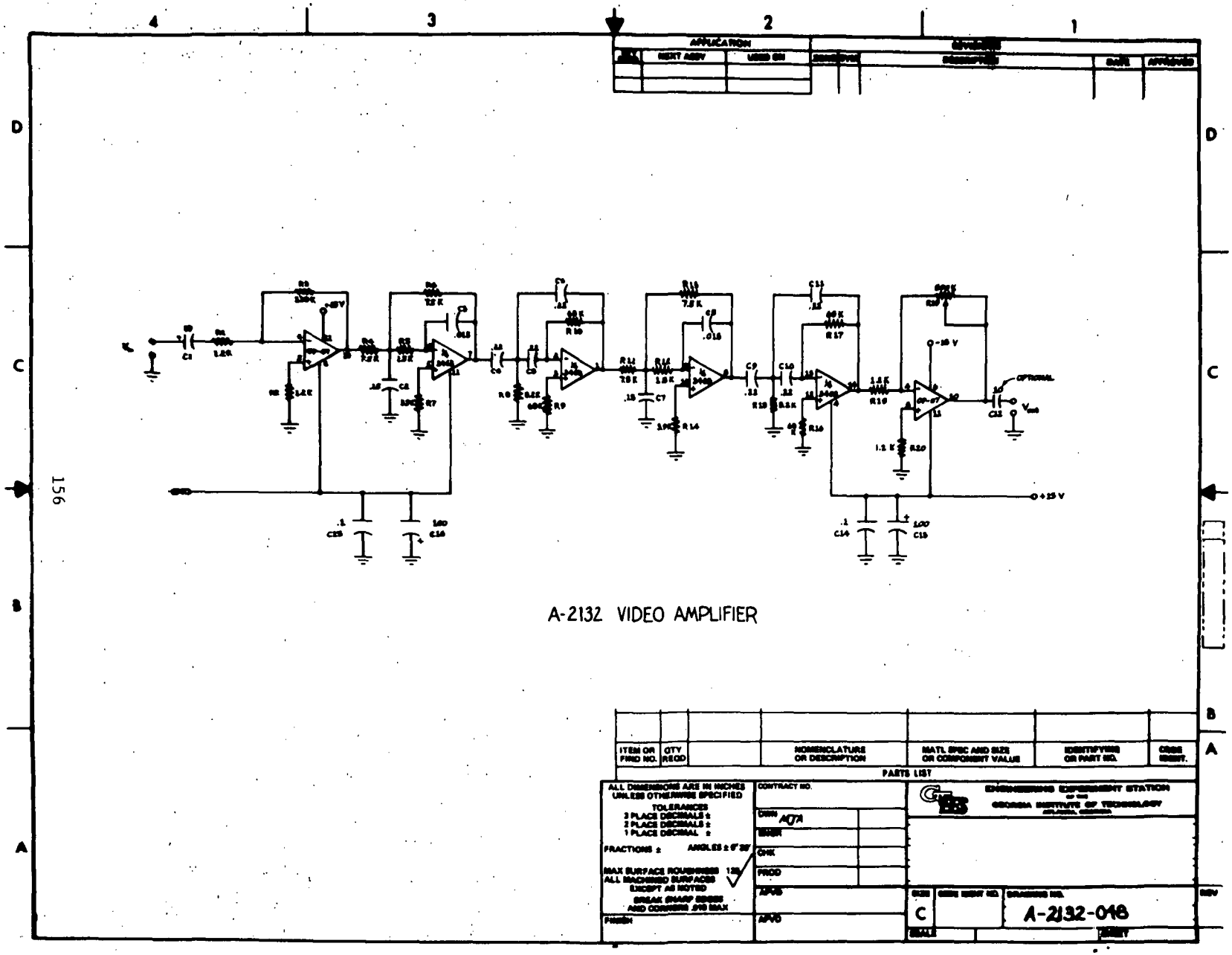
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
TOLERANCES
3 PLACE DECIMALS ±
2 PLACE DECIMALS ±
1 PLACE DECIMAL ±
FRACTIONS ± ANGLES ± 0° 30'
MAX SURFACE ROUGHNESS 125 ALL MACHINED SURFACES EXCEPT AS NOTED BREAK SHARP EDGES AND CORNERS .005 MAX
FINISH

CONTRACT NO. A-2132
DRAWN MSF 6/12/78
ENGR
CHK
PROD
APVD
APVD

ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA

DATA ACQUISITION BOARD WIRING SCHEMATIC

SIZE C
DRAWING NO. A-2132-017
SCALE
SHEET



A-2132 VIDEO AMPLIFIER

ITEM OR FIND NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	CAGE SHEET
		PARTS LIST			

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
TOLERANCES
3 PLACE DECIMALS ±
2 PLACE DECIMALS ±
1 PLACE DECIMAL ±
FRACTIONS ± ANGLES ± 0° 30'
MAX SURFACE ROUGHNESS 125 ALL MACHINED SURFACES EXCEPT AS NOTED
BREAK SHARP EDGES AND CORNERS .005 MAX
FINISH

CONTRACT NO.
DWN AOA
ENGR
CHK
PROD
APVD
APVD

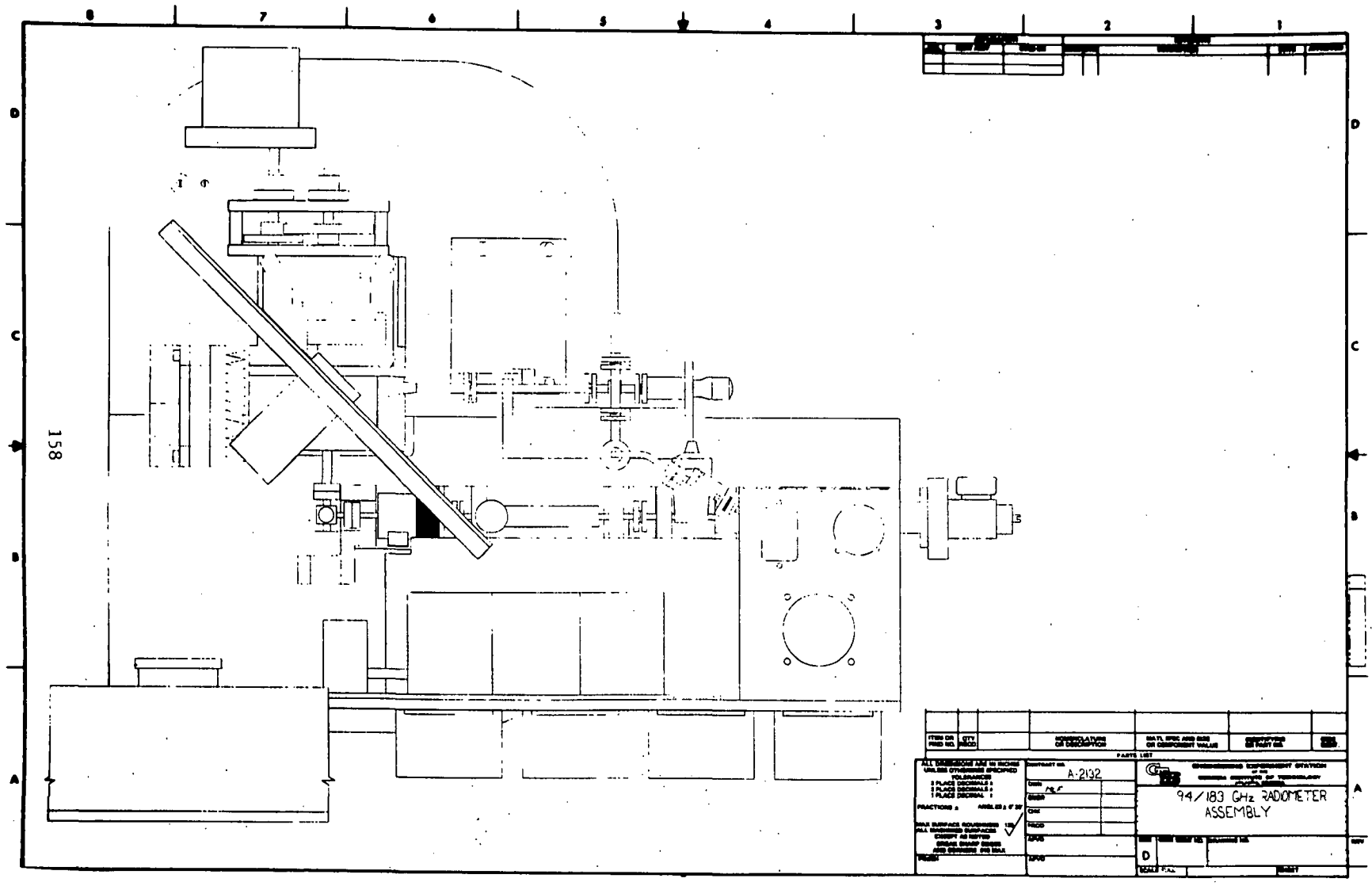
ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA

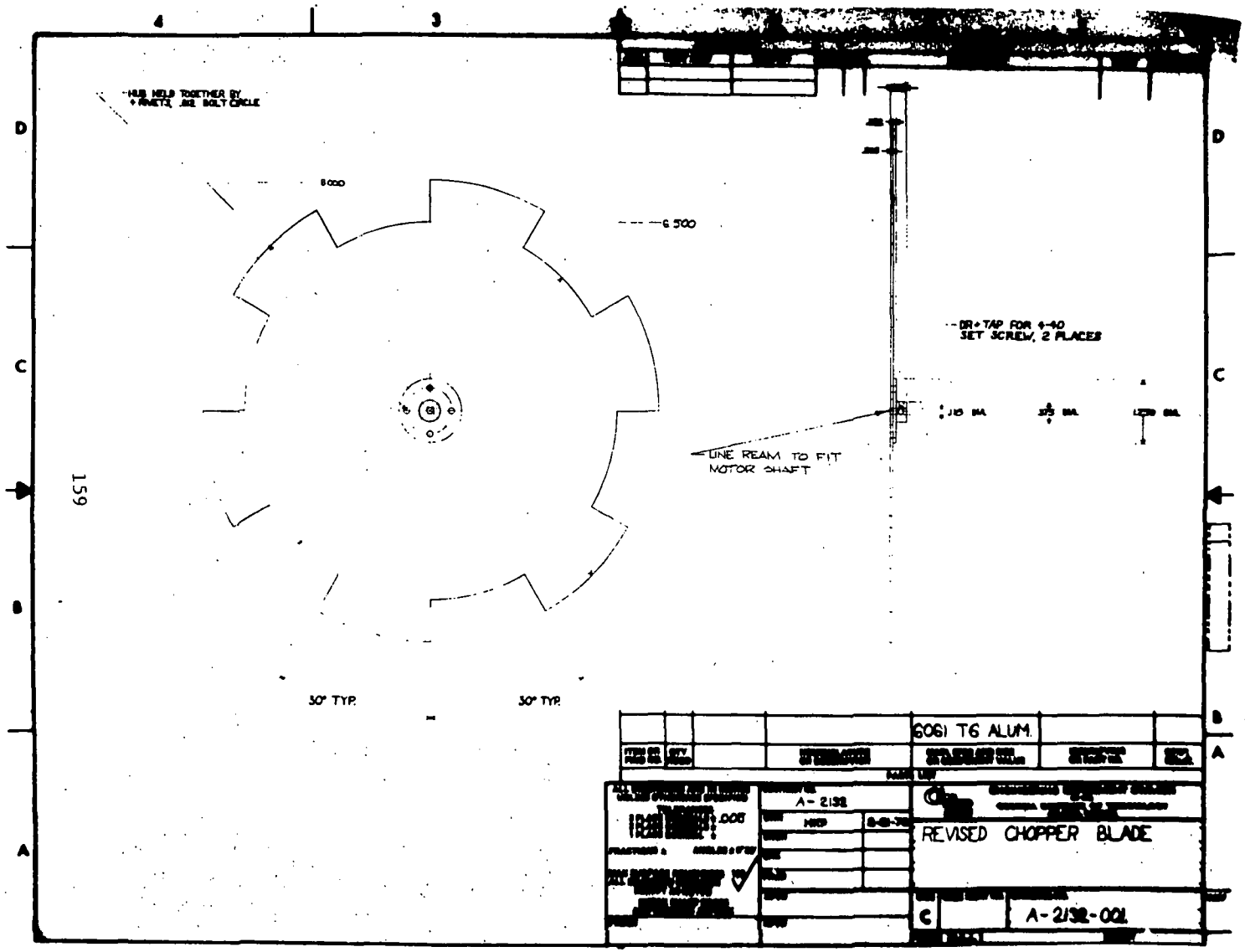
SIZE C | CAGE SHEET NO. | DRAWING NO. A-2132-018 | REV

