

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

ALB

Date: May 12, 1978

Project Title: 94/183 GHz Radiometer for CV 990 Flights

Project No: A-2132

Project Director: Mr. J. A. Gagliano

Sponsor: NASA - Goddard Space Flight Center; Greenbelt, Md. 20771

Agreement Period: From 4/6/78 Until 10/1/78(R&D Period)

Type Agreement: Contract No. NAS5-24480

Amount: \$54,188

Reports Required: Monthly Letter Reports; Final Project Report.

Sponsor Contact Person (s):

Technical Matters

Mr. J. L. King, Code 953
Technical Officer
NASA - Goddard Space Flight Center
Building 19, Room 60
Greenbelt, Maryland 20771

Contractual Matters

(thru OCA)
Office of Naval Research
Resident Representative
Hinman Research Building
Georgia Institute of Technology
Atlanta, Ga. 30332

Defense Priority Rating: None.

Assigned to: Electromagnetics Laboratory (School/Laboratory)

COPIES TO:

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OK*

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT TERMINATION

Date: March 27, 1979

Project Title: 94/183 GHz Radiometer for CV 990 Flights

Project No: A-2132

Project Director: Mr. J. A. Gagliano

Sponsor: NASA-Goddard Space Flight Center; Greenbelt, MD 20771

Effective Termination Date: 2/2/79(Contr. expiration)

Clearance of Accounting Charges: by 2/28/79

Grant/Contract Closeout Actions Remaining:

- ☒ Final Invoice and Closing Documents
- ☐ Final Fiscal Report
- ☐ Final Report of Inventions
- ☒ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

*memo to EES
16 APR 79*

Assigned to: Electromagnetics Laboratory (School/Laboratory)

COPIES TO:

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LIBRARY DOES NOT HAVE:

MONTHLY LETTER REPORT (TECHNICAL) AND COST AND PERFORMANCE REPORT No. 2

MONTHLY LETTER REPORT (TECHNICAL)

and

COST AND PERFORMANCE

Report No. 2

Report Period

1 May 1978 through 31 May 1978

Report Prepared

June 19, 1978

94/183 GHz CV-990 Radiometer

J. A. Gagliano

Contract NAS5-24480

(A-2132)

Prepared For

The National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared By

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

WORK TO BE PERFORMED THIS PERIOD

Noise figure measurements were made at 1, 5, and 10 GHz IF for the 180 GHz mixer and at 2 GHz IF for the 90 GHz unit.

Noise figure measurements and gain versus frequency measurements were made on each of the four IF amplifiers being used, i.e. 1, 2, 5, and 10 GHz. Three of the four amplifiers are in-house and the fourth unit (2 GHz), from International Microwave Corporation, arrived this month.

Efforts to minimize insertion losses in the IF triplexer were accomplished by optimizing the filter geometry and the proper placement of filter sections on the PCB. The 1 GHz IF port has been designed to pass the DC bias current required by the 180 GHz mixer. This was accomplished by using a bias tee at the 1 GHz port as shown in Figure 1.

In addition to housing DC power supplies and thermister amplifier boards, the interconnect box provides feed-through of all signals between the radiometer shelf and the rack mountable hardware. The four video amplifier outputs have been routed direct to the four phase sensitive detectors (PSD) in this manner. Spade terminal connections were replaced with a single bulkhead type connector for ease in making hook-up as well as improved reliability.

Four channels of analog lock-in amplifiers (multichannel PSD) have been housed in a rack-mountable panel. Evans Instruments' phase control and phase sensitive detectors were used as in the previous Convair flights.

The data collection system has been housed in a rack-mountable panel directly above the analog lock-in panel. Coax cable connection has been used between the lock-in amplifier outputs and the analog-to-digital converter which is located in the data collection system. Monitor outputs were provided on the front panel for oscilloscope or volt-meter readouts.

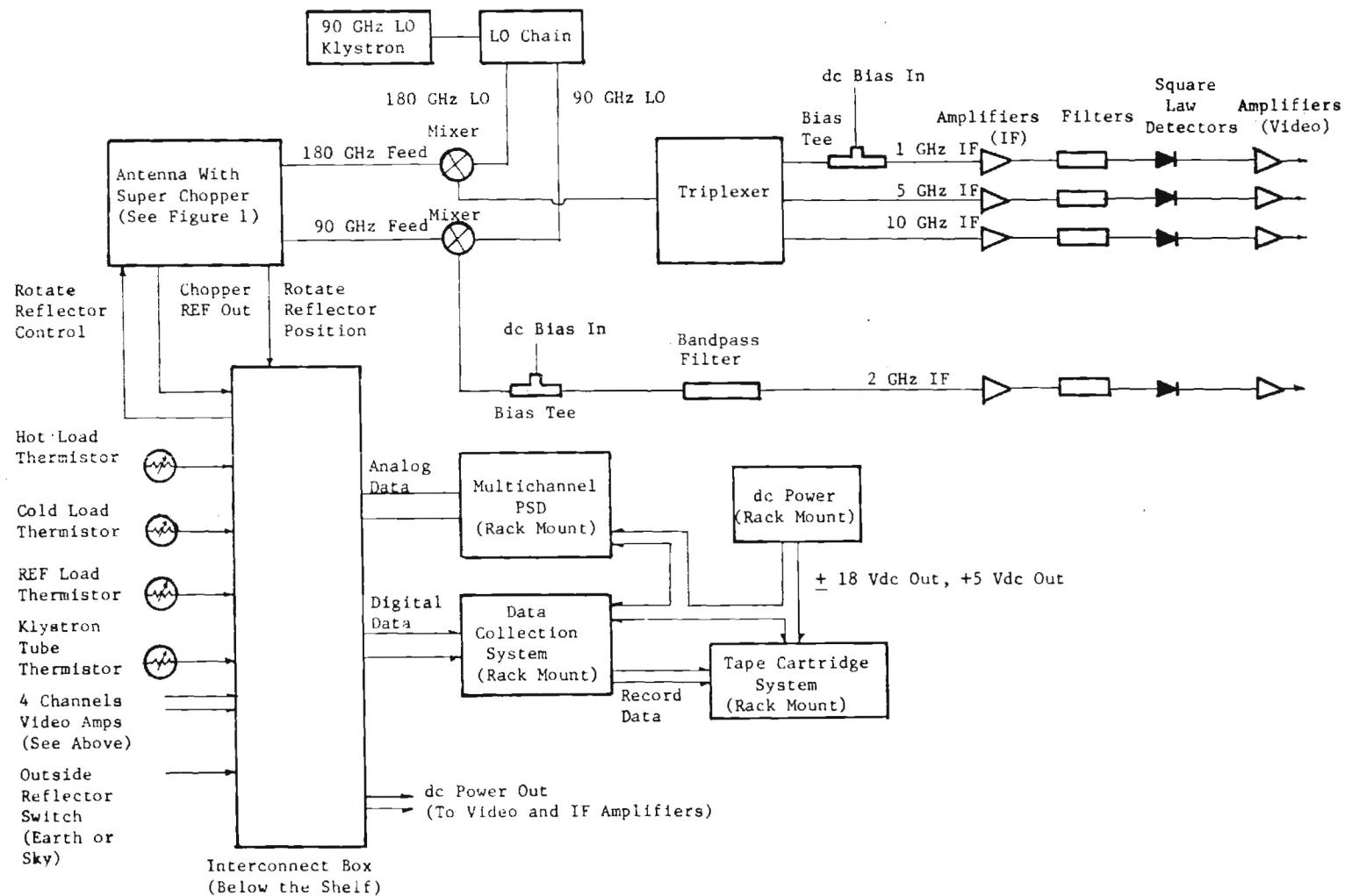


Figure 1. Block Diagram of Convair 990 Multichannel Radiometer.

PROBLEMS ENCOUNTERED THIS PERIOD

There were no problems encountered this period.

WORK TO BE PERFORMED NEXT PERIOD

The radiometer and all equipment associated with it will be packaged and delivered by J. A. Stratigos and J. A. Gagliano to Moffett Field, California, for installation in the Convair 990. Test flights are scheduled for mid-June and July.

Cost Information

The following charges have been incurred against the contract during period

Personal Services (PS)	\$15,033.05
Materials and Supplies	931.39
Travel	-0-
Overhead (@ 68% of PS)	10,222.47
Retirement (@ 9.35% of PS)	1,082.25
TOTAL	\$27,269.16

The breakdown of personal services is as follows:

	<u>Dollars</u>	<u>Approximate Man Hours</u>
Principal Research Engineers	-0-	-0-
Senior Research Engineers	568.43	41
Research Engineers	2914.85	272
Assistant Research Engineers	3304.50	384
Student Assistants	3458.21	795
Technicians, Machinists	4620.81	708
Clerical	166.25	35
TOTAL	\$15,033.05	2,235

The current financial status of the contract is as follows:

	<u>Budget As Proposed</u>	<u>Expended</u>	<u>Free Balance</u>
Personal Services (PS)	\$25,826.00	\$24,026.58	\$1,799.42
Materials and Supplies	4,200.00	1,404.20	2,795.80
Travel	4,185.00	-0-	4,185.00
Computer	-0-	-0-	-0-
Overhead	17,562.00	16,338.07	1,223.93
Retirement	2,415.00	1,813.62	601.38
Funding	\$54,188.00	\$43,582.47	\$10,605.53

Based on present full funding, the funding and equivalent man hours are sufficient to complete the task. Approximately 80% of the proposed task has been completed.

MONTHLY LETTER REPORT (TECHNICAL)

and

COST AND PERFORMANCE

Report No. 3

Report Period

1 June 1978 through 30 June 1978

Report Prepared

10 July 1978

94/183 GHz CV-990 Radiometer

J. A. Gagliano

Contract NAS5-24480

(A-2132)

Prepared For

The National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared By

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

WORK PERFORMED DURING THIS PERIOD

During this period the 94/183 GHz radiometer was shipped to NASA-Ames, installed on the Convair 990 aircraft, and flew on the Convair during the experimenters' system checkout flights (approximately 10 hours total flight time).

Upon arrival at Ames the radiometer system was first inspected for any visual damage due to shipping. No major damage was found. The system functioned properly in the experimenters' lab following the initial power up of all electronics. The Tektronic's microprocessor based test system was connected to the radiometer in order that the system software could be tested. Some of the programs tested include: 1) automatic calibration, typically every 5 minutes, using the hot and cold loads; 2) display of any of the four radiometer channel outputs in °K; 3) printout of the four channels as well as hot load, cold load, reference load, and klystron thermistor voltages; 4) status printout of radiometer including flight no., time of day, radiometer channels outputs, link to Goddard on or off, etc.

Plots were run, with the Hewlett Packard recorder, of each radiometer channel looking at a liquid nitrogen test load. The following $\Delta T_{\min}$ were determined from each plot using the method of standard deviation: 1.40°K at 1 GHz IF, 0.70°K at 2 GHz IF, 2.52°K at 5 GHz IF, and 6.30 °K at 10 GHz IF. These measurements were accomplished using the Evans instruments analog lock-in amplifiers with an integration time of 0.25 sec. Extrapolating to 1.10 sec. integration time yields the following: 0.67°K at 1 GHz, 0.33°K at 2 GHz, 1.20°K at 5 GHz, and 3.00°K at 10 GHz. These values were higher than expected based on the last measurements taken at Georgia Tech prior to shipment. A major difference was the presence of TACAN interference at 1 GHz and an even more serious problem near 10 GHz (Weather Radar) once the system was airborne on the Convair.

The gain of each video amplifier was modified in the lab prior to installing on the Convair. Nominal gain was determined to provide the same voltage swing at the phase sensitive detector output when switching from the cold load (300°K in the lab) to the hot load (340°K).

PROBLEMS ENCOUNTERED THIS REPORT PERIOD

The engineering test flight (June 28) brought forth the interference problem at 10 GHz due to the on board weather radar system. The interference at 1 GHz was also stronger in the air. It was determined that one cause of the problem at 1 GHz was due to the poor shielding of the dual dc bias box for the 94 and 183 GHz mixers. Following the test flight the bias box package was modified to provide better shielding. The 10 GHz interference problem was compounded by the fact that the pulse repetition rate of the weather radar was 200 pulses per second, which is the same as the radiometer chopping rate of 200 Hz. Consequently the chopping frequency was changed to approximately 250 Hz by increasing the chopper blade to a speed of 2500 rpm. After readjusting all four phase sensitive detectors to the new lock-in frequency, the 10 GHz radiometer channel improved significantly.

The second engineering test flight (June 30) did show improvement in all four radiometer channels due to better shielding as discussed above. However, by monitoring the video amplifier output of the 1 GHz channel, interference was still evident. The low pass filter (in the phase sensitive detector) does help reduce the effect of the radar interference.

The gains of the 1 GHz and 2 GHz channels are increasing as the temperature of the radiometer shelf (mounted to skin of aircraft) goes down. This is a difficult problem to locate because of the wide variation in temperatures of the different components in the IF channels. However, by automatic calibration of the radiometer, every 5 minutes, the new gain and temperature offset constants were updated for each of the four IF channels. The display continued to provide all four radiometer outputs in °K, accurate to within the minimum detectable temperatures ($\Delta T_{\min}$) for each channel.

WORK TO BE PERFORMED NEXT PERIOD

Data flights begin with the microwave measurements of the freeze-thaw line in Alaska on July 11 - 13. One Georgia Tech operator will be on board for the Alaska flights. Effective July 15th Georgia Tech personnel will be available to support hurricane flight missions as the need arises. Double crew support will be available beginning August 1st.

Cost Information

The following charges have been incurred against the contract during the period 1 June 1978 through 30 June 1978.

Personal Services (PS)	\$7,396.81
Materials and Supplies	\$383.47
Travel	\$3,701.00
Overhead (@ 68% of PS)	\$5,029.83
Retirement (@ 9.1% of PS)	\$691.60
TOTAL	\$17,202.71

The breakdown of personal services is as follows:

	<u>Dollars</u>	<u>Approximate Man Hours</u>
Principle Research Engineers	\$222.25	13
Senior Research Engineers	\$12.02	1
Research Engineers	\$3,557.73	332
Assistant Research Engineers	-0-	0
Student Assistants	\$3,234.83	834
Technicians, Machinists	\$297.84	40
Clerical	\$72.14	15
TOTAL	\$7,396.81	1,235

The current financial status of the contract is as follows:

	<u>Budget As Proposed</u>	<u>Expended</u>	<u>Free Balance</u>
Personal Services (PS)	\$25,826	\$31,423.39	- \$5,597.39
Materials and Supplies	\$4,200	\$1,787.67	\$2,412.33
Travel	\$4,185	\$3,701.00	\$484.00
Computer	-0-	-0-	-0-
Overhead	\$17,562	\$21,367.90	- \$3,805.90
Retirement	\$2,415	\$2,202.76	\$212.24
Funding	\$54,188	\$60,482.72	- \$6,294.72

Based on present full funding, the funding and equivalent man hours are not sufficient to complete the task. Approximately 112% of the proposed task has been completed.

MONTHLY LETTER REPORT (TECHNICAL
and
COST AND PERFORMANCE

Report No. 4

Report Period
1 July 1978 through 31 July 1978

Report Prepared

14 August 1978

94/183 GHz CV-990 Radiometer

J. A. Gagliano

Contract NAS5-24480

(A-2132)

Prepared For
The National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared By
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

WORK PERFORMED DURING THIS PERIOD

The 94/183 GHz radiometer flew on the Convair 990 aircraft during the Alaska Flight Series (July 11-13) in support of the experiment on "Multispectral Studies of the Freeze-Thaw Line and Surface Water". In addition, the 94/183 GHz radiometer was tested in flight to insure proper operation for future hurricane activity.

During the flights, Goddard personnel requested a check of the serial data link between Georgia Tech's radiometer and Goddard's Interdata computer. It was verified, with each request, that the data was received by the Interdata computer.

Another request made by Goddard was that the calibration interval be reduced from 5 min. to 2 min. The flexibility of the microcomputer system allowed the operator to make this change by simple typing in a new "SETCAL" time.

The radiometer appeared to function properly throughout the three days of Artic Flights. Automatic calibration of the system updated the gains and temperature offsets of all four radiometer channels. These constants were printed out on the Georgia Tech terminal with each calibration interval.

PROBLEMS ENCOUNTERED DURING THIS PERIOD

It was observed that the radiometer gains and offsets provided on the ADDAS display were significantly different from the constants printed out on the Georgia Tech terminal. This was due to the fact that the gain and temperature offsets are changing throughout the flight. At present, there is no provision for updating these constants to ADDAS without requesting manual changes while in flight. This is not practical since it would require almost continuous manual entries of new gain and temperature offsets for each channel during the flight. It was agreed upon that this problem would be solved prior to the start of the Hurricane Flights.

The problem associated with the radiometer components dropping in temperature, due to the shelf mounted to skin of the aircraft, was still evident. This shows up as an increase in the gain (volts/°K) and a decrease (in magnitude) of the offset temperature for all channels as the plane's skin temperature drops with higher altitude. The coldest temperature observed for the radiometer's cold load (mounted to skin of aircraft) was approximately 260°K.

WORK TO BE PERFORMED DURING THE NEXT PERIOD

On the first Hurricane Flight, Georgia Tech will provide ADDAS with a new analog signal which will inform ADDAS that a calibration cycle has begun. This signal will assume one of three voltage levels; 0 volts means the radiometer is presently taking data, +5 volts says that a cold load calibration is occurring, and +10 volts means that a hot load calibration is in progress. With this signal ADDAS should be able to update the channel gains and offsets following each calibration cycle. Consequently any data plots provided by the ADDAS system during flight will be more meaningful in terms of checking the performance of the radiometer.

During this period Georgia Tech personnel will be available to support any Hurricane Flights on either a single or double crew basis.

Cost Information

The following charges have been incurred against the contract during the period 1 July through 31 July 1978.

Personal Services (PS)	\$1,621.71
Materials and Supplies	664.26
Travel	2,566.66
Overhead (@ 68% of PS)	1,232.50
Retirement (@ 9.1% of PS)	159.41
TOTAL	<u>\$6,244.54</u>

The breakdown of personal services is as follows:

	<u>Dollars</u>	<u>Approximate Man Hours</u>
Principle Research Engineers	-0-	-0-
Senior Research Engineers	-0-	-0-
Research Engineers	\$1,621.71	151
Assistant Research Engineers	-0-	-0-
Student Assistants	-0-	-0-
Technicians, Machinists	-0-	-0-
Clerical	-0-	-0-
TOTAL	<u>\$1,621.71</u>	<u>151</u>

The current financial status of the contract is as follows:

	<u>Budget As Proposed</u>	<u>Expended</u>	<u>Free Balance</u>
Personal Services (PS)	\$25,826	\$33,045.10	- \$7,219.10
Materials and Supplies	4,200	1,931.93	2,268.07
Travel	4,185	3,230.66	954.34
Computer	-0-	-0-	-0-
Overhead	17,562	22,600.40	- 5,038.40
Retirement	2,415	2,521.59	52.82
Funding	<u>\$54,188</u>	<u>\$63,004.68</u>	<u>- \$9,141.68</u>

Based on present full funding, the funding and equivalent man hours are NOT sufficient to complete the task. Approximately 116% of the proposed task has been completed.

MONTHLY LETTER REPORT TECHNICAL
and
COST AND PERFORMANCE

Report No. 5

Report Period
1 August 1978 through 31 August 1978

Report Prepared
20 September 1978

94/183 GHz CV-990 Radiometer

J. A. Gagliano

Contract NAS5-24480
(A-2132)

Prepared For
The National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared By
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

WORK PERFORMED DURING THIS PERIOD

The radiometer flew on the Convair 990 aircraft during the Hurricane Cora penetration flight. The aircraft was deployed from San Juan, Puerto Rico. Cora was classified as a tropical storm at the approximate time of the Convair penetration. Figure 1 is a reproduction of ADDAS plots of the four output channels of the 94/183 GHz radiometer. The radiometer was looking down during this data run. Observe the detection of a rain cell as seen by a significant drop in temperature on the 94 GHz radiometer. There is also a less pronounced temperature drop on the 183 GHz radiometer, 10 GHz IF channel.

Figure 2 is a reproduction plot of the radiometer outputs measured on the return leg of the flight during a spiral descent. While looking up, the three radiometer outputs at 183 GHz show an increase in temperature as the aircraft descends further into the cloud structure. Unfortunately the 10 GHz channel was impaired by radar interference during a portion of the descent. Observe the periodic peaks occurring with each calibration cycle.

PROBLEMS ENCOUNTERED DURING THIS PERIOD

Radar interference of short duration was encountered as shown in the data plot of Figure 2. Apparently the interference was intense enough and of low enough repetition rate to cause a problem at the 10 GHz radiometer channel output. Improved shielding technique will be considered for the future.

The auto-calibrate signal interface to ADDAS was not completed in time for the Tropical Storm Cora flight. The software algorithm developed by ADDAS personnel is still to be checked. The 94 GHz variable attenuator was returned to Georgia Tech to replace a tuning screw lost during the flight.

WORK TO BE PERFORMED DURING THE NEXT PERIOD

Georgia Tech has been asked to support the SEASAT Gulf of Alaska Experiment Flights in September. Single crew operation will be required. The auto-calibrate signal to ADDAS will be installed on the Convair 990 prior to the SEASAT underflights. Since the gain and offset of each channel will be updated with each calibration, this will allow ADDAS to provide accurate plots of the radiometer outputs.

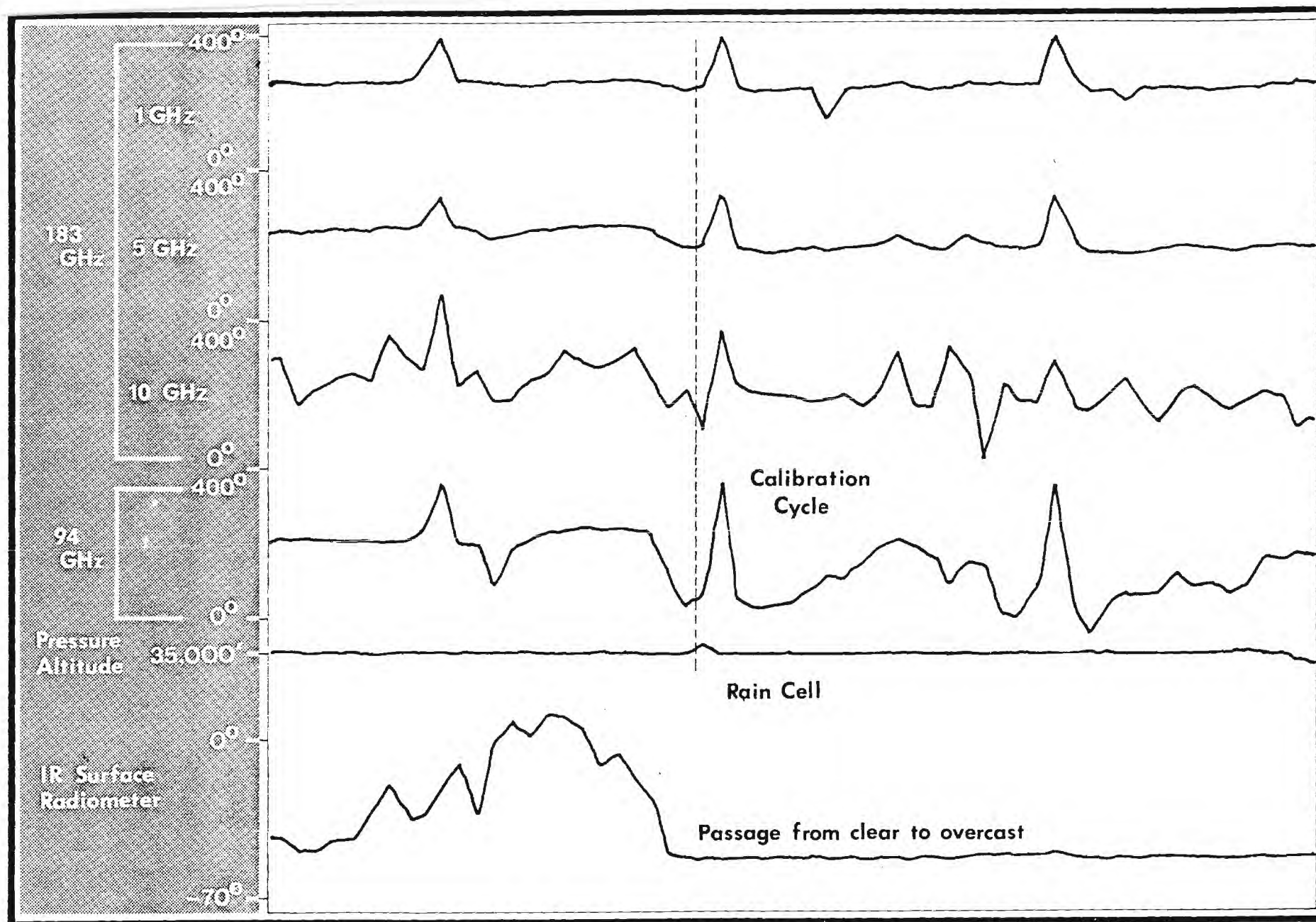


Figure 1. 94/183 GHz Radiometer Data Reproduced From ADDAS Plots of Tropical Storm Cora Penetration Flight.

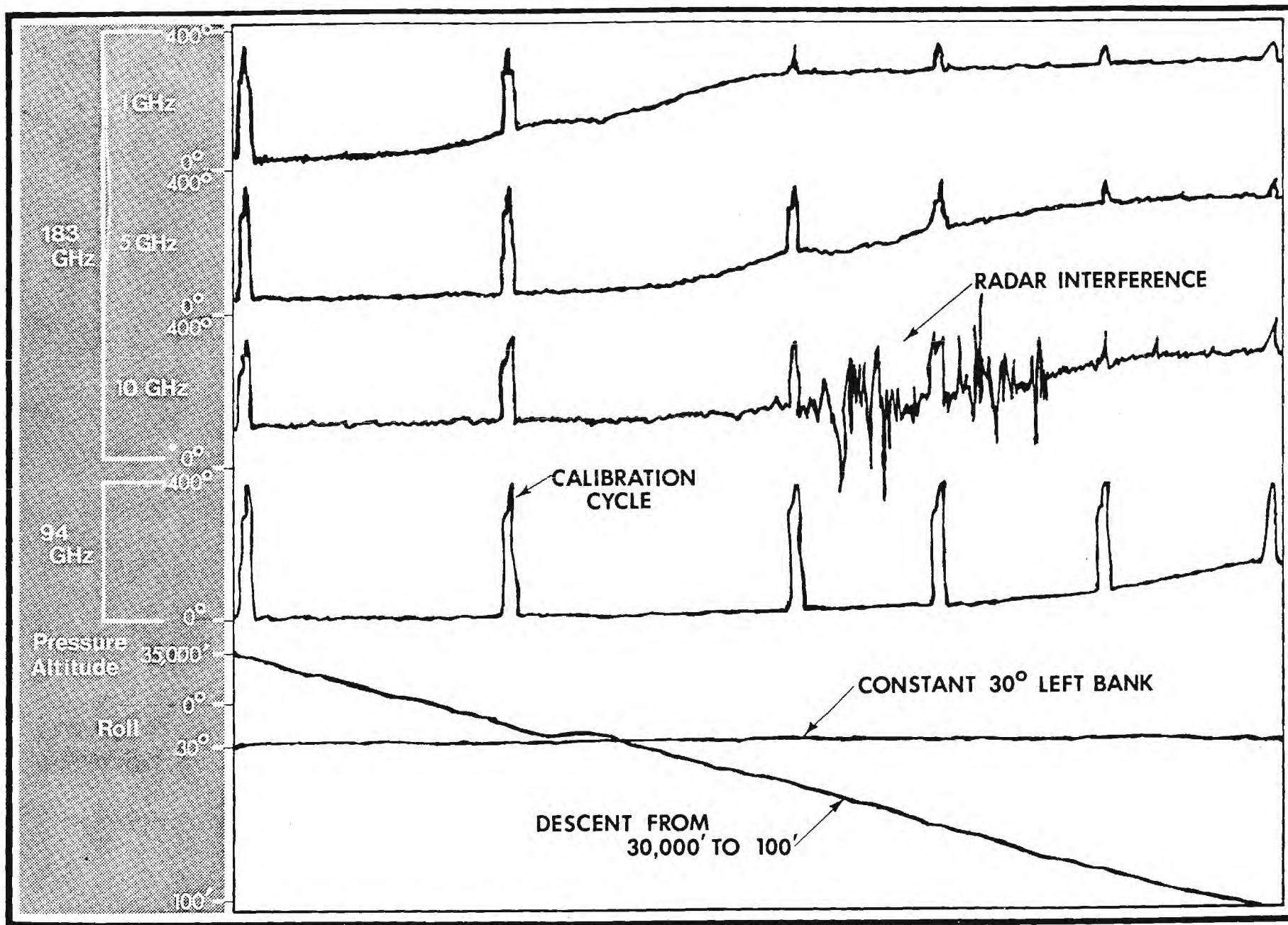


Figure 2. 94/183 GHz Radiometer Looking up at Sky During the Convair 990 Spiral Descent at Constant 30° Left Bank.