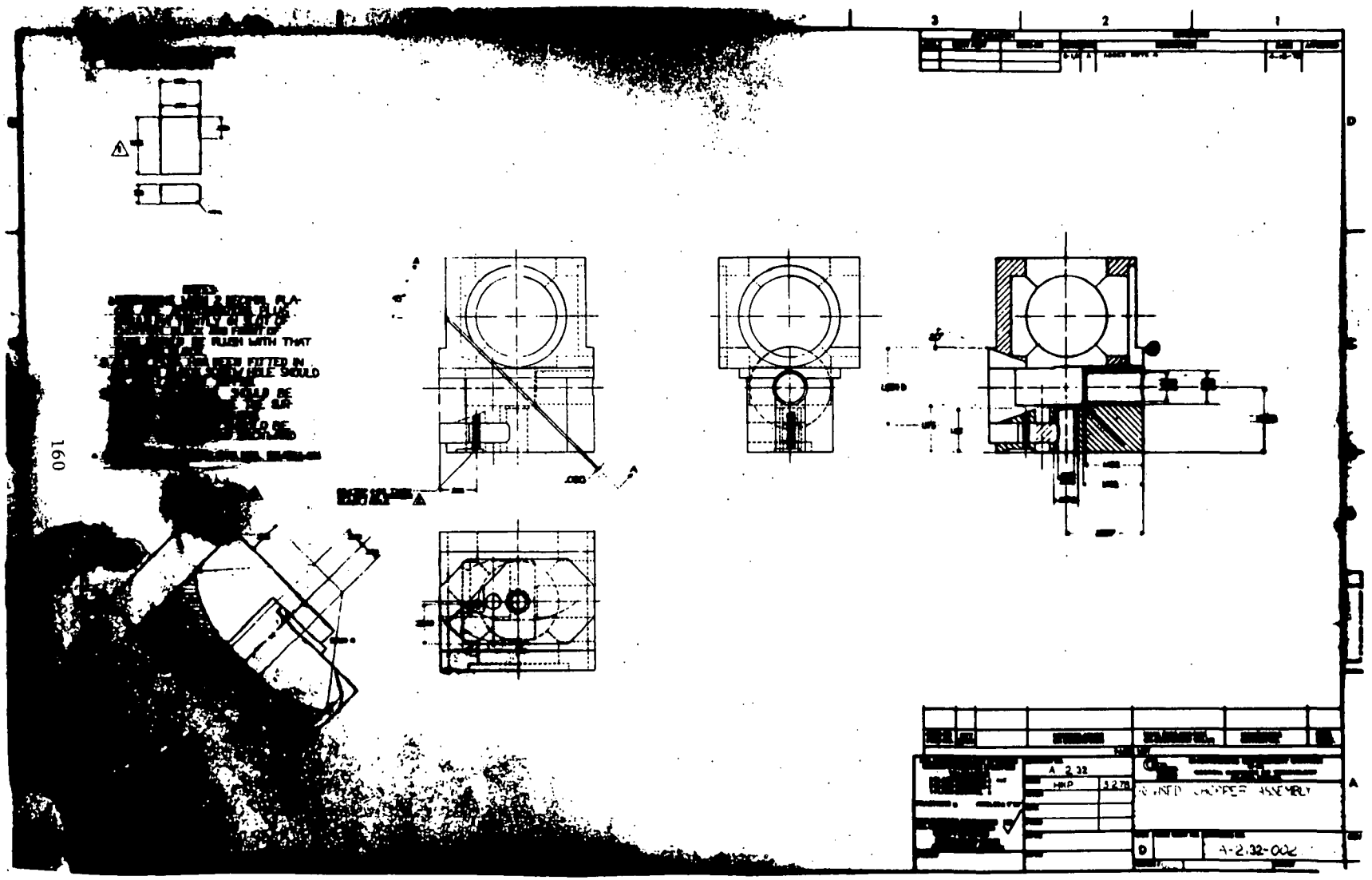
SCALE | SHEET

APPENDIX C

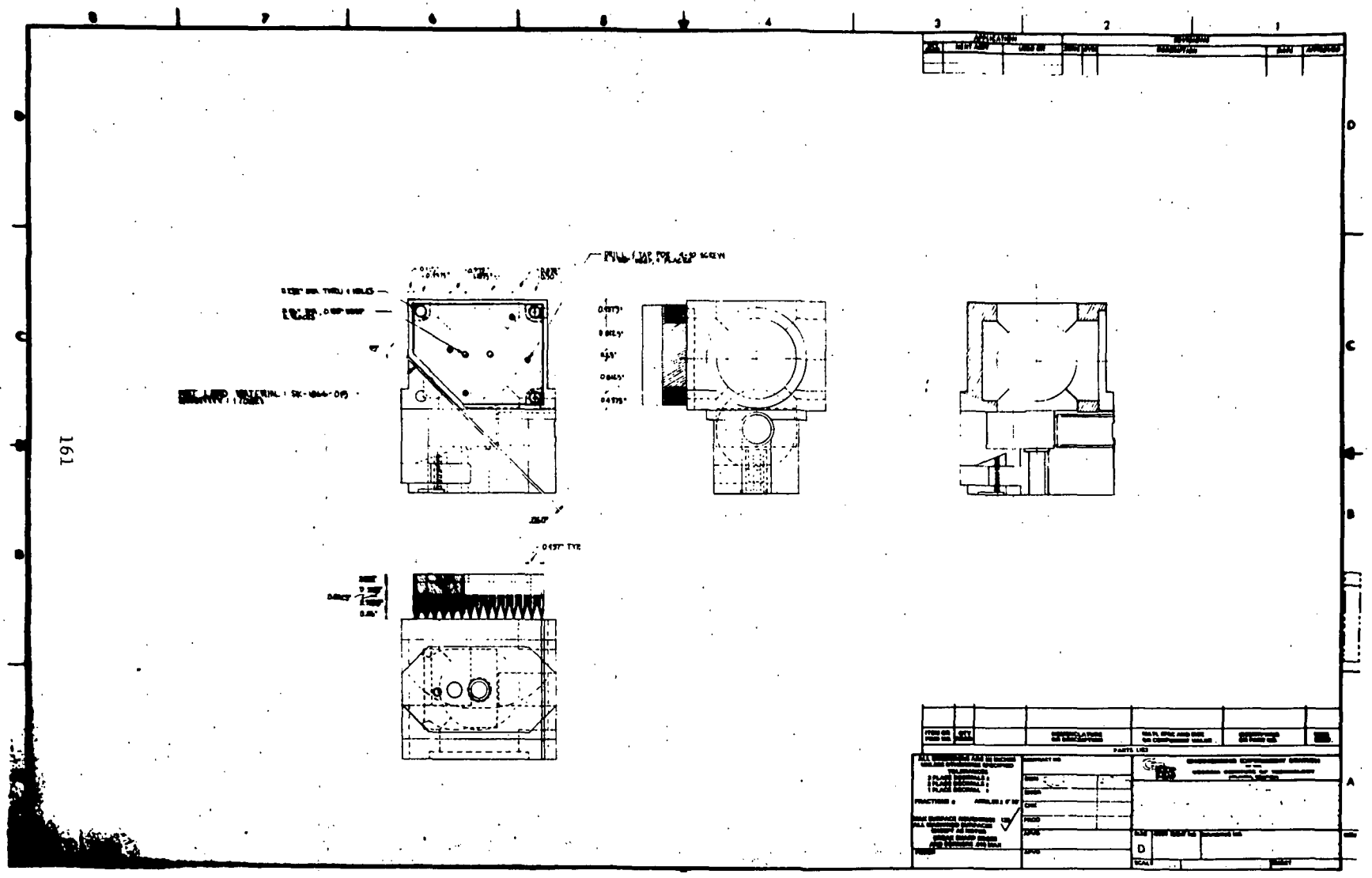
MECHANICAL DRAWINGS

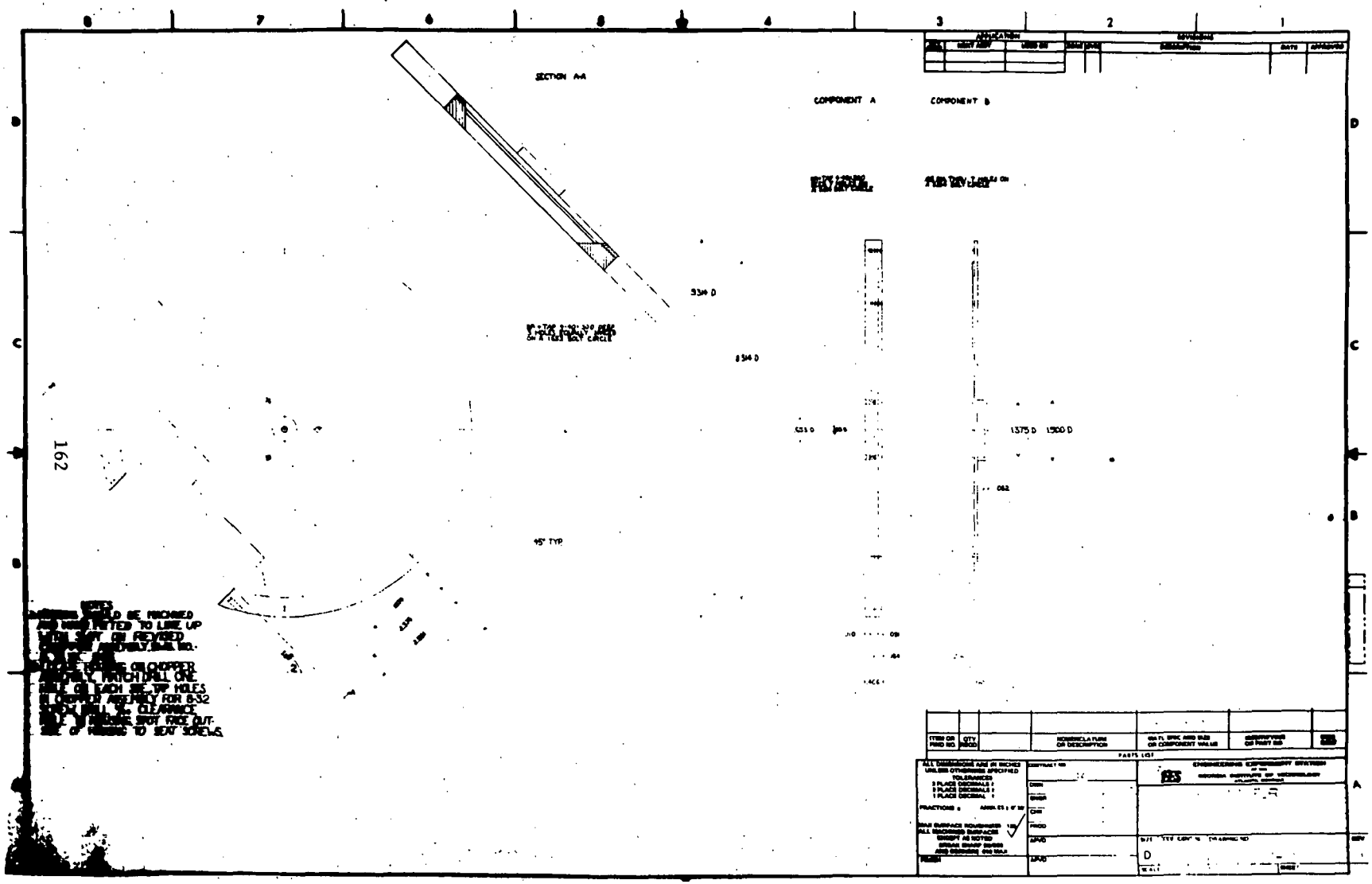

158
A-2132
94/183 GHz RADIOMETER ASSEMBLY
D

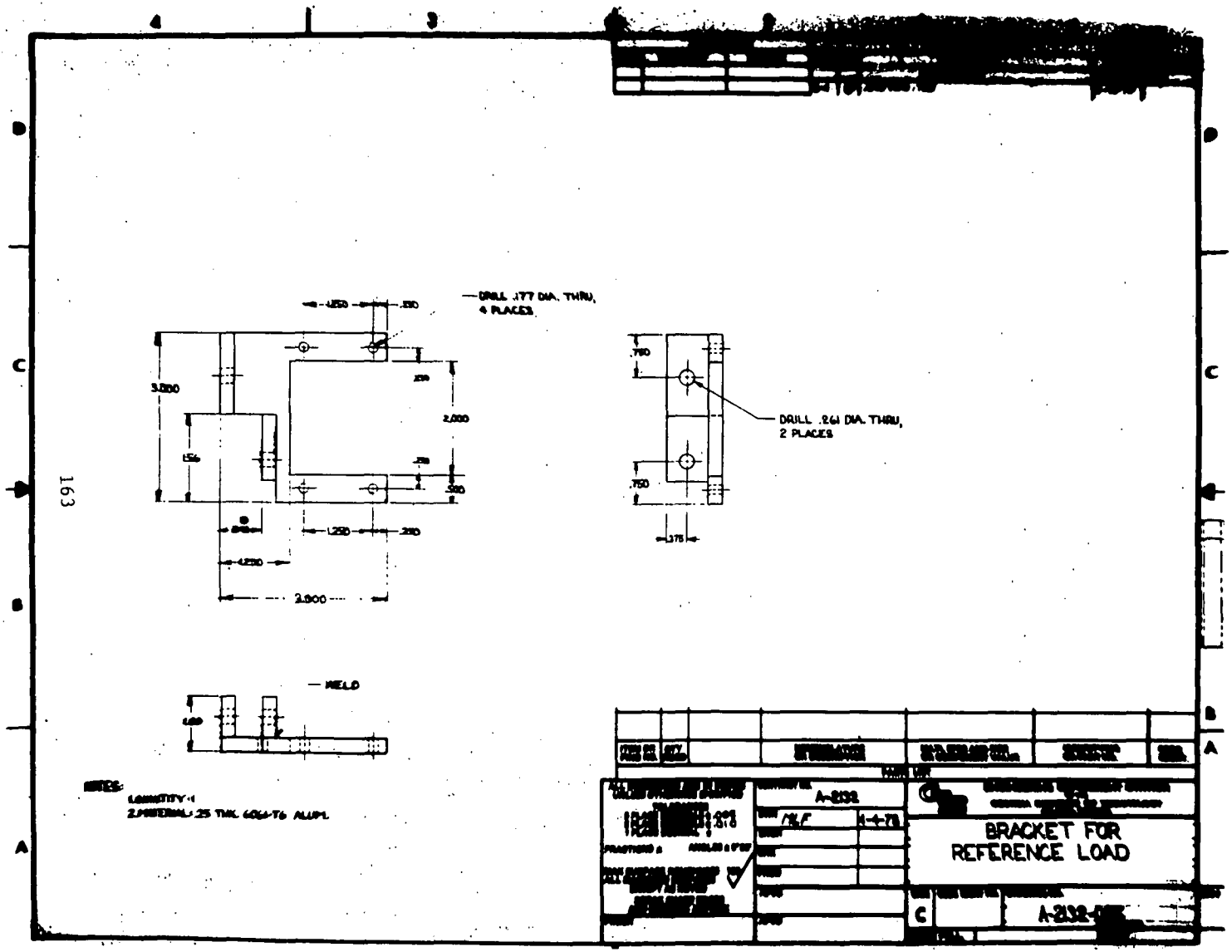

HUB HELD TOGETHER BY
RIVETS, .312 BOLT CIRCLE
6.500
DR & TAP FOR 4-40
SET SCREW, 2 PLACES
LINE REAM TO FIT
MOTOR SHAFT
30° TYP.
30° TYP.
4
3
D
C
B
A
159
SOGI T6 ALUM.
A-2132
REVISED CHOPPER BLADE
C
A-2132-001

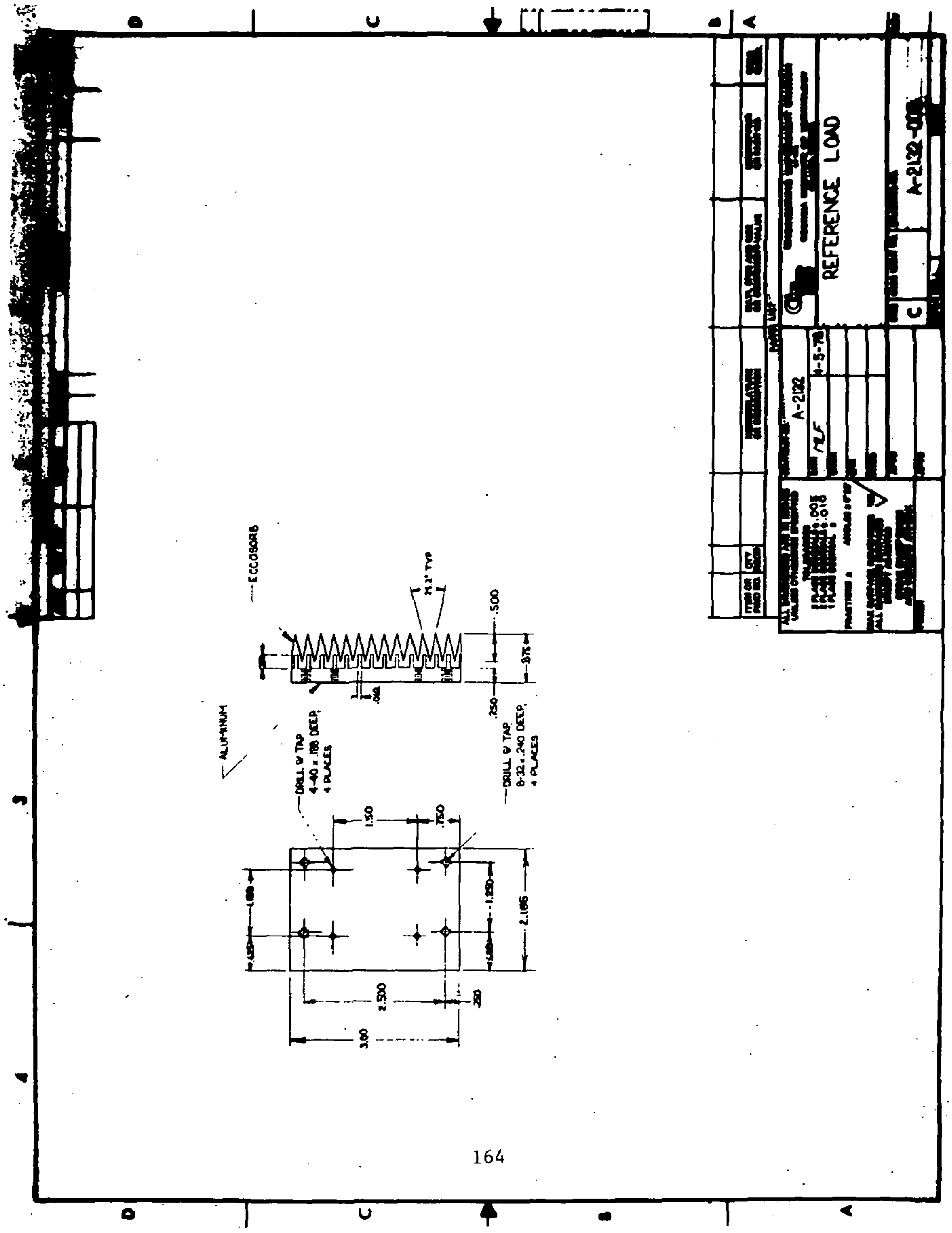


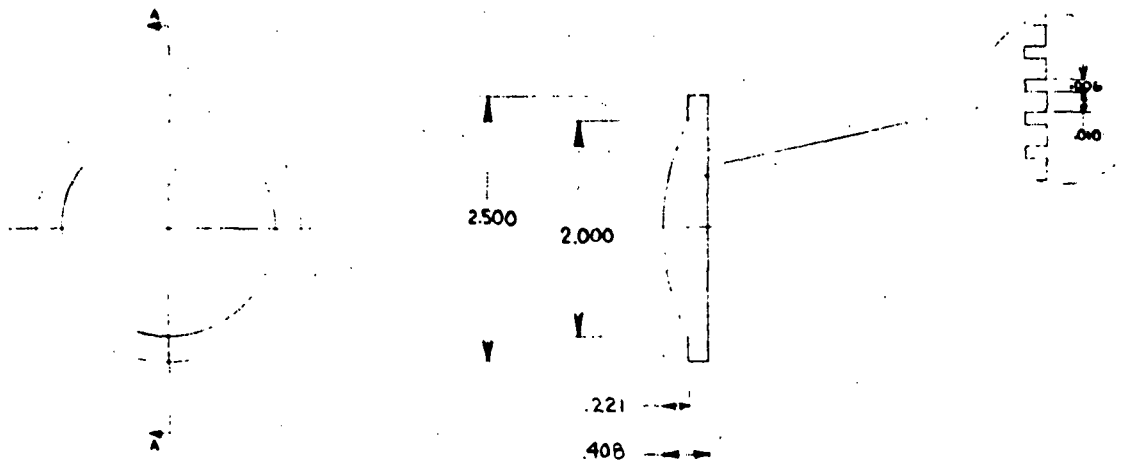
160




SECTION A-A
COMPONENT A
COMPONENT B
534 D
534 D
1375 D
1500 D
45° TYP
162


DRILL .177 DIA. THRU, 4 PLACES
DRILL .261 DIA. THRU, 2 PLACES
WELD
NOTES:
QUANTITY: 1
MATERIAL: .25 THK. 6061-T6 ALUM.
A-232
BRACKET FOR REFERENCE LOAD
A-232


REFERENCE LOAD
A-2132
4-5-78
ECCOSORB
ALUMINUM
DRILL & TAP
4-40 x .188 DEEP
4 PLACES
DRILL & TAP
8-32 x .240 DEEP
4 PLACES
.500
.375
.750
1.50
2.500
3.00
2.186
1.250



SECTION A-A

NOTES:

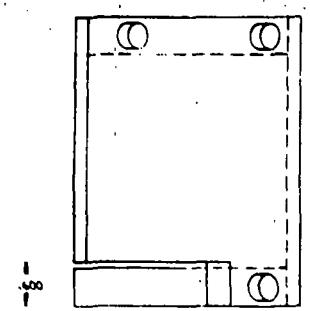
1. MATERIAL-REXOLITE
2. QUANTITY-4
3. TOLERANCES-OVERALL DIM. - ±.005
   GROOVE DIM. - ±.002
4. CUT CURVED SURFACE USING TEMPLATE PROVIDED

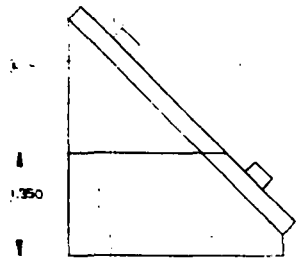
NO.	DESCRIPTION OF CHANGE	CH.	DATE

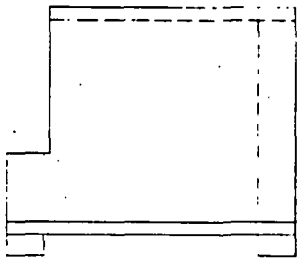
ENGINEERING EXPERIMENT STATION
OF THE
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

LENS

SCALE: FULL
DATE: 4-14-78
DR. MLF
ENGR.
CH.
APP.
CONTRACT NO.
PROJECT NO. A-2132
DRAWING NO. A-2132-018







NOTES:

1. SURFACE OF MIRROR MUST BE PROTECTED DURING MACHINING
2. MODIFY EXISTING PART (DWG. NO. SK-1866-010)

ITEM OR FIND NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	CODE IDENT.

PARTS LIST

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

TOLERANCES
3 PLACE DECIMALS ± .005
2 PLACE DECIMALS ±
1 PLACE DECIMAL ±

FRACTIONS ± ANGLES ± 0° 30'

MAX SURFACE ROUGHNESS 125 ALL MACHINED SURFACES EXCEPT AS NOTED

BREAK SHARP EDGES AND CORNERS .010 MAX

FINISH

CONTRACT NO A-2132

DWN MLF 4-6-78

ENGR

CHK

PROD

APVD

APVD

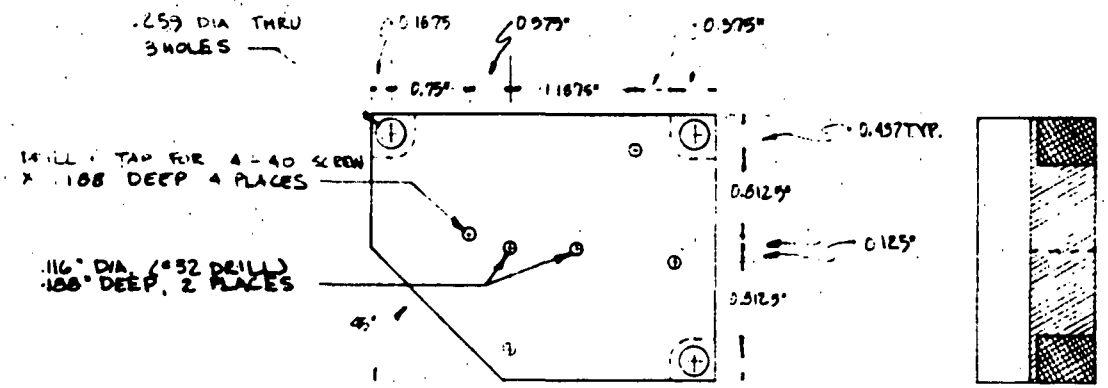
GTRI GEORGIA TECH ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA

MODIFICATION TO [illegible] LOAD MIRROR

SIZE C | CODE IDENT NO. | DRAWING NO A-2132-122 | REV

SCALE FULL | SHEET

166



NOTES:

1. MODIFY EXISTING PART (DWG. NO. SK-1866-018)

NO.	DESCRIPTION OF CHANGE	CH.	DATE
A	HOLE RELOCATIONS		
B	45° CUT TO CORNER		

SCALE: 1" = 1" DATE: 4/10/18

CONTRACT NO.

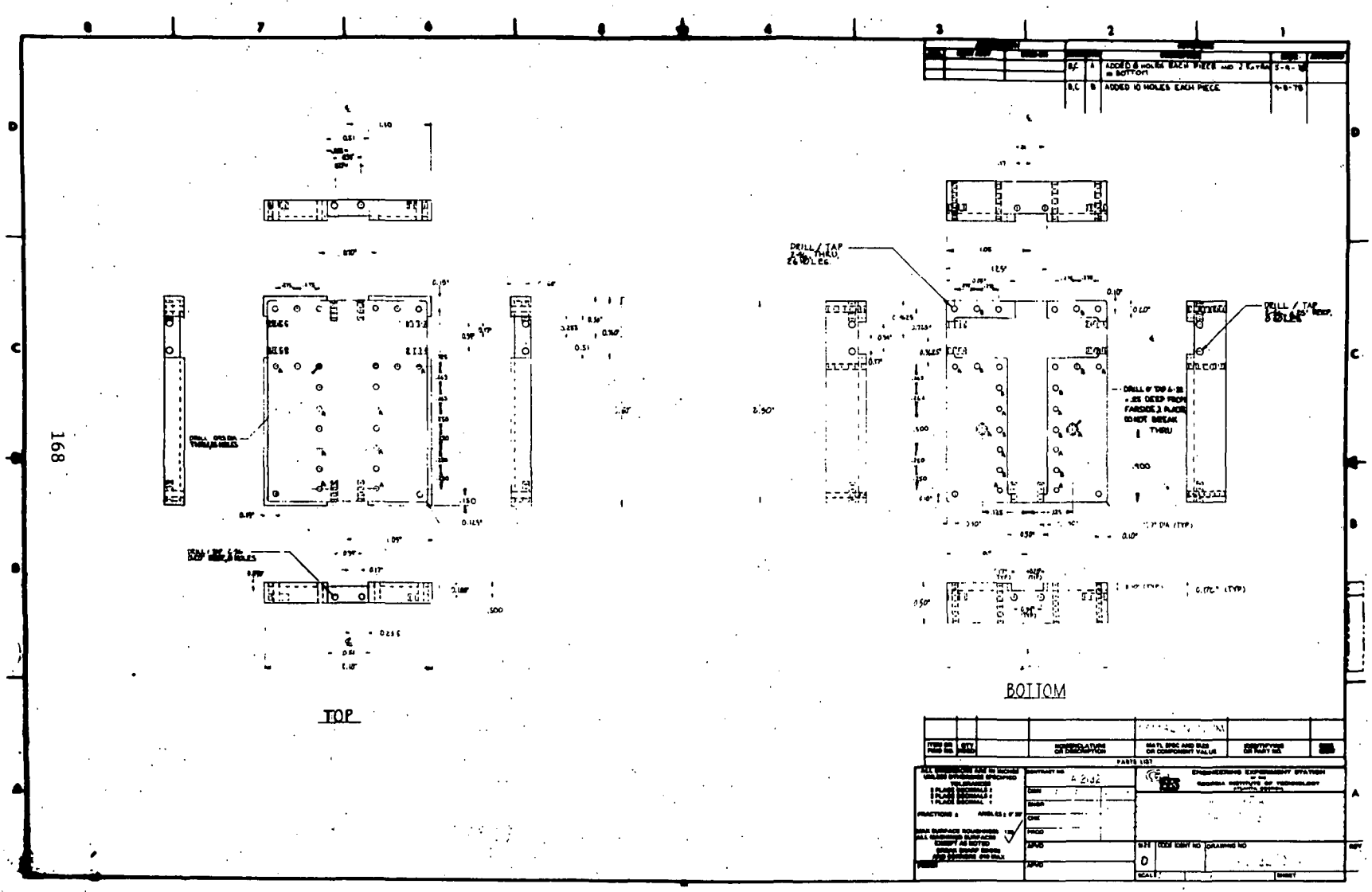
PROJECT NO.

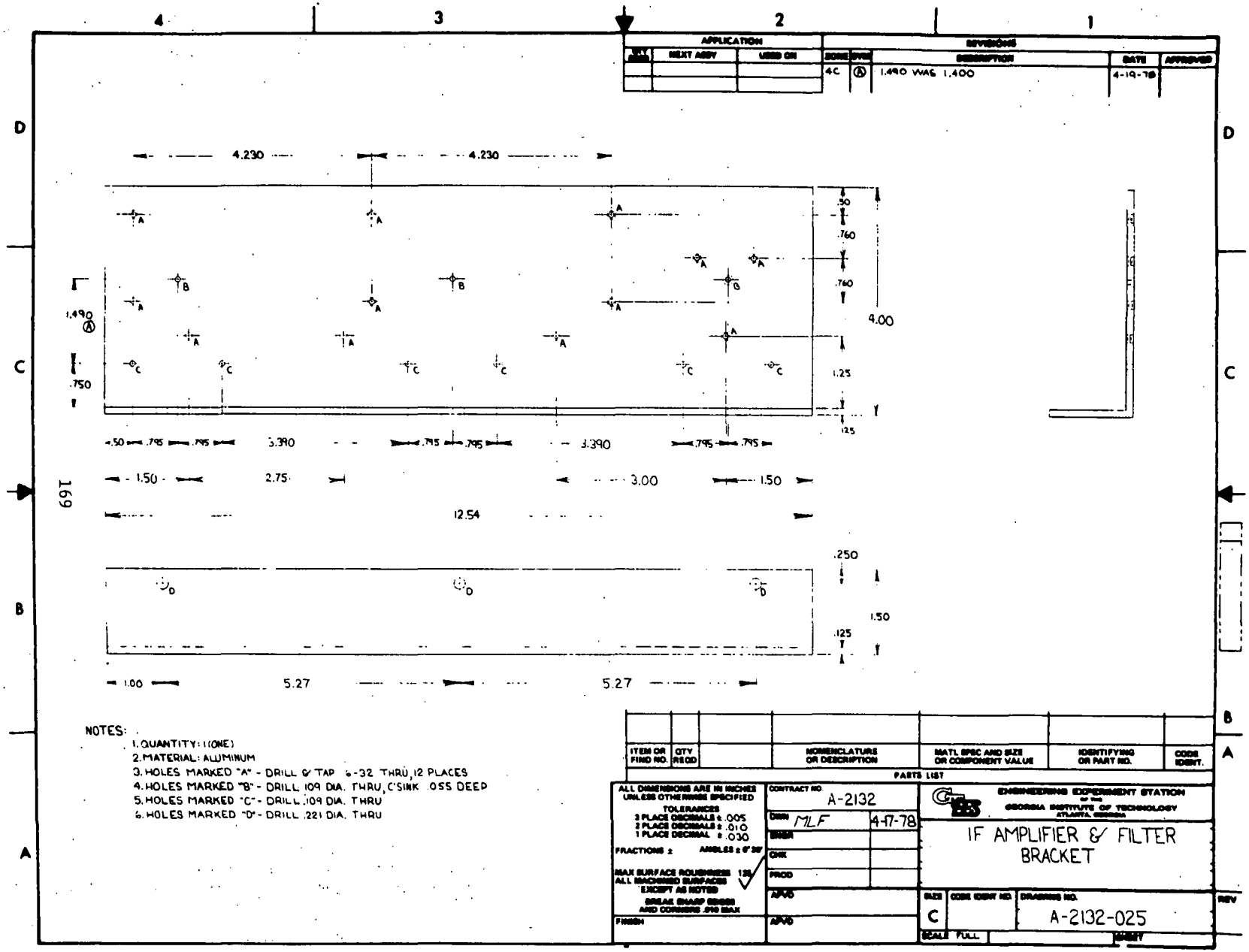
ENGINEERING EXPERIMENT STATION
OF THE
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

HOT LOAD MODIFICATION

DR. RLR
ENGR.
CH.
APP.

DRAWING NO. A2132-023


168
TOP
BOTTOM
DRILL / TAP
THRU
ALL HOLES
DRILL & TAP
.25 DEEP FROM
BOTH SIDES
THRU
.100
.100
.50"
ADDED 8 HOLES EACH PIECE AND 2 SLOTS IN BOTTOM
ADDED 10 HOLES EACH PIECE


4
3
2
1
D
C
B
A
APPLICATION
NEXT ASSY
USED ON
REVISIONS
ZONE
DESCRIPTION
DATE
APPROVED
4C
A
1.490 WAS 1.400
4-19-78
4.230
4.230
1.490
.750
.50
.760
.760
4.00
1.25
.125
.50
.795
.795
3.390
.795
.795
3.390
.795
.795
1.50
2.75
3.00
1.50
12.54
.250
1.50
.125
1.00
5.27
5.27
169
NOTES:
1. QUANTITY: 1 (ONE)
2. MATERIAL: ALUMINUM
3. HOLES MARKED "A" - DRILL & TAP 6-32 THRU, 12 PLACES
4. HOLES MARKED "B" - DRILL 109 DIA. THRU, C'SINK .055 DEEP
5. HOLES MARKED "C" - DRILL .109 DIA. THRU
6. HOLES MARKED "D" - DRILL .221 DIA. THRU
ITEM OR FIND NO.
QTY REQD
NOMENCLATURE OR DESCRIPTION
MATL SPEC AND SIZE OR COMPONENT VALUE
IDENTIFYING OR PART NO.
CODE IDENT.
PARTS LIST
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
TOLERANCES
3 PLACE DECIMALS ± .005
2 PLACE DECIMALS ± .010
1 PLACE DECIMAL ± .030
FRACTIONS ±
ANGLES ± 0° 30'
MAX SURFACE ROUGHNESS 125
ALL MACHINED SURFACES EXCEPT AS NOTED
BREAK SHARP EDGES AND CORNERS .010 MAX
FINISH
CONTRACT NO A-2132
DWN MLF 4-17-78
ENGR
CHK
PROD
APVD
APVD
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ATLANTA, GEORGIA
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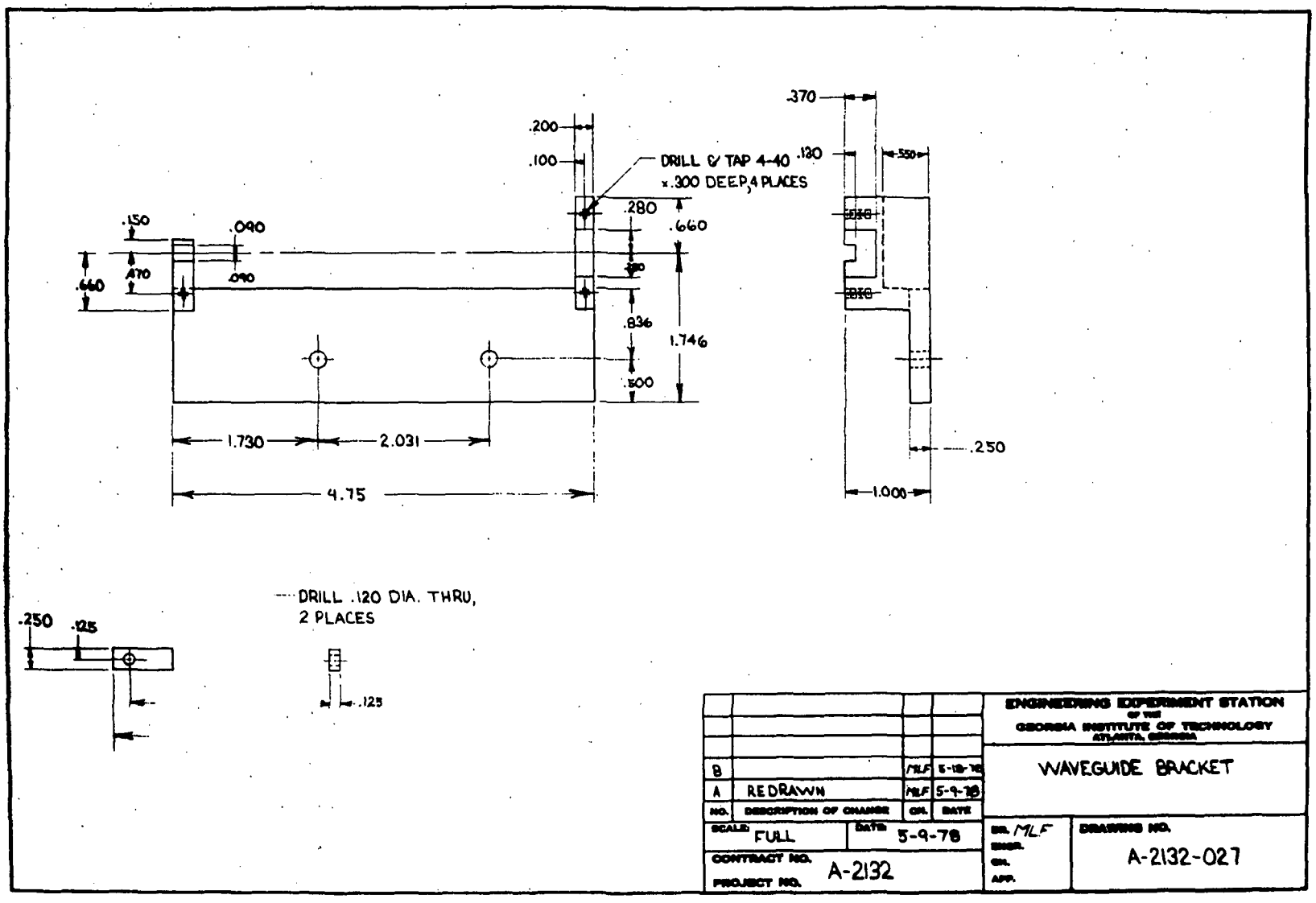

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ENGINEERING EXPERIMENT STATION
OF THE
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

WAVEGUIDE BRACKET

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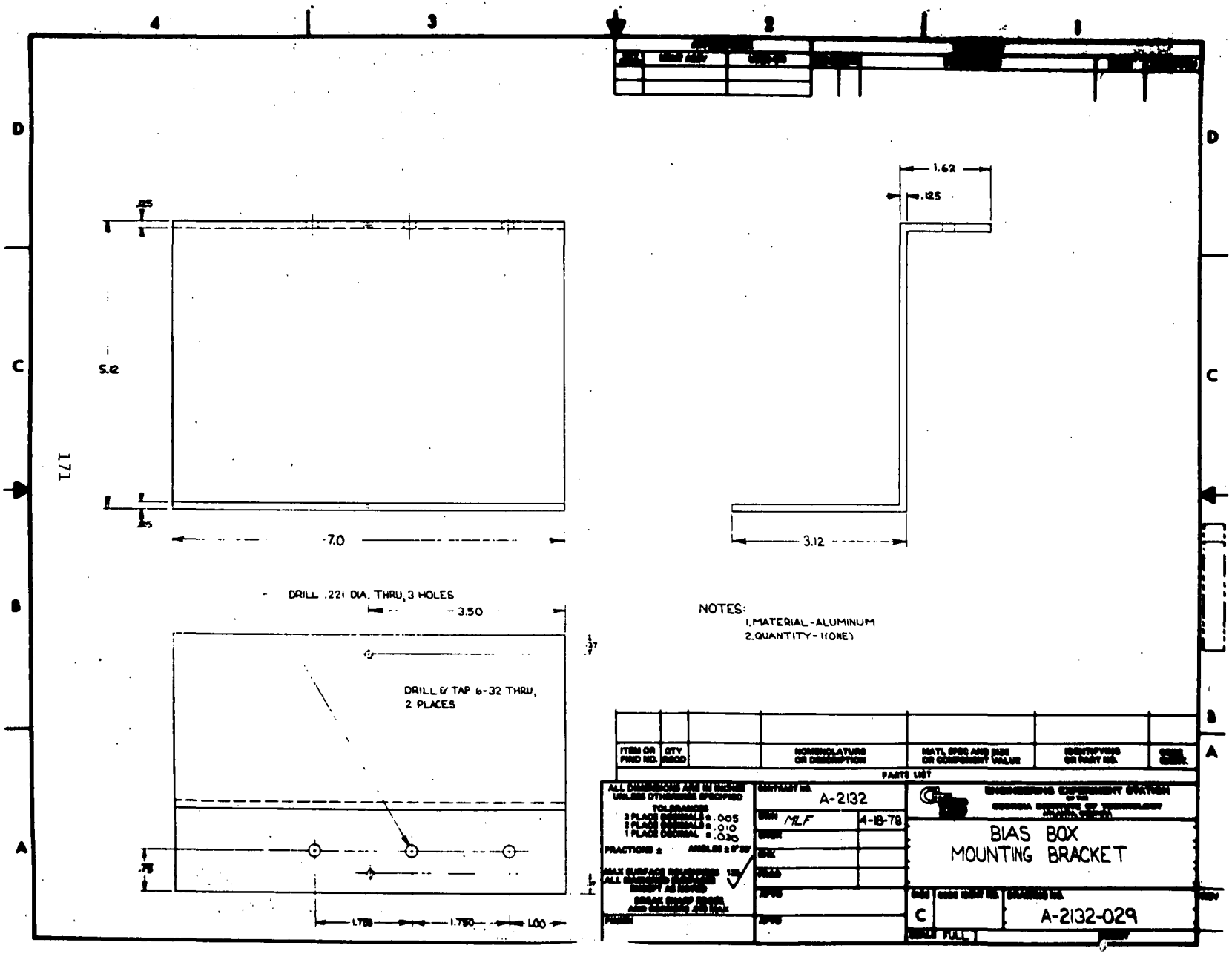
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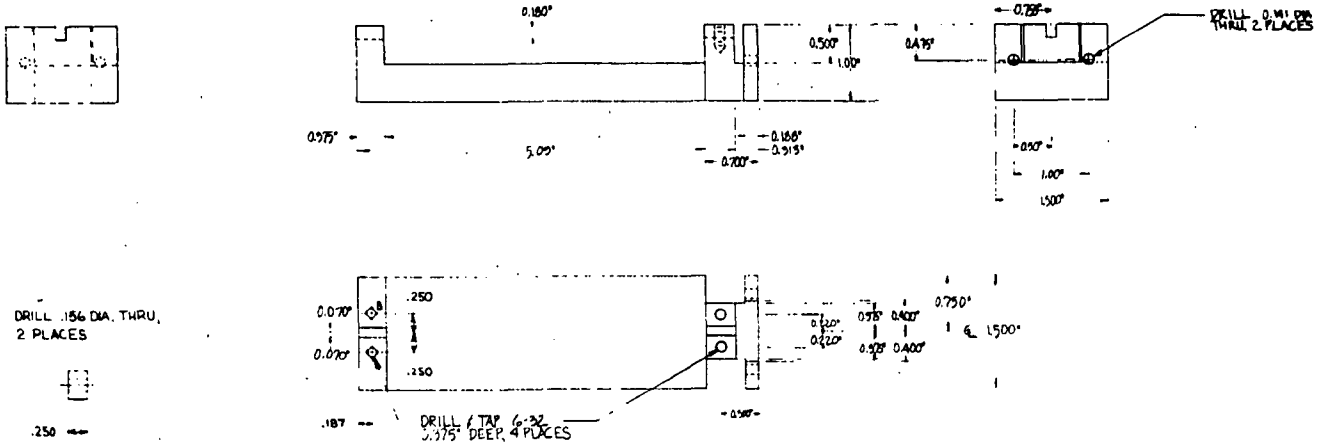

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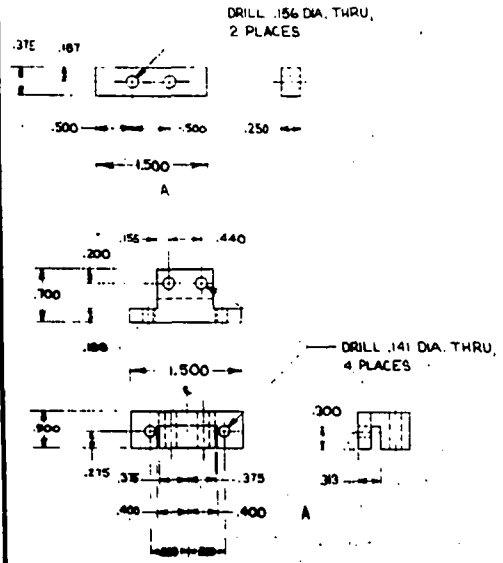

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ALL MACHINED SURFACES EXCEPT AS NOTED
BREAK SHARP EDGES AND CORNERS .010 MAX
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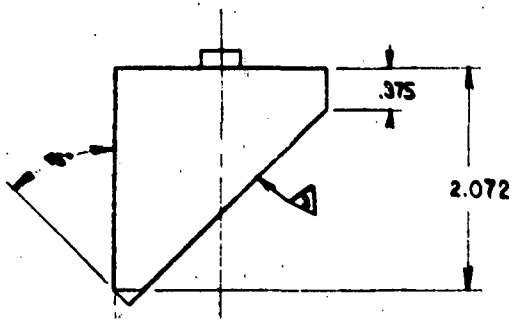

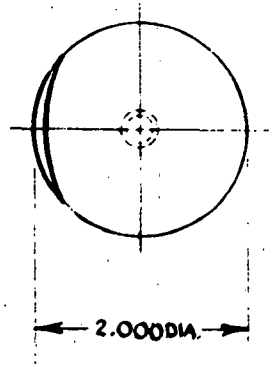

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MODIFICATION OF ROTATING MIRROR

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PROJECT NO.