Cost Information

The following charges have been incurred against the contract during period 1 August through 31 August 1978.

Personal Services (PS)	\$1,389.63
Materials and Supplies	41.87
Travel	571.22
Overhead (@ 76% of PS)	1,056.12
Retirement (@ 9.83% of PS)	<u>136.61</u>
TOTAL	\$3,195.45

The breakdown of personal services is as follows:

	<u>Dollars</u>	<u>Approximate Man Hours</u>
Principal Research Engineers	\$ 65.80	3
Senior Research Engineers	-0-	-0-
Research Engineers	1,265.28	104
Assistant Research Engineers	-0-	-0-
Student Assistants	-0-	-0-
Technicians, Machinists	30.20	4
Clerical	<u>28.35</u>	<u>5</u>
TOTAL	\$1,389.63	116

The current financial status of the contract is as follows:

	<u>Budget As Proposed</u>	<u>Expended</u>	<u>Free Balance</u>
Personal Services (PS)	\$25,826.00	\$34,434.73	\$ -8,608.73
Materials and Supplies	4,200.00	1,973.80	2,226.20
Travel	4,185.00	3,801.88	383.12
Computer	-0-	-0-	-0-
Overhead	17,562.00	23,656.52	-6,094.52
Retirement	<u>2,415.00</u>	<u>2,498.79</u>	<u>-83.79</u>
Funding	\$54,188.00	\$66,365.72	\$-12,177.72

Additional funding of \$15K is anticipated to be available next report period.

MONTHLY LETTER REPORT (TECHNICAL
and
COST AND PERFORMANCE)

Report No. 6

Report Period
1 September 1978 through 30 September 1978

Report Prepared

24 September 1978

94/183 GHz CV-990 Radiometer

J. A. Gagliano

Contract NAS5-24480
(A-2132)

Prepared For
The National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared By
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

WORK PERFORMED DURING THIS PERIOD

The 94/183 GHz radiometer flew onboard the Convair 990 aircraft during the SEASAT Gulf of Alaska Experimental Flight Program in September. During the flight program, the Convair 990 made underflights coincident with the passage of the satellite over the NOAA Survey Vessel OSS OCEANOGRAPHER located in the Gulf of Alaska. The 94/183 GHz radiometer was used to remotely sense water vapor in the atmosphere and to detect rain. Single crew support of the SEASAT underflights was provided by Georgia Tech.

An automatic calibration signal was provided to ADDAS in order that the system gain and offset for each IF channel (GT0-GT3) could be updated with each calibration.* Figure 1 is an ADDAS plot taken with the radiometer looking up and the Convair 990 at 1,000 feet altitude over the Gulf of Alaska. The traces from top to bottom are 183/1 GHz, 183/5 GHz, 183/10 GHz, 94 GHz, Press Alt., and IR surface temperature. During the time of this data plot, aircraft weather radar reported rain cells above the Convair. The 94 GHz channel shows an increase in temperature of approximately 100°K starting at event time 7:09. This is due to the overlying rain cell reflecting the warm surface temperature of the earth causing an increase in the observed brightness temperature. The peaks appearing at time 7:15 represent a calibration of the system. Another rain cell detection occurs at 7:17 as shown on the 94 GHz channel.

PROBLEMS ENCOUNTERED DURING THIS PERIOD

The only major problem encountered during one of the underflights was an intermittent connection between the computer terminal and the data collection system. However ADDAS continued to receive the analog data on channels GT0-GT3 since the terminal only interfaces with the Georgia Tech data processor. The bad connection was soon corrected (in flight) and the computer terminal was back on line.

* This change allows ADDAS to record continuously calibrated brightness temperatures for plotting purposes as opposed to previously having only one set of calibration constants for an entire flight.

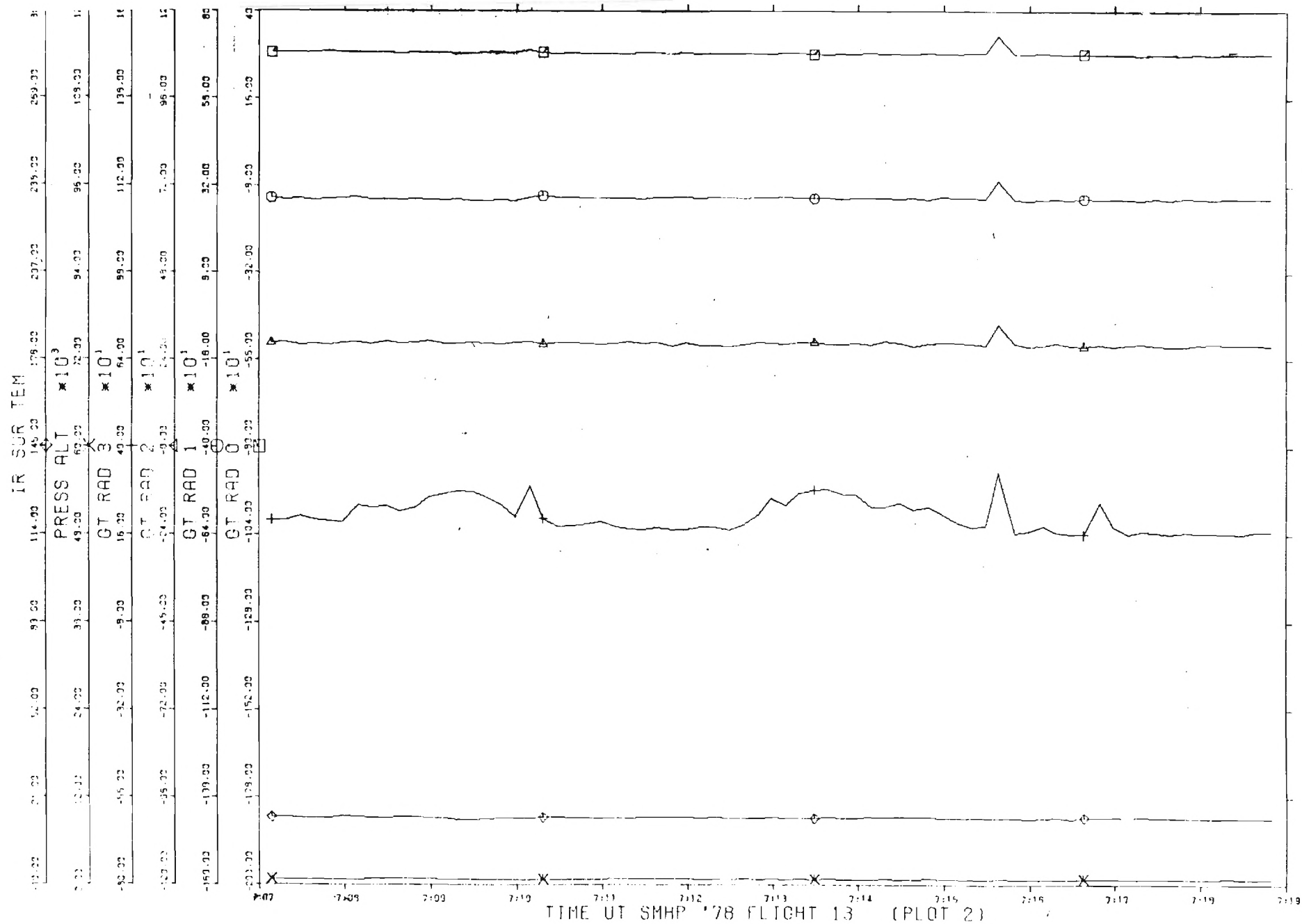


Figure 1. 94/183 GHz Radiometer ADDAS Plot from SEASAT Underflight 13 Illustrating Detection of Rain Cells.

WORK TO BE PERFORMED DURING THE NEXT PERIOD

Georgia Tech will continue to support possible hurricane flight operations during early October. Following the completion of the hurricane flight program, Georgia Tech personnel will support the NIMBUS-G underflights using the 94 GHz portion of the radiometer onboard the Convair 990 aircraft. The NIMBUS-G underflight program is scheduled to begin on October 24th and will run for approximately five weeks.

The 183 GHz portion of the radiometer will be removed from the Convair 990 following the hurricane program and returned to Georgia Tech to determine if any corrective action is needed prior to the FY-79 RB-57 flights (NAS5-23710). The 94 GHz radiometer will be returned to Georgia Tech following NIMBUS-G underflight program in late November.

Cost Information

The following charges have been incurred against the contract during period 1 September through 30 September 1978.

Personal Services (PS)	\$1,920.02
Materials and Supplies	415.07
Travel	390.00
Overhead (@ 76% of PS)	1,459.22
Retirement (@ 9.83% of PS)	<u>188.73</u>
TOTAL	\$4,373.04

The breakdown of personal services is as follows:

	<u>Dollars</u>	<u>Approximate Man Hours</u>
Principal Research Engineers	\$ -0-	-0-
Senior Research Engineers	-0-	-0-
Research Engineers	1,876.95	154
Assistant Research Engineers	-0-	-0-
Student Assistants	-0-	-0-
Technicians, Machinists	43.07	5
Clerical	<u>-0-</u>	<u>-0-</u>
TOTAL	\$1,920.02	159

The current financial status of the contract is as follows:

	<u>Budget As Proposed</u>	<u>Expended</u>	<u>Free Balance</u>
Personal Services (PS)	\$25,826.00	\$36,354.75	\$-10,528.75
Materials and Supplies	4,200.00	2,388.87	1,811.13
Travel	4,185.00	4,191.88	-6.88
Computer	-0-	-0-	-0-
Overhead	17,562.00	25,115.74	-7,553.74
Retirement	<u>2,415.00</u>	<u>2,687.52</u>	<u>-272.52</u>
Funding	\$54,188.00	\$70,738.76	\$-16,550.76

Additional funding of \$15K is anticipated to be available next report period.

FINAL REPORT
PROJECT NO. A-2132

**94/183 GHz MULTICHANNEL RADIOMETER
FOR CONVAIR FLIGHTS**

By

**J. A. Gagliano,
J. A. Stratigos
R. E. Forsythe
J. M. Schuchardt**

Prepared For

**GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland 20771
Contract NAS5-24480**

January, 1979

GEORGIA INSTITUTE OF TECHNOLOGY

**Engineering Experiment Station
Atlanta, Georgia 30332**



1979



94/183 GHz MULTICHANNEL RADIOMETER
FOR CONVAIR FLIGHTS

J. A. Gagliano, J. A. Stratigos
R. E. Forsythe and J. M. Schuchardt.
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

January, 1979
Final Report (A-2132)

Prepared For
GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland 20771
Contract NAS5-24480

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle 94/183 GHz Multichannel Radiometer for Convair Flights		5. Report Date	
		6. Performing Organization Code	
7. Author(s) J. A. Gagliano and others		8. Performing Organization Report No.	
9. Performing Organization Name and Address Engineering Experiment Station Georgia Institute of Technology Atlanta, Georgia 30332		10. Work Unit No.	
		11. Contract or Grant No. NAS5-24480	
12. Sponsoring Agency Name and Address NASA Goddard Space Flight Center Greenbelt, Maryland 20771 Project Manager, J. L. King		13. Type of Report and Period Covered Final Technical Report 4/6/78 to 2/2/79	
		14. Sponsoring Agency Code 946	
15. Supplementary Notes			
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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Report authors are J. A. Gagliano, J. A. Stratigos, R. E. Forsythe and J. M. Schuchardt.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of NASA GSFC or the U. S. Government.

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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

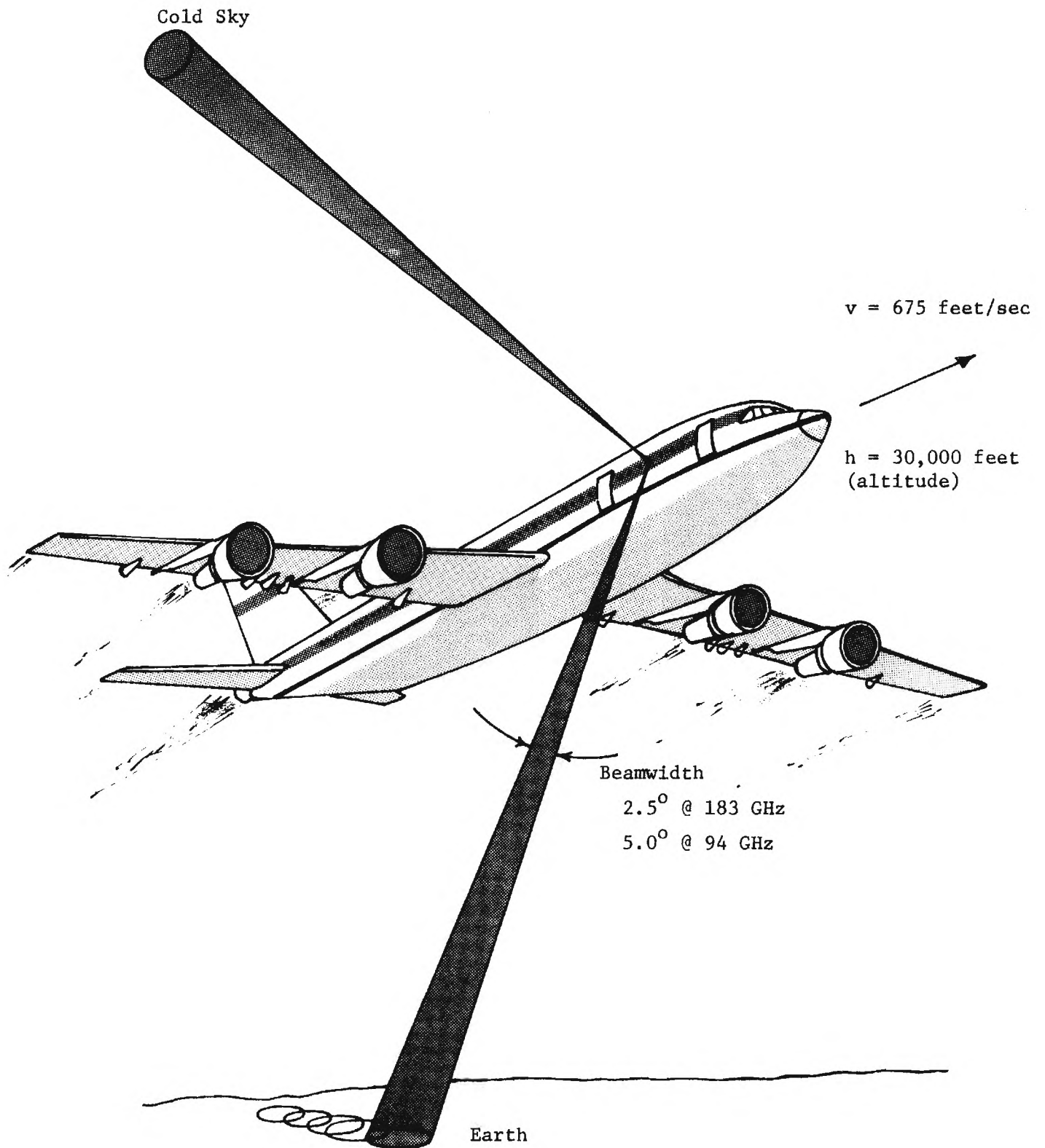


Figure 1. CV 990 Aircraft - Radiometer Flight Geometry.

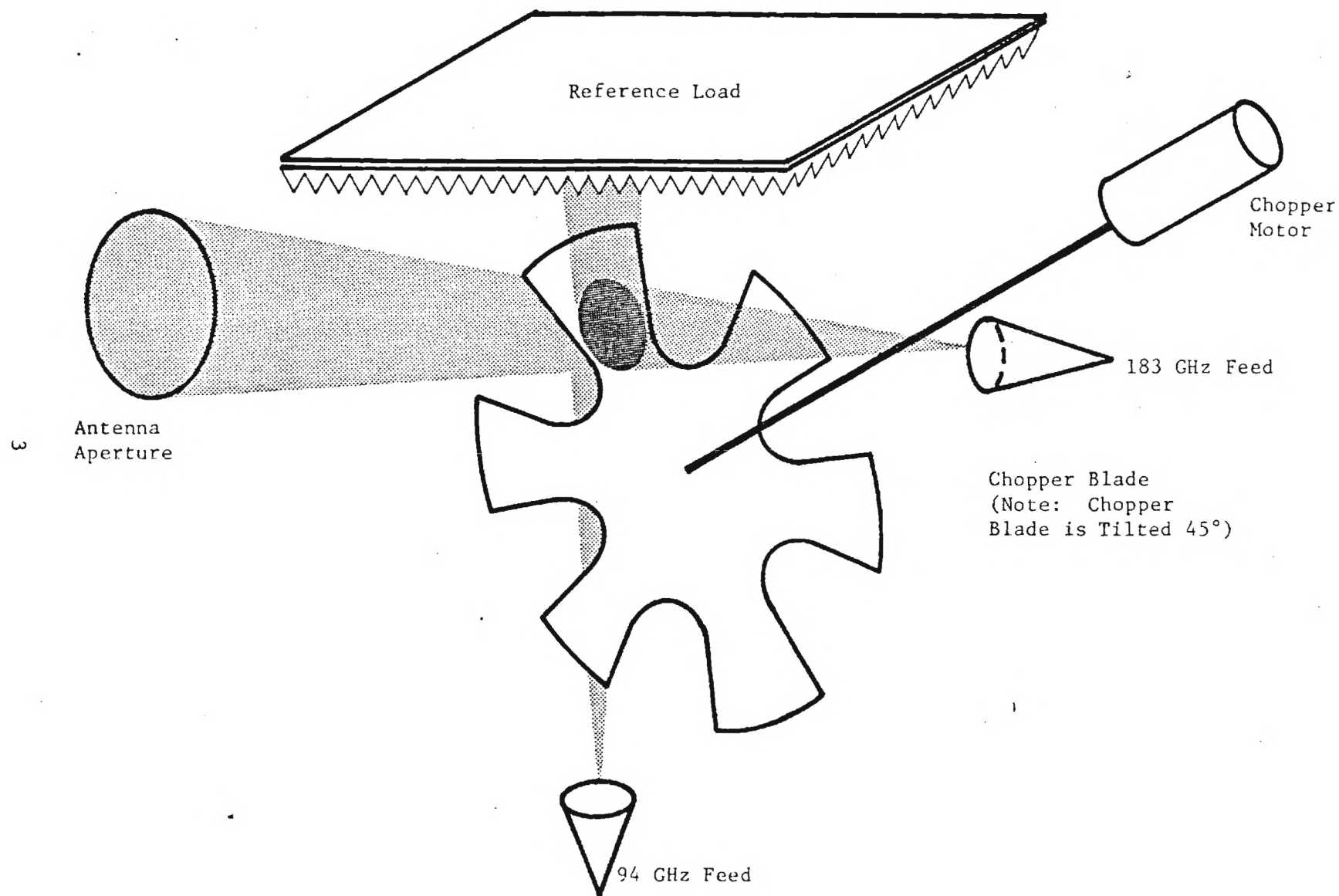


Figure 2. Super-Chopper Concept - Shown Reflecting To Antenna At 94 GHz and Reflecting Into Reference Load at 183 GHz.

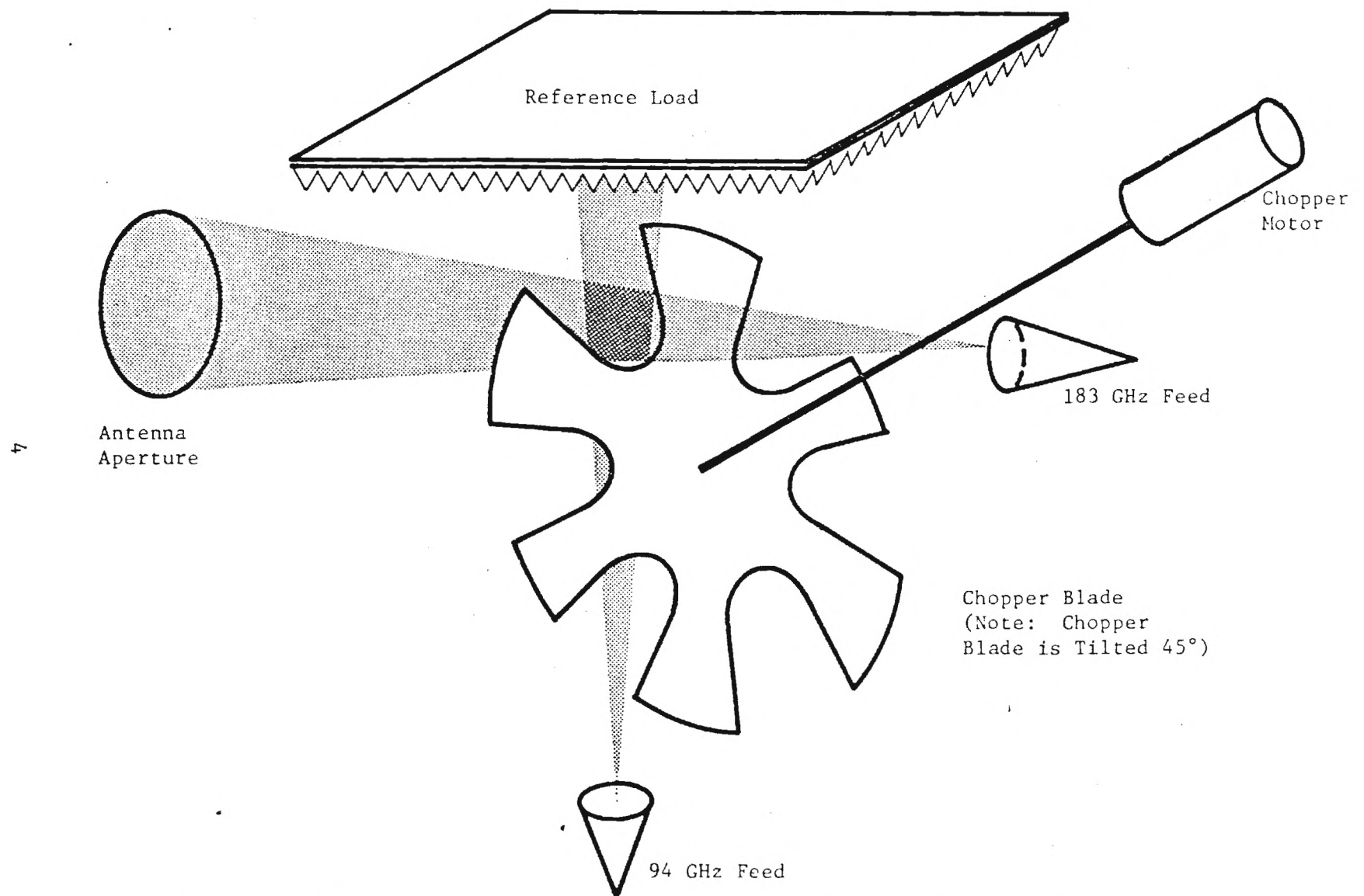


Figure 3. Super-Chopper - Shown Transmitting To Reference Load at 94 GHz and Transmitting to Antenna at 183 GHz.

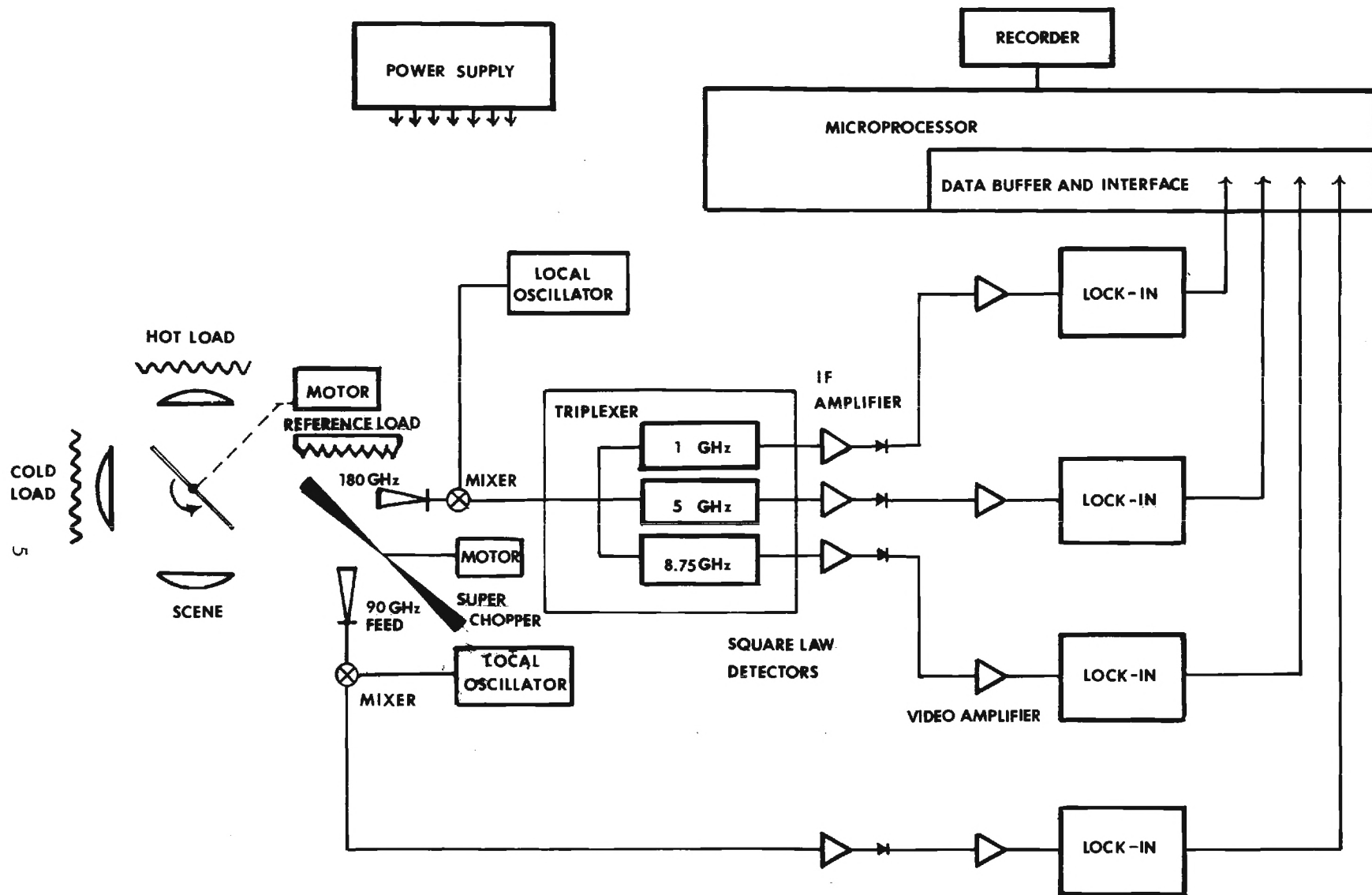


Figure 4. 94/183 GHz CV 990 Radiometer Block Diagram.

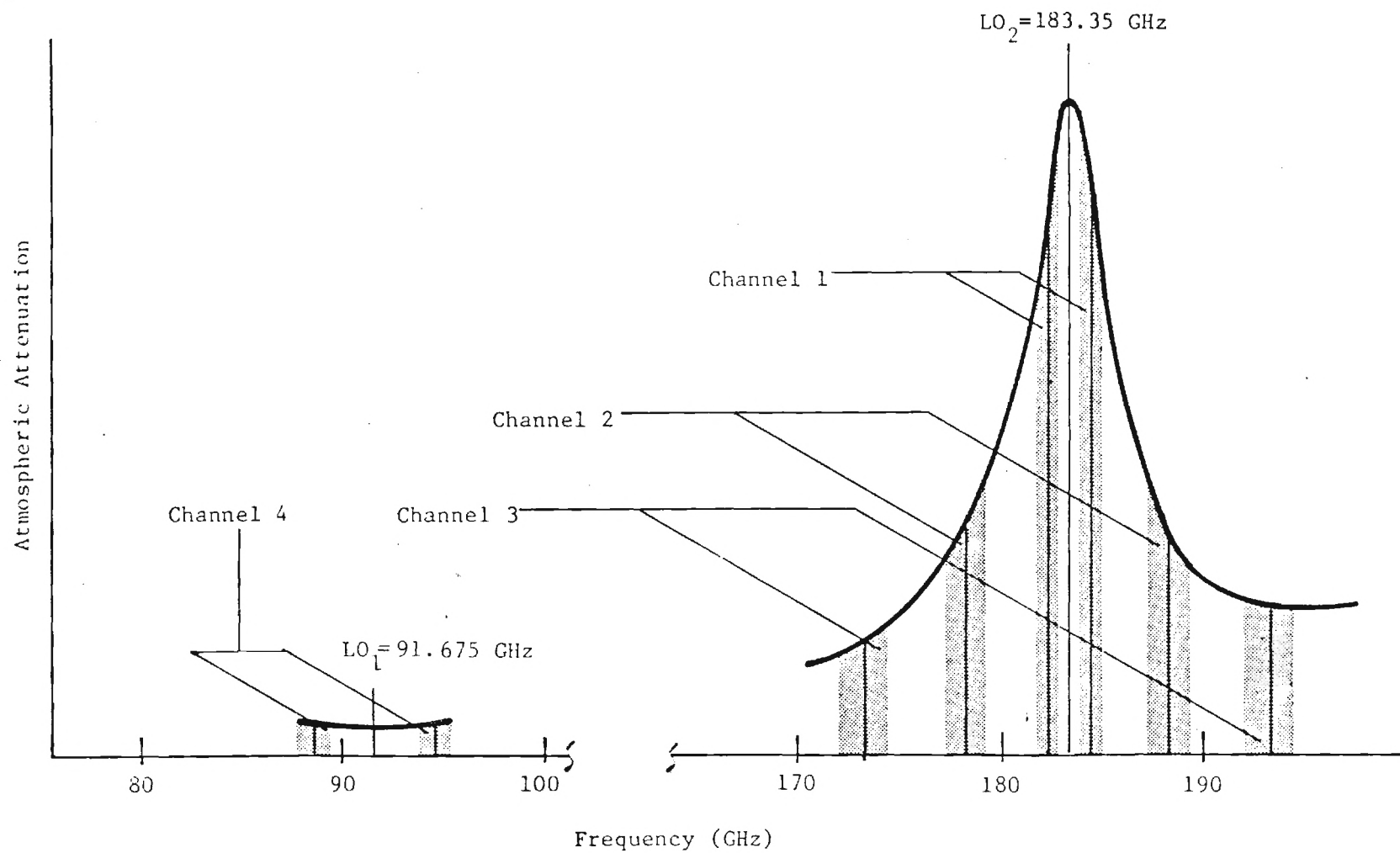


Figure 5. 94/183 GHz CV 990 Radiometer Channel Allocation.

at three channels provide a more accurate estimate of water vapor concentration by determining the shape of the absorption line over a ± 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.

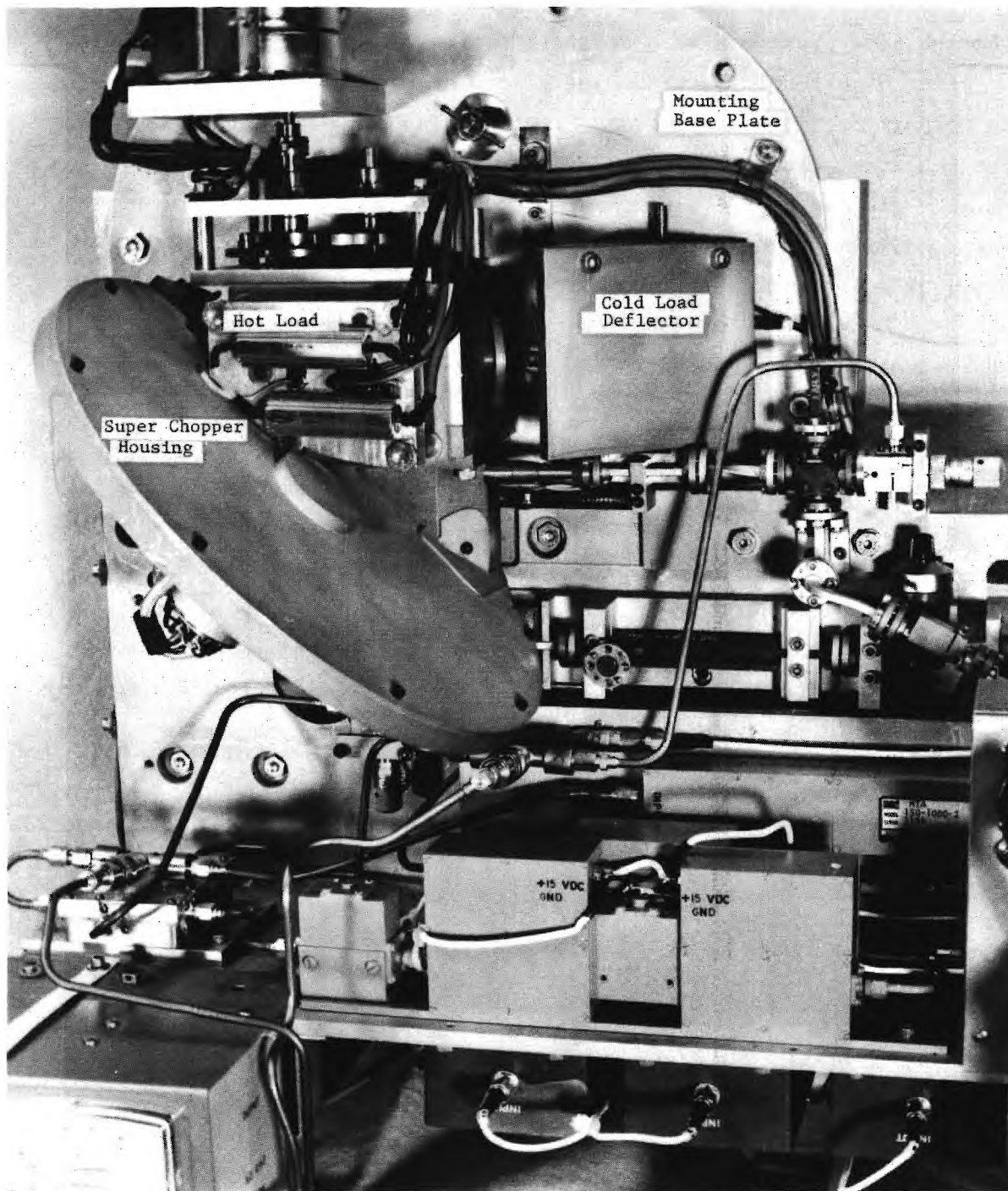


Figure 6. 94/183 GHz Radiometer (Window Mounted Components).



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.

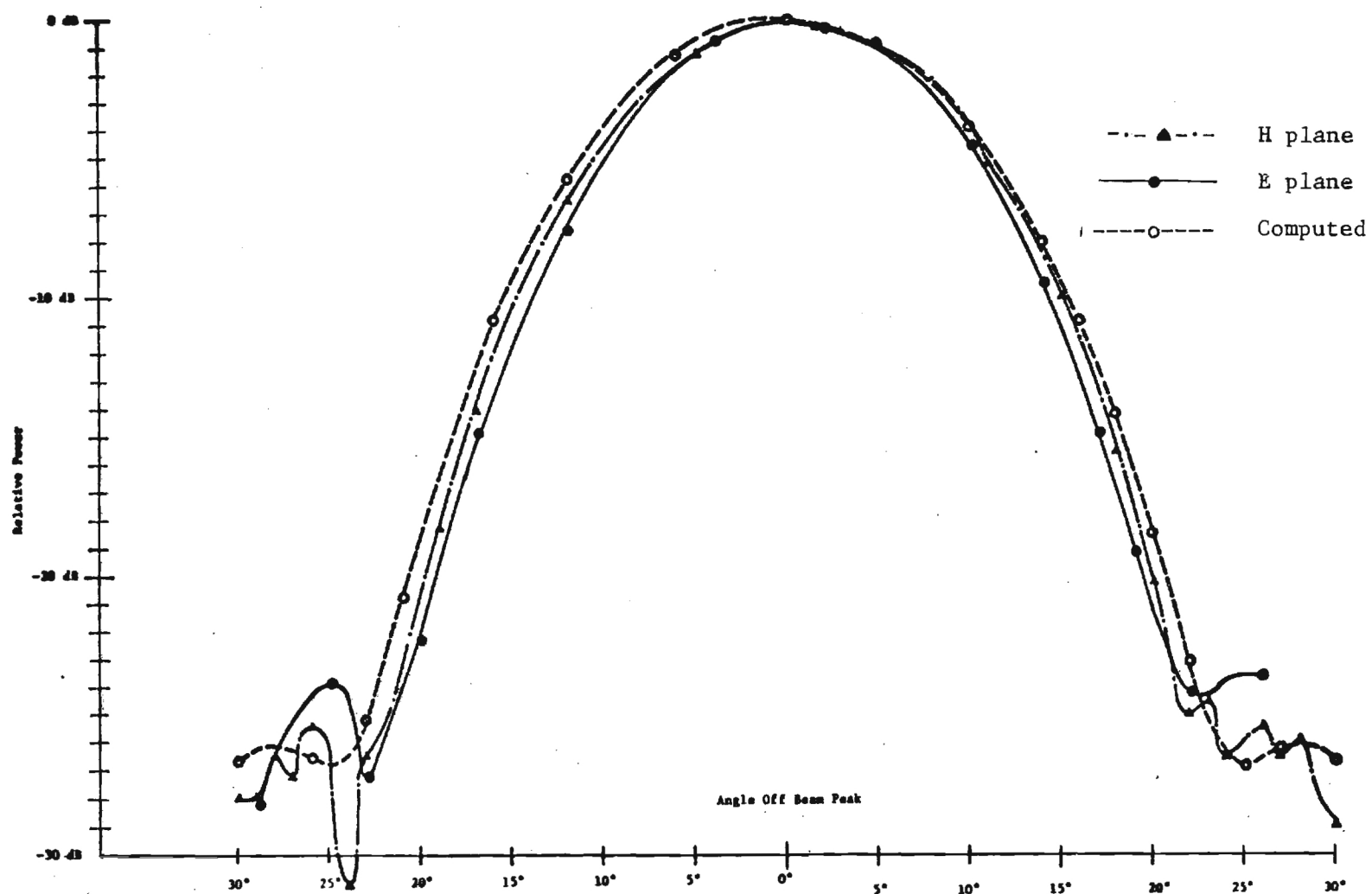


Figure 8. Measured and Calculated 180 GHz Feed Horn Antenna Pattern.

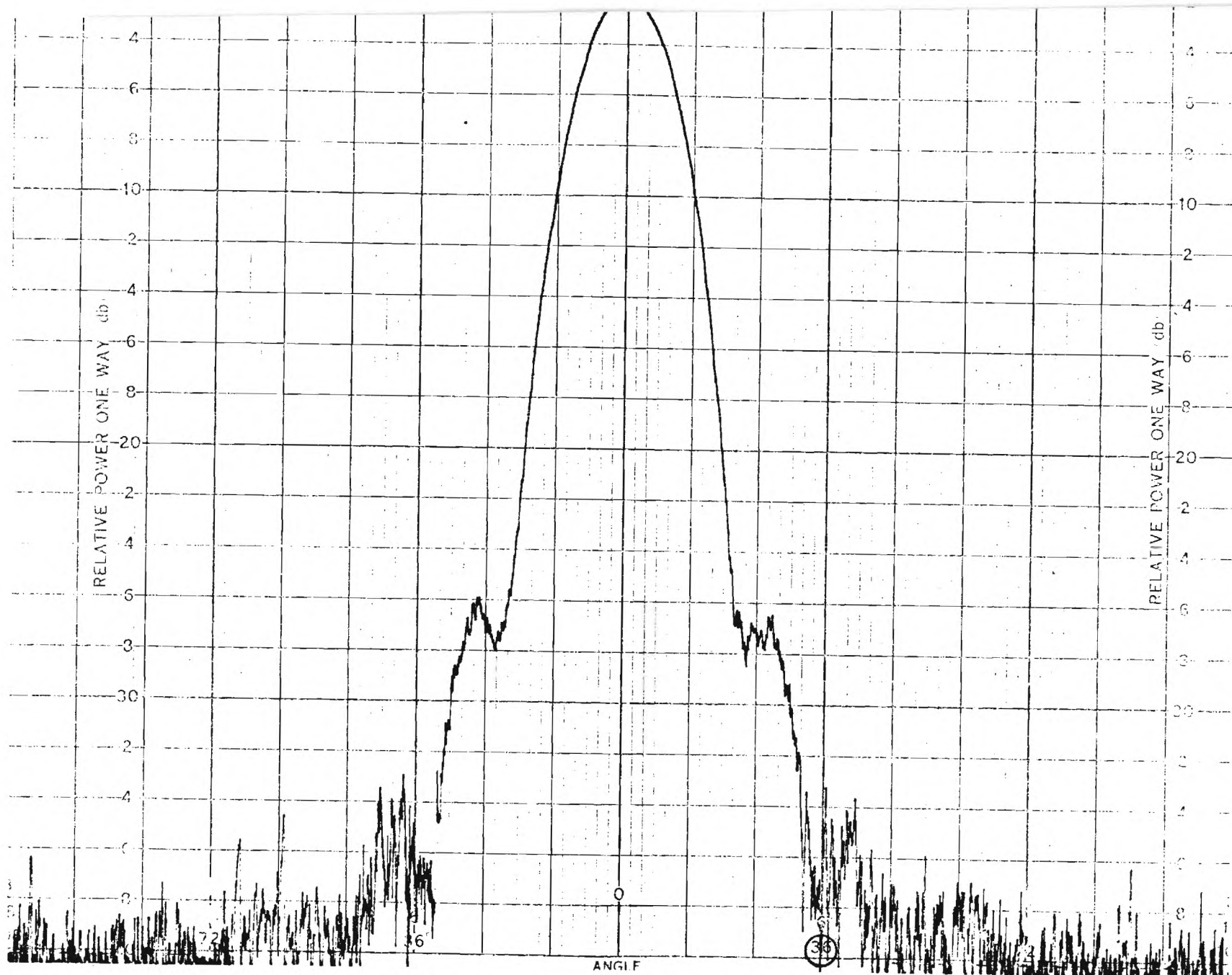


Figure 9. Corrugated Horn Pattern, E-Plane (94.5 GHz).

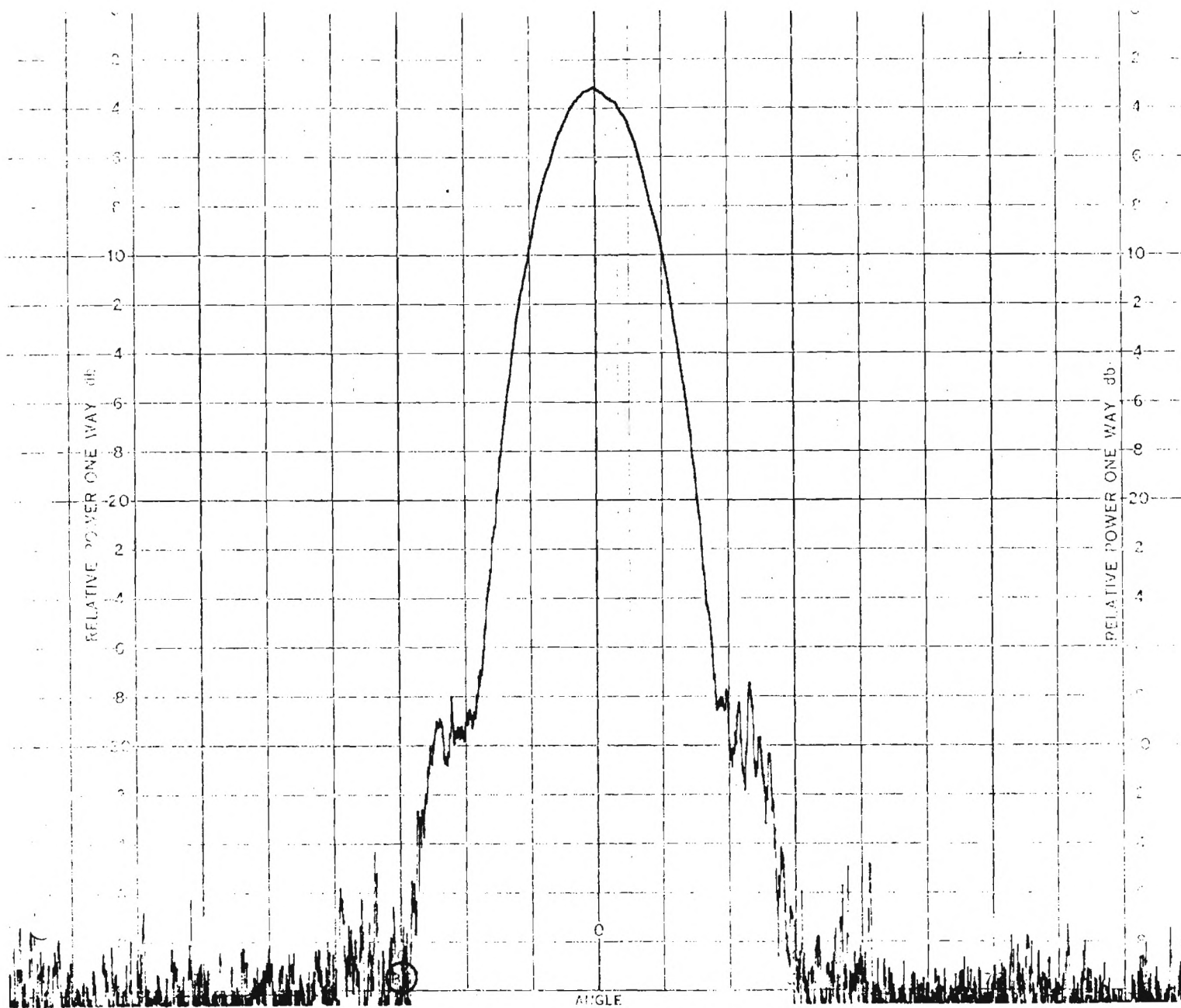


Figure 10. Corrugated Horn Pattern, H-Plane (94.5 GHz).

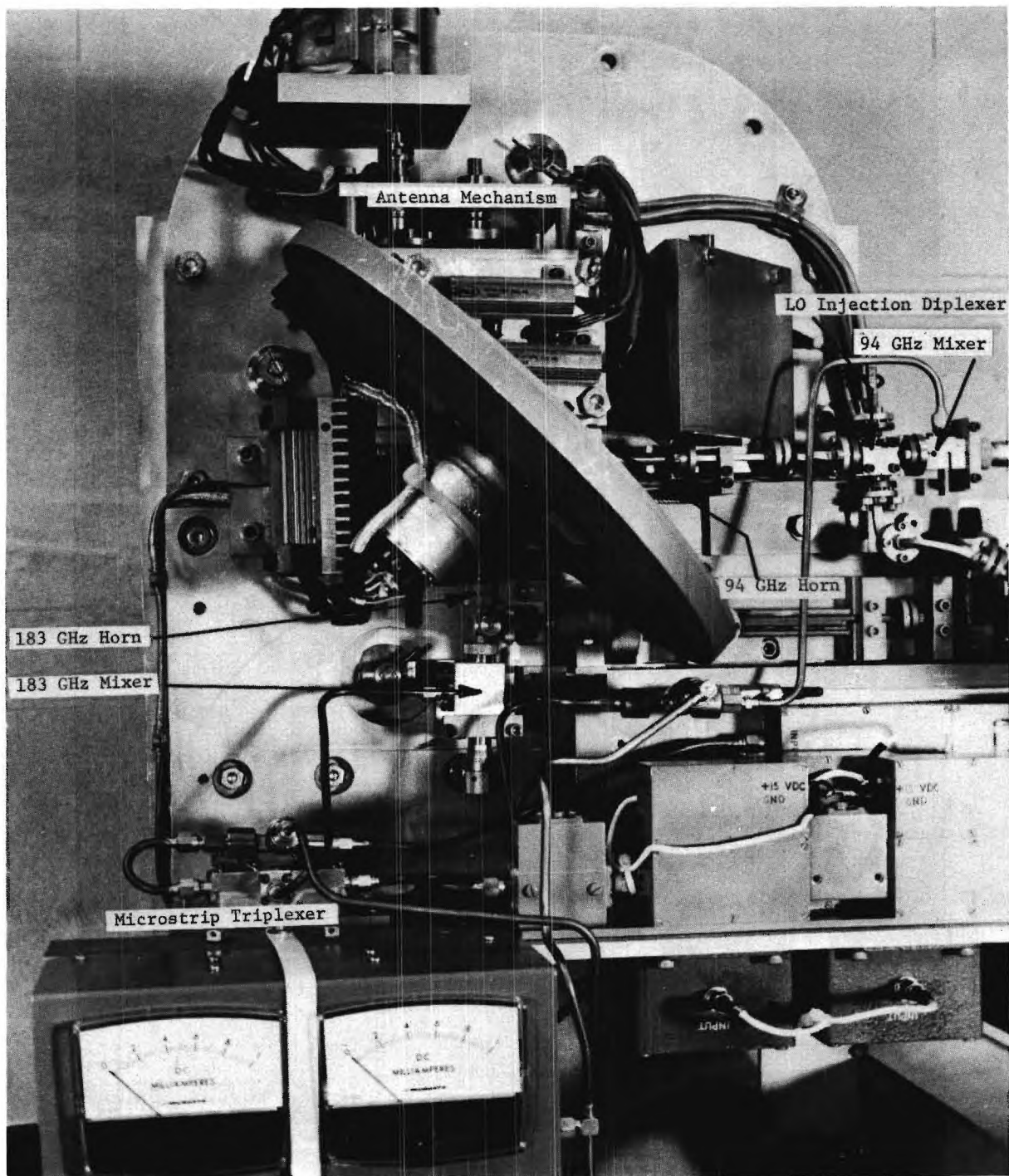


Figure 11. 94/183 GHz Radiometer (Showing Major Components).

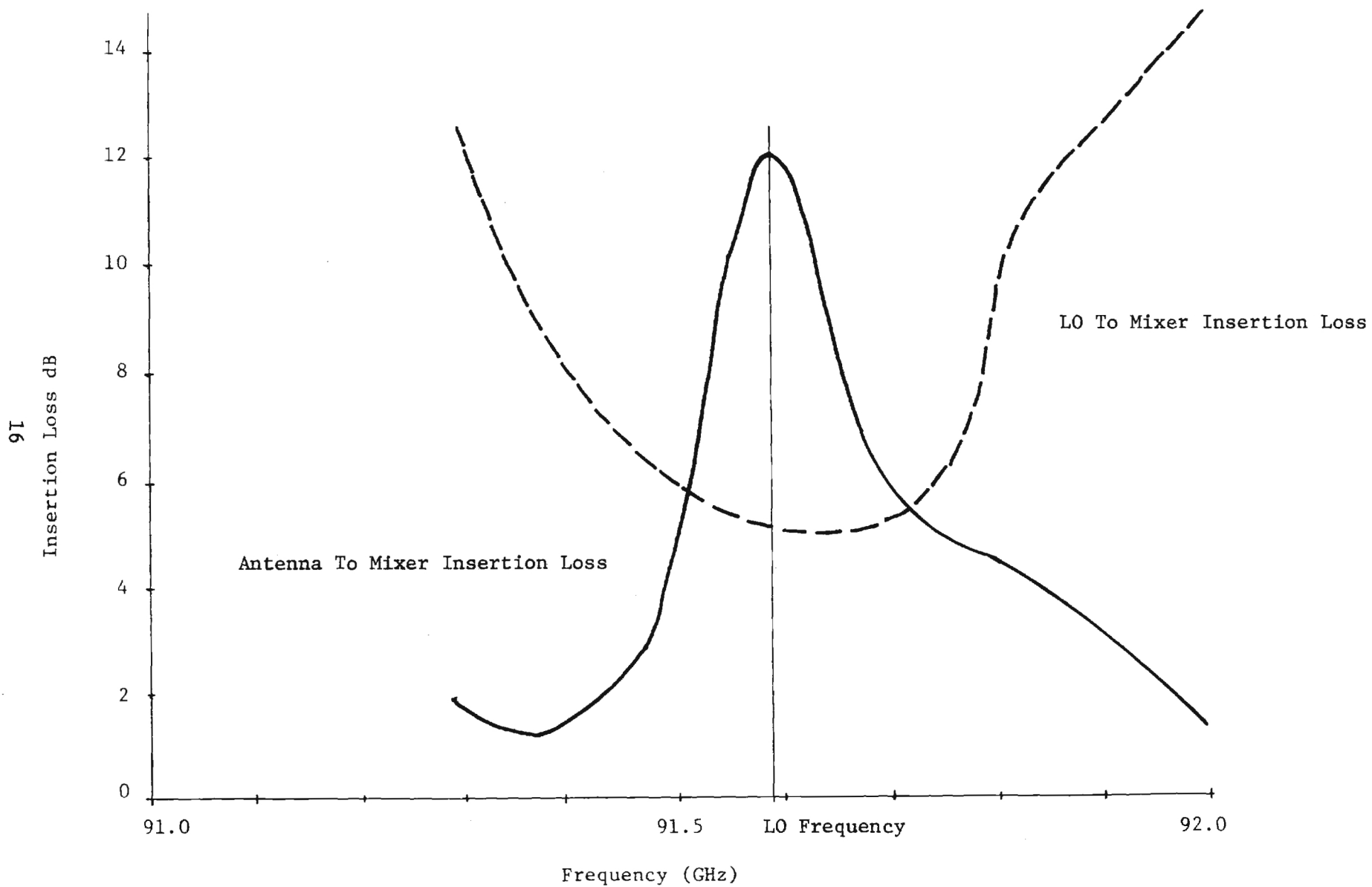


Figure 12. Insertion Loss Measured From LO to Mixer (Dotted Line) and Mixer to Antenna (Solid Line) of 91.65 GHz Directional Filter. Less than 0.5 dB loss at signal

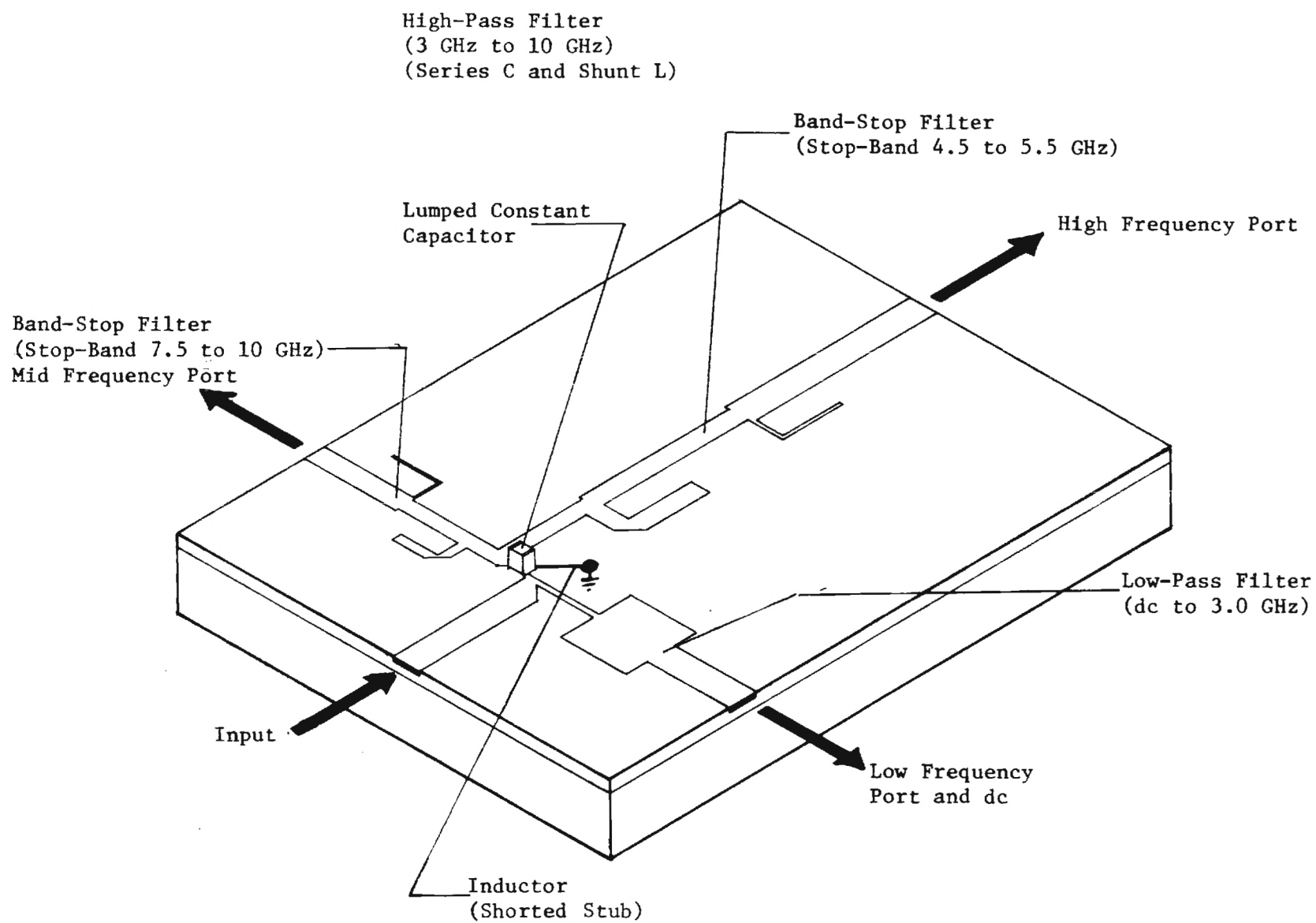


Figure 13. Microstrip Triplexer (With dc Port).