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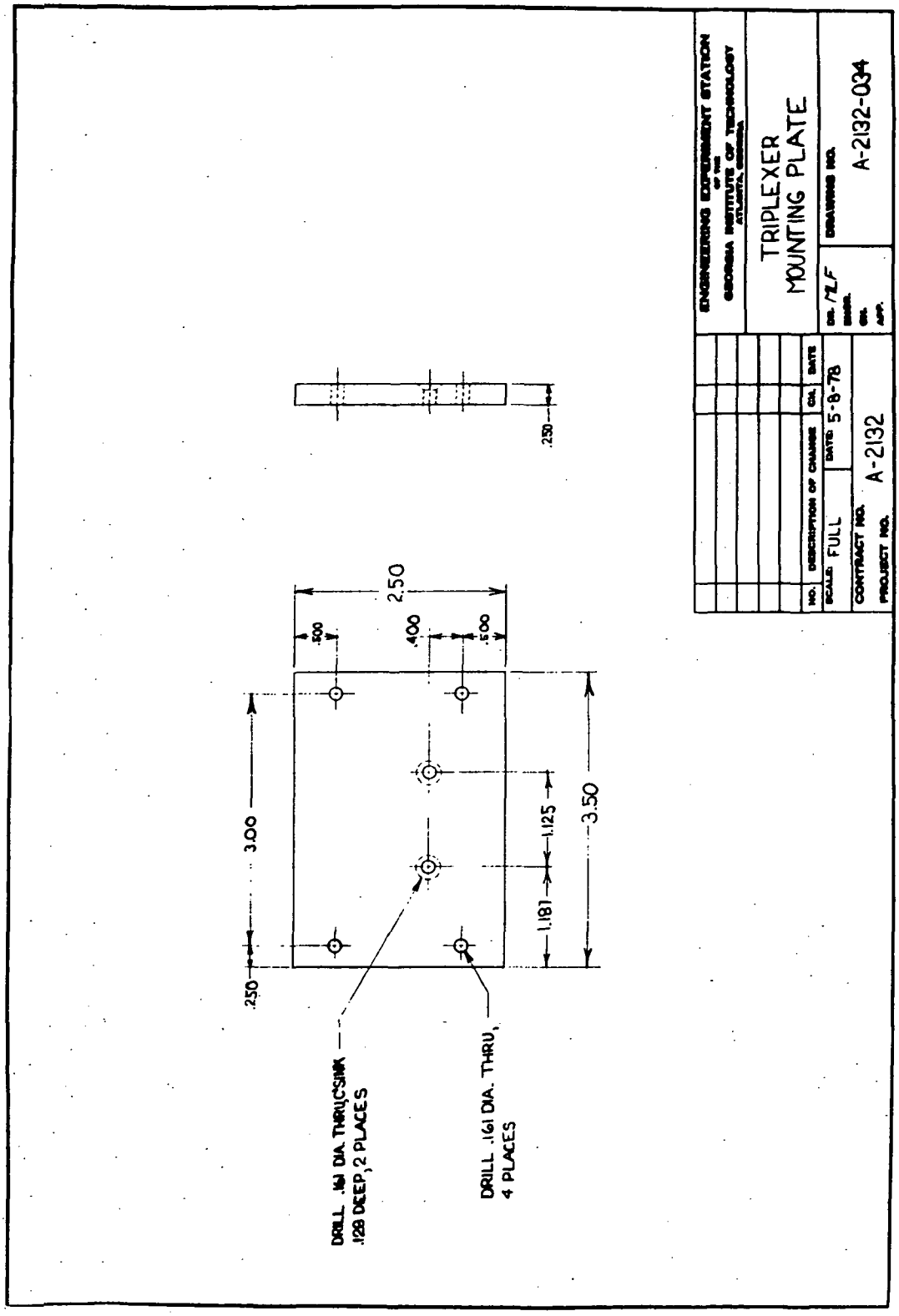
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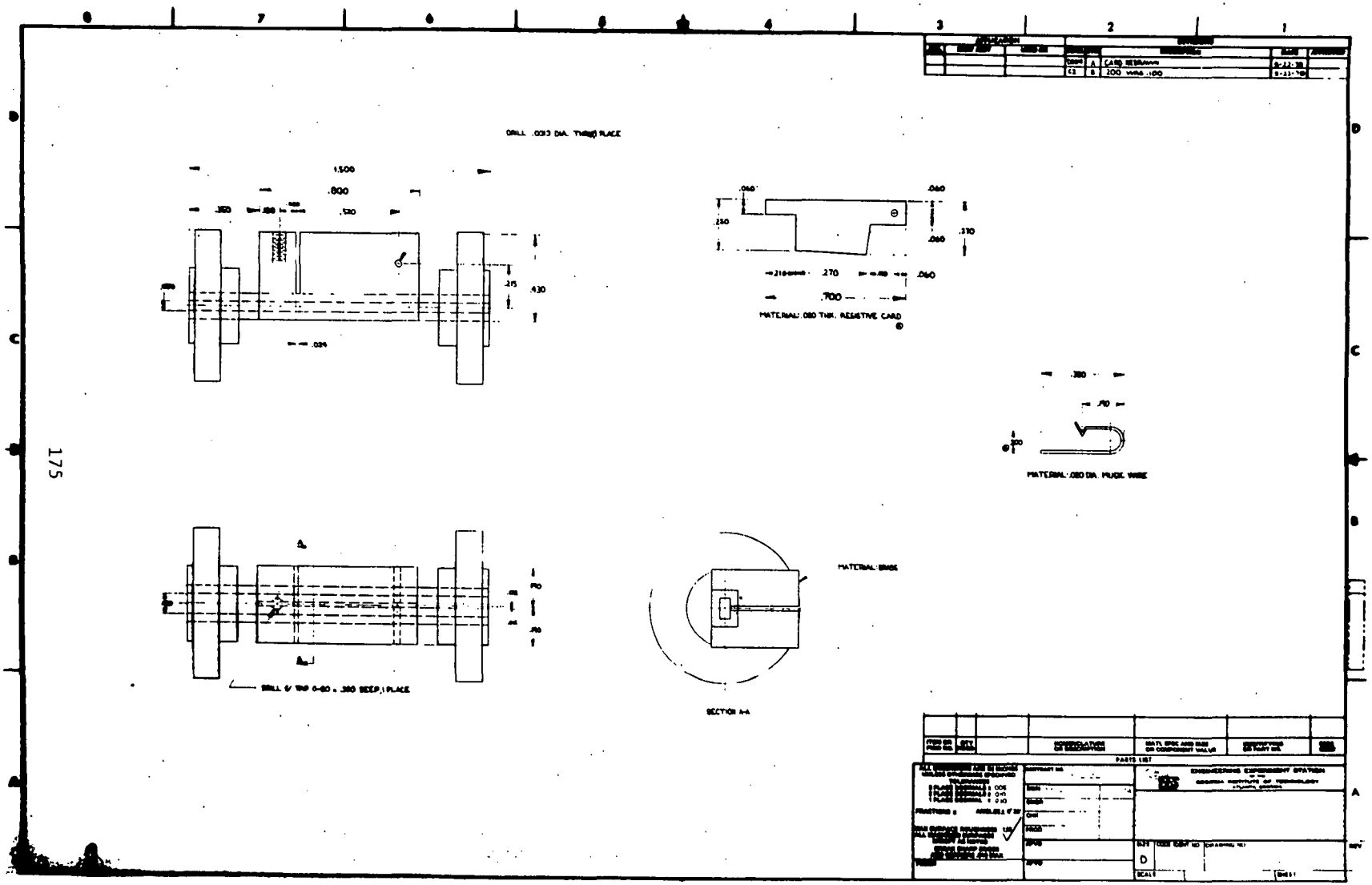
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GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA
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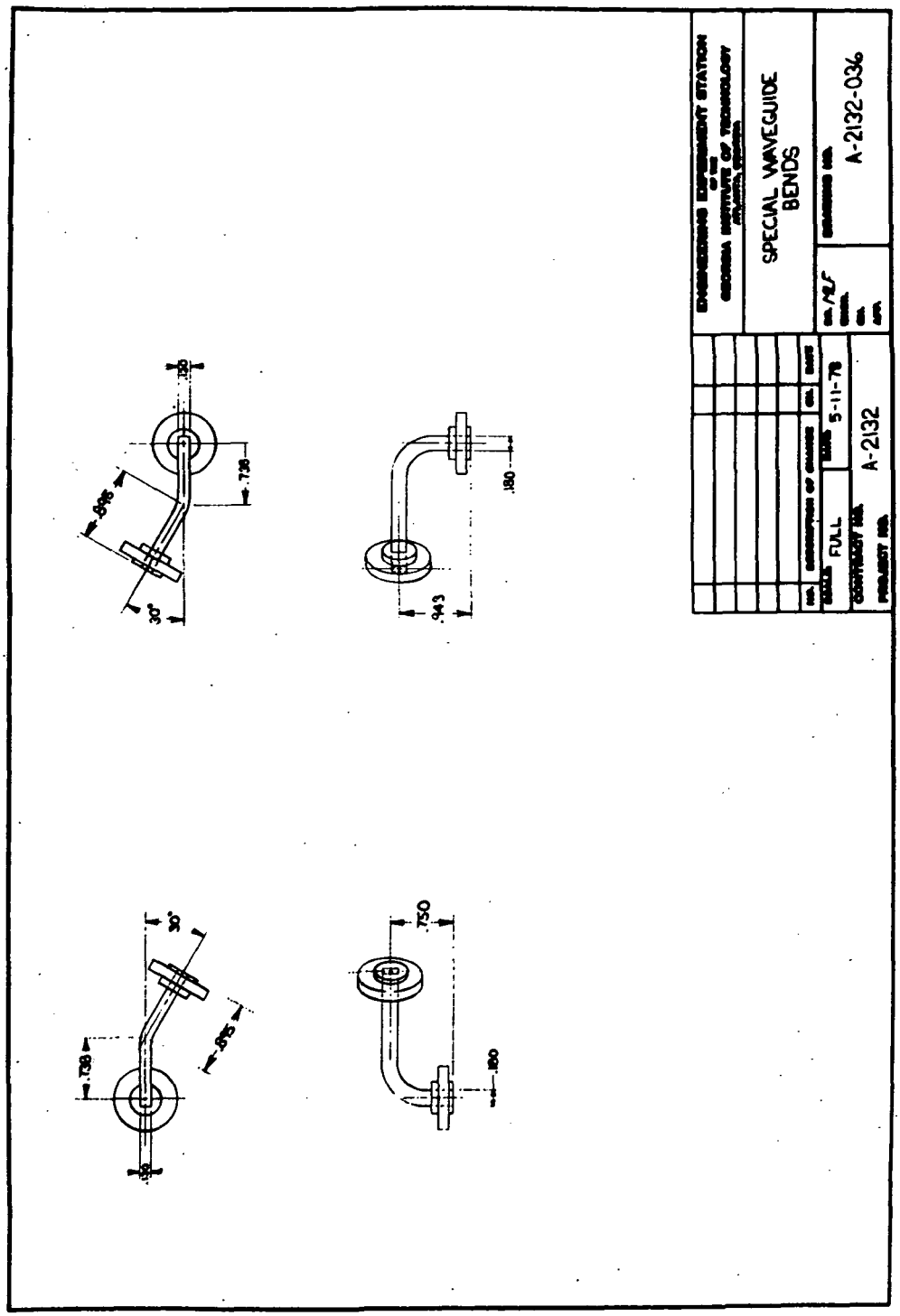
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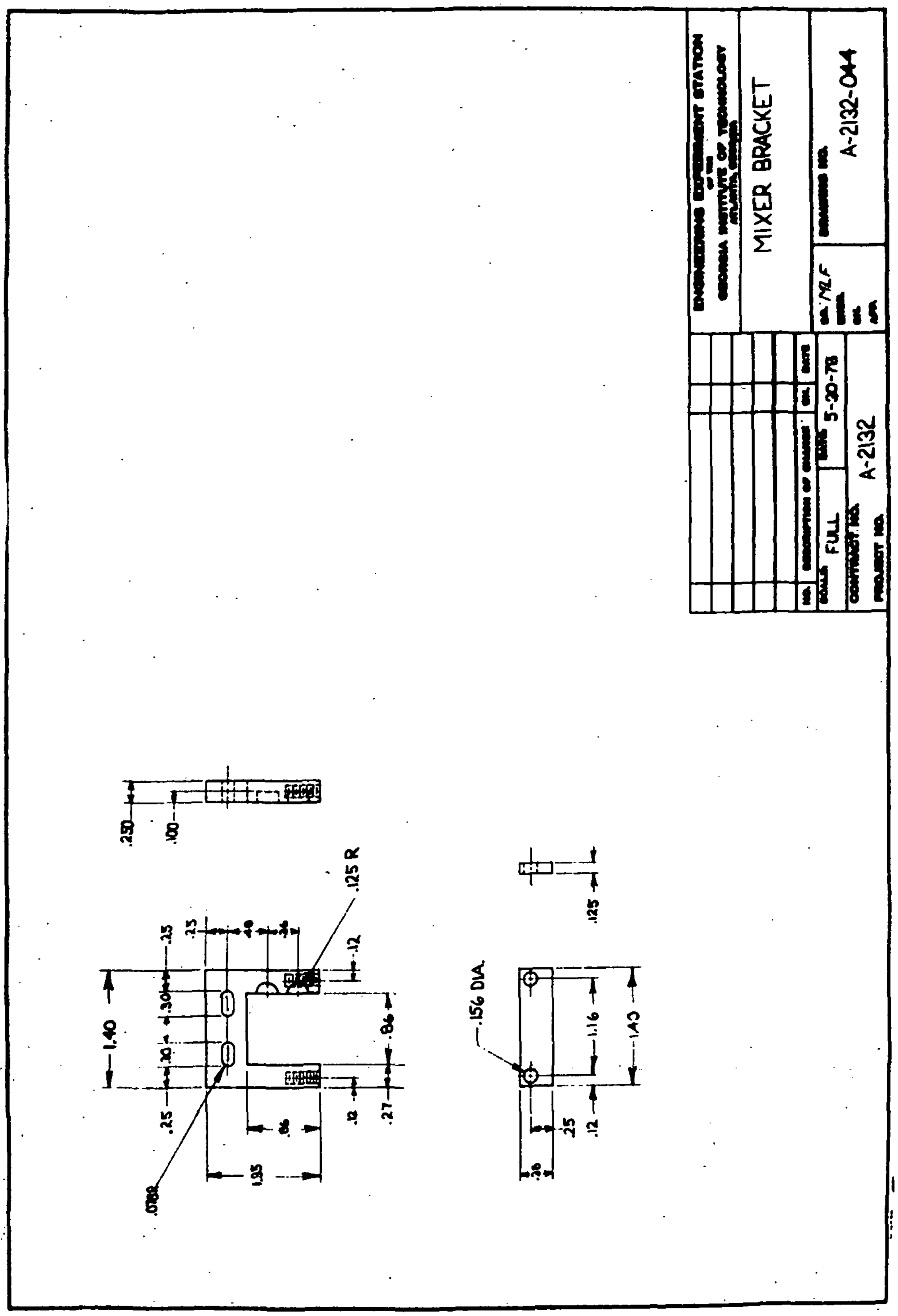
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ATLANTA, GEORGIA
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APPENDIX D

SEASAT GULF OF ALASKA EXPERIMENT PLAN


easat
GULF OF ALASKA
EXPERIMENT PLAN
28 August – 26 September 1978

SECTION III

PLAN OF OPERATION (SPECIFIC)

A. PHASE I

The Oceanographer (Figure 3-1) will depart Seattle on August 28 and proceed directly to Ocean Station PAPA, 50°N 145°W. There the Oceanographer will inspect the mooring of a previously deployed Waverider buoy, which will be monitored by the Canadian Coast Guard Cutters, Quadra and Vancouver, during the

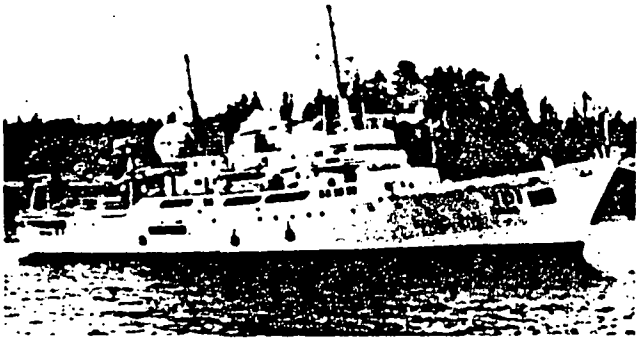

Figure 3-1. The OSS Oceanographer

experiment. The mooring for the Waverider buoy is as shown in Figure 3-2. The 200-m section of 3/8-in. nylon rope between the rubber shock cord and the buoyant tether will be replaced with a section of 3/8-in. nylon with shielded cover to protect the line against chafing if it becomes entangled with the main mooring during a storm. The light and radar reflector on the surface float will enable the Ocean Station vessels to keep position on the buoy at all times while on station.

Also while at Ocean Station PAPA, the Oceanographer will conduct a performance comparison of shipboard oceanographic and meteorological instruments with the Vancouver. This intership calibration of instruments will provide the necessary information for relating the analyses of data from both platforms. During this performance test, both ships will take continuous one-half hour anemometer wind records, sea surface temperature, and appropriate simultaneous surface and upper air measurements of temperature and pressure. A 30-min wave record will also be taken with the pitch and roll buoy from the Oceanographer while the Vancouver takes equal records with the Waverider and Tucker meter. Following the performance tests, the Oceanographer will proceed to the starting point of the first CTD section.

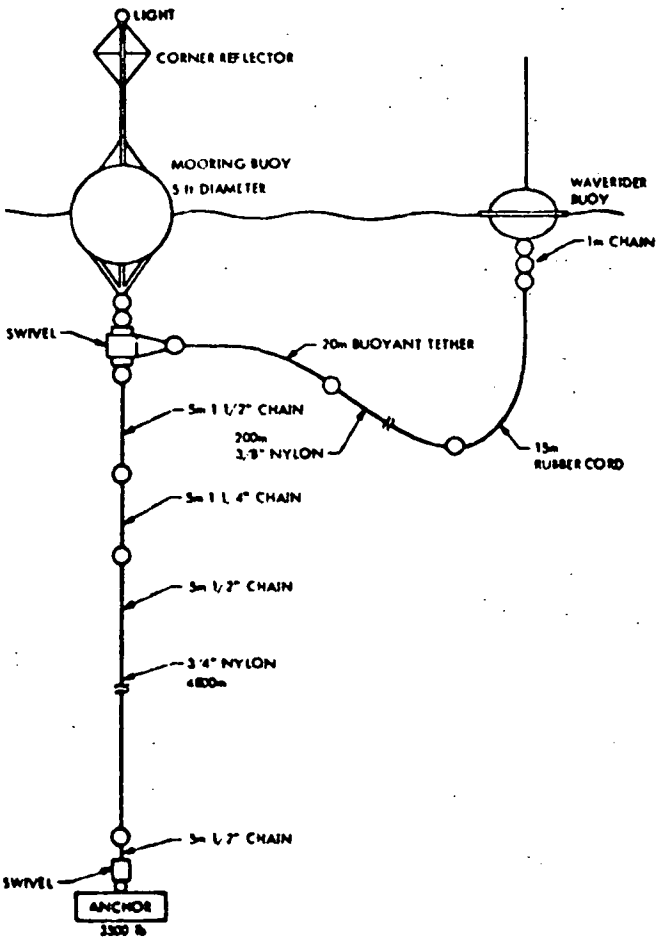

Figure 3-2. Waverider Buoy Mooring Configuration

B. PHASE II

Upon completion of the performance tests, the Oceanographer will proceed to the starting point of the first CTD section. A total of 18 stations will be taken at locations shown in Figure 3-3 and tabulated in Table 3-1. The station spacing is closest together (5 nm) along the section line normal to the continental slope off Kodiak Island, where the westward flow is generally most intense. Three geostationary satellite-tracked buoys will be set adrift near station 15 to track the flow during the period of the experiment. After completing the 18 stations of Section 1, the Oceanographer will proceed to Section 2, where an additional 19 CTD stations will be taken. See Figure 3-4 and Table 3-2 for station locations. The two CTD sections and the satellite-tracked drift buoys should provide sufficient information to describe the large-scale field of motion and the sea level slope in the region.

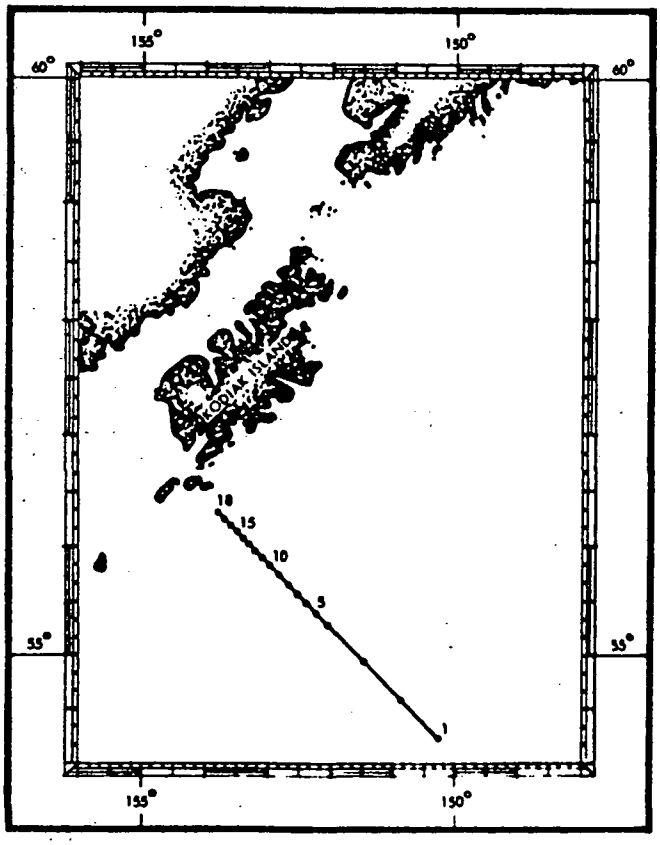

Figure 3-3. CTD Stations – Section 1

Table 3-1. CTD Locations – Section 1

Station	Latitude (°N)	Longitude (°W)
1	54°-12'	150°-18'
2	54°-32'	150°-53'
3	54°-54'	151°-28'
4	55°-12'	152°-00'
5	55°-18'	152°-13'
6	55°-25'	152°-24'
7	55°-32'	152°-25'
8	55°-38'	152°-46'
9	55°-42'	152°-52'
10	55°-45'	152°-58'
11	55°-48'	152°-04'
12	55°-52'	153°-10'
13	55°-55'	153°-15'
14	56°-00'	153°-22'
15	56°-04'	153°-28'
16	56°-08'	153°-35'
17	56°-11'	153°-42'
18	56°-18'	153°-48'

During this phase, underway data will be taken between all stations. Also, at relevant satellite overpass times, the Oceanographer will make the appropriate *in situ* oceanographic and meteorological observations for satellite sensor validation.

C. PHASE III

Upon completion of Section 2, the Oceanographer will proceed to Site B, arriving there September 7 in time to make observations for the first satellite pass for that day. The Oceanographer will remain on station at Site B until completing observations for the second

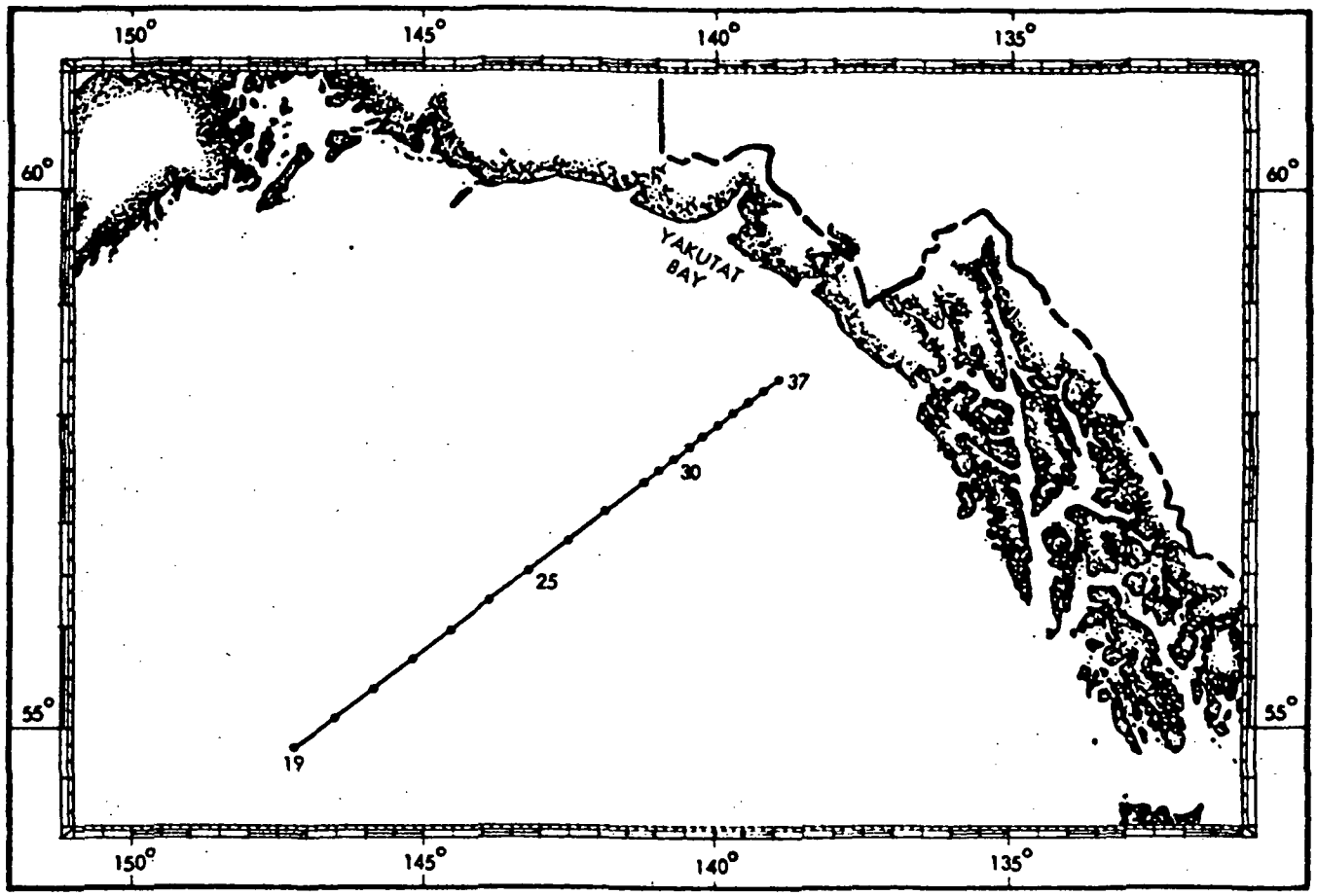

Figure 3-4. CTD Stations – Section 2

satellite overpass for September 9, and then proceed to Site A arriving there on September 10. Because of time constraints west to east, the Oceanographer will not arrive at Site A in time for the first orbit for that day. Data will be taken underway for this pass thus eliminating the pitch and roll buoy observation. At Site A, the Oceanographer will make observations for the remaining satellite overpass for September 10. It will then return to Site B on September 12, where this observational procedure will again be repeated. This alternate occupation of Sites A and B will continue through September 25.

During each overpass at Sites A and B, the ship will obtain 30-min wind and wave records, standard surface and upper air meteorological observations, and a CTD station. Between sites, the Oceanographer will make underway observations including the expendable bathythermograph (XBT). On the westward leg, XBT casts will be taken every 60 nm. On the eastward leg, because of the lack of time, no CTD stations will be taken.

Part of Phase III operations may also include the Synthetic Aperture Radar (SAR) coastal wave experiment. In the event of a well-developed swell, the ship may be directed to break off the above-described operations and proceed to a coastal site off Vancouver Island to await the satellite overpass. For details of this experiment see Section IV-B, "Measurement Procedures, Coastal Wave Measurements."

Table 3-2. CTD Locations – Section 2

Station	Latitude (°N)	Longitude (°W)
19	54°-48'	147°-11'
20	55°-07'	146°-28'
21	55°-27'	145°-46'
22	55°-44'	145°-04'
23	55°-57'	144°-34'
24	56°-13'	143°-59'
25	56°-32'	143°-15'
26	56°-51'	142°-32'
27	57°-07'	141°-46'
28	57°-28'	141°-00'
29	57°-34'	140°-45'
30	57°-40'	140°-30'
31	57°-45'	140°-15'
32	57°-53'	140°-00'
33	58°-00'	139°-44'
34	58°-05'	139°-28'
35	58°-11'	139°-12'
36	58°-14'	139°-06'
37	58°-20'	138°-55'

A major element of the Phase III operation will be the aircraft overflights of the Oceanographer at Sites A and B coincident with the satellite's passage. The four aircraft will periodically rendezvous over the ship on days when orbits pass over regions selected for aircraft underflights (Figure 3-5). Selection of aircraft operating areas was based on the following considerations: (1) sensor experiment involved, (2) range capabilities of individual aircraft, and (3) on-station time requirements for data collection.

Because the mission requirements differ for each of the four aircraft, the flight schedules are largely independent of one another.

The four aircraft participating in the Gulf of Alaska Experiment are:

(1)	NASA	NC-130B
(2)	NASA	CV-990A
(3)	Navy	RP-3A
(4)	Canadian	CV-580

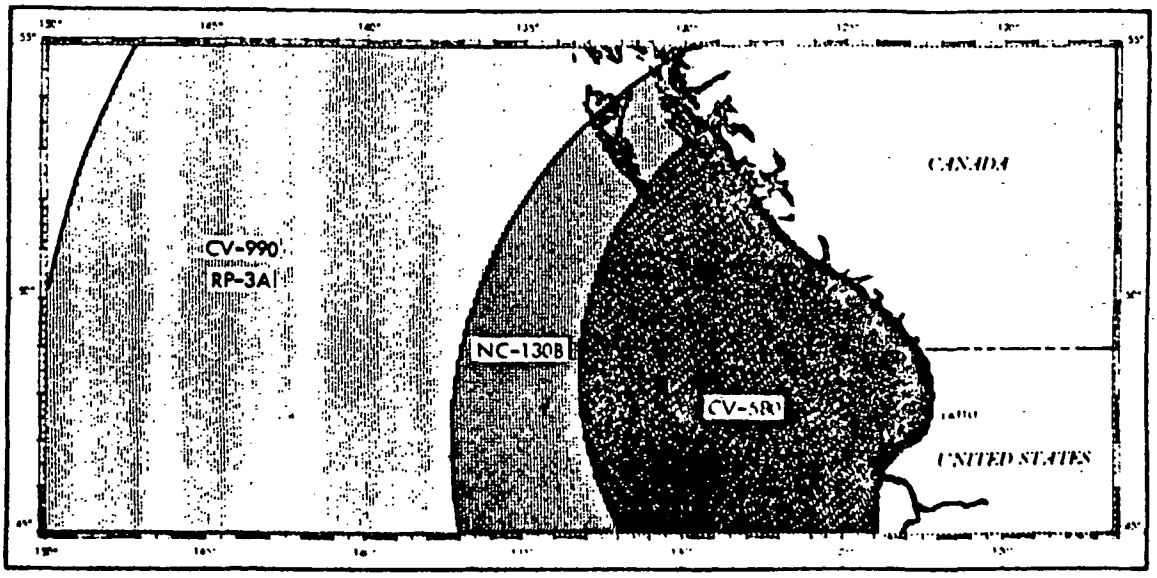

Figure 3-5. Aircraft Operating Regions

Table 4-7. Observation Plan for NC-130B

Data Type	Recording Method	Recorded Output	Processing Schedule	Responsible Individual
Radar Backscattering Cross Section	Digital 9-track tape recorder	Backscatter power as a function of incidence angle and azimuth-1/2 s integration	2 weeks	L. Schroeder LRC
Surface Wave Profiles	Analog FM	Surface wave profiles	2 months	L. Schroeder LRC
Sea Surface Temperature	Digital 9-track tape recorder	1-s samples	2 weeks	L. Schroeder LRC
Air Temperature	Digital 9-track tape recorder	1-s samples	2 weeks	L. Schroeder LRC
Photography	Photographic film	Photo prints	2 months	L. Schroeder LRC
Wind Speed, Direction	LTN-51 digital tape	Wind speed and direction listings	2 weeks	L. Schroeder LRC

3. NASA CV-990A

a. General Flight Plans. The CV-990A (Figure 4-12) is equipped with an airborne version of the Seasat Scanning Multifrequency Microwave Radiometer (SMMR). Table 4-8 lists remote sensing instrumentation aboard this aircraft. The CV-990A will measure emitted radiation from the ocean surface at five frequencies while flying within the 659-km-wide swath of the satellite's SMMR. The CV-990A is scheduled to make four flights during the period of September 11 to 16, 1978. The details of the data collection flights are shown in Figures 4-13 through 4-16.

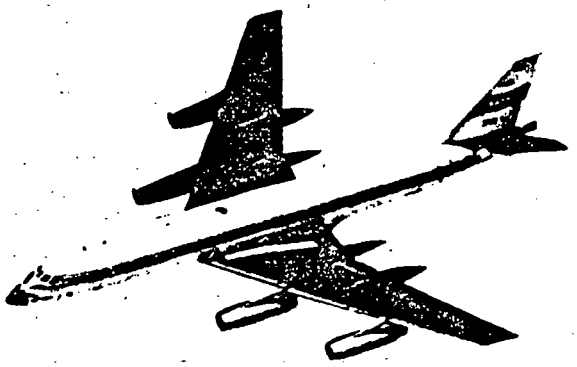

Figure 4-12. NASA CV-990A

The data collection schemes for all CV-990A flights call for the recording of continuous airborne SMMR observations at 35,000-ft altitude through the Seasat SMMR swath, with arrival times over either the Oceanographer or the Ocean Station PAPA weather ship at Satellite overpass times.

CV-990A data collection will continue through the swath until the aircraft reaches the swath's outer edge. A descent to 500 ft will be made, and data collection will continue at this altitude on the return leg. During return, the aircraft will measure surface winds using its Inertial Navigation System (INS), conducting INS calibration maneuvers each half hour. These maneuvers consist of a 5 deg right-bank 90 deg turn and a return to track at 5 deg left bank (Figure 4-17). Also during the return leg at 500-ft altitude, the aircraft will collect radiation data from airborne upward-looking radiometers.

b. Schedule. Because of Faraday rotation effects on the polarization of surface-emitted radiation, all but one flight of the CV-990A will be conducted during night-time hours when the ionospheric density is lowest, and rotational effects are at a minimum. These flights are shown in Figures 4-13 through 4-15. The single daylight flight will be conducted in the region of Ocean Station PAPA. The track for this flight is shown in Figure 4-16.

Table 4-8. Remote Sensing Instrumentation for CV-990A

Sensor	Measurement
Synthetic Aperture Radar L-Band	Wave directional spectra
Scanning Multichannel Microwave Radiometer Simulator 6.6, 10.6, 18, 21, 37 GHz	Sea surface temperature Surface winds Atmospheric water vapor and liquid water
Electronic Scanning Microwave Radiometer (ESMR) 19.35 GHz	Rain mapping
Microwave Radiometers, 21, 37 GHz upward looking	Atmospheric water vapor and liquid water
1.4 GHz Nadir Viewing	Exploratory
94, 183 GHz 45° to right side	Rain, water vapor
118 GHz 45° to right side	Atmospheric temperature profiles
PRT-5 Infrared Radiometer	Sea surface temperature
RC-9 Camera	Cloud cover, foam