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.

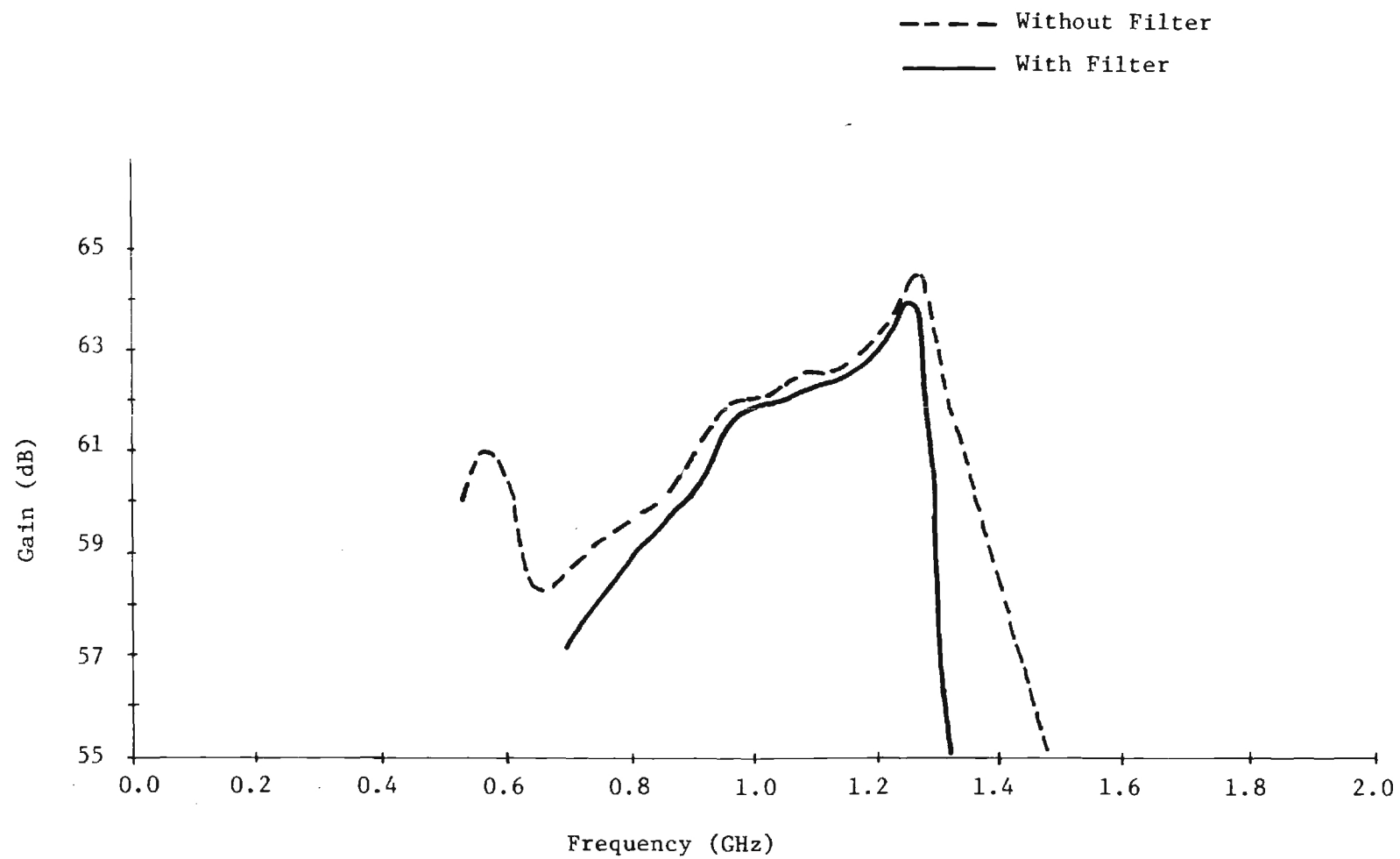


Figure 14. Measured Gain Versus Frequency of 1 GHz IF Amplifier.

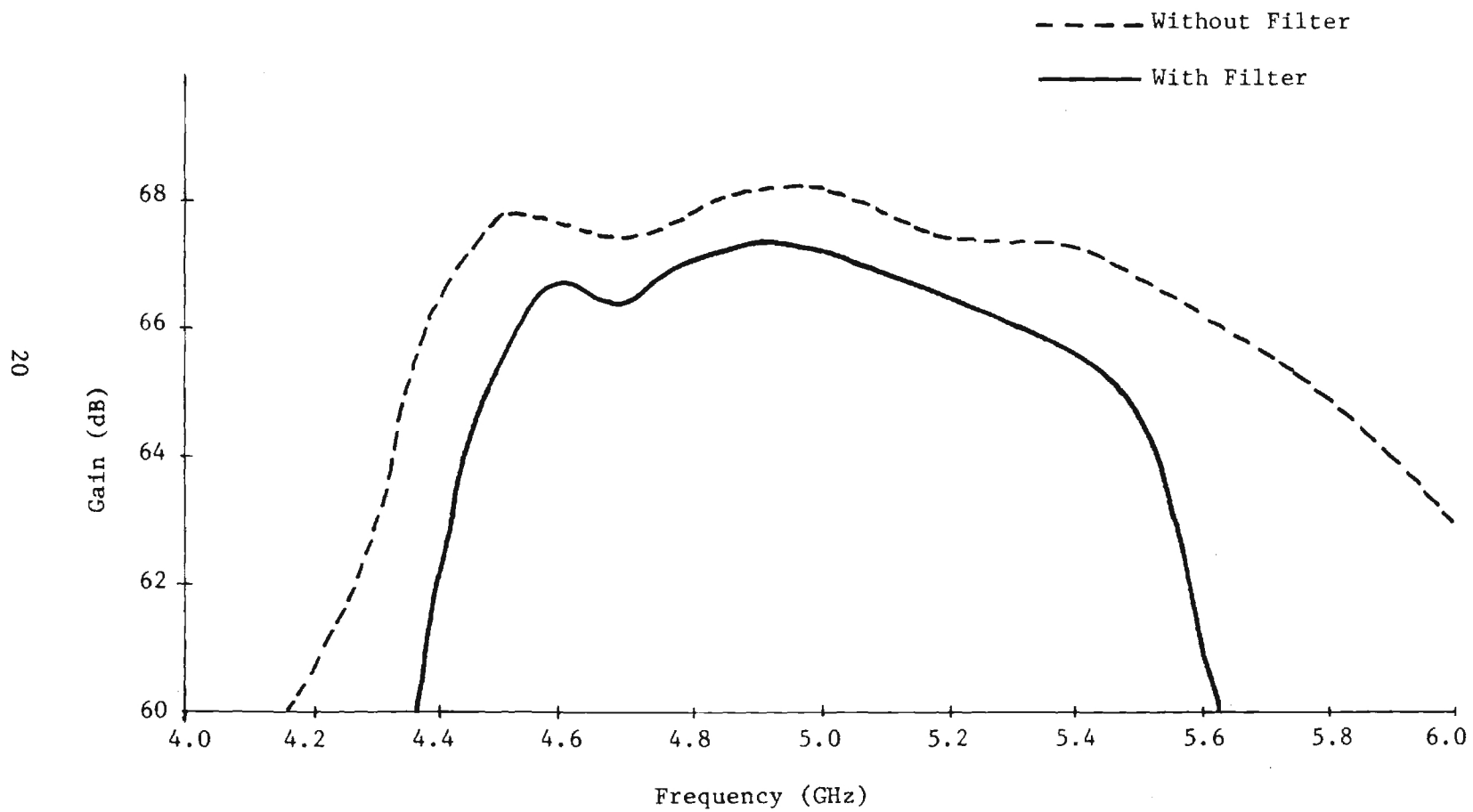


Figure 15. Measured Frequency Response of 5 GHz IF Amplifier.

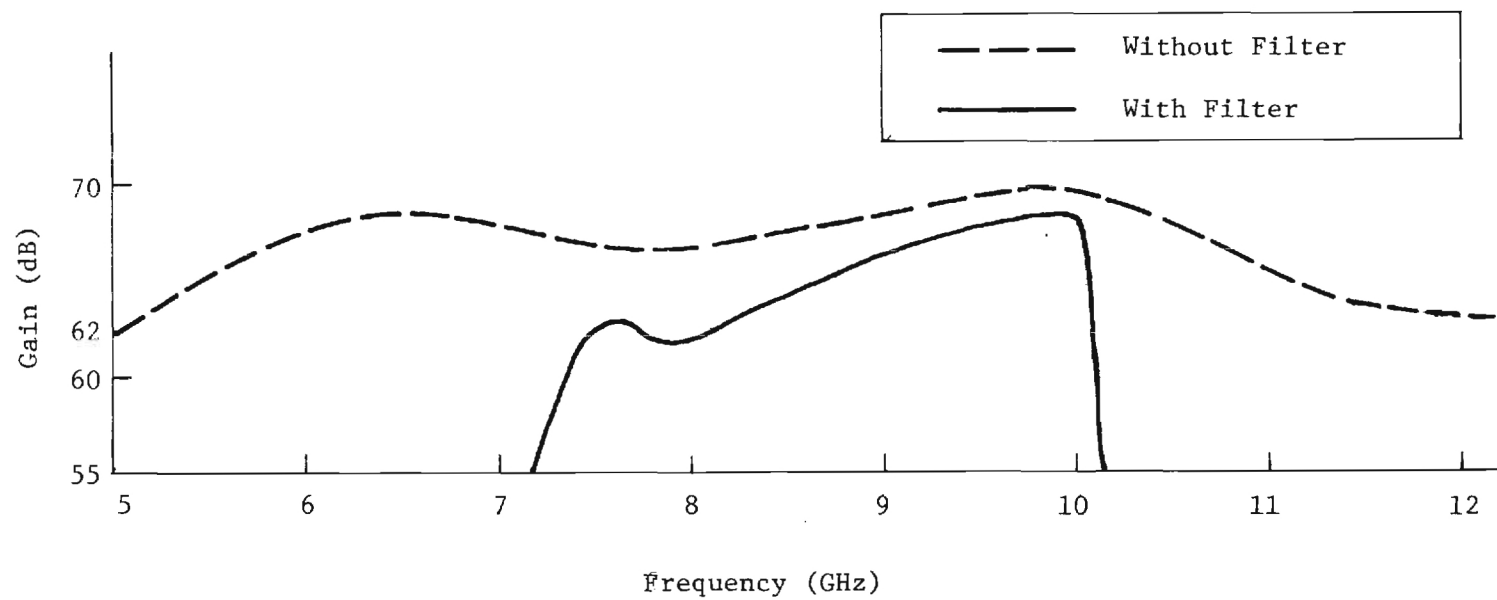


Figure 16. Measured Gain versus Frequency of 10 GHz IF Amplifier (183 GHz Channel).

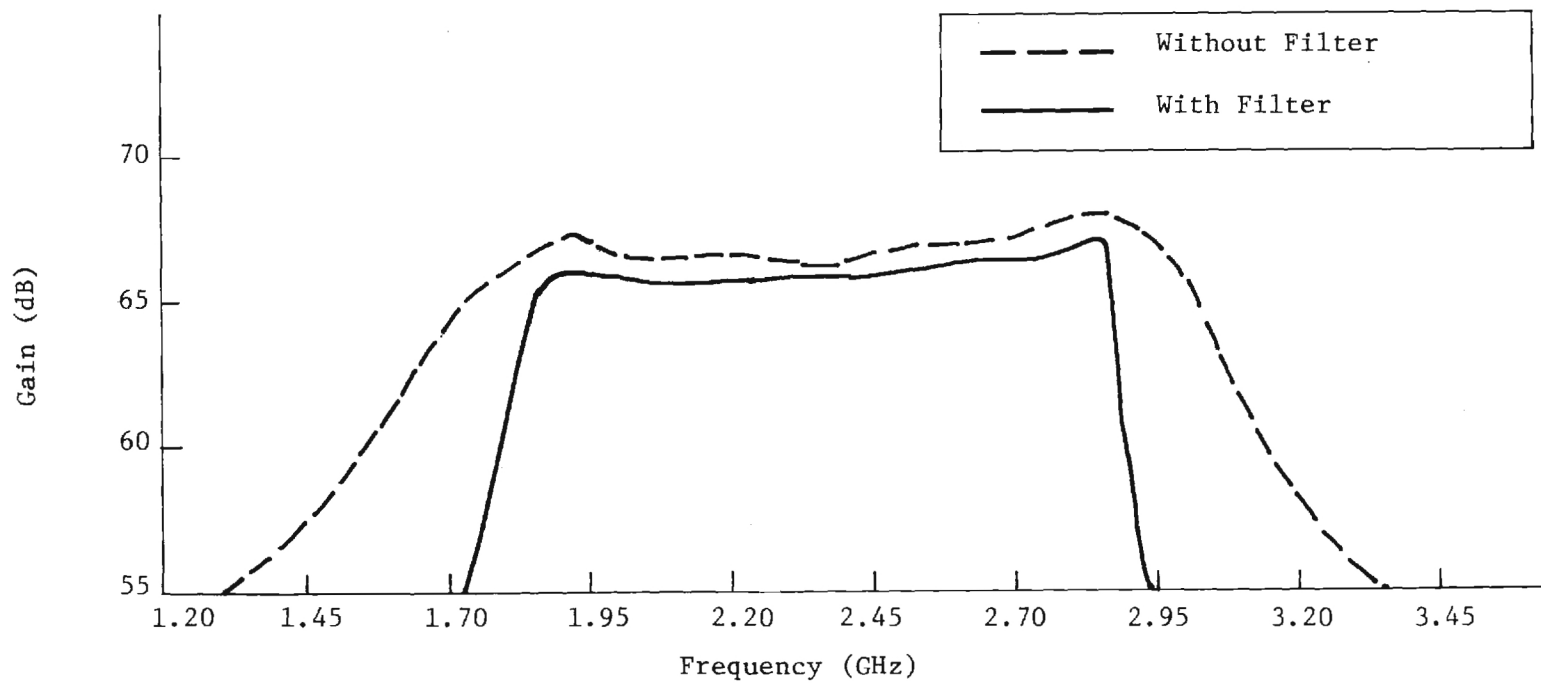


Figure 17. Measured Gain versus Frequency of 2.3 GHz IF Amplifier (94 GHz Channel).

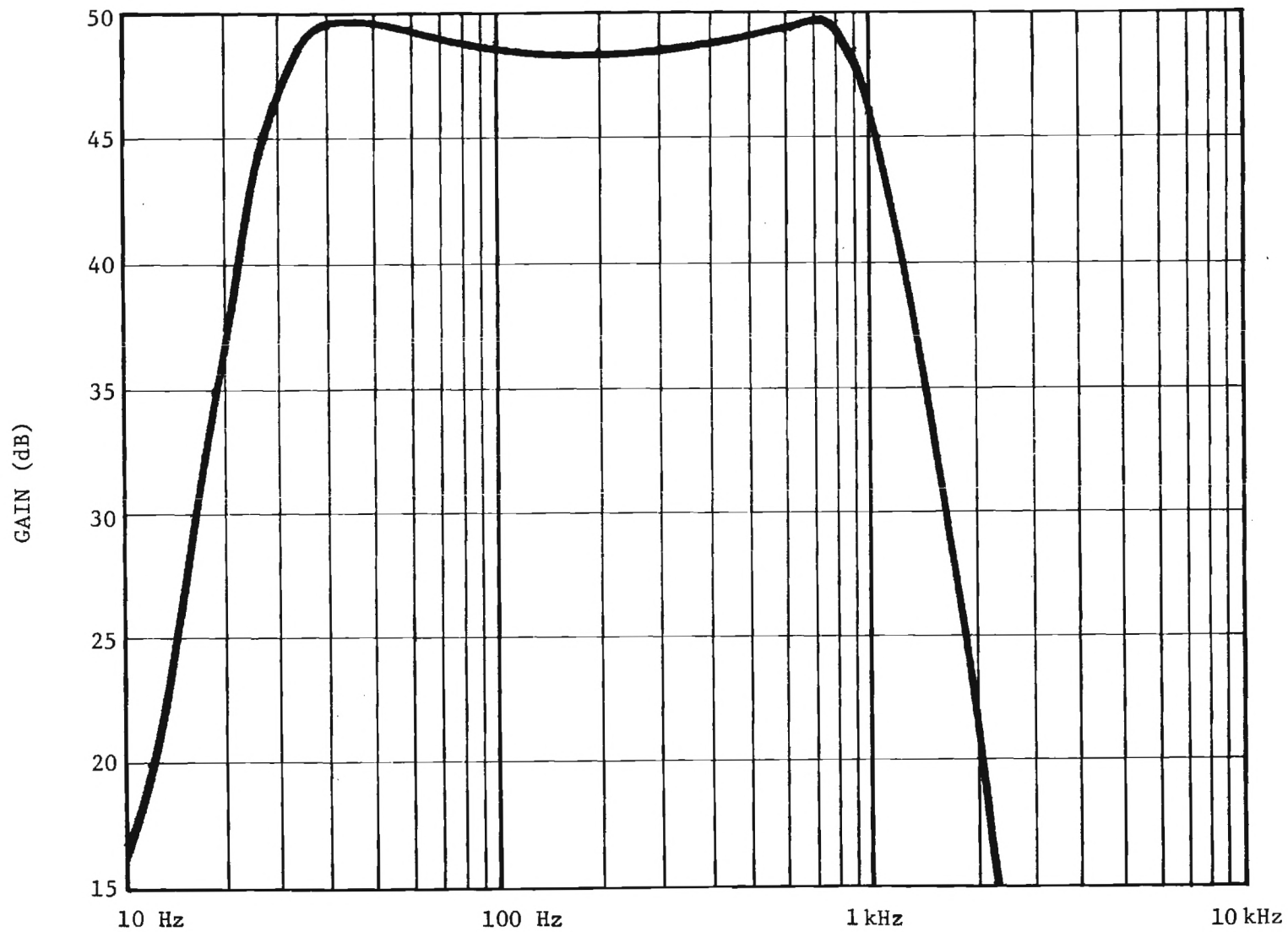


Figure 18. Video Amplifier Frequency Response.

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.

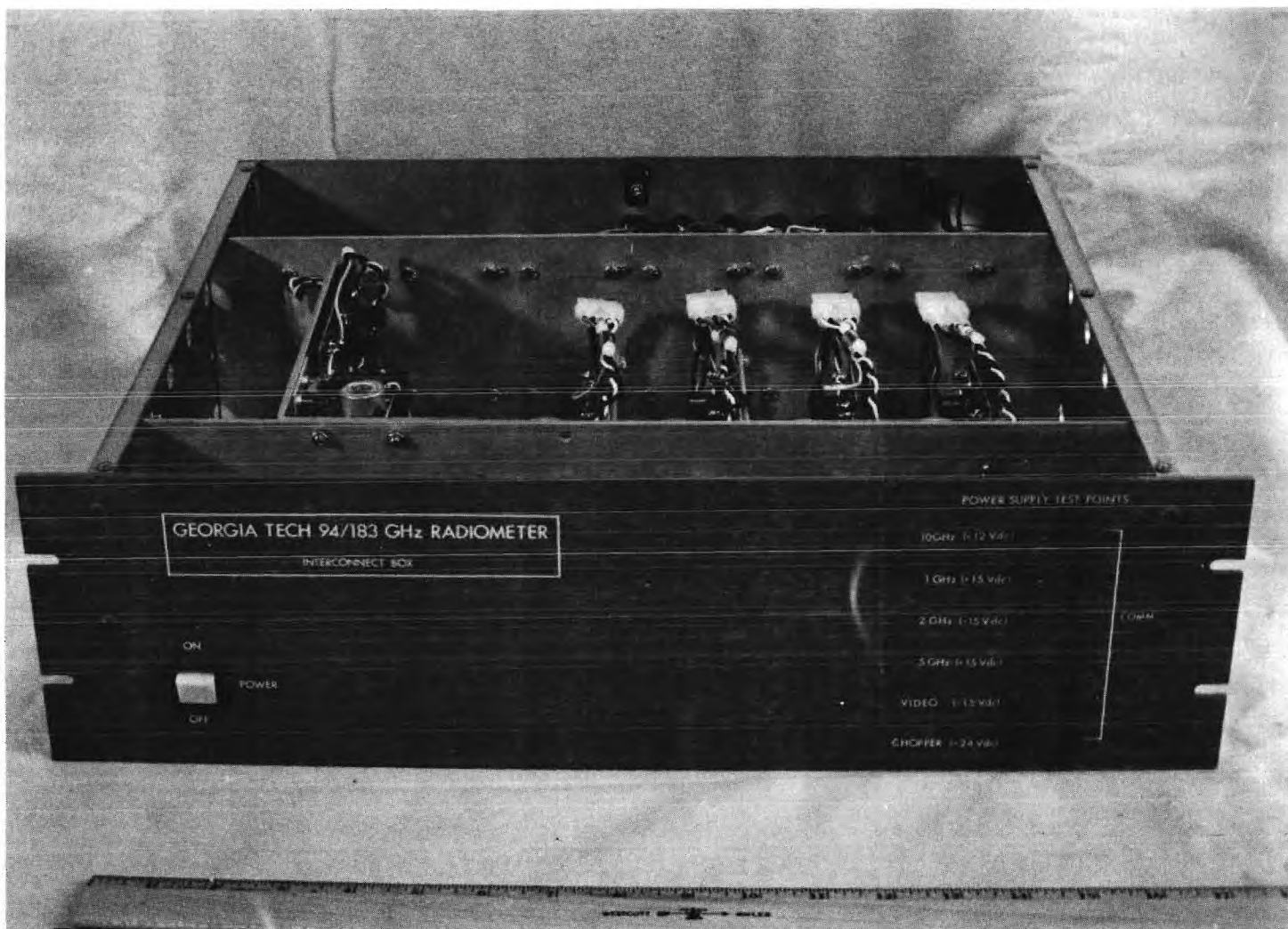


Figure 19. 94/183 GHz Radiometer Interface Electronics Package.

TABLE 1

94/183 GHz CONVAIR 990 RADIOMETER DATA SOURCES

<u>DATA SOURCE</u>	<u>DESIGNATION</u>	<u>SIZE (BITS)</u>	<u>RECORDING INTERVAL</u>
<u>PSD OUTPUTS:</u>			
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	$\tau/2$
<u>TEMPERATURES:</u>			
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
<u>HOUSEKEEPING DATA:</u>			
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 $\Delta T_{\min}$ within the constraints of the relative "speed" of the observed phenomenon. Even if τ is shorter than the integration time required for the desired $\Delta T_{\min}$, 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 desirable 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

<u>TYPED COMMAND</u>	<u>OPERATION</u>
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 ($^{\circ}\text{K}$) and radiometer temperatures ($^{\circ}\text{K}$) 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.

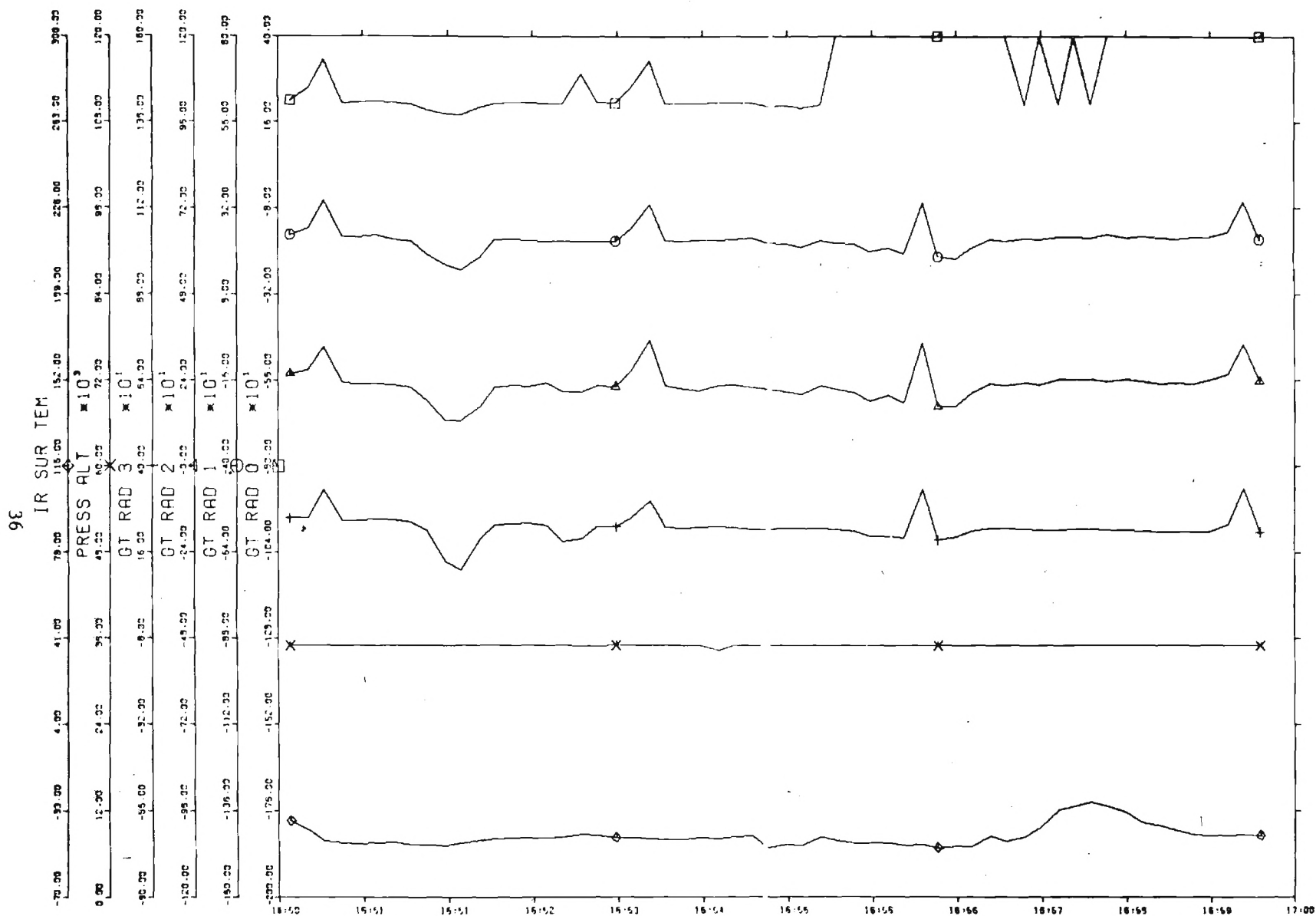


Figure 22. Time UT SMHP '78 Flight 7 - Cora: Convair Over Raincell Area and 94/183 GHz Radiometer Looking Down.

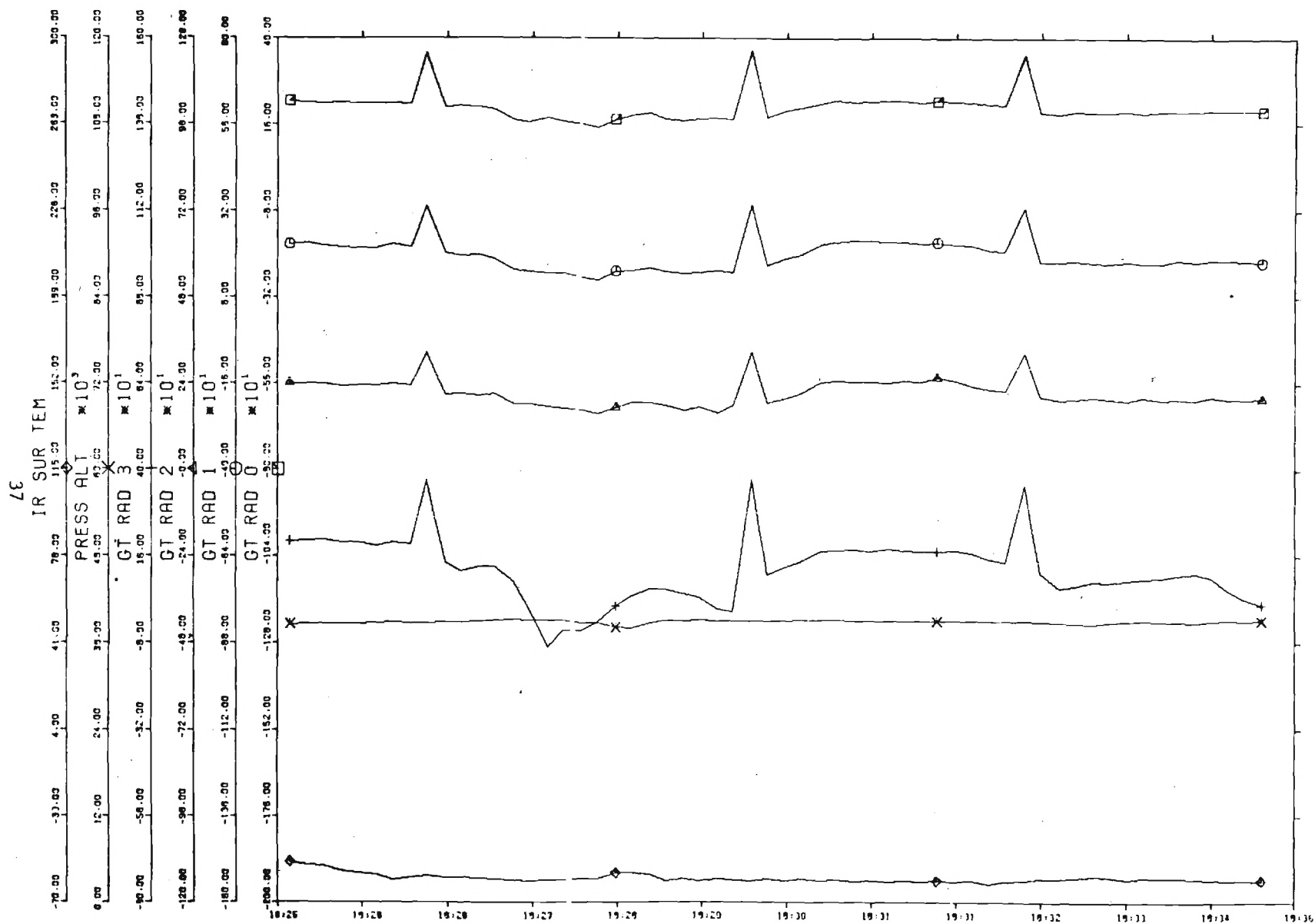


Figure 23. Time UT SMHP '78 Flight 7 - Cora: Raincell detected at 18:27 UT.

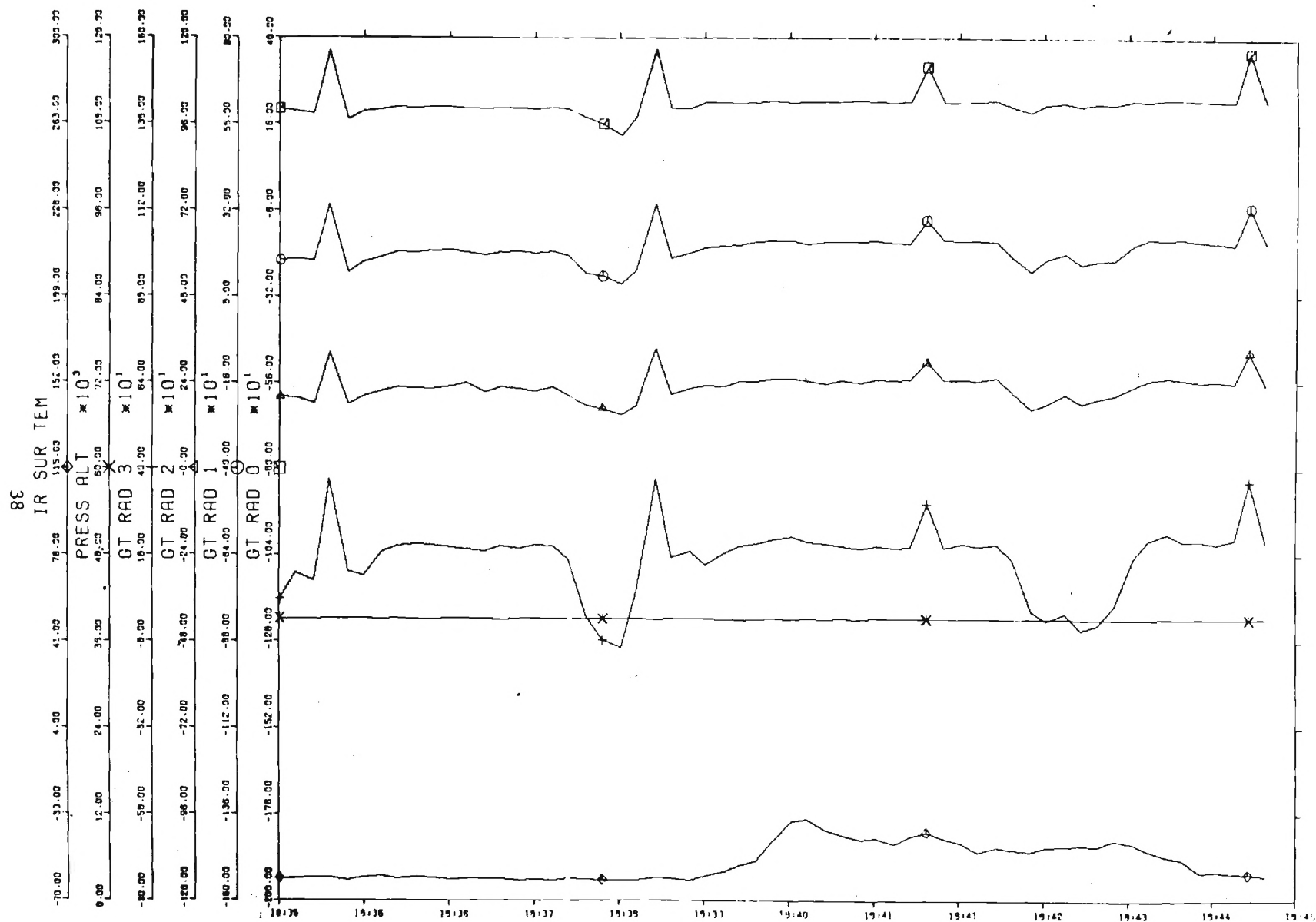


Figure 24. Time UT SMHP '78 Flight 7 - Cora: Raincell detected at 18:38 UT.

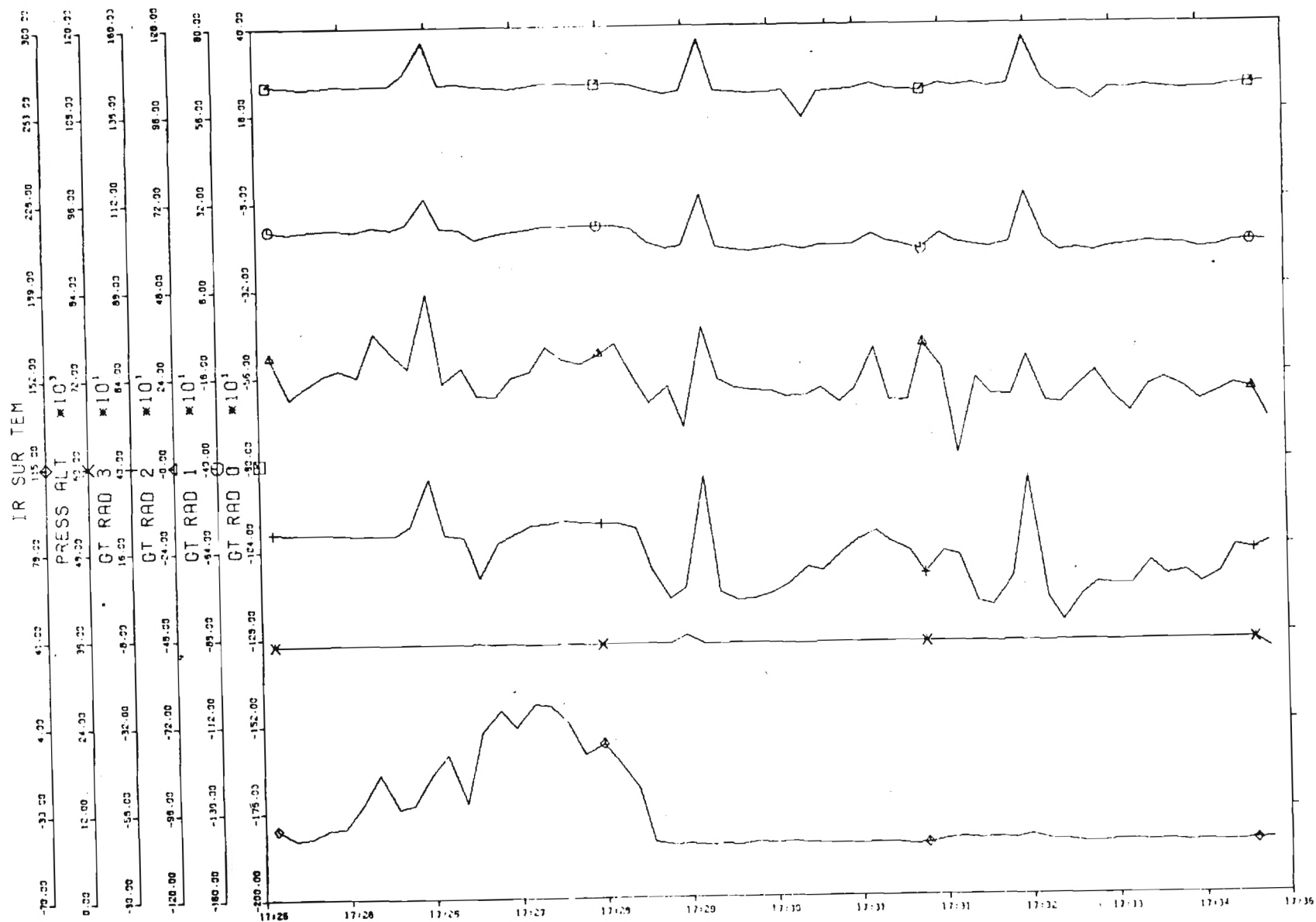


Figure 25. Time UT SMHP '78 Flight - Cora: Multiple Raincells measured as Convair Flies Through Overcast Region.

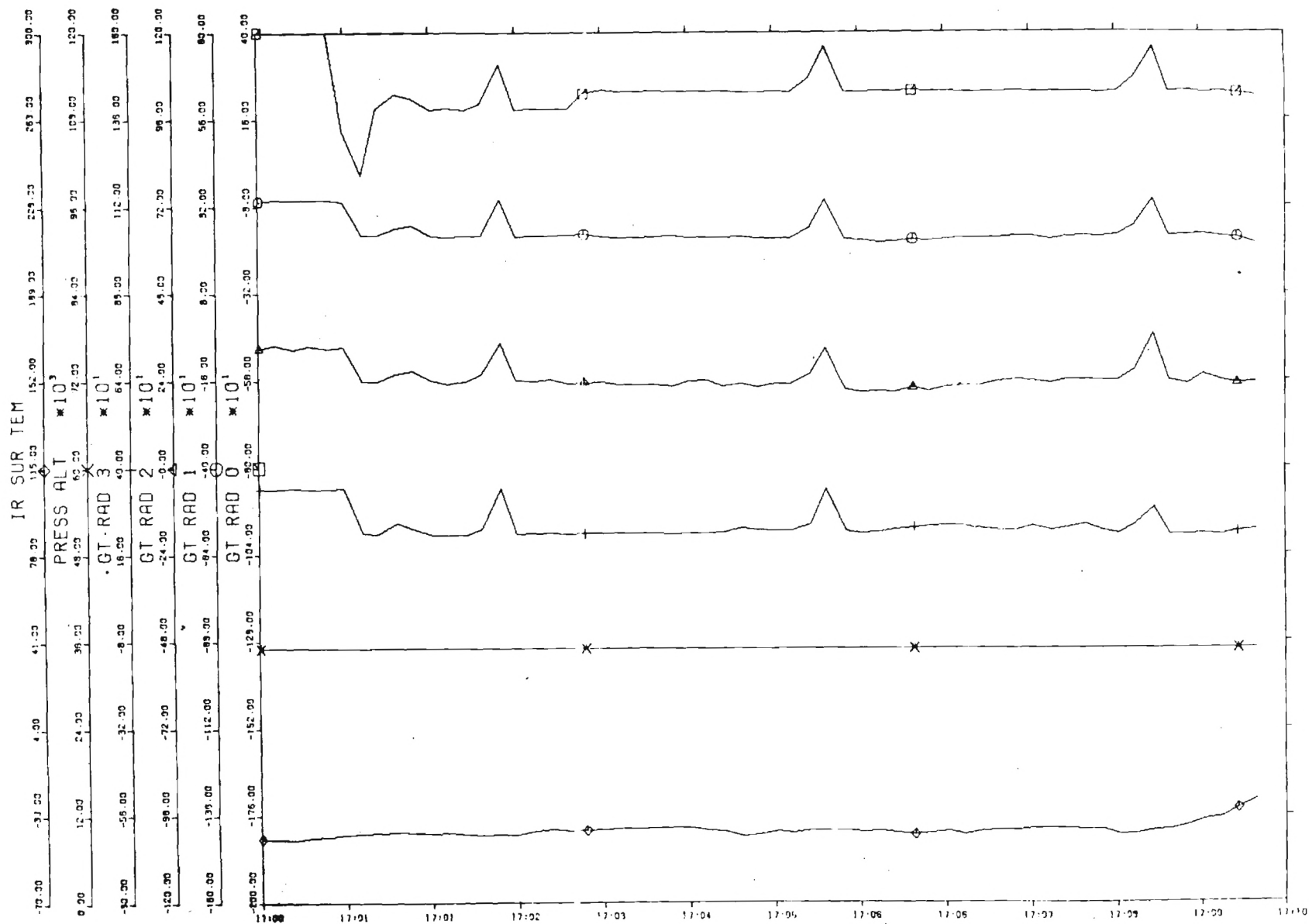


Figure 26. Time UT SMHP '78 Flight - Cora: Temperature Drop In All Four Radiometer Channels at 17:01 UT.

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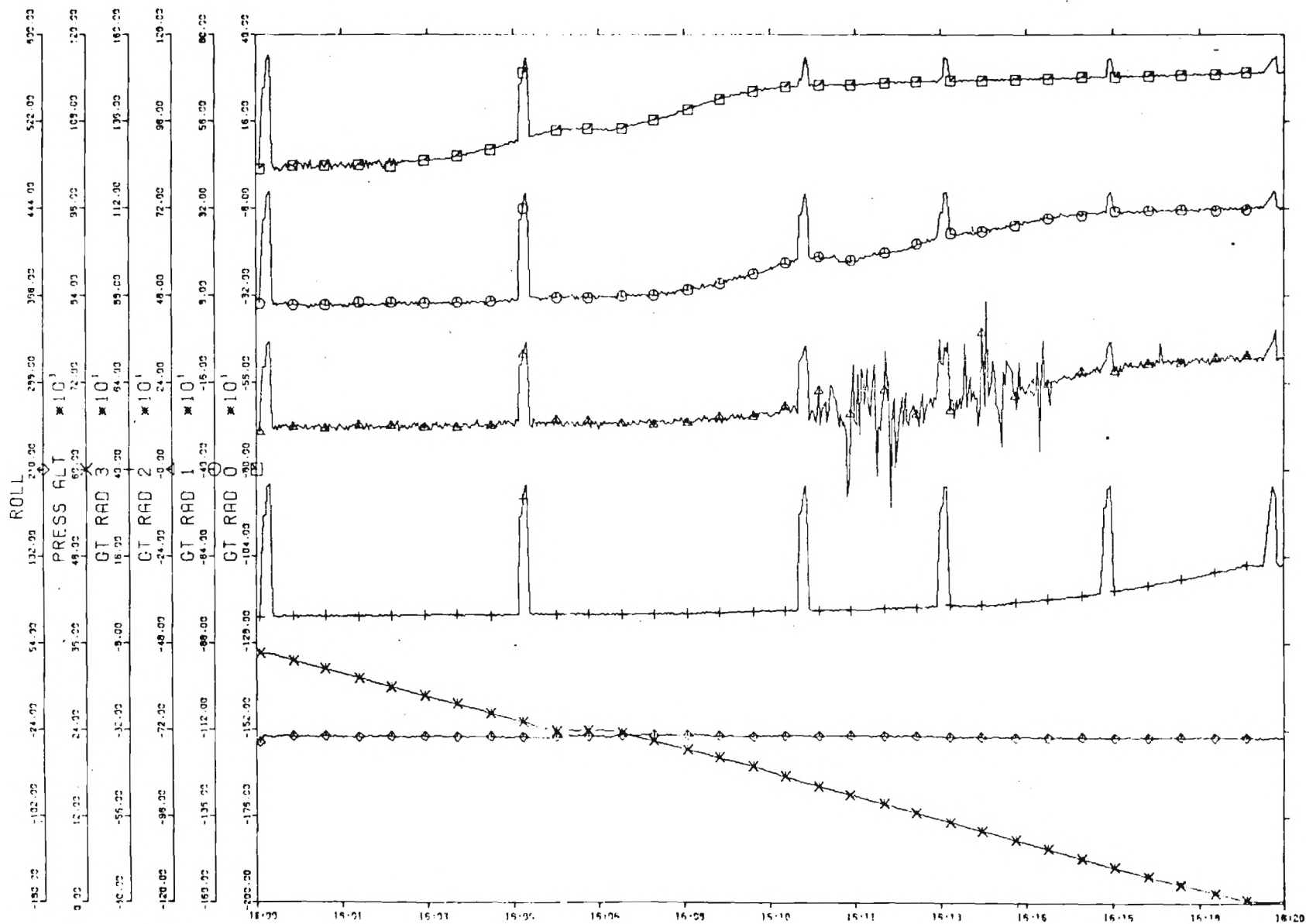


Figure 27. Time UT SMHP '78 Flight 8 (Day 225): Spiral Descent With 30° Left Roll Angle.
Note Radar Interference At GT RAD 2 (10 GHz IF Channel).

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 verifies 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.

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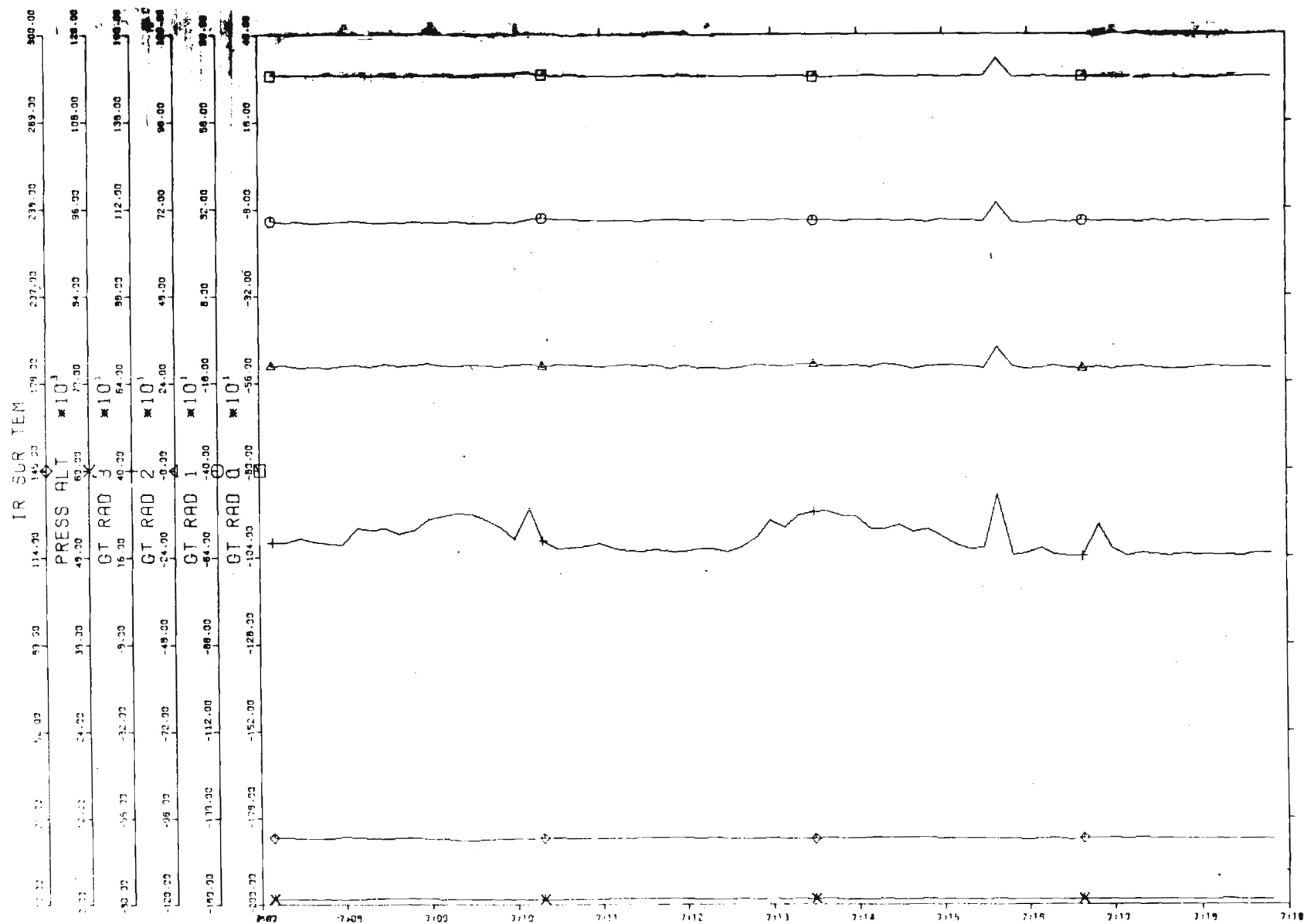


Figure 28. Time UT SMHP '78 Flight 13 (Plot 2): Convair Under Raincell Area and 94/183 GHz Radiometer is Looking Up.

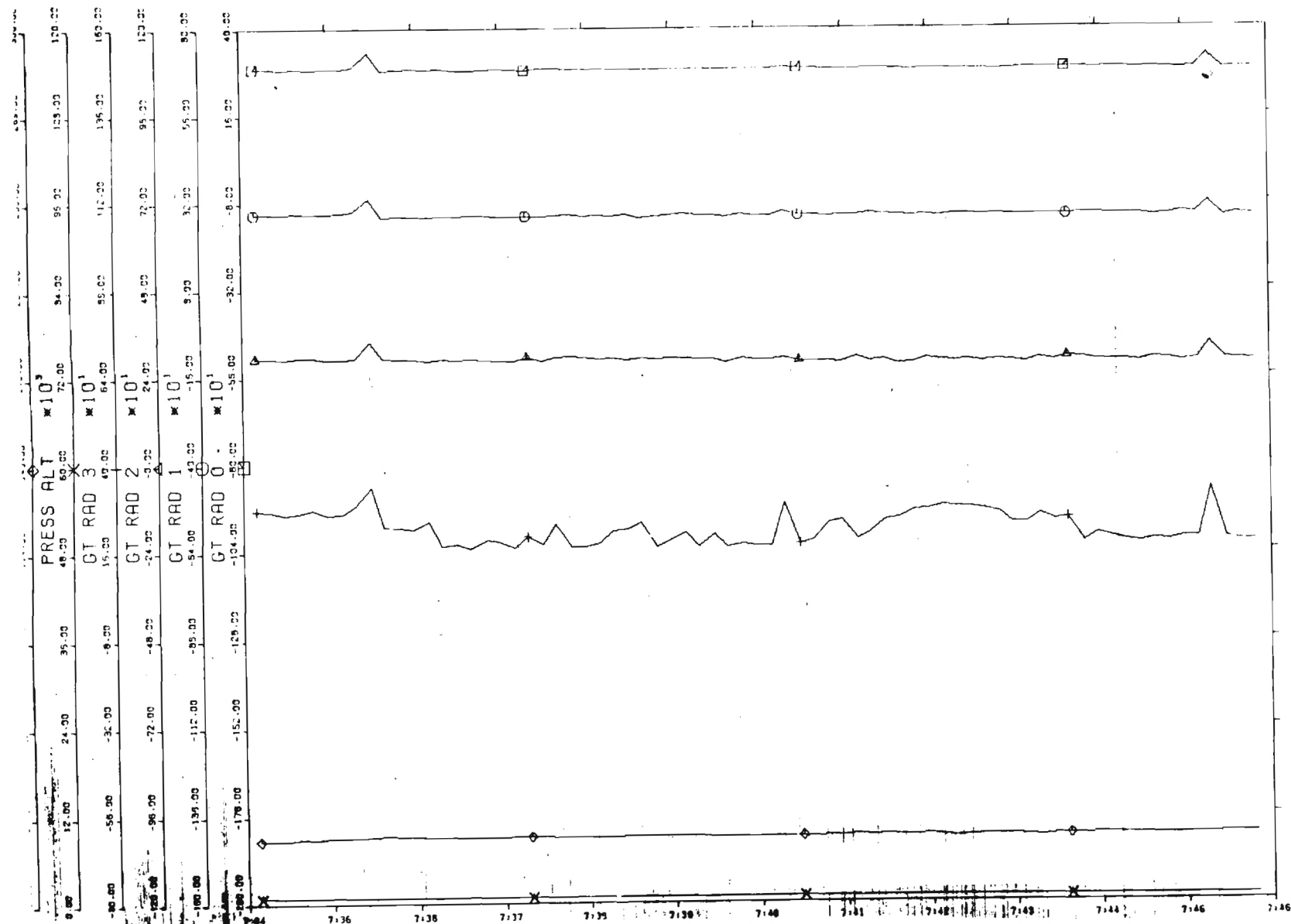


Figure 29. Time UT SMHP '78 Flight 13 (Plot 2): Multiple Raincells Detected By GT RAD 3 (94 GHz).

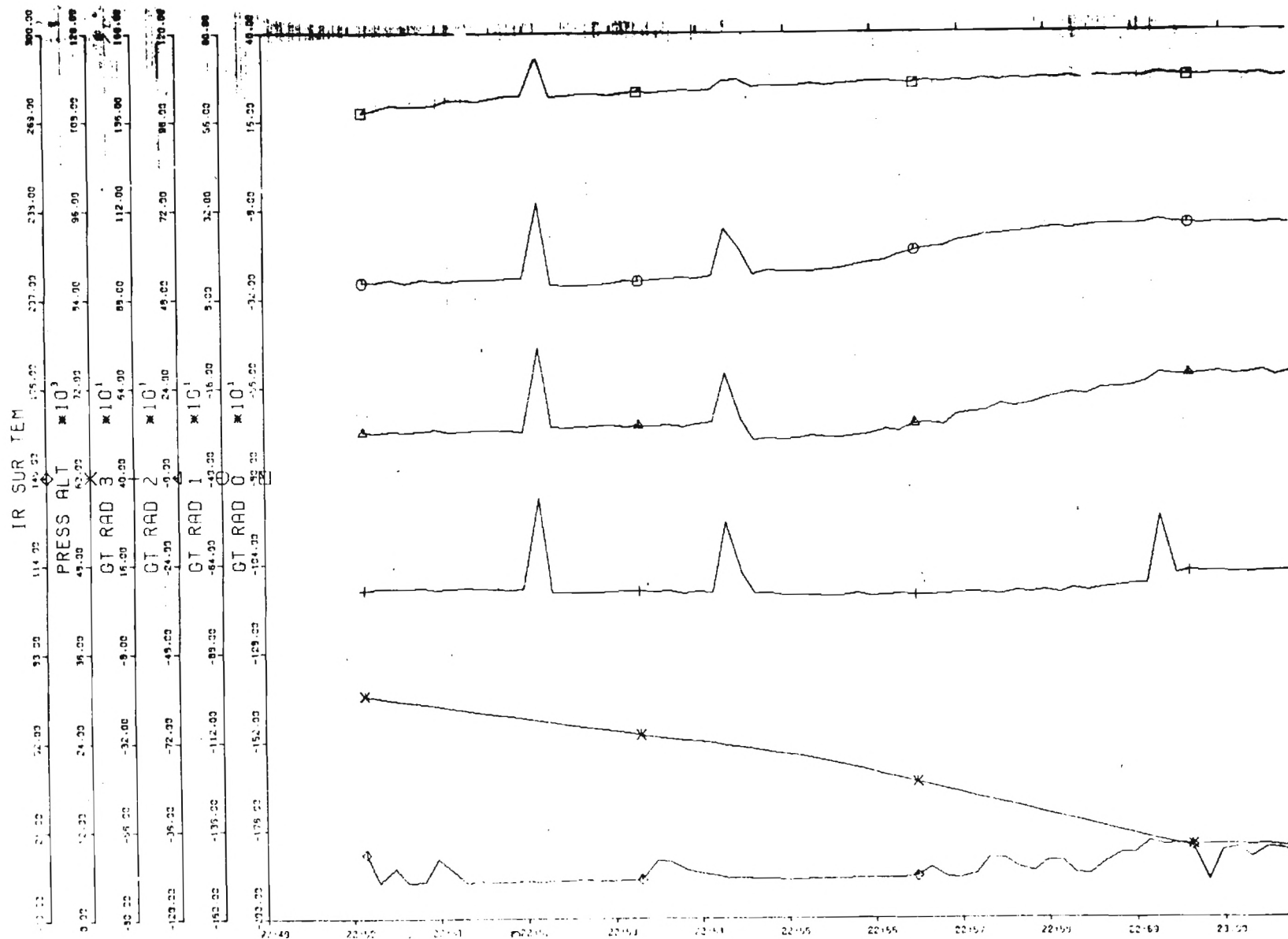


Figure 30. Time UT SMHP '78 Flight 12A (Plot 2): Radiometer Looking Up As Convair Performs Descent. Note Increase In Temperature On All Three 183 GHz Channels (Upper Three Traces).