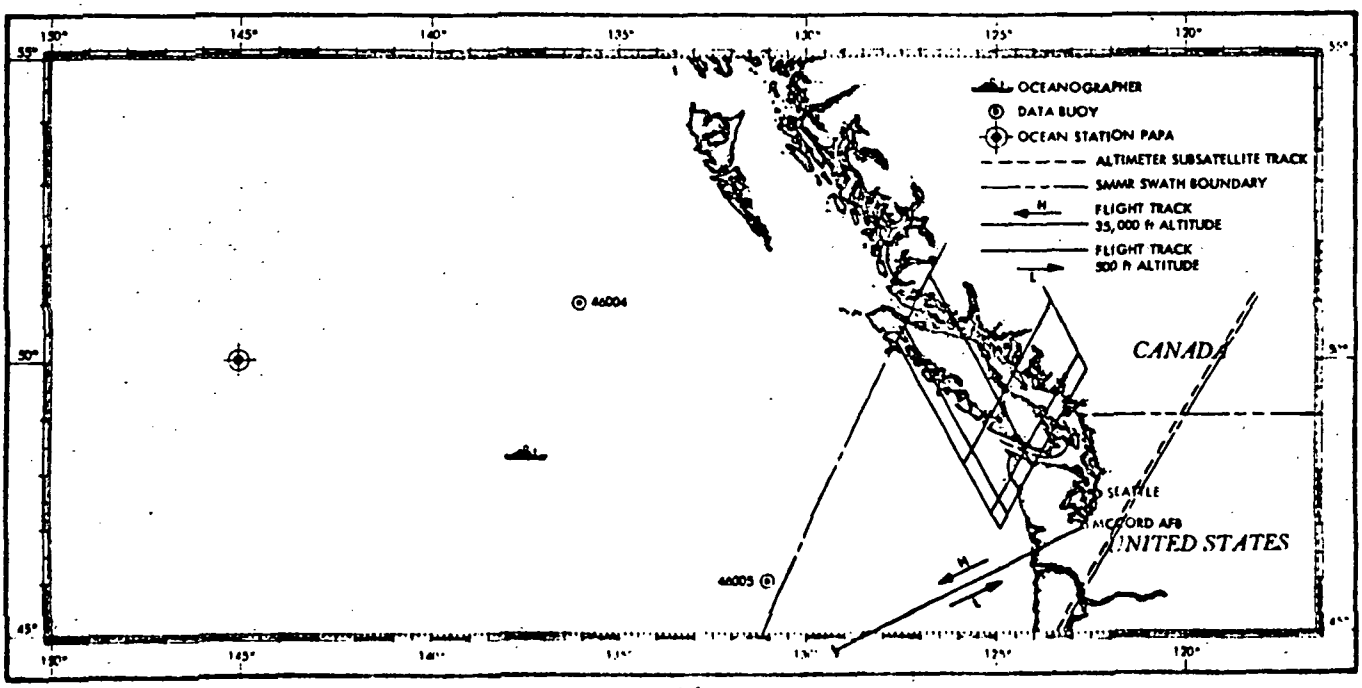

Figure 4-13. Flight Plan for CV-990A, Option 1

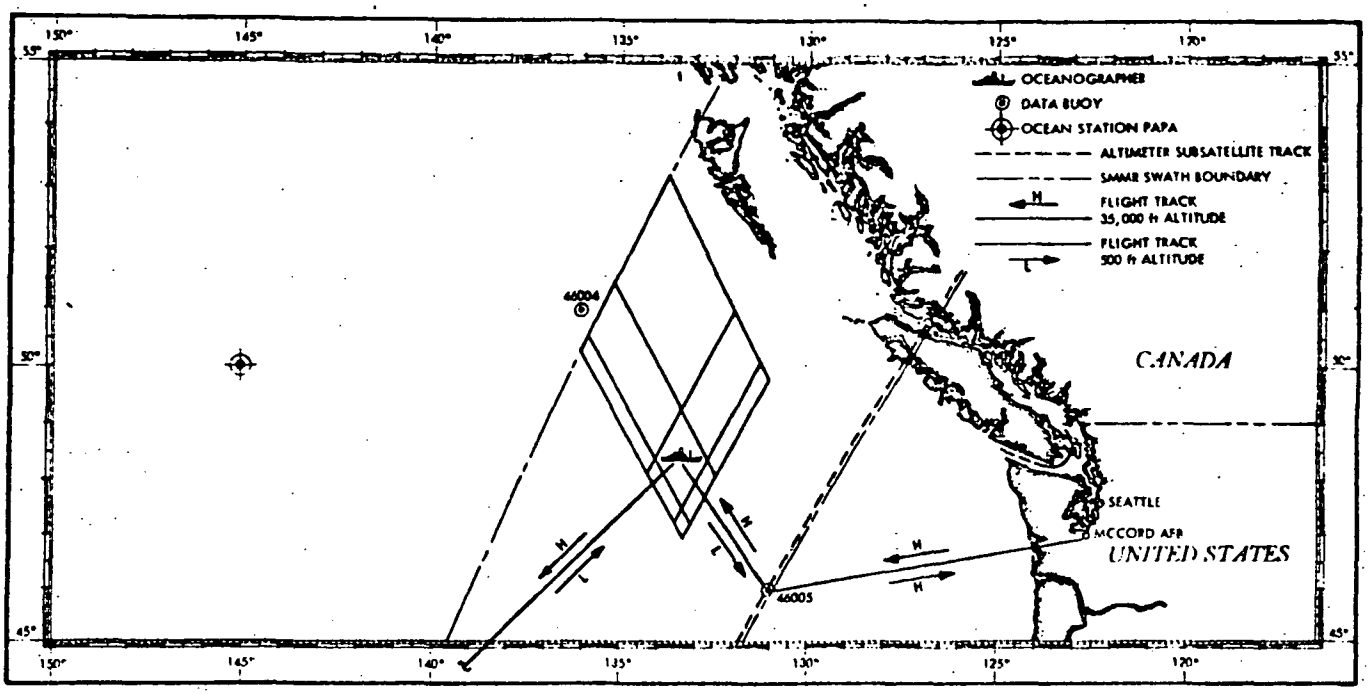

Figure 4-14. Flight Plan for CV-990A, Option 2

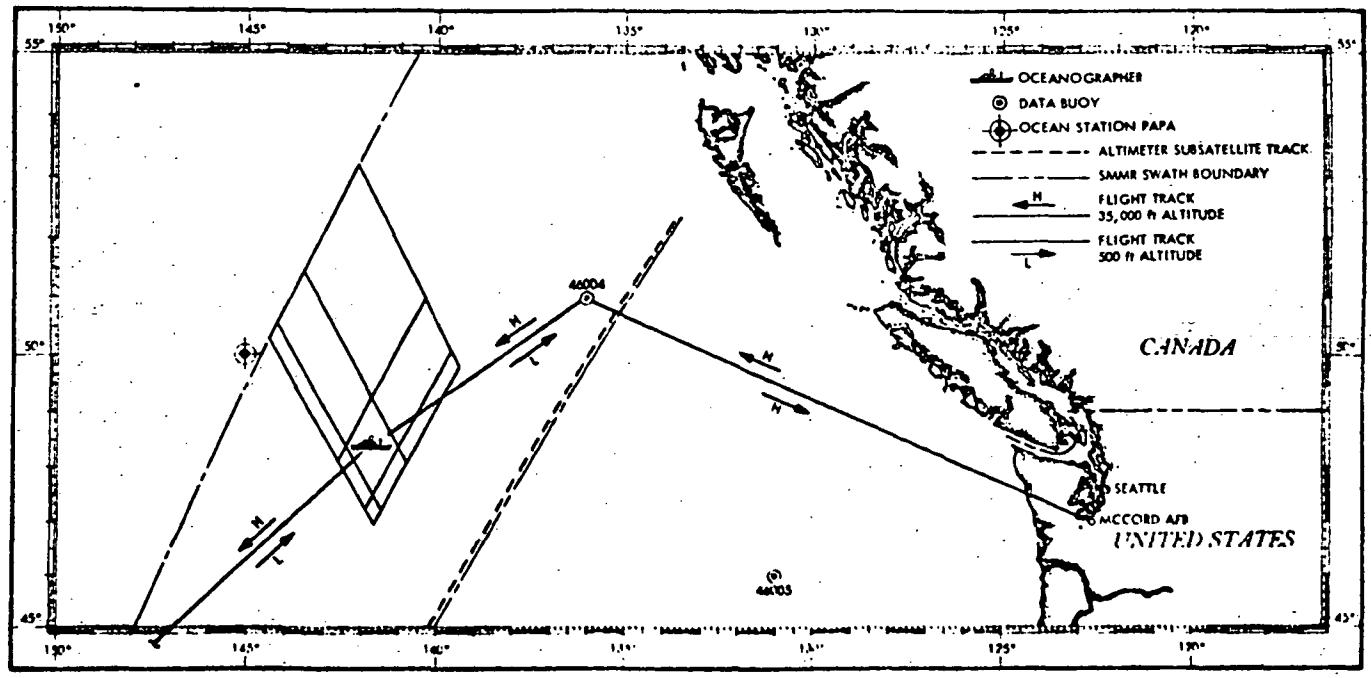

Figure 4-15. Flight Plan for CV-990A, Option 3

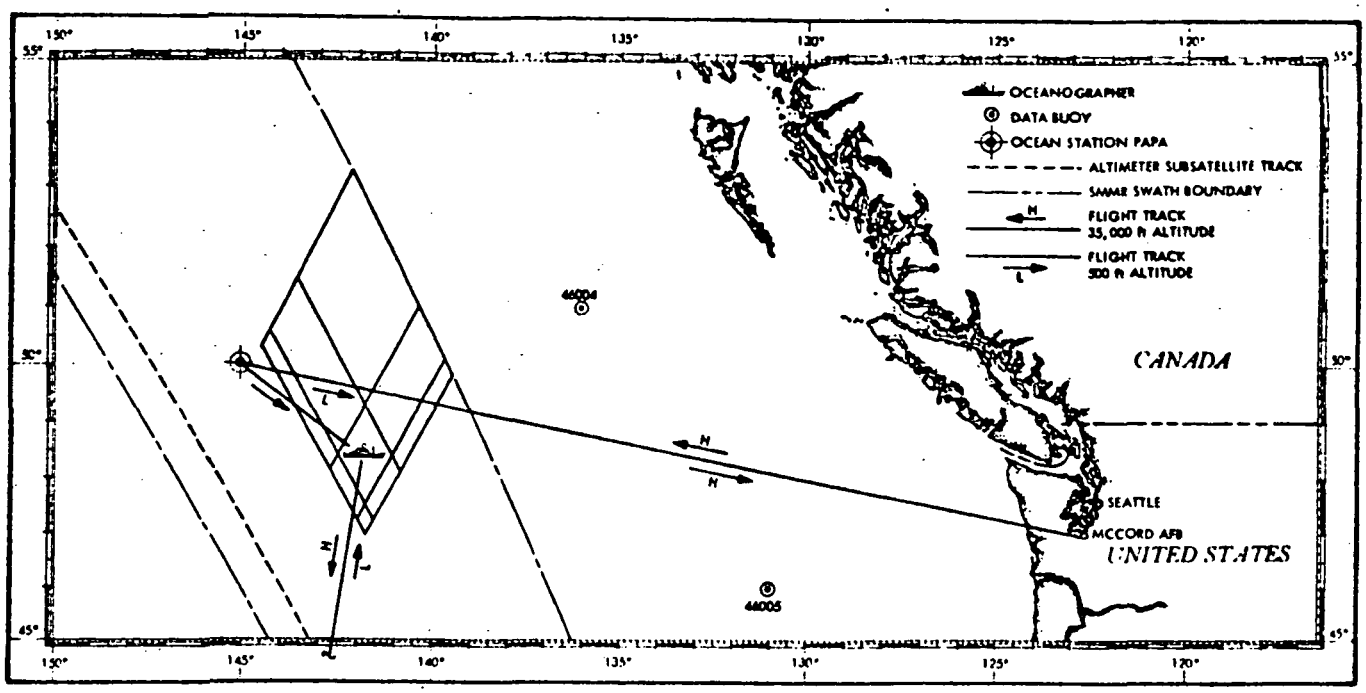

Figure 4-16. Flight Plan for CV-990A, Option 4

The flight dates and times possible under these restrictions are listed in Table 4-9, which identifies the night-time orbits (descending) covering the regions depicted in Figures 4-13 through 4-15, and the daytime orbits (ascending) required for coverage of Ocean Station PAPA.

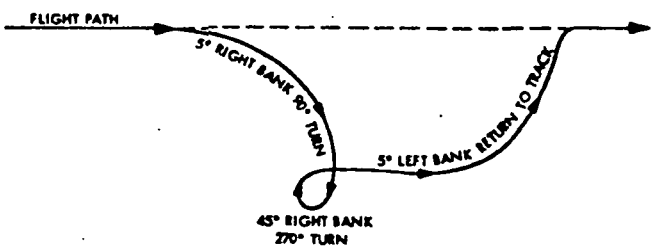

Figure 4-17. Inertial Navigation System Calibration Maneuver

c. Data Observation Responsibilities. The observation plan for each type of data to be taken aboard the CV-990A is outlined in Table 4-10. This table specifies the recording method, the instruments' recorded output, the processing schedule, and the responsible individuals. The Chief Scientist aboard the CV-990A will be responsible for providing copies of all processed data to the Seasat Support Center, JPL, Pasadena, California.

4. Navy RP-3A

a. General Flight Plans. The RP-3A (Figure 4-18) is instrumented with a five-frequency airborne radiometer system comparable to, but not identical with, the airborne system being flown by the NASA CV-990A. Table 4-11 lists remote sensing instrumentation aboard this aircraft. The RP-3A is scheduled to make eight flights during the period September 18 to 28, 1978. Four of these flights will be in the area of Ocean Station PAPA. The remaining four flights will be carried out in the region between Ocean Station PAPA and the U.S.—Canadian Coast. Details of these flight plans are shown in Figures 4-19 through 4-22.

Table 4-9. Flight Day Opportunities for CV-990A

Day	Orbit	Time (GMT) at 50°N
11 Sept	none	
12 Sept	1106	0828
	1112	1814
13 Sept	1120	0759
14 Sept	1134	0730
15 Sept	1149	0840
	1155	1825
16 Sept	1163	0811

Table 4-10. Observation Plan for CV-990A

Data Type	Recording Method	Recorded Output	Processing Schedule	Responsible Individual
Microwave Radiation, Scanning 6.6, 10.6, 18, 22.2, 37 GHz	Digital 9-track tape recorder	Brightness temperature 20 samples/s	6 months	T. Wilheit GSC
Microwave Radiation, Upward 21, 37 GHz	Digital 9-track tape recorder	Brightness temperature 20 samples/s	6 months	T. Wilheit GSC
Microwave Radiation Upward 21, 37 GHz	Digital 9-track tape recorder	Brightness temperature 20 samples/s	6 months	T. Wilheit GSC
Microwave Radiation, Fixed Angle 94, 183 GHz	Digital tape cassette, digital 9-track tape recorder	Brightness temperature 20 samples/s	6 months	T. Wilheit GSC
Microwave Radiation, Fixed Angle 118 GHz	Digital tape cassette, digital 9-track tape recorder	Brightness temperature 20 samples/s	6 months	T. Wilheit GSC
Microwave Radiation (ESMR) Scanning, 19.35 GHz	Digital 9-track tape recorder	Brightness temperature 20 samples/s	6 months	T. Wilheit GSC
Infrared Radiation 9.5 - 10.5 μ	Airborne digital data acquisition system	Instantaneous value every 10-s	List-immediately digital tape - 2 month	E. Peterson ARC
Radar Imagery, L-Band Synthetic Aperture	Optical recorder	Film	1 month	R. Jordon JPL
Photography	Photographic film	Photo prints	1 month	T. Wilheit GSC

APPENDIX E

FALL 1978 CV-990 NIMBUS G/SMMR MISSION

National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California
94035

NASA

Reply to Attn of: SEM:211-12

October 6, 1978

TO: Distribution

FROM: Earl V. Petersen, CV-990 Project Manager

SUBJECT: The Fall 1978 -- CV-990 NIMBUS-G/SMMR Mission
Bulletin No. 1 - Flight Requests, Schedule, Bases of Operation, Passports, Coordinators, Arctic Clothing, and Hotel Reservations

This bulletin announces the Fall 1978 -- CV-990 NIMBUS-G/SMMR Mission (NIMBUS-G Mission).

1.0 FLIGHT REQUESTS

The CV-990 NIMBUS-G Mission is an integrated program supporting several flight requests which have a common set of sensors and flight requirements. The CV-990 NIMBUS-G Mission FY 1979 OSTA Flight Requests are as follows:

#0311 Multipurpose Short Pulse Radar;
P.I. - D. M. LeVine, NASA/GSFC
(No flight hours assigned)

The objectives are as follows:

1. To demonstrate the feasibility and practicality of a real aperture, non-imaging microwave technique for routine measurements of ocean wave directional spectra and surface wind speed from high-altitude aircraft and satellites.

2. To acquire sea ice, snow, and ice sheet signatures in vertical soundings and side-looking imagery. This cryospheric data will be used (1) to assess potential of remote active microwave sensing of ice physical parameters, and (2) to support the CV-990 Fall Microwave Experiment (FR #0714), principally with side-looking imagery.

This experiment will concentrate on the development, operation, and data analysis of the Short Pulse Radar (13.9 GHz).

The flight areas required by Flight Request #0714 are adequate to meet the flight objectives of #0311; thus, no dedicated flights for this request are planned.

#0655 Multispectral Studies of the Freeze-Thaw Line, Surface Water, and Lake Ice;
P.I. - D. K. Hall, NASA/GSFC
(One flight; 6 flight hours)

The objective is to study the hydrology of the North Slope of Alaska and to provide more information so that the volume of surface water contained on the North Slope can be estimated. Active and passive microwave data will be used to attempt ice thickness determinations on some of the larger thaw lakes on the North Slope. Signatures of frozen and unfrozen tundra will be determined using passive microwave data. Overflow river ice, or aufeis, will be overflown and its extent and volume determined by analysis of stereo air photos. The extent and volume will be compared with results obtained in 1978 utilizing aircraft and satellite data.

The sensors required are common to those listed under Flight Request #0714.

This request requires one dedicated data flight over several rivers and lake test sites on the North Slope of Alaska. This flight can be easily integrated into the overall flight schedule of Flight Request #0714.

#0714 SMMR Underflights for Ocean/Atmosphere Parameters and New Sea Ice Signatures;
P.I. - P. Gloersen, NASA/GSFC
(18 flights; 104 flight hours)

The objectives are as follows:

1. Obtain multispectral microwave radiometric and other supporting data to be used in calculating offsets, retrieval algorithms and constants for spacecraft (S/C) SMMR open ocean, atmosphere, and sea ice (particularly new sea ice) parameters. Aircraft (A/C) underflights using the A/C simulator and other support instruments are essential for proper S/C SMMR radiometric calibration and adjustment of geographical parameter retrieval algorithm constants.

2. Obtain sufficiently large and varied data set to permit an initial assessment of the accuracy of the sea ice retrieval algorithm. The present A/C data set is not sufficient for verifying the functional form of the sea ice parameter retrieval algorithm.

3. Obtain a sufficiently large and varied data set to permit an initial assessment of the accuracy of the sea surface, temperature retrieval algorithm, including comparison with Airborne Expandable Bathy Thermograph (AXBT) data. Aircraft SMMR data in areas known to be free of Radio Frequency Interference (RFI) for the S/C SMMR are required, along with detailed ocean surface truth (e.g., AXBT's) in order to establish the accuracy of the SST retrieval algorithm.

4. Obtain data to determine retrievable continental ice sheet parameters. Based on the existing A/C SMMR data set for the Greenland ice sheet, present concepts of the retrievable parameters developed from analysis of NIMBUS-5 ESMR and P-3 Multifrequency Microwave Radiometer (MFMR) data do not appear entirely appropriate. Additional A/C SMMR data obtained in different locations on the ice sheet and with different temperature profiles are required to establish the ice sheet parameters that may be retrieved.

5. Obtain a sufficiently large and varied data set to permit an initial assessment of the accuracy of the algorithm to obtain near-surface wind (NSW) speeds over oceans (cold ocean case). Aircraft underflights for NSW speed data sets are required, over and above those acquired during the 1978 CV-990 hurricane expedition. These are needed to obtain additional data from sufficiently large samplings and variations of sea/atmosphere conditions for proper evaluation of NSW retrieval accuracies.

6. Obtain additional data for radiometric calibration of the S/C SMMR.

To meet the objectives, the P.I. (P. Gloersen) will make the necessary arrangements to provide sensor systems as follows:

(1) Aircraft SMMR (Scanning Multichannel Microwave Radiometer) Simulator (6.6, 10.7, 18, 21, and 37 GHz); NASA/GSFC.

(2) Microwave Radiometers (1.4 and 94 GHz); NASA/GSFC.

(3) Short Pulse Radar (13.9 GHz); NASA/GSFC (supported by Flight Request #0311).

(4) Ocean Temperature Scanner; NASA/GSFC.

(5) Downward Viewing Infrared (10-micron) PRT-5 Radiometer; NASA/ARC.

(6) Aerial Cameras; NASA/ARC.

This request required sufficient flights to acquire a satisfactory data set for first-year thin ice, multiyear ice, ice concentration under initial annual ice canopy growth conditions, sheet ice, sea surface temperature (SST), and near-surface winds (NSW). To acquire the data set, several flight areas and test sites have been requested as follows:

1. Canadian Archipelago Test Sites (sea ice).
2. Arctic Ocean (multiyear ice).
3. Greenland Sea (sea ice and SST).
4. Greenland Test Sites (ice sheet).
5. Beaufort and Chuckchi Seas, and Baffin Bay (sea ice).
6. Norwegian Sea/Ocean Polar Front (SST).
7. Pacific Ocean and Gulf of Alaska (SST and NSW).

2.0 SCHEDULE

The CV-990 flights will be planned and coordinated primarily to underfly NIMBUS-G and, to the extent possible, SEASAT-A. Also, the flights will be coordinated with several ground-truth sites in Canada and Greenland, and with two aircraft -- a NOAA/RFC P-3 out off the Seattle area and a Norwegian P-3.

The general schedule that follows is based on the contingency of a successful NIMBUS-G (to be designated NIMBUS-7 in orbit) launch on October 23, 1978.

October

10 - 16 (Tue - Mon)	Experimenters' Equipment Installation and Ground Calibration
17 - 18 (Tue - Wed)	Aircraft Preflight
19 (Thur)	Pilot Proficiency
Oct 20 - Nov 19	Experimenters' Flight Period

The tentative flight schedule for the NIMBUS-G/SMMR underflights is as follows (specific flight dates may change because of NIMBUS-G and SEASAT-A orbital updates or weather conditions):

Flight #	October	
1	20 (Fri)	Experimenters' Check-out and Data Flight/Pacific Ocean. Moffett to Moffett.
2	24 (Tue)	Transit and Data Flight/Fresh and Salt Water Lakes, and Desert Calibration Test Sites. Moffett to Andrews AFB, Maryland.
3A, B	25 (Wed)	Transit, Sea Surface Temperature (SST) (Gulf Stream), and Sea Ice Data Flight/ Atlantic Ocean and Baffin Bay. Andrews to Gander, Canada to Thule AB, Greenland.
4	27 (Fri)	Multiyear Sea Ice and Ice Sheet Data Flight/Arctic Ocean and Greenland. Thule to Thule.
5	28 (Sat)	Transit and Ice Sheet Data Flight/ Greenland Test Sites. Thule to Sondrestrom, Greenland.
6	30 (Mon)	Transit, Ice Sheet, Sea Ice, and SST (Polar Ocean Front) Data Flight/ Greenland Test Sites; Greenland and Norwegian Seas. Sondrestrom to Bodo, Norway.
	November	
7	1 (Wed)	SST (Polar Ocean Front) and Sea Ice Data Flight/Greenland and Norwegian Seas. (Flight to be coordinated with AXBT drops from Norwegian P-3 aircraft.) Bodo to Bodo.
8A, B	2 (Thur)	Transit Flight (a.m.)/Bodo to Bergen, Norway. Aircraft on Display. Transit Flight (p.m.)/Bergen to Bodo.

Flight #	November	
9	3 (Fri)	Same as Flight #7 Above. Bodo to Bodo.
10	6 (Mon)	Transit, SST (Polar Ocean Front), Sea Ice and Ice Sheet Data Flight/ Norwegian and Greenland Seas, and Greenland Test Sites. Bodo to Thule.
11	7 (Tue)	Sea Ice Data Flight/Baffin Bay, and Canadian Eastern Shore and Inlet Test Sites. Thule to Thule.
12	8 (Wed)	Transit and Sea Ice Types Data Flight/ Canadian Archipelago and Beaufort Sea Test Sites. Thule to Fairbanks, Alaska (Port of Entry).
13	10 (Fri)	Sea Ice Types and Concentrations Data Flight/Chuckchi and Beaufort Seas, and Mackenzie Bay Test Sites. Fairbanks to Fairbanks.
14	11 (Sat)	Multispectral Studies of Freeze-Thaw Line, Surface Water, and Lake Ice (FR #0655)/North Slope of Alaska and Frozen Lakes Near Barrow. Fairbanks to Fairbanks.
15	12 (Sun)	Transit and SST Data Flight/Gulf of Alaska and Pacific Ocean. Fairbanks to Hickam AFB, Hawaii.
16	13 (Mon)	Nighttime SST Data Flight/Pacific Ocean. Hickam to Hickam.
17	16 (Thur)	Transit, SST, RFI (Aircraft and NIMBUS-G Intercomparison Test), and NOAA P-3 Coordination Data Flight/ North Pacific Ocean Buoy Test Site. (Flight to be coordinated with NOAA/RFC P-3 aircraft based at Seattle-Tacoma International.) Hickam to McChord AFB, Washington.

Flight #	November	
18	17 (Fri)	Near-Surface Winds (NSW) and P-3 Coordination Data Flight/North Pacific Ocean Buoy Test Site. McChord to McChord.
19	19 (Sun)	Transit, SST, NSW, Ocean, Atmosphere, and P-3 Coordination Data Flight/ North Pacific Ocean Buoy Test Site. McChord to Moffett.
	20 (Mon)	Ground Calibration of Microwave Systems and Start of Removal of Equipment.
	21 & 22 (Tue & Wed)	Unloading of Experimenters' Equipment.

3.0 BASES OF OPERATION

The bases of operation for the CV-990 NIMBUS-G Mission are as follows:

October 20 - 23	Moffett Field, California
October 24	Andrews AFB, Maryland
October 25 - 27	Thule AB, Greenland, Denmark
October 28 - 29	Sondrestrom AB, Greenland
October 30 - November 5	Bodo, Norway
November 6 - 7	Thule AB, Greenland
November 8 - 11	Fairbanks International, Alaska
November 12 - 15	Hickam AFB, Hawaii
November 16 - 18	McChord AFB, near Tacoma, Washington
November 19	Moffett Field, California

4.0 PASSPORTS

All participants traveling to Thule and Sondrestrom, Greenland, and Bodo, Norway with the CV-990 are required to have a passport.

5.0 COORDINATORS

5.1 The personnel who will coordinate the NASA-ARC support of this CV-990 program are as follows:

1. Earl V. Petersen - NASA/ARC CV-990 NIMBUS-G/SMMR Mission Manager and Mission Director. (Commercial 415 965-5342*; FTS 448-5342*)

2. John O. Reller, Jr. - NASA/ARC CV-990 Assistant Mission Manager and Mission Director. (Commercial 415 965-5392*; FTS 448-5392*)

5.2 Support personnel for this mission are as follows:

1. Curtis L. Muehl - NASA/ARC CV-990 Facility Manager who is responsible for the Airborne Digital Data Acquisition System (ADDAS), housekeeping system, aircraft system-experiment interfaces, and aircraft systems calibrations. (Commercial 415 965-6431*; FTS 448-6431*)

2. Donald L. Wilson (Informatics) - CV-990 ADDAS Programming/ Contract Supervisor. (Commercial 415 965-6493; FTS 448-6493)

3. Seth S. Kurasaki - NASA/ARC CV-990 Program Engineer who is responsible for certification of the experiment equipment installation design and construction, and the installation of the equipment aboard the CV-990. (Commercial 415 965-6320; FTS 448-6320)

6.0 ARCTIC CLOTHING

For the mission to Alaska, Greenland, and Norway, all flight personnel will be furnished parka and gloves. (Our supply of gloves has dwindled over the years; therefore, please try to furnish your own.) This clothing will be for general use in the cold climates; however, it will also be part of your aircraft arctic survival equipment. Thus, on all flights in Alaksa, Greenland, and Norway, this clothing must be aboard the CV-990.

To facilitate issuance of this clothing, everyone who will participate in these flights will be contacted by John Reller to get his/her parka size. Remember, this clothing is U.S. Government property and must be returned to the Ames Research Center/Medium Altitude Missions branch at the completion of the mission.

*If no answer at this number, call 415 965-5336 or FTS 448-5336 and leave a message with the secretary.

7.0 HOTEL RESERVATIONS

Hotel reservations will be made for all personnel who will travel with the CV-990. The hotels and rates will be announced in an Experimenters' Notice.

Earl V. Petersen

Earl V. Petersen

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APPENDIX F

CALIBRATION ERROR CORRECTION

PROBLEM

Warmer temperatures (∿30°K) were observed when looking at the scene with the 94 GHz channel of the radiometer system than were expected during the flight tests. The radiometer was reassembled upon return from the test flights. This same characteristic was present when viewing the liquid nitrogen load used in the lab. This load has been investigated both theoretically and experimentally to determine its brightness temperature which is ∿100°K.

POST FLIGHT LAB TEST

First the 94 GHz channel was calibrated with the liquid nitrogen load in front of the scene lens with and without the 183 GHz channel turned on. No significant change was seen in the apparent temperature of the liquid nitrogen load under these two conditions. This test was performed several times with the same results. Then the 94 GHz channel was loosened from its bracket. The 94 GHz antenna was moved to a slightly different angle and set firmly into the RF head. Calibration tests were again made with and without the 183 GHz channel turned on. It was found that by moving the antenna a brightness temperature of 100°K was observed both with and without the 183 GHz system turned on. These tests firmly indicate a slight misalignment of the antenna was the reason for the observation of the warmer than expected scene temperatures during the flight on the 94 GHz radiometer channel. It is thought that adjustments of the feed to obtain the proper polarization alignment for the 94 GHz channel produced the angular misalignment that may have contributed to this problem.

SOLUTION

During the tests no error was found when viewing a room temperature load through the scene lens. This should be expected considering the source of the error. If the antenna is partially viewing room temperature loads and a colder scene, then the scene would look warmer due to the partial contribution of the room temperature load. However,

if the antenna is viewing a room temperature load through the scene lens then partially viewing another room temperature load would have no effect on the apparent scene temperature. An error curve can be made which shows actual and observed temperatures if a linear error contribution is assumed. An example is shown in Figure F1.

An observed gain of 63.33°K per volt and an observed offset of -198.5°K were recorded following a typical calibration cycle. For this cycle the radiometer output voltage was +8.44 volts looking at the hot load (336°K) and the voltage was +7.24 volts looking at the cold load (260°K).

Using Equation [A] on Figure F1,

$$\text{Observed Gain} = \frac{336°K - 260°K}{8.44v - 7.24v}$$

$$= 63.33°K \text{ per volt} .$$

Using Equation [B] on Figure F1,

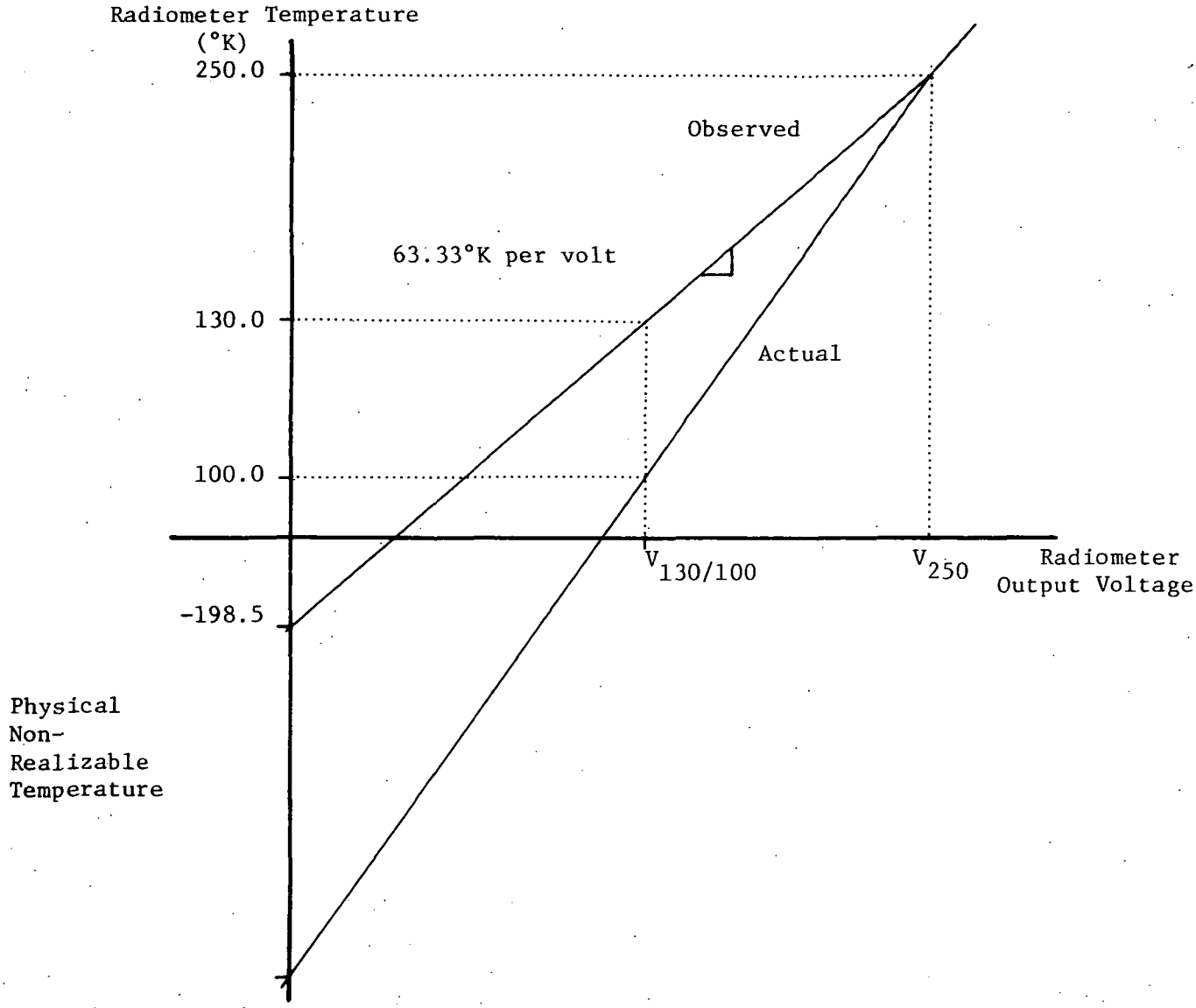
$$\text{Observed Output} = 336°K - (8.44v)(63.33°K \text{ per volt})$$

$$= -198.5°K$$

Using Equation [C] on Figure F1,

$$\text{Observed Output} = \frac{\text{Observed Temperature} + 198.5°K}{63.33°K \text{ per volt}}$$

For an observed temperature of 130°K, Equation [C] yields an output of +5.19 volts ($V_{130/100}$) and for a temperature of 250°K the output is +7.08 volts (V_{250}).



$$\text{Gain (°K per volt)} = \frac{T_2 - T_1}{V_2 - V_1} \qquad [A]$$

$$\text{Offset (°K)} = T_2 - (V_2)(\text{Gain}) \qquad [B]$$

$$\text{Output (volts)} = \frac{\text{Temperature - Offset}}{\text{Gain}} \qquad [C]$$

Figure F1. Observed Radiometer Temperature Curve versus Actual Radiometer Temperature Curve for the 94 GHz Channel Only.

From Figure F1 the gain and offset for the actual radiometer temperature can now be computed.

Using Equation [A] on Figure F1,

$$\text{Actual Gain} = \frac{250°K - 100°K}{7.08v - 5.19v}$$

$$= 79.37°K \text{ per volt}$$

Using Equation [B] on Figure F1,

$$\text{Actual Offset} = 250°K - (7.08v)(79.37°K \text{ per volt})$$

$$= -311.9°K$$

The actual temperature as a function of the observed voltage output is given by:

Using Equation [D],

Actual Temperature = (79.37°K per volt(Observed Output Voltage)-311.9°K

Typical temperatures are tabulated below for output voltages observed.

Observed Output (volts)	Actual Radiometer Temperature (°K)
+7.08	250
+5.57	130
+5.19	100
+4.31	30
+3.93	0

Equation [D] above should be updated with each calibration cycle as new Gain and Offset constants are calculated.

APPENDIX G

CARTRIDGE TAPE DATA FORMAT

CARTRIDGE TAPE DATA FORMAT

Data from the four radiometer channels along with various housekeeping parameters were recorded in fixed length blocks using a modified ANSII standard recording format*. Each block of data contains 2048 bytes of information which results from approximately 25 seconds of radiometer operation. The Nimbus-G flight data (94 GHz only) were recorded every 100 seconds. Each block of data is preceded by a preamble and followed by a 16 bit CRC (Cyclic Redundancy Check) character and a postamble. The preamble consists of 4 bytes of 00_{16} followed by a 55_{16} and then the ANSII standard preamble of 00_{16}, 01_{16} (15 zero bits followed by a 1). The 2048 bytes of data are then followed by a 16 bit CRC character computed with the CRC polynomial:

$$X^{16} + X^{12} + X^5 + X^1 + 1$$

Following the CRC character is the postamble consisting of a 1 followed by 15 zeros (80_{16}). Figure G1 illustrates the data block format. Blocks are separated by the ANSII standard inter-record gap.

DATA BLOCK FORMAT

The first 19 bytes of each data block contain housekeeping data that is recorded only once per block. The remainder of the block contains samples of the outputs of the four phase sensitive detectors on the four radiometer channels. These data repeat every 16 bytes. Table G1 lists the various parameters in the data block. Note that all voltages (load temperatures and radiometer temperatures) are 12 bit values in 2 bytes with the most significant 4 bits always zero. All temperatures are represented as 0-10 Vdc values with 0000_{16} corresponding to 0 volts and $0FFF_{16}$ corresponding to 10.0 volts. The section of this appendix on calibration explains how to convert these voltages to temperatures.

---

*American National Standards Committees, X3, X4, "Recorded Magnetic Tape Cartridge for Information Interchange," April 1975.

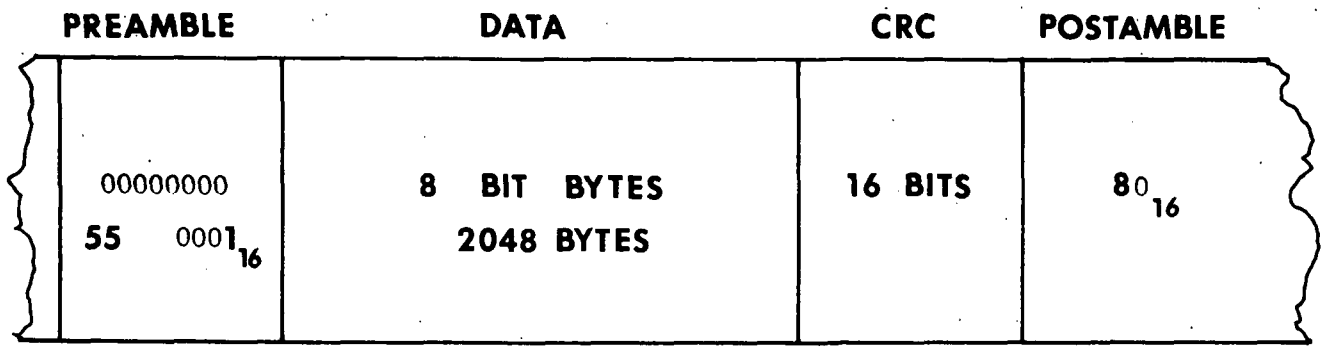


Figure G1. Magnetic Cartridge Tape Format.

TABLE G1

CONVAIR 990 183/94 GHz RADIOMETER DATA BLOCK FORMAT

BYTE NO.	CONTENTS	COMMENT
0	Block Number (High)	Most Significant Byte
1	Block Number (Low)	Least Significant Byte
2	Day (High)	Julian Date
3	Day (Low)	Julian Date
4	Flight Num.	
5	Hours	Time of Start of Block
6	Minutes	Time of Start of Block
7	Seconds	Time of Start of Block
8	Block ID	
9	Hot Load Temp. (High)	
10	Hot Load Temp. (Low)	
11	Cold Load Temp. (High)	
12	Cold Load Temp. (Low)	
13	Reference Load Temp. (High)	
14	Reference Load Temp. (Low)	
15	Klystron Temp. (High)	
16	Klystron Temp. (Low)	
17	Spare Temp. (High)	
18	Spare Temp. (Low)	
19	Channel 0 (High)	183 GHz, 1 GHz IF
20	Channel 0 (Low)	
21	Channel 1 (High)	183 GHz, 5 GHz IF
22	Channel 1 (Low)	
23	Channel 2 (High)	183 GHz, 10 GHz IF
24	Channel 2 (Low)	
25	Channel 3 (High)	94 GHz
26	Channel 3 (Low)	

TABLE G1 (CONT'D.)

CONVAIR 990 183/94 GHz RADIOMETER DATA BLOCK FORMAT

BYTE NO.	CONTENTS	COMMENT
27	Channel 0 (High)	
28	Channel 0 (Low)	
29	Channel 1 (High)	
30	Channel 1 (Low)	
31	Channel 2	
32	Channel 2	
33	Channel 3	
34	Channel 3	
2047	Sequence Repeats	

HOUSEKEEPING DATA

Bytes 0-1: Block Number (Binary)

This number represents the block count of the total number of data blocks recorded since the data collection system was initialized. In the event of a power failure or system failure during a flight this number will be reset to zero. It will also be reset at the start of a new track.

Bytes 2-3: Julian Date (BCD)

This number is entered manually into the system during initialization. Due to equipment problems this data may be incorrect (i.e. 0000) on some tapes. It should be always verified against the flight number.

Byte 4: Flight Number (BCD)

The flight number was also entered manually and is correct on all tapes.

Bytes 5-7: Time (BCD)

These bytes contain the GMT time (hours, minutes, seconds) of the start of the data block. In order to determine the time of a particular radiometer output sample, add 100 ms for each four channel cycle.

Byte 8: Block ID

This byte indicates where the radiometer was looking during a particular block. Table G2 illustrates possible values of block ID and their meaning. Note that during normal operation a block ID of 80_{16} indicates a calibration block containing hot load, cold load and "outside" temperature data.

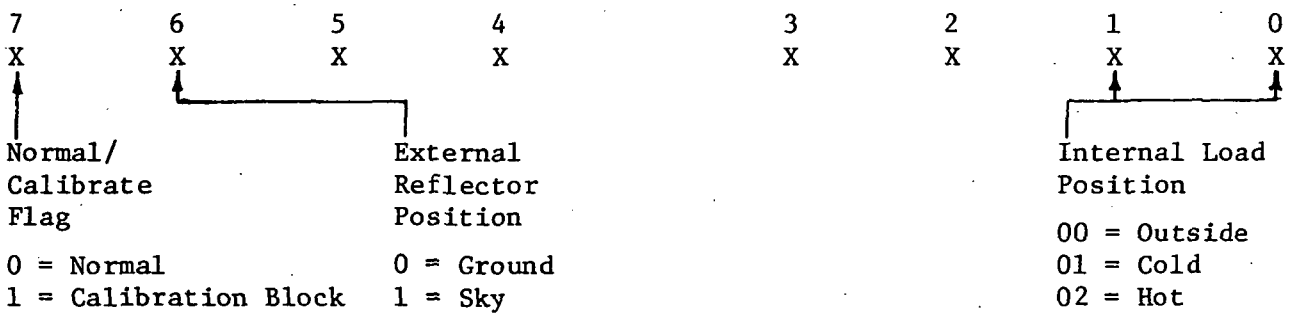
Bytes 9-18: Load Temperatures

The temperature of the hot load, cold load, reference load, klystron and a spare thermistor channel are recorded as 12 bit values corresponding to the voltage developed by a linear thermistor sensor.

TABLE G2

BLOCK ID CODE

BIT MAP



Normal ID Codes

BLOCK ID (HEX)	MEANING
00	Normal Operation Viewing Ground
40	Normal Operation Viewing Sky
80	Calibration Frame Viewing Ground
C0	Calibration Frame Viewing Sky

NOTE: Other codes indicate abnormal operation such as interruption of calibration sequence.