4.3 NIMBUS-G Satellite Underflights (Arctic 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.

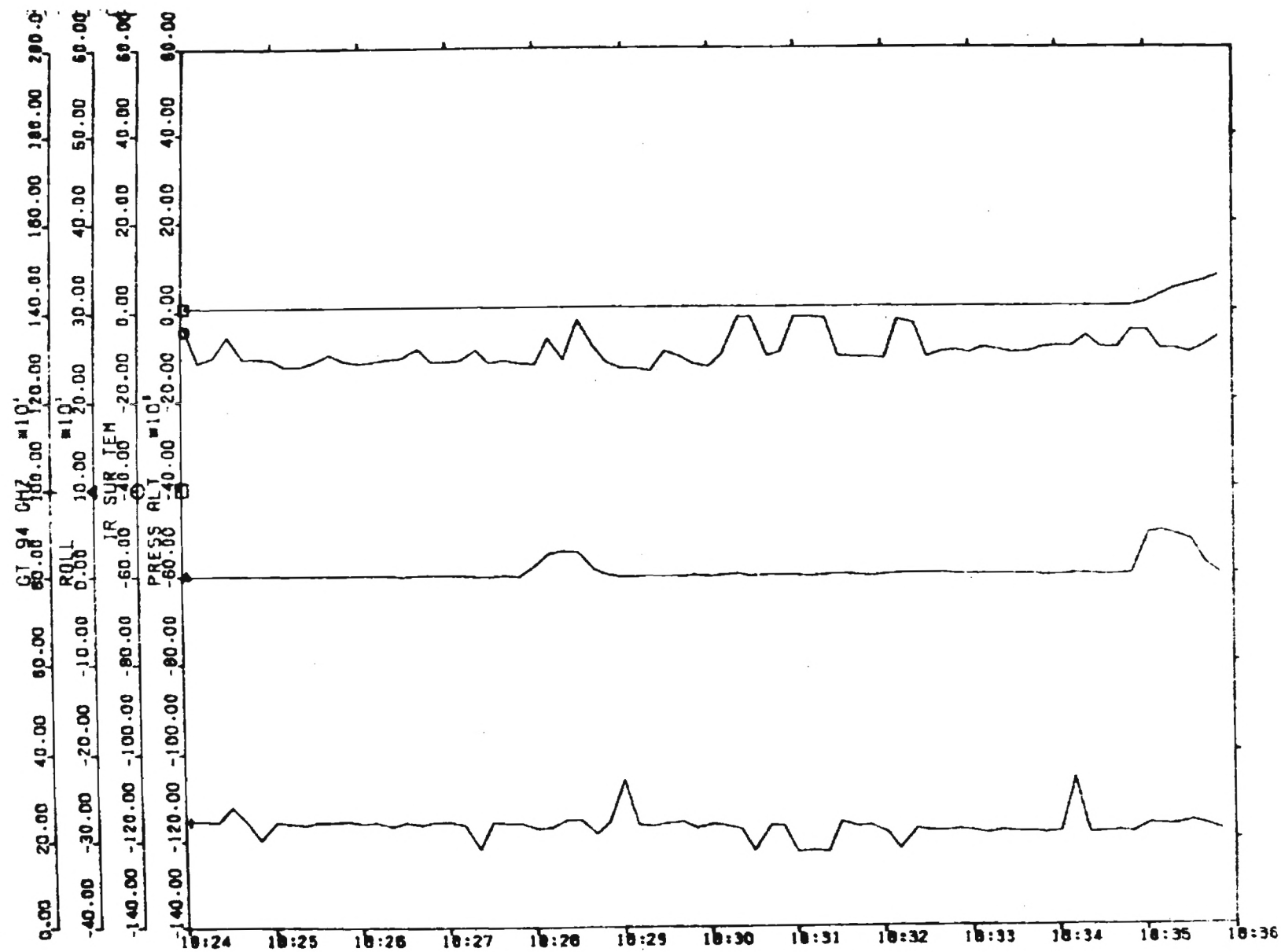


Figure 31. Time UT Day 301 Flight 99 Nimbus G: Convair Flying 500 Feet Above Sea Level Over Ice Cap Regions. Note Negative Peaks Over Open Water Seen By 94 GHz (Bottom Trace).

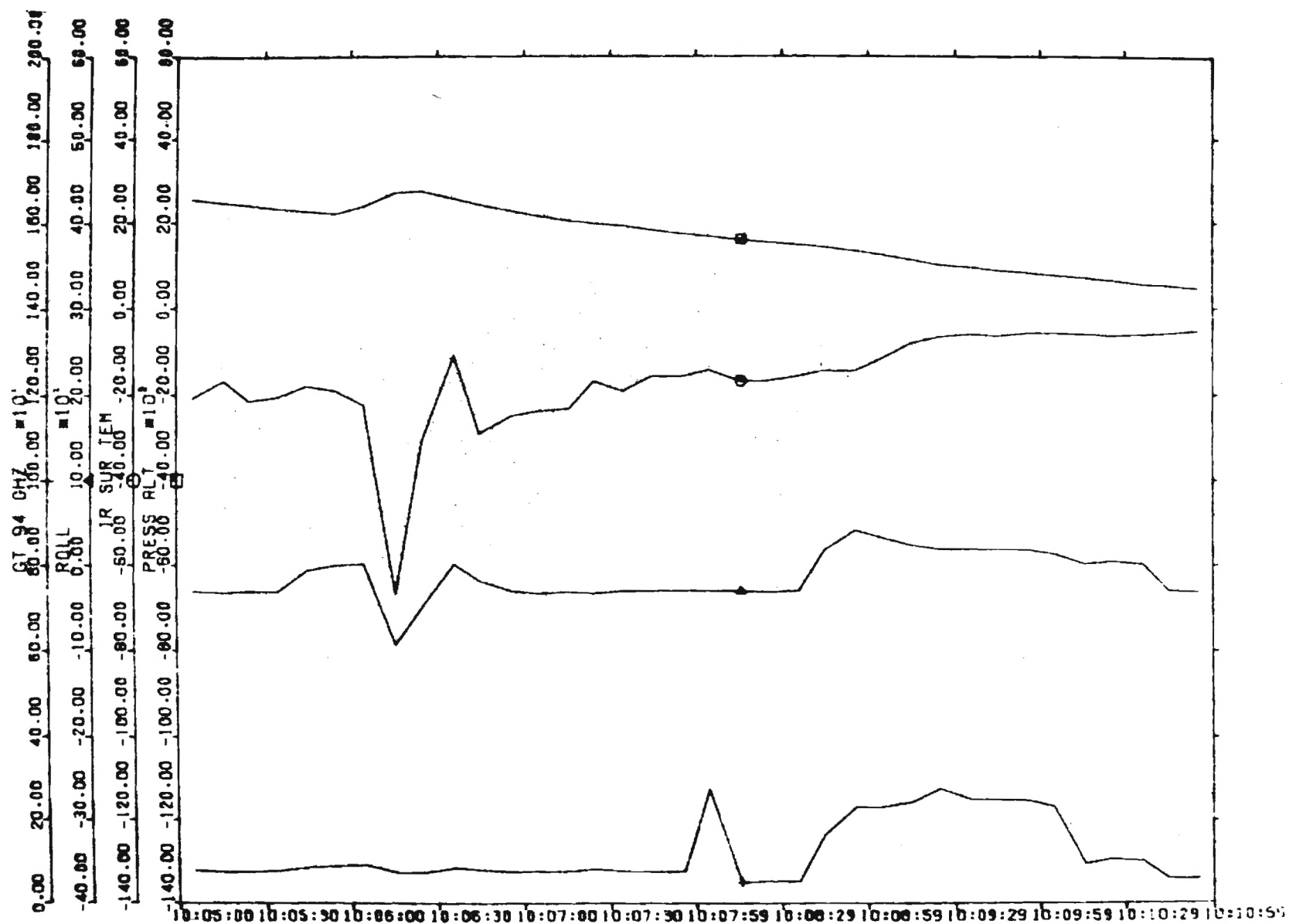


Figure 32. Time UT Day 307 Flight 9 Nimbus G: Convair Performs 90° Left Bank Wingover. 94 GHz Radiometer measures 30°K Looking Up.

APPENDIX A
OPERATING SYSTEM SOFTWARE

```

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 REG
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      CROPL      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      FFCOWCODE  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      BUFPT   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 860B      LDA A  #0BH      ;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 CEFB68      START1 LDX    #RDYMSG      ;PRINT PROMPT
00096 F84C BDF8C8      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 BDF83B      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      #STRMSG      ; 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 BDF83B      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 STATUS=0
00175 F8DF 2708          BEQ     LOAD1          ; YES, STATUS 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          ; CLEAR BLOCK NUMBER
00183 F8F0 970F          STA A   BLKNUM
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     #FPMMSG      ; 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 800C          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

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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      ; ACCESS 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 F9C8 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 BDF831     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 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 B0FA31     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

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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 FREE 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 4B3F20
00523 FB28 04          BYTE  4
00524 FB29 424C4F43      BLKMSG  ASCII  "BLOCKS? "
00524 FB2D 4B533F20
00525 FB31 04          BYTE  4
00526 FB32 54415045      FPMMSG  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	STRMSG	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	CRCPL -- 0041
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	WINTERK - FE07			

BOOTSTRAP Section Absolute (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	INCBK - 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 F8C8
STRMSG 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 Lines 536 Assembled Lines 13221 Bytes available

>>> No assembly errors detected <<<

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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 (EOC)
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      FFCODE       EQU      0AH
00054          000C      REVCODE      EQU      0CH
00055          000E      REMCODE      EQU      0EH

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00056      ;
00057      ;
00058      ; RAM VARIABLES ON PAGE 0
00059      ;
00060      0000      ORG      0
00061      ;
00062      ;
00063      ; INPUT/OUTPUT BUFFERS
00064      ;
00065      ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
00066      ; SYSTEM STATUS VARIABLES
00067      ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
00068      ;
00069      0000 0001  TRACKN  BLOCK  1      ; CURRENT TRACK NUMBER
00070      0001 0002  BLKNUM BLOCK  2      ; CURRENT BLOCK NUMBER
00071      0003 0002  FRAMTYPE BLOCK 2      ; FRAME TYPE IDENTIFIER, INDICATES POSITION OF REFLECTORS
00072      0005 0001  RFLPOS  BLOCK  1      ; REFLECTOR POSITION INDICATOR
00073      ;
00074      ; REAL TIME CLOCK DATA FROM 100 MS INTERNAL CLOCK
00075      ;
00076      0006 0001  FLIGHT   BLOCK  1      ; FLIGHT NUMBER (BCD)
00077      0007 0001  DAYS.HI  BLOCK  1      ; REAL TIME CLOCK DAY
00078      0008 0001  DAYS.LO  BLOCK  1      ; "
00079      0009 0001  HOURS    BLOCK  1      ; REAL TIME CLOCK
00080      000A 0001  MINUTES   BLOCK  1      ; "
00081      000B 0001  SECONDS   BLOCK  1      ; "
00082      ; CLOCK DATA FROM IRIGB TIME CODE
00083      ;
00084      000C 0001  IRIGFLT  BLOCK  1      ; IRIGB FLIGHT NUMBER (BCD)
00085      000D 0001  IRIGDAYH BLOCK  1      ; IRIGB DAYS MS DIGIT (BCD)
00086      000E 0001  IRIGDAYL BLOCK  1      ; " " LS "
00087      000F 0001  IRIGHOUR BLOCK  1      ; " HOURS
00088      0010 0001  IRIGMIN  BLOCK  1      ; " MINUTES
00089      0011 0001  IRIGSEC  BLOCK  1      ; " SECONDS
00090      ;
00091      ; BCD TEMPERATURE DATA FROM RADIOMETER CHANNELS
00092      ;
00093      0012 0005  CH0TEMP  BLOCK  5      ; BCD TEMPERATURE OF 183 GHZ CHANNEL (DEG. KELVIN)
00094      0017 0005  CH1TEMP  BLOCK  5      ; " " " 188 " " " "
00095      001C 0005  CH2TEMP  BLOCK  5      ; " " " 193 " " " "
00096      0021 0005  CH3TEMP  BLOCK  5      ; " " " 94 " " " "
00097      ;
00098      ; THERMISTOR TEMPERATURES
00099      ;
00100      0026 0005  HTLDTEMP BLOCK  5      ; BCD TEMPERATURE OF HOT LOAD
00101      002B 0005  COLDTEMP BLOCK  5      ; BCD TEMPERATURE OF COLD LOAD
00102      0030 0005  RELDTEMP BLOCK  5      ; BCD TEMPERATURE OF REFERENCE LOAD
00103      0035 0005  KLYSTEMP BLOCK  5      ; BCD TEMPERATURE OF KLYSTRON
00104      003A 0005  SPRETEMP BLOCK  5      ; BCD TEMPERATURE OF SPARE
00105      ;
00106      ; 32 BIT HOT AND COLD LOAD TEMPS
00107      003F 0004  HTTEMP32 BLOCK  4

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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 BIT) 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 RADIMETER ADC CHANNELS 0-8 (UPDATED EVERY SECOND).
00122 006F 0002    ADC0      BLOCK 2      ; RADIMETER CHANNEL 0
00123 0071 0002    ADC1      BLOCK 2      ; RADIMETER CHANNEL 1
00124 0073 0002    ADC2      BLOCK 2      ; RADIMETER CHANNEL 2
00125 0075 0002    ADC3      BLOCK 2      ; RADIMETER 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    SAVERA    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

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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      ;
00169      ; TEMPORARY VARIABLES AND POINTERS FOR TAPE ROUTINES
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      BUFPT BLOCK 2      ; TEMP FOR DECODE
00178 00BA 0002      TABPT 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      GSFCIO 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      DATAFNTR 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      ; " " " "

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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      CH0FST  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      CH1FST  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      CH2FST  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      CH3FST  WORD 0000H     ; " " OFFSET
00236 0159 0000                WORD 0000H
00237                ;
00238 015B 0064      XMITBUF  BLOCK 100     ; TRANSMITT BUFFER

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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 0FC3      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      GSFCIO          ; 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      CH00FST
00280 1055 FF0147      STX      CH10FST
00281 1058 FF014F      STX      CH20FST
00282 105B FF0157      STX      CH30FST
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

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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 A700          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 CE0800          INIT4 LDX #0800H          ; 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 RSS232--PORT 0
00338
00339 10B8 8603          INIT5 LDA A #3          ; RESET CODE
00340 10BA B78408        STA A ACIA1C          ; RESET ACIA
00341 10BD 8605          LDA A #05H          ; 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

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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

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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 #DEMSG ; 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    BUFPTNT    ; 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     ; COMMAND FOUND?
00442 1171 A100      CMP    A 0,X        ; COMPARE CHARACTERS
00443 1173 260C      BNE    DECODE3     ; ARE THEY EQUAL?
00444 1175 DEB8      LDX    BUFPTNT    ; RESTORE POINTER
00445 1177 08        INX                ; BUMP IT
00446 1178 A600      DECODE21 LDA    A 0,X    ; GET NEXT CHAR
00447 117A DFB8      STX    BUFPTNT    ; 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 ADDRESS
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    ; POINTER 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
    
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00488 11B7 16          TAB
00489 11B8 A600        LDA A 0,X          ; GET NEXT CHARACTER
00490 11BA 08          INX
00491 11BB 8008        BSR TESTHEX
00492 11BD 2504        BCS INBYTE2        ; ERROR EXIT
00493 11BF 18          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 80C8        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 ;

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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

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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
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 129A 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 CE24B0    WRITE  LDX    #STRMSG      ; ASK FOR START ADDRESS
00661 1295 BD1DF0    JSR    STRNGNOC      ; PRINT WITH NO CR
00662 1298 7A00A0    DEC    F. NUMBR      ; SET NUMBER FLAG
00663 129B CE12A0    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 BD11D0    WRITE1  JSR    IN2BYTES  ; CONVERT ASCII IN CBUFFER TO HEX
00667 12A5 2408      BCC    WRITE2      ; GO ON IF NO ERROR
00668 12A7 CE2470    LDX    #NUMERR      ; PRINT ERROR MESSAGE
00669 12AA BD1DF0    JSR    STRNGOUT
00670 12AD 20E3      BRA    WRITE      ; TRY AGAIN
00671 12AF DFB4      WRITE2  STX    XTEMP4      ; SAVE ADDRESS
00672 12B1 CE2480    WRITE22 LDX    #BLKMSG      ; ASK FOR NUMBER OF BLOCKS
00673 12B4 BD1DF0    JSR    STRNGNOC
00674 12B7 7A00A0    DEC    F. NUMBR      ; SET NUMBER FLAG
00675 12BA CE12C0    LDX    #WRITE3      ; SET STATE POINTER
00676 12BD DFC1      STX    NEXSTATE
00677 12BF 2012      BRA    WRITE5
00678 12C1 BD11A0    WRITE3  JSR    INBYTE      ; GET BLOCK COUNT
00679 12C4 2408      BCC    WRITE4      ; SKIP OF NO ERROR
00680 12C6 CE2470    LDX    #NUMERR
00681 12C9 BD1DF0    JSR    STRNGOUT
00682 12CC 20E3      BRA    WRITE22
00683 12CE DEB4      WRITE4  LDX    XTEMP4      ; GET START ADDRESS BACK
00684 12D0 BD1410    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 CE24B0    READ    LDX    #STRMSG      ; ASK FOR START ADDRESS
00690 12D7 BD1DF0    JSR    STRNGNOC
00691 12DA 7A00A0    DEC    F. NUMBR      ; SET NUMBER FLAG
00692 12DD CE12E0    LDX    #READ1
00693 12E0 DFC1      STX    NEXSTATE
00694 12E2 2031      BRA    READ5
00695 12E4 BD11D0    READ1   JSR    IN2BYTES  ; CONVERT TO HEX

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00096 12E7 2408          BCC    READ2      ; SKIP IF NO ERROR
00097 12E9 CE247D        LDX    #NUMERR
00098 12EC BD1DF4        JSR    STRNGOUT
00099 12EF 20E3          BRA     READ      ; TRY AGAIN
00700 12F1 DFB4          READ2  STX    XTEMP4    ; SAVE ADDRESS
00701 12F3 CE248C        READ2  LDX    #BLKMSG    ; 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 C?ART 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 C?BUFFER
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

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00748	1353	CE1353		LDX	#BLOCK1	
00749	1356	DFC1		STX	NEXSTATE	
00750	1358	39		RTS		
00751	1359	BD1101	BLOCK1	JSR	IN2BYTES	; GET BLOCK NUMBER IN X
00752	135C	2408		BCC	BLOCK2	; SKIP IF NO ERROR
00753	135E	CE2467	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	; SUBTRACT DESIRED FROM PRESENT BLOCK
00761	1370	9002		SUB A	BLKNUM+1	
00762	1372	D6CD		LDA B	BLKCNT	
00763	1374	D201		SBC B	BLKNUM	
00764	1376	2409		BCC	SKIPPOS	; POSITIVE SKIP
00765	1378	43	SKIPNEG	COM A		; CONVERT BACK TO SIGN MAG
00766	1379	53		COM B		
00767	137A	8B01		ADD A	#1	
00768	137C	C900		ADC B	#0	
00769	137E	7A00CC		DEC	SKIPSGN	; SET FOR NEG SKIP
00770	1381	D7CD	SKIPPOS	STA B	BLKCNT	
00771	1383	97CE		STA A	BLKCNT+1	
00772	1385	DECD	SKIP1	LDX	BLKCNT	
00773	1387	09		DEX		
00774	1388	DFCD		STX	BLKCNT	
00775	138A	8CFFFF		CPX	#0FFFFH	; MINUS?
00776	138D	276A		BEQ	SKIPS3	
00777	138F	8C0000		CPX	#0	
00778	1392	273A		BEQ	SKIPS	; SKIP SLOW
00779	1394	96CC		LDA A	SKIPSGN	
00780	1396	2B05		BMI	SKIP1B	
00781	1398	BD14DA		JSR	INCBLK	
00782	139B	2003		BRA	SKIPF	; SKIP FAST
00783	139D	BD1412	SKIP1B	JSR	DECBLK	
00784	13A0	8D58	SKIPF	BSR	FAST	
00785	13A2	B68404		LDA A	PIA2AD	; CHECK GAP BIT
00786	13A5	48		ASL A		
00787	13A6	2A16		BPL	SKIPG	; IN GAP
00788	13A8	96CB		LDA A	FCNT	; BLOCK TIMER
00789	13AA	22F4		BHI	SKIPF	; ALREADY CHECKED TIMER
00790	13AC	8106		CMP A	#6	
00791	13AE	2309		BLS	SKIPF1	
00792	13B0	7F00C1		CLR	TCNT	
00793	13B3	86FF		LDA A	#0FFH	
00794	13B5	97CB		STA A	FCNT	
00795	13B7	20CC		BRA	SKIP1	
00796	13B9	7C00C1	SKIPF1	INC	FCNT	
00797	13BC	20E2		BRA	SKIPF	
00798	13BE	96CA	SKIPG	LDA A	TCNT	
00799	13C0	81C8		CMP A	#200	

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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     SKIPSP1
00807 13D2 BD1412        JSR     DECBLK
00808 13D5 20D3          BRA     SKIPSP1
00809 13D7 BD14DA        SKIPSP1 JSR     INCBLK
00810 13DA BD1216        SKIPSP1 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 DF80          DECBLK  STX     XTEMP2
00845 1414 DE01          LDX     BLKNUM
00846 1416 09           DEX
00847 1417 DF01          STX     BLKNUM
00848 1419 DE80          LDX     XTEMP2
00849 141B 39           RTS
00850                   ;
00851                   ;

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00052      ;TAPE WRITE ROUTINE
00053      ;WRITES 2048 BYTES TO TAPE.  STARTING ADDRESS OF BLOCK IN X.
00054      ;
00055 141C 97C0      TWRITE  STA A  BLOCKS      ;SAVE NO. OF BLOCKS TO WRITE
00056 141E BD1240      JSR    CKRDY      ;SEE IF DRIVE READY FOR WRITE
00057 1421 BD1260      JSR    CKFP      ;SEE IF FP SET
00058 1424 8620      TWRITES LDA A  #20H
00059 1426 B78406      STA A  PIA2BD      ;SET WRN=0
00060 1429 8680      LDA A  #80H      ;ACCESS SYNC CODE REGISTER
00061 142B B78804      STA A  SSDAC
00062 142E 4F        CLR A
00063 142F B78805      STA A  SSDAD      ;SET SYNC CODE TO 00
00064 1432 C6C0      LDA B  #0C0H      ;ACCESS XMIT FIFO
00065 1434 F78804      STA B  SSDAC
00066 1437 B78805      STA A  SSDAD      ;ZERO OUT FIFO
00067 143A B78805      STA A  SSDAD
00068 143D B78805      STA A  SSDAD
00069 1440 BD156F      JSR    CRC      ;COMPUTE CRC FOR BLOCK
00070 1443 BD125F      JSR    CKLOAD      ;SEE IF AT LOAD POINT (A=FF IF TRUE)
00071 1446 36        PSH A      ;SAVE LOAD STATUS
00072 1447 BD121F      JSR    FORWD      ;START DRIVE
00073 144A 32        PUL A      ;GET LOAD STATUS BACK
00074 144B 4D        TST A      ;TEST LOAD FLAG
00075 144C 2605      BNE    TWRITE1      ;BYPASS 1 SEC DELAY
00076 144E 8601      LDA A  #1
00077 1450 BD166F      JSR    SECDLY      ;DELAY 1 SEC
00078 1453 862F      TWRITE1 LDA A  #47      ;47 MS IRG DELAY
00079 1455 BD1666      JSR    MSDLY
00080 1458 DFAE      STX    XTEMP1      ;SAVE BLOCK POINTER
00081 145A CE0806      LDX    #0800H      ;2048 BYTE COUNT
00082 145D DFAC      STX    BYCOUNT
00083 145F DEAE      LDX    XTEMP1      ;RETRIEVE POINTER
00084 1461 4F        CLR A
00085 1462 B78406      STA A  PIA2BD      ;SET WDR=0
00086 1465 8D68      BSR    WRTBYT      ;PAD WITH A FEW ZEROS
00087 1467 8D66      BSR    WRTBYT      ;WRITE A FEW ZEROS FOR SPACING
00088 1469 8D64      BSR    WRTBYT
00089 146B 8D62      BSR    WRTBYT
00090 146D 8655      LDA A  #55H      ;WRITE SYNC BYTE
00091 146F 8D5E      BSR    WRTBYT
00092 1471 4F        CLR A      ;WRITE PREAMBLE (0001)
00093 1472 8D5B      BSR    WRTBYT
00094 1474 8601      LDA A  #1      ;SECOND BYTE OF PREAMBLE
00095 1476 8D57      BSR    WRTBYT
00096 1478 A600      TWRITE2 LDA A  0,X      ;GET BYTE FROM BLOCK
00097 147A 8D53      BSR    WRTBYT      ;SEND BYTE TO SSDA
00098 147C 08        INX      ;INCREMENT BYTE POINTER
00099 147D DFAE      STX    XTEMP1      ;SAVE BYTE POINTER
00090 147F DEAC      LDX    BYCOUNT      ;GET BYTE COUNTER
000901 1481 09        DEX      ;DECREMENT BYTE COUNTER
000902 1482 2706      BEQ    TWRITE3      ;DONE
000903 1484 DFAC      STX    BYCOUNT      ;SAVE COUNT

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00904 1486 0EAE          LDX    XTEMP1      ; RETREIVE POINTER
00905 1488 20EE          BRA     TWRITE2     ; DO NEXT BYTE
00906 148A 9686          LDA A   CRCH        ; WRITE CRC ON TAPE
                                TWRITE3      ; BYPASS CRC
00907 148C 8D41          BSR     WRTBYT
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 0EAE          LDX     XTEMP1     ; GET DATA POINTER BACK
00930 14C1 7A00C0        DEC     BLOCKS     ; DEC BLOCK COUNT
00931 14C4 2703          BEQ     TWRITE6     ; DONE
00932 14C6 7E1424        JMP     TWRITES   ; 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

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TAPE CONTROL ROUTINES

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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 DF80 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 8D1666 JSR MSDLY
00970 14F3 8601 LDA A #1 ;RESET SSDA RCVR
00971 14F5 B78804 STA A SSDAC
00972 14F8 8608 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 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 ;RETRIEVE POINTER
01006 153D BD156A JSR CRC ;COMPUTE CRC STARTING WITH OLD CRC
01007 1540 32 PUL A ;COMPARE NEW CRC WITH ONE FROM TAPE

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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 7A00C0      DEC BLOCKS      ; DECREMENT BLOCK COUNTER
01018 1559 2704        BEQ TREAD5      ; DONE
01019 155B DEAE        LDX XTEMP1      ; GET DATA POINTER
01020 155D 2027        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

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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	

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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 00      INX
01078 15B8 8C2903   CPX  #DISPLY+20 ; DONE?
01079 15BB 26F8    BNE  CLRDISP1
01080 15BD 39      RTS
01081
01082      ; PUT BCD TEMPERATURE POINTED TO BY X IN NEXT 5 DISPLAY LOCATIONS
01083      ; ONLY PUTS 3 DIGITS TO LEFT AND 1 TO RIGHT OF DECIMAL. ASSUMES
01084      ; 4 BYTE PLUS SIGN PACKED BCD FORMAT
01084 15BE A601    DISPTMP LDA A  1,X      ; GET MS DIGITS
01085 15C0 B01612   JSR  DISPHR      ; PUT LS DIGIT IN DISPLAY
01086 15C3 A602    LDA  A  2,X
01087 15C5 B01605   JSR  DISPHEX
01088 15C8 662E    LDA  A  #". "
01089 15CA B015F1   JSR  DISPCHAR
01090 15CD A603    LDA  A  3,X
01091 15CF B0160C   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    DISPTNG 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 800B    BSR  DISPCHAR      ; PUT CHAR IN BUFFER
01108 15E6 DEB0    LDX  XTEMP2      ; GET MESSAGE POINTER BACK
01109 15E8 00      INX
01110 15E9 20F1    BRA  DISPNEXT
01111 15EB 39      DISP2  RTS
01112
01113 15EC 8620      ; PUT A SPACE IN DISPLAY BUFFER
01114 15EE 8D01    DISPSPC LDA A  #20H
01115 15F0 39      BSR  DISPCHAR
01116      RTS
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

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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

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01115 1640 5A          DEC B
01116 1641 26F0        BNE  NEXTCH
01117 1643 39          RTS
01118
01119                ; PUT HEX DATA FROM MEMORY IN DISPLAY FOR DEBUGGING
01120                ; MEMORY POINTER "HEXPTR" IS SET BY "SETHex"
01121 1644 CE28EF        PUTHEx  LDX  #DISPLy      ; INIT DISp PTR
01122 1647 DFC3          STX   NEXTDISP
01123 1649 96C7        LDA  A  HEXPTR      ; DISpLAY POINTER
01124 164B BD1605        JSR  DISPHEX
01125 164E 96C8        LDA  A  HEXPTR+1
01126 1650 BD1605        JSR  DISPHEX
01127 1653 863D        LDA  A  #"="      ; DISpLAY EQUALS
01128 1655 BD15F1        JSR  DISPCHAR
01129 1658 DEC7          LDX  HEXPTR      ; GET PTR
01130 165A C607          LDA  B  #7        ; COUNTER FOR 7 BYTES
01131 165C A600        PUTHEx1 LDA  A  0,X
01132 165E 08          INX
01133 165F BD1605        JSR  DISPHEX
01134 1662 5A          DEC  B
01135 1663 26F7        BNE  PUTHEx1
01136 1665 39          RTS
01137
01138
01139
01140                ; DELAY ROUTINES
01141 1666 C6A5        MSDLY  LDA  B  #0A5H
01142 1668 5A          MSDLY1 DEC  B
01143 1669 26FD        BNE  MSDLY1
01144 166B 4A          DEC  A
01145 166C 26F8        BNE  MSDLY
01146 166E 39          RTS
01147
01148                ; DELAY A SECONDS
01149 166F 36          SECDLY  PSH  A          ; SAVE A
01150 1670 86FF        LDA  A  #0FFH
01151 1672 8DF2        BSR  MSDLY
01152 1674 86FF        LDA  A  #0FFH
01153 1676 8DEE        BSR  MSDLY
01154 1678 86FF        LDA  A  #0FFH
01155 167A 86FF        BSR  MSDLY
01156 167C 8DE8        LDA  A  #0FFH
01157 167E 32        BSR  MSDLY
01158 167F 4A          PUL  A
01159 1680 26ED        DEC  A
01160 1682 39          BNE  SECDLY
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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

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01276 16FA 4C          INC A          ; NEXT TRACK
01277 16FB BD1273      JSR TRACK
01278 16FE BD1226      JSR REWIND
01279 1701 CE2710      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 BD1230      TAFEDONE JSR UNLOAD ; UNLOAD TAPE
01285 1711 CE1C12      LDX #TAPEWARN
01286 1714 DF05        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 HIGH 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

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01307      ;
01308      ;
01309      ;
01310      ; MOVE CALIBRATION REFLECTOR TO COLD AND HOT LOAD POSITIONS AND
01311      ; CALCULATE GAIN AND OFFSETS FOR ALL 4 CHANNELS
01312 172A BD1A5H CALIBRTE JSR COLD      ; MOVE TO COLD LOAD
01313 172D 8606 LDA A #6      ; WAIT 2 SECONDS
01314 172F BD166F JSR SECPLY
01315 1732 BD18B0 JSR AVERAGE ; AVERAGE COLD LOAD SAMPLES
01316 1735 BD1A6F JSR HOT
01317 1738 8606 LDA A #6      ; WAIT 2 SEC
01318 173A BD166F JSR SECPLY
01319      ; CALCULATE 183/1 GHZ CAL DATA
01320      ;
01321 173D BD18E1 CAL0 JSR AVERAGE0 ; AVERAGE HOT LOAD SAMPLES AND LEAVE AT TOS
01322 1740 CE013E LDX #CH0GAIN ; PTR TO GAIN/OFFSET CONSTANTS
01323 1743 DF8D STX SAVEX
01324 1745 CE004E LDX #CH0VAVG ; PTR TO COLD LOAD AVERAGE
01325 1748 BD182C JSR CALCGAIN ; CALCULATE GAIN AND OFFSET
01326      ;
01327      ; CALCULATE 183/5 GHZ CAL DATA
01328      ;
01329 174B BD18E6 CAL1 JSR AVERAGE1 ; AVERAGE HOT LOAD DATA
01330 174E CE0143 LDX #CH1GAIN
01331 1751 DF8D STX SAVEX
01332 1753 CE004F LDX #CH1VAVG
01333 1756 BD182C JSR CALCGAIN
01334      ;
01335      ; CALCULATE 183/10 GHZ CAL DATA
01336      ;
01337 1759 BD18EF CAL2 JSR AVERAGE2
01338 175C CE014B LDX #CH2GAIN
01339 175F DF8D STX SAVEX
01340 1761 CE0053 LDX #CH2VAVG
01341 1764 BD182C JSR CALCGAIN
01342      ;
01343      ; CALCULATE 94 GHZ CAL DATA
01344      ;
01345 1767 BD18F6 CAL3 JSR AVERAGE3
01346 176A CE0153 LDX #CH3GAIN
01347 176D DF8D STX SAVEX
01348 176F CE0057 LDX #CH3VAVG
01349 1772 BD182C JSR CALCGAIN
01350      ;
01351      ; DONE WITH CAL, NOW RETURN TO OUTSIDE AND PRINT RESULTS
01352 1775 BD1A25 JSR OUTSIDE ; MOVE REFLECTOR BACK OUTSIDE
01353      ; PRINT GAIN AND OFFSETS
01354 1778 BD1CFF PRINTCAL JSR WHERE
01355 177B BD1A18 JSR CRLF
01356 177E CE25E6 LDX #HOTMSG1 ; PRINT OUT HOT/COLD LOAD TEMP DIFF
01357 1781 BD1DFF JSR STPNGNOC
01358 1784 862D LDA A #"- "

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01359 1786 BD1DED JSR OUTCH
01360 1789 BD1DCD JSR OUTSPACE
01361 178C CE25F0 LDX #COLMSG1
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 CE2688 LDX #CALMSG1
01369 17A3 BD1DF4 JSR STRNGOUT
01370 17A6 CE263E LDX #MSG183
01371 17A9 BD1DFF JSR STRNGNOC
01372 17AC BD1DBC JSR OUT2SPC
01373 17AF CE013B LDX #CH0GAIN
01374 17B2 BD1813 JSR PRINT32 ; PRINT 32 BIT NUMBER IN BCD
01375 17B5 BD1DB4 JSR OUT10SPC
01376 17B8 CE013F LDX #CH00FST
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 #CH10FST
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 #CH20FST
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 #CH30FST
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

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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 BD22BC        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-COLD AVG
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      FDIY      ; (HOT TEMP-COLD TEMP)/(HOTAVG-COLD AVG)
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      ; (COLD AVG)(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)(COLD AVG)
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

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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      ;
01488      ; AVERAGE 10 SAMPLES FROM CH0-CH3 STORED IN AVGBUFF BY INTERRUPT
01489      ; SERVICE ROUTINE EVERY 100 MS
01490      ; PUT RESULT IN CH0AVG-CH3AVG
01490 18B8 8D27      AVERAGE BSR    AVERAGE0      ;AVERAGE CH0 SAMPLES
01491 18BA CE004B      LDX    #CH0AVG      ;PTR TO RESULT
01492 18BD C604        LDA B  #4
01493 18BF BD23A7      JSR    PULL
01494 18C2 8D24      BSR    AVERAGE1
01495 18C4 CE004F      LDX    #CH1AVG
01496 18C7 C604        LDA B  #4
01497 18C9 BD23A7      JSR    PULL
01498 18CC 8D21      BSR    AVERAGE2
01499 18CE CE0053      LDX    #CH2AVG
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    #CH3AVG
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

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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    #DATMSG
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    #DATMSG
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

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01567 1950 CE24B2      SETHEX  LDX      #STRMSG
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 CHANNELS 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      #FLMSG
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      #SETT2
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    #TIMMSG
01623 19C8 BD10FF                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 BD11A8                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 BD10FF                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 BD10FF                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 BD10FF                JSR    STRNGNOC
01667 1A1E 39          RTS
01668                      ;
01669 1A1F 860A      LFEEED  LDA A  #0AH
01670 1A21 BD1DED                JSR    OUTCH

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CALIBRATION ROUTINES

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01671 1A24 39
01672

RTS

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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 PBS=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 PBS=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      ;

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01727      ; MOVE TO HOT LOAD
01728 1A6F 9605      HOT      LDA A  RFLPOS
01729 1A71 2608      BNE      HOT1      ; IS IT HOME?
01730 1A73 80D6      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 80CF      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 80C7      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      #GNOMSG
01769 1AC5 BD1DF4      JSR      STRNGOUT
01770 1AC8 39      VIEW3   RTS
01771
01772

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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 DISPTMP
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 DISPTMP
01819 1B27 39      RTS
01820      ;
01821 1B28 CE25FB DISPKLYS LDX #KLYSMMSG
01822 1B2B BD15D3 JSR DISPSTNG
01823 1B2E CE0035 LDX #KLYSTEMP
01824 1B31 BD15BE JSR DISPTMP
01825 1B34 39      RTS
01826      ;

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01827 1835 CE25D6      DISPREF LDX      #REFMSG
01828 1838 BD15D3      JSR      DISPSTNG
01829 183B CE0030      LDX      #RELDTEMP
01830 183E BD15BE      JSR      DISPTEMP
01831 1841 39          RTS
01832
01833 1842 CE28EF      DISP183 LDX      #DISPLY      ;INTI DISPLAY BUFF
01834 1845 DFC3        STX      NEXTDISP
01835 1847 CE0012      LDX      #CH0TEMP      ;DISPLAY ALL 183 GHZ TEMPS
01836 184A BD15BE      JSR      DISPTEMP
01837 184D BD15EC      JSR      DISPSPC
01838 1850 CE0017      LDX      #CH1TEMP
01839 1853 BD15BE      JSR      DISPTEMP
01840 1856 BD15EC      JSR      DISPSPC
01841 1859 CE001C      LDX      #CH2TEMP
01842 185C BD15BE      JSR      DISPTEMP
01843 185F BD15EC      JSR      DISPSPC
01844 1862 39          RTS
01845
01846 1863 CE2660      DISP94  LDX      #MSG94
01847 1866 BD15D3      JSR      DISPSTNG
01848 1869 DEC3        LDX      NEXTDISP      ;BACKUP POINTER
01849 186B 09          DEX
01850 186C 09          DEX
01851 186D 09          DEX
01852 186E 09          DEX
01853 186F DFC3        STX      NEXTDISP
01854 1871 CE25BF      LDX      #TEMPMSG
01855 1874 BD15DC      JSR      DISPNEXT
01856 1877 BD15EC      JSR      DISPSPC
01857 187A CE0021      LDX      #CH3TEMP
01858 187D BD15BE      JSR      DISPTEMP
01859 1880 39          RTS
01860
01861
01862 1881 CE28EF      ; DISPLAY AVERAGE RAD TEMPS
01863 1884 DFC3        DISP183A LDX      #DISPLY
01864 1886 CE005B      STX      NEXTDISP
01865 1889 BD15BE      LDX      #CH0TAVG
01866 188C BD15EC      JSR      DISPTEMP
01867 188F CE0060      JSR      DISPSPC
01868 1892 BD15BE      LDX      #CH1TAVG
01869 1895 BD15EC      JSR      DISPTEMP
01870 1898 CE0065      JSR      DISPSPC
01871 189B BD15BE      LDX      #CH2TAVG
01872 189E BD15EC      JSR      DISPTEMP
01873 18A1 39          JSR      DISPSPC
01874
01875
01876 18A2 CE2660      ;
01877 18A5 BD15D3      DISP94A  LDX      #MSG94
01878 18A8 DEC3        JSR      DISPSTNG
                                LDX      NEXTDISP

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01879 1BAA 09          DEX
01880 1BAB 09          DEX
01881 1BAC 09          DEX
01882 1BAD 09          DEX
01883 1BAE 0FC3        STX    NEXTDISP
01884 1BB0 CE25BF      LDX    #TEMPMSG
01885 1BB3 E015DC      JSR    DISPNEXT
01886 1BB6 E015EC      JSR    DISPSPC
01887 1BB9 CE006A      LDX    #CH3TAVG
01888 1BBC E015BE      JSR    DISPTMP
01889 1BBF 39          RTS
01890
01891
01892                ; PUT TIME IN DISPLAY
01893 1BC0 CE28EF      TESTIME LDX    #DISPLY    ; RESET DISPLAY BUFFER
01894 1BC3 0FC3        STX    NEXTDISP
01895 1BC5 9601        LDA    A    BLKNUM    ; DISPLAY TAPE BLOCK NUMBER
01896 1BC7 E01605      JSR    DISPHEX
01897 1BCA 9602        LDA    A    BLKNUM+1
01898 1BCC E01605      JSR    DISPHEX
01899 1BCF E015EC      JSR    DISPSPC
01900 1BD2 9609        LDA    A    HOURS
01901 1BD4 E01605      JSR    DISPHEX
01902 1BD7 C63A        LDA    B    #": "
01903 1BD9 17          TBA
01904 1BDA E015F1      JSR    DISPCHAR
01905 1BDD 960A        LDA    A    MINUTES
01906 1BDF E01605      JSR    DISPHEX
01907 1BE2 17          TBA
01908 1BE3 E015F1      JSR    DISPCHAR
01909 1BE6 960B        LDA    A    SECONDS
01910 1BE8 E01605      JSR    DISPHEX
01911 1BEB E015EC      JSR    DISPSPC
01912 1BEE 96DC        LDA    A    CAL. CNTR    ; DISPLAY TIME TO CAL
01913 1BF0 E01605      JSR    DISPHEX
01914 1BF3 E015EC      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 E015DC      JSR    DISPNEXT
01919 1C00 E015EC      JSR    DISPSPC
01920 1C03 39          RTS
01921 1C04 CE2687      NOTONN LDX    #OFFMSG
01922 1C07 E015DC      JSR    DISPNEXT
01923 1C0A 39          RTS
01924
01925                ; PUT SIGN ON MESSAGE IN DISPLAY
01926 1C0B CE243C      INITMS LDX    #INITMSG
01927 1C0E E015D3      JSR    DISPSTNG
01928 1C11 39          RTS
01929
01930                ; FLASH END OF TAPE WARNING MESSAGE IN DISPLAY AND RING BELL ON CONSOLE

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031 1C12 CE26EC    TAPEWARN LDX    #WNGMSG
032 1C15 BD15D3    JSR      DISPSTNG
033 1C18 8607      LDA A    #7          ; BELL
034 1C1A BD1DED    JSR      OUTCH
035 1C1D 8608      LDA A    #200        ; WAIT
036 1C1F BD1666    JSR      MSDLY
037 1C22 BD15AE    JSR      CLRDISP
038 1C25 8608      LDA A    #200
039 1C27 BD1666    JSR      MSDLY
040 1C2A 39        RTS
041
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044
045 ; STATUS PRINTOUT ROUTINES
046
047 ; PRINT CURRENT TRACK AND BLOCK NUMBER
048 1C2B CE25A3    TAPE      LDX    #TAPMSG
049 1C2E BD1DFF    JSR      STRNGNOC    ; PRINT MSG WITH NO CR LF
050 1C31 CE26C9    TAPE1     LDX    #TRKMSG
051 1C34 BD1DFF    JSR      STRNGNOC
052 1C37 9600      LDA A    TRACKN    ; GET TRACK NUMBER
053 1C39 BD1DD4    JSR      OUTHEX
054 1C3C BD1DCD    JSR      OUTSPACE    ; PRINT A SPACE
055 1C3F CE26D0    LDX      #BLKMSG
056 1C42 BD1DFF    JSR      STRNGNOC    ; PRINT "BLOCK"
057 1C45 CE0001    LDX      #BLKNUM
058 1C48 BD1DC9    JSR      OUT2HEX
059 1C4B BD1A18    JSR      CRLF
060 1C4E 39        RTS
061
062
063 ; PRINT LOAD TEMPS ON CONSOLE
064 1C4F BD1A18    TEMPL     JSR      CRLF
065 1C52 CE25B7    LDX      #HOTMSG    ; PRINT "HOT LOAD#"
066 1C55 BD1DFF    JSR      STRNGNOC
067 1C58 BD1DCD    JSR      OUTSPACE
068 1C5B BD1DCD    JSR      OUTSPACE
069 1C5E CE25C6    LDX      #COLDMSG
070 1C61 BD1DFF    JSR      STRNGNOC
071 1C64 BD1DCD    JSR      OUTSPACE
072 1C67 BD1DCD    JSR      OUTSPACE
073 1C6A CE25D6    LDX      #REFMSG
074 1C6D BD1DFF    JSR      STRNGNOC
075 1C70 BD1DCD    JSR      OUTSPACE
076 1C73 BD1DCD    JSR      OUTSPACE
077 1C76 CE25FB    LDX      #KLYSMMSG
078 1C79 BD1DFF    JSR      STRNGNOC
079 1C7C BD1A18    JSR      CRLF
080 1C7F CE0026    LDX      #HTLDTEMP
081 1C82 BD1D42    JSR      OUTTEMP
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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      FLIGHT

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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      #TIMMSG      ; 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      ; PRINT FLIGHT, DAY AND TIME
02085 1D75 CE2584      LDX      #DATMSG
02086 1D78 BD1DFF      JSR      STRNGNOC

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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 BD1C28        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 1DAB 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                   ;

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118 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
119 ;
120 ;
121 ;
122 1DB4 C60A OUT10SPC LDA B #10
123 1DB6 2008 BRA OUTSPC
124 1DB8 C606 OUT6SPC LDA B #6
125 1DBA 2004 BRA OUTSPC
126 1DBC C602 OUT2SPC LDA B #2
127 1DBE 2000 BRA OUTSPC
128 1DC0 37 OUTSPC PSH B
129 1DC1 8D1DCD JSR OUTSPACE
130 1DC4 33 PUL B
131 1DC5 5A DEC B
132 1DC6 26F8 BNE OUTSPC
133 1DC8 39 RTS
134 ;
135 ;
136 ;
137 ;PRINT 2 HEX BYTES POINTED TO BY X
138 1DC9 8006 OUT2HEX BSR THB
139 ;
140 ;PRINT SINGLE HEX BYTE POINTED TO BY X
141 1DCB 8D04 OUT1HEX BSR THB
142 1DCD 8620 OUTSPACE LDA A #20H
143 1DCF 201C BRA OUTCH
144 ;
145 ;PRINT SINGLE HEX BYTE FROM X
146 ;
147 1DD1 A600 THB LDA A 0,X
148 1DD3 08 INX
149 ;PRINT SINGLE HEX CHARACTER FROM A
150 1DD4 36 OUTHEX PSH A
151 1DD5 8D04 BSR OUTHEXL
152 1DD7 32 PUL A
153 1DD8 8D07 BSR OUTHEXR
154 1DDA 39 RTS
155 ;
156 1ddb 44 OUTHEXL LSR A
157 1ddc 44 LSR A
158 1ddd 44 LSR A
159 1dde 44 LSR A
160 1ddf 2002 BRA THB1
161 1de1 840F OUTHEXR AND A #0FH ;MASK OFF LS PART
162 1de3 810A THB1 CMP A #0AH
163 1de5 2502 BCS THB2
164 1de7 8607 ADD A #07
165 1de9 8B30 THB2 ADD A #30H ;MAKE ASCII
166 1deb 2000 BRA OUTCH
167 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
168 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

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02169      ;
02170      ;          ****   OUTCH   ****
02171      ;
02172      ;
02173      ;          ****   TRANSMIT SINGLE CHARACTER IMMEDIATELY
02174      ;          ****   INPUT ASCII IN RA
02175      ;
02176      ;
02177      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02178      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02179      ;
02180      1DED 8D1B      OUTCH      BSR      CHAR.INS      ; PUT CHARACTER ONTO BUFFER
02181      1DEF 8604      LDA A      #04      ; AND SEND AN ETX TO START TRANSMISSION
02182      1DF1 8D17      BSR      CHAR.INS      ; BY WRITING AN ETX TO BUFFER
02183      1DF3 39      RTS
02184      ;
02185      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02186      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02187      ;
02188      ;          ****   STRNGOUT   ****
02189      ;
02190      ;
02191      ;          ****   PUT STRING POINTED TO BY RX ONTO TRANSMIT BUFFER
02192      ;          ****   STRING MUST END WITH AN 04H (ETX)
02193      ;          ****   SENDS OUT CR AND LF FOLLOWING STRING
02194      ;
02195      1DF4 8D09      STRNGOUT BSR      STRNGNOC      ; SEND STRING
02196      1DF6 860D      LDA A      #0DH      ; SEND CARRIAGE RETURN
02197      1DF8 8DF3      BSR      OUTCH
02198      1DFA 860A      LDA A      #0AH      ; SEND LINE FEED
02199      1DFC 8DEF      BSR      OUTCH
02200      1DFE 39      RTS
02201      ;
02202      ;
02203      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02204      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02205      ;
02206      1DFF A600      STRNGNOC LDA A      0,X      ; GET THE CHARACTER POINTED TO BY RX
02207      1E01 BD1E0A      JSR      CHAR.INS      ; PUT IT INTO TRANSMIT BUFFER ( EVEN IF ETX )
02208      1E04 08      INX      ; BUMP THE POINTER
02209      1E05 8104      CMP A      #04      ; SEE IF AN ETX
02210      1E07 26F6      BNE      STRNGNOC      ; IF NOT THEN GET NEXT CHAR
02211      1E09 39      RTS
02212      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02213      ;
02214      ;          ****   CHAR.INS   ****
02215      ;
02216      ;
02217      ;          ****   PUTS THE INPUT ASCII CODE INTO TRANSMIT BUFFER
02218      ;          ****   INPUT CODE IS IN RA
02219      ;          ****   STARTS TRANSMISSION WHEN CODE IS 04H ( ETX )
02220      ;          ****   ETX IS NOT PUT INTO BUFFER

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02221 ;
02222 ;
02223 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02224 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02225
02226 1E0A DFAE CHAR INS STX XTEMP1 ;SAVE THE X REGISTER
02227 1E0C D6A7 LDA B F.XMIT ;SEE IF WE ARE ALREADY SENDING A BLOCK FROM THE BUFFER
02228 1E0E 2A0E BPL CHARINS2 ;IF WE ARE NOT THEN SKIP
02229 ;
02230 ; **** INSERT WHEN ALREADY TRANSMITTING ****
02231 ;
02232 1E10 8104 CMP A #04 ;SEE IF ETX
02233 1E12 2707 BEQ CHARINS1 ;IF SO THEN GO ON AND EXIT
02234 1E14 DEE5 LDX LASTCHAR ;IF NO THEN PUT ON AS LAST CHAR IN BUFFER
02235 1E16 08 INX
02236 1E17 A700 STA A 0,X
02237 1E19 DFE5 STX LASTCHAR ;REPLACE THE POINTER
02238 1E1B DEAE CHAR INS1 LDX XTEMP1 ;REPLACE THE X REGISTER
02239 1E1D 39 RTS
02240 ;
02241 ; **** INSERT WHEN NOT TRANSMITTING ****
02242 ;
02243 1E1E 8104 CHAR INS2 CMP A #04 ;SEE IF ETX
02244 1E20 2709 BEQ CHARINS3 ;IF SO THEN SKIP TO SET TRANSMIT FLAG
02245 1E22 DEE3 LDX NEXTCHAR ;IF NOT ETX THEN PUT ONTO CURRENT BLOCK
02246 1E24 A700 STA A 0,X
02247 1E26 08 INX
02248 1E27 DFE3 STX NEXTCHAR ;REPLACET THE POINTER
02249 1E29 20F0 BRA CHARINS1 ;AND EXIT
02250 ;
02251 ; **** END OF STRING. START TRANSMITTING ****
02252 ;
02253 1E2B DEE3 CHAR INS3 LDX NEXTCHAR ;GET THE ADDRESS OF NEXT FREE CHAR ON BLOCK
02254 1E2D 09 DEX ;POINT IT TO LAST INPUT CHAR
02255 1E2E DFE7 STX BLOCKEND ;RESET THE OTHER TWO POINTERS
02256 1E30 DFE5 STX LASTCHAR
02257 1E32 DE015B LDX #XMITBUF ;NOW RESET THE BLOCK POINTER (CHARS TO BE SENT)
02258 1E35 DFE3 STX NEXTCHAR
02259 1E37 C6FF LDA B #0FFH ;SET FLAG THAT SAYS WE RARE XMITTING
02260 1E39 D7A7 STA B F.XMIT
02261 1E3B C6A1 LDA B #0A1H ;CAUSE THE ACIA TO BE INTERRUPTING
02262 1E3D F78408 STA B ACIA1.C
02263 1E40 20D9 BRA CHARINS1 ;AND EXIT
02264 ;
02265 ;SEND BYTE IN A TO SERIAL PORT 1 (ACIA2)
02266 ;GODDARD COMPUTER LISTENS THERE
02267 1E42 37 OUTGSC PSH B ;SAVE B
02268 1E43 F68808 OUTGS1 LDA B ACIA2C ;CHECK CTS FROM GODDARD
02269 1E46 C508 BIT B #08H ;MASK OFF CTS BIT
02270 1E48 260F BNE OUTGS2 ;DONT TRY TO SEND OF CTS=1
02271 1E4A 7F00AB CLR F.GSFC ;CLEAR FLAG IF CTS GOES LO
02272 1E4D 7F00C9 CLR CTSCNTR ;RESET COUNTER
  
```

====CHARACTER OUTPUT ROUTINES====

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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 8D1666        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  GSFCT0    ; 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

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[illegible]

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02349
02350 1E81 96A2      NMI IRQ LDA A  F.5MIN      ;SEE IF 5 MINUTES ARE UP (THAT IS PERIOD OF RTC SYNCH CHECK)
02351 1E83 2808      BMI  IRIGB.1      ;IF SO THEN PROCESS IRIGB IRQ
02352 1E85 96D4      LDA A  NMI.F0      ;TEST IF WE ARE INITIAL ENTRY INTO PROGRAM
02353 1E87 2704      BEQ  IRIGB.1      ;IF SO THEN PROCESS IRIGB IRQ (GET INITIAL VALUES)
02354 1E89 B68802     LDA A  IRIGB.IN    ;NEITHER CASE VALID, SO RESET IRQ AND EXIT
02355 1E8C 3B        NMI.EX0 RTI        ;HERE IS AN EXIT POINT
02356
02357                ;
02358                ;          **** INPUT THE IRIGB TIME CODE ( TAKES 1 SEC )   ***
02359 1E8D BD2061     IRIGB.1 JSR  IRIGBSET ;GO READ THE CODE
02360                ;
02361                ;          **** SEE IF INITIAL ISR ENTRY   ****
02362                ;
02363 1E90 96D4      LDA A  NMI.F0      ;INITIAL ENTRY?
02364 1E92 2609      BNE  IRIGB.3      ;IF NOT THEN SKIP
02365 1E94 96D5      LDA A  NMI.F1      ;SEE IF IRIGSET GOT HUNG (IRIGB NONFUNCTIONAL)
02366 1E96 2BF4      BMI  NMI.EX0     ;IF WE ARE HUNG THEN EXIT WITHOUT TRYING TO INIT THE VALUES
02367 1E98 7300D4     IRIGB.2 COM  NMI.F0 ;WE DID NOT GET HUNG, SO RESET FLAG AND UPDATE
02368 1E9B 2029      BRA  IRIG.UPD
02369                ;
02370                ;          **** TEST IF IRIGB WAS HUNG UP   ****
02371                ;
02372 1E9D 96D5     IRIGB.3 LDA A  NMI.F1      ;READ THE "HUNG-UP" FLAG
02373 1E9F 28EB      BMI  NMI.EX0      ;IF WE ARE HUNG THEN EXIT ( FLAG IS ALREADY SET )
02374                ;
02375                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02376                ;
02377                ;          **** CHECK THE IRIGB AGAINST THE SYSTEM CLOCK   ****
02378                ;
02379                ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02380
02381                ;
02382                ;          **** FIRST TEST THE SECONDS CLOCK   ****
02383                ;
02384 1EA1 9611     IRI: LDA A  IRIGSEC      ;READ THE SECONDS VALUE RETURNED FROM IRIGSET
02385 1EA3 900B      SUB A  SECONDS      ;FIND THE DIFFERENCE BETWEEN IT AND THE SYS TIME
02386 1EA5 4D       TST A                ;TAKE THE ABSOLUTE VALUE
02387 1EA6 2A01      BPL  IRIGB.5      ;IF POS THEN SKIP
02388 1EA8 43       COM A
02389 1EA9 8101     IRI: CMP A  #1        ;SEE IF WITHIN ERROR
02390 1EAB 2E32      BGT  IRIG.BAD      ;IF NOT THEN GOTO FAIL SECTION
02391                ;
02392                ;          **** TEST THE MINUTES   ****
02393                ;
02394 1EAD 9610      LDA A  IRIGMIN      ;READ THE MINUTES
02395 1EAF 910A      CMP A  MINUTES      ;COMPARE TO SYSTEM MINUTES
02396 1EB1 262C      BNE  IRIG.BAD
02397                ;
02398                ;          **** TEST THE HOURS   ****
02399                ;
02400 1EB3 960F      LDA A  IRIGHOUR