CALIBRATION

In order to convert the radiometer output voltages from the cartridge tape data, GSFC Interdata tapes or the ADDAS tapes into brightness temperatures they must be scaled by the appropriate calibration data. This is accomplished by examining the data blocks for a block ID of 80_{16} which denotes a block containing both hot and cold load calibration cycle at intervals of either 3 or 5 minutes. The calibration interval was variable in 1 minute intervals by the operator but was usually set at 3 or 5 minutes depending on a particular flight plan. Under normal operation the radiometer collected data for 25 seconds and wrote the data on tape for 2 seconds. An internal timer set a calibration flag on the whole minute when the calibration interval had elapsed. Since it was desireable to start the calibration at the beginning of a 25 second data collection cycle, the calibration cycle was not initiated until the start of the next cycle. Thus, the actual calibration interval could vary up to approximately 3 minutes, 27 seconds. Once a calibration cycle was initiated, the cold and hot loads were each viewed for six seconds to allow time for the PSD outputs to settle. The radiometer integration time was 0.2 seconds. Switching time was one second for outside to cold and for cold to hot and 2 seconds for hot to outside. The entire cycle thus took 16 seconds. In order to extract calibration data from a data block it is necessary to examine the first 16 seconds (160 samples) of data in order to pick out the peak of the cold and hot calibration cycles.

CONVERSION CONSTANTS

To convert the load temperature voltages into degrees Kelvin, the constants in Table G3 should be used. The binary number from the data block must first be converted to volts by multiplying by 1/4096 volts/bit or 2.44 mV/bit then use the constants in Table G3 to convert to temperature. Figure G2 shows a printout of a typical data block and its interpretation. Once the load temperatures are known, it is then necessary to extract the peak PSD output voltage for each channel when the radiometer was viewing the cold and hot loads, convert these data to voltage and then use this information to obtain the point-scope calibration formula for each channel. Table G4 shows a sample calibration example.

TABLE G3

THERMISTOR CALIBRATION CONSTANTS

	Gain (°K/Volt)	Offset (°K)
Cold Load	-10	323
Hot Load	-10	373
Reference Load	-10	373
Klystron	-10	373

Example: Hot Load Data = $05D8_{16}$ = 1496

1496 x 2.44 mV/BIT = 3.65 Volts

(3.65 Volts x -10 °K/Volt) + 373°K = 336.5°K

```
00 05 02 78 17 23 28 57 00 05 D8 07 51 0B 72 09
BD 08 4A 0A E5 0B 8B 0B 05 09 3D 0A EC 0B 84 0A
FE 09 39 0A E4 0B 85 0A F9 09 3B 0A E6 0B 85 0A
F9 09 3A 0A EB 0B 8A 0A F3 09 3D 0A F0 0B 83 0A
FB 09 3B 0A F1 0B 89 0B 05 09 3B 0A EF 0B 8A 0B
11 09 39 0A E5 0B 88 0B 1B 09 36 0A DA 0B 85 0B
1F 09 37 0A DA 0B 86 0B 16 09 3B 0A C5 0B 86 0B
15 09 3B 0A BB 0B 86 0B 10 09 38 0A B5 0B 8E 0B
07 09 3C 0A B2 0B 8A 0B 05 09 38 0A AB 0B 87 0B
05 09 3B 0A B1 0B 85 0B 06 09 39 0A B2 0B 89 0B
02 09 3A 0A AE 0B 84 0A FE 09 39 0A B1 0B 85 0A
FE 09 39 0A AF 0B 84 0A FE 09 3A 0A B2 0B 85 0B
03 09 3B 0A C1 0B 80 0A FF 09 3A 0A CE 0B 83 0B
09 09 3B 0A DA 0B 81 0B 0C 09 35 0A E5 0B 86 0B
0D 09 37 0A F4 0B 85 0B 09 09 38 0A F7 0B 83 0B
09 09 38 0A FB 0B 85 0B 01 09 3B 0A F8 0B 88 0A
FF 09 36 0A EE 0B 86 0B 06 09 36 0A E2 0B 8A 0B
0A 09 39 0A D0 0B 87 0B 0A 09 3B 0A B8 0B 86 0B
05 09 3C 0A B6 0B 84 0B 0B 09 3D 0A B6 0B 83 0B
0D 09 3D 0A BC 0B 86 0B 05 09 3C 0A B6 0B 83 0B
01 09 3C 0A BA 0B 83 0B 02 09 3E 0A C0 0B 81 0B
06 09 3D 0A D0 0B 81 0B 0C 09 3E 0A DE 0B 82 0B
0E 09 3C 0A DC 0B 82 0B 0C 09 3F 0A DE 0B 83 0B
04 09 3B 0A E4 0B 85 0A FC 09 3B 0A E7 0B 81 0A
F9 09 39 0A E7 0B 86 0A F9 09 3A 0A DF 0B 83 0A
FF 09 3A 0A DF 0B 84 0B 03 09 3A 0A E1 0B 85 0B
```

BLOCK NUMBER: 0005

JULIAN DATE: 278

FLIGHT NUMBER: 17

TIME (GMT): 23:28:57

BLOCK ID: 00

Hot Load Voltage: $05D8_{16}$ = 1496 x 2.44 mV/BIT = 3.65 Volts

Cold Load Voltage: 0751_{16} = 1873 x 2.44 mV/BIT = 4.57 Volts

Reference Load Voltage: $0B72_{16}$ = 2930 x 2.44 mV/BIT = 7.15 Volts

Klystron Voltage: $09BD_{16}$ = 2493 x 2.44 mV/BIT = 6.08 Volts

Spare Voltage: $084A_{16}$ = Not Used

Figure G2. Data Block Decoding

TABLE G4

RADIOMETER CALIBRATION EXAMPLE

Hot Load Temperature = 336.5°K (T_{HOT})

Cold Load Temperature = 250.0°K (T_{COLD})

PSD Voltage When Viewing Hot Load = 7.54 Volts (V_{HOT})

PSD Voltage When Viewing Cold Load = 6.23 Volts (V_{COLD})

$$\text{Gain} = G = \frac{T_{HOT} - T_{COLD}}{V_{HOT} - V_{COLD}} = 66.03°K/\text{Volt}$$

$$\text{Offset} = 0 = T_{HOT} - G\,V_{HOT} = 336.5 - 497.9 = -161.4°K$$

$$T_{RAD} = V_{RAD}\,G + 0 = V_{RAD}\,(66.03°K/\text{Volt}) - 161.4°K$$

APPENDIX H

LOG OF CONVAIR 990 94/183 GHz RADIOMETER

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER

FLIGHT	DAY	LOCATION	TIME	COMMENTS
07	8/11/78	San Juan, PR	16:08:59	Take Off
		Hurricane Cora	16:12:21	Data on, looking up
			16:16	Power failure
			16:39	Adjusted offsets, looking up
			16:43	Entered clouds at fringes of Cora
			16:45	Some TACAN at 1,2 GHz
			16:52	Severe turbulence and drop in temperature on all channels
			16:56	1 GHz stuck at 10 volts.
			17:00	Back on, bad connection on offset pot
			17:19	TACAN, 1,2 GHz
			17:25	RFI at 1 GHz
			17:28	Turbulence and drop of 100° on 94 GHz
			17:34	Rain
			16:54	16:54 16:55 ADDAS plots
				17:25 17:35 ADDAS plots
			18:00	Track 02
			18:14	Until 18:17 rain
			18:19	Until 18:22 rain
			18:27	135° at 94 GHz. Coldest yet
			18:34	Rain
			18:43	Rain
			18:52	TACAN at 1 GHz
			19:04	Switched up for wingover (WO)
			19:11:07	WO at 25,000 feet
				Last block 02-00AE

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
08	8/13/78	San Juan-Homestad	14:11:41	Take off, start data on track 02 Block 00AF
			14:31:20	Data on
			14:32:21	Restarted, looking up during climb
			14:41:12	System restart
			14:35	Switched down
			14:47	TACAN 1 GHz
			15:17	Adjust 10 GHz to match ADDAS
			15:21	Bad RFI on 10 GHz
			15:55	Data started
			15:56	Tuned 94 GHz
			16:00	30° left spiral from 35,000 feet started decent with left turns, clear air, begin plot
			16:06	Holding at 24,000 feet
			16:10	Altitude 18,000 feet
			16:12	RFI at 10 GHz
			16:18:58	500 feet altitude
09	9/10/78	Moffett-Moffett	04:34:40	Data on, Tape #4, Track 00
			04:36:40	Data off
			04:38:51	Data on
			04:46:12	Data off
			04:52:54	Data on
			04:53:16	Begin satellite underflight data run Radiometer viewing sky 183 GHz okay, 94 GHz has problems Checked 94 GHz attenuator and bias - OK

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
09	9/10/78	Moffett-Moffett	06:16:44	Altitude 20,000 feet
			06:16:45	Begin 90° WO looking at sky Saw temperature rise on 183 GHz, left spiral
			6:39:30	Fly at low altitude (1,000 feet) Switch Radiometer to viewing ground
			7:11:00	System bombs,* reboot and start data collection. System bombed when switched to track 01
			8:11:22	Data on
			8:30:30	Start altitude climb, radiometer temperature rise
			8:59:30	Data collection off. Tape status: Track 01, Block 00
12 A,B	9/14/78	Moffett-McCord	21:27:26	Begin flight
			22:52:00	Ascent begins, data on, looking at sky
			05:04:37	Data collection on Interference at 1 GHz, repetitive
			05:18:40	94 GHz drops temperature over water Altitude 32,000 feet
			05:48:35	Data collection off
			06:49:00	Data collection on, terminal problems
			07:45:39	Terminal is back on, problem appears to be intermittent
			08:06:44	Switch to sky
			08:13:00	Data off

*Software conflict between system status printout and calibration. Radiometer continues to collect data and send to ADDAS.

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
18	11/17/78	McCord-McCord	19:14:00	Take off, tape #9, block 03.
			22:11:00	Looking up. Saw change of 250° to 200°. May be rain overhead.
			22:30:00	Down looking
			22:40:00	Passing through rain. Saw 50° Change in down looking 94 GHz temperature
			22:48:00	Big temperature increase, 210°- 280°
			22:49:00	Uplooking
			22:58:00	Rain
			23:02:00	Climbing out of rain
			23:11:00	Down looking
			23:34:00	94 GHz temperature display is indicating in hex. Also showing low temperature.
			23:38:00	Rebooted system
			00:43:05	WO. 33° coolest temperature
19	11/19/78	McCord to Moffett	19:24:00	Take off. Uplooking
			20:07:00	Restart system
			21:37:00	30° spiral to right, switched up then back down
			21:48:00	500 feet
			21:50:00	Alternating between up and down at 60 second intervals
			22:00:00	Switching to 5 minute up/down intervals
			23:58:00	WO. 23° on display

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
17	10/5/78	Hurricane Rosa	22:50:00	Adjusted gains and offsets, gain at 5 GHz and 2 GHz is now a little low
			23:26:00	Start data looking down
			23:30:00	Some TACAN at 1 GHz
			00:00:00	Adjusting frequency of klystron
			00:51:00	Passing 90 miles west of eye of Hurricane Rosa
			01:04:00	System bombed
			01:10:00	Restarted
			01:46:00	Rain on 94 GHz
			02:00:00	Tape on track 01, wrong track
			02:30:00	Switched to track 03
			04:13:12	WO at 25,000 feet 94 GHz 30° 183/1 GHz 62° 183/5 GHz 50° 183/10 GHz 100°
18	10/6/78	Miramar-Moffett	19:29:37	Take off, tape #6, track 04, bad TACAN on 2 GHz
			19:47:00	Right WO
			19:49:00	Right WO
			19:52:00	Left WO
			19:55:00	Left WO
			19:56:00	Get plot until 19:56
			20:45:00	Looking up during descent into Moffett
			21:02:00	Touch down

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
			NIMBUS-G FLIGHTS	
2	10/24/78	Moffett-Andrews AFB	15:05:59	Terminal on line, viewing fresh and salt water lakes during flight
			15:18:10	Saw a 90°K drop in temperature over a small body of water
			15:34:40	Begin data collection
			15:51:55	Data off
			16:15:00	Start run over Salt Lake, Utah
			16:19:30	Temperature down to 186.5°K
			16:27:00	Data off
			16:31:00	Data on
			17:26:14	Data off
			17:37:05	Data collection on
			17:41:10	Switch to looking up at sky, 94 GHz shows 42.6°K
			17:50:00	System bombs
			17:58:20	Data collection on, 94 GHz looks up at sky at 36,000 feet and sees 35°K
			18:12:26	Switch to radiometer looking down, data on
			18:13:20	System bombs
			18:15:17	System on, data on, altitude 37,000 feet
			18:30:30	Over Lake Michigan, temperature reads 263°K prior to lake run
			18:34:09	198°K over water
			18:35:20	Calibrate
			18:37:20	194°K over water
			18:38:50	191°K over water
			18:40:32	Calibration
			18:42:25	Shoreline, temperature 265°K
			18:45:20	Data off
			19:23:00	System off

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
3,A,B	10/25/78	Andrews-Gander-Thule	12:11:35	Terminal on, data collection off, 90 GHz front-end OK
			12:38:00	Aircraft power is interrupted, reset system, problem with terminal after power surge
			12:44:45	System on line, over Nova Scotia, Gulf of St. Lawrence, Newfoundland
			13:21:00	Set calibration interval 3 minutes
			13:23:00	Terminal problems
			13:31:56	Passing over weight point 7, land: 94 GHz goes to 256°K
			13:35:00	Start plot, plot taken from Nova Scotia to Newfoundland
			13:47:00	Stop plot, over land: 256°K, water: 180°K
			13:50:00	Data collection off, terminal problems
			14:01:34	Terminal back on
			16:22:09	Data collection on, calibrate internal 5 min
			16:51:30	System bombs, terminal stops responding while in local mode
			19:32:00	Switch to sky
			19:35:50	Start left bank WO
			19:33:00	Data Plot till 19:39
			20:09:00	500 feet over sea ice and icebergs
			20:11:50	Turn system off

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
4	10/26/78	Thule-Thule	15:20:24	Terminal on
			15:21:00	Data collection on, track 01, block 0000
			15:46:10	94 GHz approximately 155°K
			16:22:00	45° right bank, 94 GHz = 175°K
			16:50:00	System bombs
			16:55:30	System back on
			17:18:55	Data collection on
			18:09:00	WO at 88°, look at sky, 94 GHz = 29° low temperature
			18:15:00	Switch radiometer to look at ground altitude 500 feet
			19:48:00	Shut off front-end, last data block track 02, block 004A
05	10/29/78	Thule-Thule	13:57:00	Data collection on tape 2, track 02 calibration interval = 04 minutes
			14:23:34	45° right bank for 360° turn
			15:18:00	94 GHz, cold temperature = 164°K snow covering ice at 9,000 feet elevation
			15:24:00	System bombs
			15:31:00	Terminal back on
			15:44:31	Data collection back on
			16:56:00	Switch to sky in preparation for left bank WO
			17:04:00	Calibrate
			17:05:00	Start left WO, 30°K temperature
			17:06:00	Start right WO, 200°K temperature

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
05	10/29/78	Thule-Thule	17:16:33	Data on, Looking at ground
			17:39:13	Flying over sea ice, Temperature = 213°K
			17:43:00	More sea ice. Temperature = 225°K (1725 feet radar altitude)
			17:49:00	Temperature down to 200°K over snow covered ice.
			17:54:00	Open water. (188°K)
			17:58:00	Shore fast ice. (230°K)
			18:22:00	Uniform ice. (240°K)
			18:37:47	Data collection off
06	10/30/78	Thule-Bodo	14:32:20	Data collection on. Do manual calibration
			15:33:15	Data off.
			16:14:00	Left bank WO, 45°, Temperature drops to 90°
			16:53:45	System bombs, back on, block 48
			17:42:00	Switch to sky to prepare for WO
			17:56:00	System bombs, block 0004
			18:32:32	Turn data off, block 000F
07	11/01/78	Bodo-Bodo	07:53:45	Terminal on. Sea surface Temperature flight. Tape #7, track 03.
			08:00:19	Data collection on
			08:05:16	Data collection off. 2 GHz channel appears noisy (no RFI)
			08:43:31	Data collection on, 2 minutes to WP3. Software bombs on track 03, block 001E.

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
07	11/01/78	Bodø-Bodo	09:39:40	Data collection back on
			10:00:00	Problem with 94 GHz display, sometimes displays in Hex. Software bomb.
			11:10:00	Data collection on
			11:37:25	Switch radiometer to sky for WO, begin WO.
			11:55:00	Begin 500 feet run over ocean, data collection on, start plot.
			12:03:00	Start plot
			12:16:00	Start plot
			12:19:00	Start plot
			12:41:01	Data collection off (Block 0004)
09	11/03/78	Bodo-Bodo over sea	08:01:05	Tape #7, track 03, block 77_{16}
			08:40:49	Data collection on, software bomb
			09:47:20	Data on
			10:06:14	90° left WO
			10:08:00	Calibration, right 90° WO
			10:11:00	90° left WO
			10:11:35	Calibration
			11:06:27	Data collection off
			11:28:56	Data collection on

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
10	11/06/78	Bodo-Sondrestrom	09:16:48	Data collection on
			09:49:28	Data collection on, problem with PCU* board, replace with spare.
			10:00:38	Data collection on
			10:20:00	Software bomb
			10:22:53	Data collection on, hot temperature = 335.35°K, $Volt_{hot}$ = 5.220 volts, cold temperature = 262.89°K, $Volt_{cold}$ = 7.48 volts
			11:27:00	Software bomb, block 0021
			11:29:17	Data on
			12:47:30	Start plot
			13:48:00	Start data plot
			13:58:00	Power "Glitch", turn system off in preparation for descent
11	11/07/78	Sondrestrom-Thule	13:30:35	Data on
			13:50:00	Software bomb, block 0003
			13:53:06	Data back on
			14:10:00	Power is interrupted
			14:14:44	Data link on
			14:23:00	Calibrate
			14:26:00	Calibrate, terminal problems, will repair terminal at end of flight.
12	11/08/78	Thule-Thule	15:00:00	GSFC has spare terminal (TI 735)
			15:30:43	Data collection on
			15:48:00	Software bombs, block 009
			15:50:55	Data on

*Phase Control Unit

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
12	11/08/78	Thule-Thule	16:26:44	Switch to sky
			16:34:13	Data off
			16:40:42	Data on
			16:42:44	Switch to ground
			16:55:41	Data off
			17:44:44	System bombs. Problem with initial startup. PCB loose. Refit PCB. System OK.
			18:32:14	Data on
			18:39:44	Data off
13	11/09/78	Thule to Fairbanks	16:03:44	Data on. Tape # 8, track 03
			16:50:44	Software bombs, block 0013
			16:52:25	Data on
			17:04:44	Change offset to decrease PSD voltage. Temperature Hot = 336° V Hot = 1 volt Temperature Cold = 267° V Cold = 3 volts
			17:12:34	Turn off front end
			19:16:31	Front end back on.
			19:19:37	Data Collection on
			21:44:44	Switch to sky. Preparation for WO
			21:47:45	WO Temperature = 24°C Voltage = 8 volts Gain = -51.75 Offset = 396.85°K
			21:11:44	System down for landing
14	11/11/78	Fairbanks to Fairbanks	19:34:44	Take off. Looking up
			19:46:00	Switched down
			20:06:00	Missed cold load in calibration cycle. Manual cycle commanded on TTY.

APPENDIX H

FLIGHT LOG OF CONVAIR 990 94/183 GHz RADIOMETER (continued)

FLIGHT	DAY	LOCATION	TIME	COMMENTS
14	11/11/78	Fairbanks-Fairbanks	20:24:00	Crash.
			20:46:00	10° drop as plane flew over patch of thin ice.
			20:53:00	Crash. Status/Calibration conflict.
			21:23:00	Back up.
			21:31:00	Switch up for 30° spiral sky = 23° at 30600 ft.
			21:33:00	Crash. Patch of 2A00. Will not allow status print out.
			21:45:00	Level at 2300 feet. Looking down.
			21:31:00	Begin plot.
			21:45:00	End plot.
			23:36:00	Climb out for WO. Switch to looking up.
			23:40:46	WO. Saw 23°
15	11/12/78	Fairbanks-Fairbanks	20:04:22	Tape #9, track 01. Recycle system with patches. Take off.
			22:48:00	Software crash.
			00:04:00	Noted that tape was on track 04 instead of 01.
			00:58:14	WO (Up looking).
16	11/13/78	Fairbanks to Hilo	19:50:00	Take off. Tape #9. Start on track 01.
			02:17:00	Data off.
17	11/16/78	Hilo to McCord	19:58:00	Data on. All OK. Moisture problems on ground caused all PSD* channels to overload but OK in air. Started on track 02, tape 9. Finished on track 02.
			01:43:00	Touchdown.

*Phase Sensitive Detector