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02401 1EB5 9109      CMP A  HOURS
02402 1EB7 2626      BNE   IRIG.BAD
02403                ;
02404                ;           ****   TEST THE LSB OF DAYS   ****
02405                ;
02406 1EB9 960E      LDA A  IRIGDAYL
02407 1EBB 9108      CMP A  DAYS.LO      ; DAYS TAKE 2 BYTES
02408 1EBD 2620      BNE   IRIG.BAD
02409                ;
02410                ;           ****   TEST DAYS MSB   ****
02411                ;
02412 1EBF 960D      LDA A  IRIGDAYH
02413 1EC1 9107      CMP A  DAYS.HI
02414 1EC3 261A      BNE   IRIG.BAD      ; GOTO HANDLER FOR LOST TIME SYNC
02415 1EC5 3B      NMI.EX1 RTI      ; SECOND EXIT POINT
02416                ;
02417                ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02418                ;
02419                ;           ****   UPDATE THE SYSTEM POINTERS ON INITIALIZATION   ****
02420                ;
02421                ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02422                ;
02423 1EC6 9611      IRIG.UPD LDA A  IRIGSEC
02424 1EC8 970B      STA A  SECONDS
02425                ;
02426 1ECA 9610      LDA A  IRIGMIN
02427 1ECC 970A      STA A  MINUTES
02428                ;
02429 1ECE 960F      LDA A  IRIGHOUR
02430 1ED0 9709      STA A  HOURS
02431                ;
02432 1ED2 960E      LDA A  IRIGDAYL
02433 1ED4 9708      STA A  DAYS.LO      ; LEAST ORDER BYTE OF DAYS
02434                ;
02435 1ED6 960D      LDA A  IRIGDAYH
02436 1ED8 9707      STA A  DAYS.HI
02437                ;
02438 1EDA 960C      LDA A  IRIGFLT
02439 1EDC 9706      STA A  FLIGHT
02440                ;
02441 1EDE 3B      NMI.EX2 RTI      ; THIRD EXIT POINT
02442                ;
02443                ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02444                ;
02445                ;           ***   ERROR ROUTINE FOR 5-MIN TIME SYNC CHECK   ***
02446                ;
02447                ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02448                ;
02449 1EDF 8680      IRIG.BAD LDA A  #80H      ; SET THE "LOST SYNC" FLAG
02450 1EE1 97A3      STA A  F.BADTIM
02451 1EE3 3B      NMI.EX3 RTI

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02453 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02454 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02455 ;
02456 ;      ****   REAL TIME CLOCK (100 MS) DRIVER   ****
02457 ;
02458 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02459 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02460 ;
02461 1EE4 B6802 NMI.RTC LDA A  IRIGB.IN      ; CLEAR NMI FLAGS
02462 1EE7 01      NOP
02463 1EE8 0E      CLI                      ; ENABLE IRQ FOR DISPALY
02464 1EE9 96D8   LDA A  RTC.STAT          ; SEE IF WE SHOULD CHECK FOR A HUNG IRIGB
02465 1EEB 260B   BNE   RTC.SEC1          ; IF NOT THEN SKIP
02466 ;
02467 ;      ****   TEST IF IRIGB IS HUNG   ****
02468 ;
02469 1EED 96D7   LDA A  RTC.CNTR          ; COUNT UP A TEMPORARY COUNTER
02470 1EEF 4C      INC A
02471 1EF0 97D7   STA A  RTC.CNTR          ; SAVE THE NEW VALUE
02472 1EF2 8103   CMP A  #3              ; SEE IF 300 MS
02473 1EF4 2602   BNE   RTC.SEC1          ; IF NOT THEN GOTO NEXT SECTION
02474 1EF6 97D8   STA A  RTC.STAT          ; IF SO THEN MAKE THE STATE VAR NONZERO (IRIGB IS HUNG)
02475 ;
02476 ;      ****   SECONDS TIMING   ****
02477 ; SAMPLE 4 RADIOMETER CHANELS AND PUT DATA IN BUFFER FOR AVERAGING
02478 ; DONT DO IT IF TAPE IS WORKING
02479 ;
02480 1EF8 96C0   RTC.SEC1 LDA A  BLOCKS      ; SEE IF TAPE IS READING OR WRITING
02481 1EFA 2631   BNE   RTC.SEC2
02482 1EFC DEE9   FILLBUFF LDX  AVGPTR      ; GET PTR TO NEXT LOCATIONS
02483 1EFE 4F      CLR A
02484 1EFF BD2035 JSR   GETDATA      ; GET CH0 DATA
02485 1F02 A700   STA A  0,X              ; PUT IN BUFFER
02486 1F04 E701   STA B  1,X
02487 1F06 8601   LDA A  #1              ; CH1
02488 1F08 BD2035 JSR   GETDATA
02489 1F0B A714   STA A  20,X
02490 1F0D E715   STA B  21,X
02491 1F0F 8602   LDA A  #2
02492 1F11 BD2035 JSR   GETDATA
02493 1F14 A728   STA A  40,X
02494 1F16 E729   STA B  41,X
02495 1F18 8603   LDA A  #3
02496 1F1A BD2035 JSR   GETDATA
02497 1F1D A73C   STA A  60,X
02498 1F1F E73D   STA B  61,X
02499 1F21 08      INX
02500 1F22 08      INX
02501 1F23 8C00FF CPX   #AVGBUFF+20 ; DONE YET?
02502 1F26 2603   BNE   FILBUF1
02503 1F28 CE00EB LDX   #AVGBUFF
02504 1F2B DFE9   FILBUF1 STX   AVGPTR

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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 B02035     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

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[illegible]

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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 S647      LDA A  #"G"
02595 1FD2 BD1E40     JSR      OUTGSFC
02596 1FD5 S654      LDA A  #"T"
02597 1FD7 BD1E40     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 8D3A      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 BD1E40     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

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02633 2010 7F00A6      CLR    F. DATA      ; IF FULL THEN CLEAR THE DATA COLLECTION FLAG
02634 2013 8680        LDA    #80H      ; AND SET THE FULL BUFFER FLAG
02635 2015 97A8        STA    F. FULBLK
02636 2017 97A5        STA    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 8D1E42        JSR      OUTGSFC    ; SEND DATA TO SERIAL PORT 1
02643 201F E701          STA    B 1,X      ; WRITE THE TWO BYTES
02644 2021 17           TBR
02645 2022 8D1E41        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           CBR
02660 2032 23F4          BLS      GETSOME    ; SEE IF THAT IS ALL OF THE CHANNELS
02661 2034 39           RTS            ; LOOP IF NOT
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 B78400        STA    PIA1BD      ; WRITE THE CHANNEL NUMBER TO THE PIA
02676 203C 8634          LDA    #34H      ; SET SSTART CONVERSION (SC) TO 0
02677 203E B78401        STA    PIA1AC      ; BY SETTING CA1 TO A 0
02678 2041 863C          LDA    #3CH      ; NOW SET SC TO A 1
02679 2043 B78401        STA    PIA1AC      ; BY WRITING TO CA1
02680
02681 2046 B68401          GETDATA1 LDA    PIA1AC  ; READ THE PIA CONTROL REGISTER FOR END OF CONVERSION
02682 2049 2AFB          BPL      GETDATA1    ; LOOP UNTIL IT IS SET
02683
02684 204B B68400          LDA    PIA1AD      ; NOW READ THE MS 8 BITS

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02685 204E F68402 LDA B PIA1BD ;AND GET THE LS 4 BITS
02686 2051 C40F AND B #0FH ;MASK OFF THE CHANNEL NUMBER
02687 2053 D7E0 STA B NMI.TMP1 ;SAVE THE LS BITS TEMPORARILY
02688 2055 5F CLR B ;SHIFT IN THE BOTTOM 4 BITS FROM A
02689 2056 44 LSR A
02690 2057 56 ROR B
02691 2058 44 LSR A
02692 2059 56 ROR B
02693 205A 44 LSR A
02694 205B 56 ROR B
02695 205C 44 LSR A
02696 205D 56 ROR B
02697 205E DAE0 ORA B NMI.TMP1 ;OR IN THE PREVIOUS BITS
02698 2060 39 RTS ;THATS IT, SO EXIT
02699
02700 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02701 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02702 ;
02703 ; **** IRIGBSET ****
02704 ;
02705 ; **** READS IN CODED IRIGB TIME ****
02706 ;
02707 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02708 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02709
02710 2061 B68803 IRIGBSET LDA A NMI.PIA ;READ THE PIA CONTROL REGISTER
02711 2064 84C7 AND A #0C7H ;PRESERVE CB1,CB2, SET CB2 TO INTERRUPT,HI TO LOW, DISABLED
02712 2066 B78803 STA A NMI.PIA
02713 ;
02714 ; **** READ THE SECONDS ****
02715 ;
02716 2069 8D27 BSR IRIGBYT1 ;READ A SHORT DATA BYTE (DO NOT SKIP SPACER PULSE)
02717 206B C47F AND B #07FH ;MASK MSB (WHICH IS THE SPACER BIT)
02718 206D D711 STA B IRIGSEC ;SAVE IN THE TEMP REGISTER FOR SECONDS
02719 ;
02720 ; **** READ THE MINUTES ****
02721 ;
02722 206F 8D21 BSR IRIGBYT1 ;READ A SHORT DATA BYTE (NO PRECEDING SPACER PULSE)
02723 2071 C47F AND B #07FH ;MASK MSB TO REMOVE THE SPACER
02724 2073 D710 STA B IRIGMIN
02725 ;
02726 ; **** READ THE HOUR ****
02727 ;
02728 2075 8D19 BSR IRIGBYTE ;READ A FULL BYTE (THERE IS A SPACER PULSE)
02729 2077 C47F AND B #07FH ;FORCE MSB TO 0
02730 2079 D70F STA B IRIGHOUR
02731 ;
02732 ; **** READ THE DAY (LOW BYTE) ****
02733 ;
02734 207B 8D13 BSR IRIGBYTE
02735 207D D70E STA B IRIGDAYL
02736 ;

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02737      ;      ****  READ THE LOW (HIGH BYTE)  ****
02738      ;
02739  207F 8D0F      BSR      IRIGBYTE
02740  2081 D70D      STA B    IRIGDAYH
02741      ;
02742      ;      ****  READ THE FLIGHT NUMBER  ****
02743      ;
02744  2083 8D0B      BSR      IRIGBYTE
02745  2085 D70C      STA B    IRIGFLT
02746      ;
02747      ;      ****  RESET THE PIA CONTROL  ****
02748      ;
02749  2087 B68803     LDA A    NMI.PIA      ; LOAD THE PIA CONTROL REGISTER
02750  208A 8A0C      ORA A    #0CH        ; DIS-ENABLE THE INTERRUPTS
02751  208C B78803     STA A    NMI.PIA
02752  208F 39        RTS                ; GO BACK TO NMI ROUTINE
02753
02754      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02755      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02756      ;
02757      ;      ****  IRIGBYTE  ****
02758      ;
02759      ;      ****  READ 8 BITS FROM IRIGB INTO B REGISTER  ****
02760      ;
02761      ;      ****  SKIP THE LEADING SPACER PULSE IF CALLED AT "IRIGBYTE"  ****
02762      ;
02763      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02764      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02765
02766  2090 8D12      IRIGBYTE BSR      IRIGBIT      ; SKIP THE SPACE BIT
02767  2092 CE0009     IRIGBYT1 LDX      #09H        ; USE X AS A BIT COUNTER
02768  2095 8D0D      IRIGBYT2 BSR      IRIGBIT      ; READ THE 1/ST DATA BIT (LSB FIRST)
02769  2097 09        DEX                ; COUNT DOWN NUMBER OF BITS
02770  2098 8C0004     CPX      #04        ; 5/TH BIT IS NIBBLE SEPARATOR
02771  209B 27F8      BEQ      IRIGBYT2      ; IF WE ARE THERE THEN SKIP THAT BIT
02772  209D 56        ROR B              ; ELSE MOVE CARRY INTO B (CARRY WAS THE DATA BIT)
02773  209E 8C0000     CPX      #0          ; SEE IF ALL DONE
02774  20A1 26F2      BNE      IRIGBYT2      ; IF NOT THEN LOOP FOR NEXT BIT
02775  20A3 39        RTS
02776
02777
02778      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02779      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02780      ;
02781      ;      ****  IRIGBIT  ****
02782      ;
02783      ;      ****  READS A DATA BIT FROM CODE (SPACER OR NORMAL)  ****
02784      ;      ****  EXITS TO CALLING ROUTINE IF HUNG UP  ****
02785      ;
02786      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02787      ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02788

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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 868802      IRIGBIT2 LDA A      IRIGB. IN    ;READ THE PIA DATA REGISTER
02794 20B0 44          LSR A
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 868802      IRIGBIT4 LDA A      IRIGB. IN    ;READ IN THE PIA AGAIN
02802 20C0 44          LSR A
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     ;LOOP AND LOOK FOR CLOCK FALLING
02806 20C8 20F3          BRA      IRIGBIT4
02807
02808 20CA 44          IRIGBIT5 LSR A
02809 20CB 7C00D8      INC      RTC.STAT    ;WE GOT RISING AND FALLING EDGE, SO GET DATA (BIT 1)
02810 20CE 39          RTS                    ;MAKE RTC.STAT NONZERO SO THAT RTC ISR WILL NOT THINK WE ARE HUNG
02811
02812 20CF 8680          IRIGHUNG LDA A      #80H      ;EXIT WITH DATA BIT IN THE CARRY BIT
02813 20D1 97D5      STA A      NMI.F1      ;SET THE HUNG FLAG
02814 20D3 39          RTS

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02817 ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02818 ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02819 ;
02820 ;
02821 ;      ****  IRQ. ISR      ****
02822 ;
02823 ;
02824 ;      ****  POLLS FOR THE DEVICE THAT INTERRUPTED VIA IRQ LINE
02825 ;      ****  ERROR MESSAGE SENT IF NO IRQ FOUND (COULD HANG 6800)
02826 ;      ****  WINTERK VECTOR TO IRQ. ISR IS AT 03F7H
02827 ;      ****
02828 ;      ****  DEVICES:  CONSOLE ACIA, DBURROUGHS DISPLAY, APU
02829 ;
02830 ;
02831 ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02832 ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02833 ;
02834 ;
02835 ;      ****  DEFINE SOME SYMBOLS TO MAKE ROUTINE READABLE      ****
02836 ;
02837 ;
02838 8408 ACIA1.C EQU ACIA1C ; ADDRESS OF CONSOLE ACIA CONTROL REGISTER
02839 8409 ACIA1.D EQU ACIA1D ; ADDRESS OF CONSOLE ACIA DATA REGISTER
02840 110D RECEIVER EQU INBUFF ; ADDRESS OF RECEIVED CHARACTER PARSE
02841 ;
02842 ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02843 ;
02844 ;      ****  POLLING SEQUENCE      ****
02845 ;
02846 ; !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02847 ;
02848 20D4 B68408 IRQ. ISR LDA A ACIA1.C ; CHECK THE CONSOLE PORT
02849 20D7 2A0D BPL IRQ. ISR1 ; IF NOT ACIA THEN SKIP
02850 ;
02851 ;      ****  ACIA POLLING      ****
02852 ;
02853 20D9 44 LSR A ; TEST IF THE RECEIVER IS ACTIVE
02854 20DA 2405 BCC IRQ. ISR0 ; IF NOT THEN TEST FOR TRANSMITTER
02855 20DC 36 PSH A ; OTHERWISE SAVE ACIA REGISTER
02856 20DD BD110D JSR RECEIVER ; PROCESS THE RECEIVER CHARACTER
02857 20E0 32 PUL A
02858 20E1 44 IRQ. ISR0 LSR A ; SHIFT OVER TWICE TO TEST THE TRANSMITTER
02859 20E2 2402 BCC IRQ. ISR1 ; IF NOT THE TRANSMITTER THEN SKIP OUT ( SPURIOUS INTERRUPT )
02860 20E4 8D09 BSR TRANSMIT ; IF TRANSMITTER THEN PROCESS THE NEXT CHAR
02861 ;
02862 ;      ****  DISPLAY POLLING      ****
02863 ;
02864 20E6 B68801 IRQ. ISR1 LDA A PIA3AC ; SEE IF DISPLAY DATA UPDATE FLAG IS SET
02865 20E9 2A03 BPL IRQ. ISR2 ; IF NOT DISPLAY THEN SKIP OUT
02866 20EB BD2145 JSR DISPLAY ; OTHERWISE PROCESS THE DISPLAY INTERRUPT
02867 20EE 38 IRQ. ISR2 RTI
02868 ;

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02869
02870 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02871 ;
02872 ;      ****   TRANSMIT   ****
02873 ;
02874 ;!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
02875
02876 20EF 96A7      TRANSMIT LDA A  F.XMIT      ;SEE IF WE ARE TRANSMITTING ANY CHARS
02877 20F1 2B06      BMI      XMIT1          ;IF WE ARE THEN SKIP TO HANDLER
02878 20F3 8685      LDA A   #85H           ;IF WE ARENT TRANSMITTING, RESET ACIA NOT TO GET ANY MORE IRQS.
02879 20F5 B78408    STA A   ACIA1.C        ;BY STORING THE ABOVE VALUE INTO THE ACIA CONTROL REG.
02880 20F8 39        RTS                    ;AND EXIT
02881 ;
02882 20F9 DEE3      XMIT1   LDX      NEXTCHAR ;GET THE POINTER TO NEXT CHAR
02883 20FB A600      LDA A   0,X            ;NOW GET THE CHAR
02884 20FD B78409    STA A   ACIA1.D        ;WRITE THE CHAR TO THE OUTPUT PORT
02885 2100 9CE7      CPX      BLOCKEND      ;SEE IF WE ARE AT END OF TRANSMIT BUFFER
02886 2102 2704      BEQ      XMIT2        ;IF SO THEN RE-ADJUST THE TRANSMIT BUFFER
02887 2104 08       INX                    ;IF NOT THEN MOVE TO NEXT CHAR AND EXIT
02888 2105 DFE3      STX      NEXTCHAR      ;SAVE POINTER
02889 2107 39       RTS
02890 ;
02891 ;      ****   END OF TRANSMIT BLOCK. MOVE BUFFERED CHARS DOWN   ****
02892 ;
02893 2108 8685      XMIT2   LDA A   #85H      ;DISABLE TRANSMIT INTERRUPTS FOR A SECOND
02894 210A B78408    STA A   ACIA1.C
02895 2100 9CE5      CPX      LASTCHAR      ;SEE IF END OF BLOCK IS ALSO END OF BUFFER
02896 210F 272B      BEQ      XMIT4        ;IF SO THEN SKIP THE BYTE TRANSFERS
02897 ;
02898 2111 CE015B    LDX      #XMITBUF      ;GET ADDRESS OF XMIT BUFFER
02899 2114 DFE3      STX      NEXTCHAR      ;RESET THE OUTPUT CHAR POINTER
02900 2116 DEE7      LDX      BLOCKEND      ;GET ADDRESS OF 1/ST FREE CHAR
02901 2118 08       XMIT3   INX
02902 2119 DFE7      STX      BLOCKEND      ;REPLACE THE POINTER
02903 211B A600      LDA A   0,X            ;GET THE BYTE
02904 211D DEE3      LDX      NEXTCHAR      ;GET POINTER FOR STORAGE
02905 211F A700      STA A   0,X            ;WRITE THE BYTE
02906 2121 08       INX
02907 2122 DFE3      STX      NEXTCHAR      ;REPLACE THE STORAGE POINTER
02908 2124 DEE7      LDX      BLOCKEND
02909 2126 9CE5      CPX      LASTCHAR      ;SEE IF WE HAVE MOVED THEM ALL
02910 2128 26EE      BNE      XMIT3        ;IF NOT THEN LOOP
02911 ;
02912 212A DEE3      LDX      NEXTCHAR      ;GET POINTER TO THE LAST CHAR
02913 212C 09       DEX
02914 212D DFE7      STX      BLOCKEND      ;AND RESET THE OTHER TWO POINTERS
02915 212F DFE5      STX      LASTCHAR
02916 2131 CE015B    LDX      #XMITBUF
02917 2134 DFE3      STX      NEXTCHAR
02918 2136 86A1      LDA A   #0A1H        ;RESET THE ACIA FOR INTERRUPTS
02919 2138 B78408    STA A   ACIA1.C
02920 2138 39       RTS

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

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02921      ;
02922 213C 7F00A7  XMIT4   CLR    F.XMIT    ;WE SENT A WHOLE BUFFER SO EXIT
02923 213F CE015B      LDX    #XMITBUF  ;RESET THE NEWCHAR POINTER
02924 2142 0FE3      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
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   LDY   #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
02979 2194 B7880C   STA   A   APUDATA   ; PUSH 2 ZEROS FOR 32 BIT FIXED FORMAT
02980 2197 B7880C   STA   A   APUDATA
02981 219A BD23E2   JSR   FLT0        ; CONVERTS 32-BIT FIXED-PT TO 32-BIT FLT-PT FORMAT
02982 219D CE2428   LDY   #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   FDIY        ; 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 LDY   #CH0TEMP
02993 21AC DF8F     STX   SAVEX1        ; SAVE BCD RESULT POINTER
02994 21AE CE013B   LDY   #CH0GAIN     ; GET POINTER FOR CALIBRATION CONSTANTS
02995 21B1 DF91     STX   SAVEX2        ; SAVE POINTER FOR CALIBRATION CONSTANTS
02996 21B3 CE006F   LDY   #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
03000 21BB 08     INX
03001 21BC DF93   STX   SAVEX3        ; SAVE THIS POINTER

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03002 218E DE91          LDX    SAVEX2
03003 21C0 BD2253        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    ; BRANCHES 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 = "HTLTEMP" THRU "SPRETEMP" (5 BYTE BLOCKS)
03045 221A CE0026        LOADTEMP LDX    #HTLTEMP
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
03053 222C 08            INX      ; INCREMENT POINTER TO NEXT 12-BIT NUMBER

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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 8D10      BSR     TEMPBCD     ;CONVERT 12-BIT NUMBER TO TEMPERATURE (BCD)
03057 2233 DE91      LDX     SAVEX2
03058 2235 C608      LDA B   #06H
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    ;BRANCHES UNTIL CHANNEL 8 HAS BEEN CONVERTED
03068 224A 39        RTS
03069                ;
03070                ; "INCRMNTX" SUBROUTINE.
03071                ; INCREMENTS X REGISTER "B" TIME.
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, ACCB 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    ;BRANCHES 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    ;CONVERTS 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     #FSADCDW    ; 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 RESULT 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      ; INITIALIZE 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      ; DON'T 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      ; DECREASES 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 SHIFTING 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      ; DECREASES 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 UNLESS 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 5D09      BSR BINBCD      ; CONVERT INTEGER PART
03207 230C DE8F      LDX SAVEX1      ; SETS DATA POINTER
03208 230E 08      INX
03209 230F 08      INX

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00210 2310 08          INX
00211 2311 32          PUL A
00212 2312 8D53        BSR    BINFPT      ; CONVERT FRACTIONAL PART
00213 2314 39          FPTS    RTS
00214
00215          ;      "BINBCD" SUBROUTINE
00216          ;      BINARY TO PACKED BCD CONVERSION ROUTINE
00217          ;      REVISION 1.1
00218          ;      LOAD ACCA, ACCB WITH A 16-BIT BINARY NUMBER.
00219          ;      LOAD INDEX REG. WITH ADDRESS OF MS BYTE OF
00220          ;      WHERE PACKED BCD INFORMATION IS TO BE KEPT.
00221          ;      ROUTINE RETURNS WITH PACKED BCD IN THE
00222          ;      SPECIFIED MEMORY LOCATION AND ALSO IN ACCA,
00223          ;      ACCB. THE LEAST FOUR MS DECIMAL VALUES
00224          ;      WILL BE CONTAINED IN THE PACKED BCD NUMBER
00225 2315 DF8D          BINBCD  STX    SAVEX      ; SAVE DATA POINTER
00226 2317 CE241A        LDX    #K10K      ; INITIALIZES X REG. FOR 1ST BCD CONVERSION CONST.
00227 231A 7F0098        CLR    ENTRYA      ; INITIALIZES REG. FOR PACKING SUBROUTINE
00228 231D 7F0099        CLR    ENTRYB
00229 2320 7F0087        CVDEC1  CLR    SAVED      ; CLEAR BCD CONVERSION COUNTER
00230 2323 E001          CVDEC2  SUB B    1,X
00231 2325 A200          SBC A    0,X
00232 2327 2505          BCS    CVDEC5      ; BRANCH IF SUBTRACTION PRODUCES OVERFLOW
00233 2329 7C0087        INC    SAVED      ; DECIMAL CHARACTER BEING BUILT, INCREMENT SAVED
00234 232C 20F5          BRA    CVDEC2
00235 232E E801          CVDEC5  ADD B    1,X
00236 2330 A900          ADC A    0,X      ; RESTORES PARTIAL RESULT UPON OVERFLOW
00237 2332 36          PSH A      ; SAVES ACCA
00238 2333 9687          LDA A    SAVED      ; GETS BCD CONVERSION COUNTER
00239 2335 8D13          BSR    PACK      ; PACKS NEWLY FORMED BCD CHARACTER
00240 2337 32          PUL A      ; RESTORES ACCA TO FORMER VALUE
00241 2338 08          INX
00242 2339 08          INX      ; INCREMENTS INDEX REGISTER TO NEXT CONSTANT
00243 233A 8C2424        CPX    #K10K+10    ; TESTS TO SEE LAST CONSTANT HAS BEEN USED
00244 233D 26E1          BNE    CVDEC1      ; BRANCHES IF LAST CHAR HAS NOT BEEN REACHED YET
00245 233F 9698          LDA A    ENTRYA
00246 2341 D699          LDA B    ENTRYB
00247 2343 DE8D          LDX    SAVEX
00248 2345 A700          STA A    0,X
00249 2347 E701          STA B    1,X      ; SAVES 16-BIT PACKED BCD NUMBER
00250 2349 39          RTS
00251
00252          ;      "PACK" SUBROUTINE
00253          ;      PACKS BINARY NUMBERS INTO BCD FORM
00254          ;      ACCA SHOULD CONTAIN THE UNPACKED BCD FORM
00255          ;      ROUTINE DESTROYS CONTENTS OF ACCA.
00256 234A 780099          PACK    ASL    ENTRYB      ; THEN DOES 1-BIT LEFT SHIFT WITH ZERO FILL
00257 234D 790098          ROL    ENTRYA
00258 2350 780099          ASL    ENTRYB
00259 2353 790098          ROL    ENTRYA
00260 2356 780099          ASL    ENTRYB
00261 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  SAVERA      ; 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
03279 2373 5F        CLR B      ; INITIALIZES ACCA, ACCB
03280 2374 9789      BIN1  STA A  TEMPA      ; SAVES ACCA TEMPORARILY
03281 2376 780087     ASL   SAVERA      ; LOOK AT NEXT BIT
03282 2379 240A      BCC   BIN2      ; BRANCHES PAST LOOP IF C=0
03283 237B 17        TBR          ; 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 26F7        BNE  PUSH2      ; BRANCHES THRU UNTIL LS BYTE OF DATA IS ENTERED
03317 23A4 DE6         LDX  TEMPMX     ; 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 B6800C        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 B68404        TSTEND LDA A  PIA2AD ; CHECK END FLAG
03336 23B4 2BFB         BMI  TSTEND      ; LOOP TILL LOW
03337 23B6 B6680D        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 23BA C610          FADD  LDA B  #10H   ; LOADS IN ADD OPCODE
03345 23BC F7880D        STA B  APUSTAT   ; ISSUES COMMAND TO APU
03346 23BF 8DF0        BSR  TSTEND      ; WAITS UNTIL APU IS FINISHED
03347 23C1 39          RTS
03348
03349                  ; "FSUB" SUBROUTINE
03350                  ; SUBTRACTS TWO 32-BIT FLOATING 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 F7880D        STA B  APUSTAT   ; ISSUES COMMAND TO APU
03355 23C7 8DE0        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 C612          FMUL  LDA B  #12H   ; LOADS IN MULTIPLY OPCODE
03363 23CC F7880D        STA B  APUSTAT   ; ISSUES MULTIPLY COMMAND TO APU
03364 23CF 8DE0        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 8DD8      BSR   TSTEND          ;WAITS UNTIL APU IS FINISHED
03383 23E1 39        RTS
03384      ;
03385      ;      FLOAT A 32 BIT FIXED POINT NUMBER
03386 23E2 C61C      FLT0      LDA B  #1CH          ;LOADS IN FLOAT OPCODE
03387 23E4 F7880D      STA B  APUSTAT        ;ISSUES COMMAND TO APU
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          ;LOADS IN EXCHANGE COMMAND
03400 23F3 F7880D      STA B  APUSTAT        ;ISSUES COMMAND TO APU
03401 23F6 20B9      BRA   TSTEND
03402      ;
03403      ;POP NOS INTO TOS
03404 23F8 C618      POPF      LDA B  #18H          ;LOADS IN EXCHANGE COMMAND
03405 23FA F7880D      STA B  APUSTAT        ;ISSUES COMMAND TO APU
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 44524056  MESSNR  ASCII  "DRIVE NOT READY"
03439 2430 45204E4F
03439 2434 54205045
03439 2438 414450
03440 243B 04      BYTE  4
03441 243C 2047412E  INITMSG  ASCII  " GA. TECH RADIONETER"
03441 2440 20544E43
03441 2444 48205041
03441 2448 44494F4D
03441 244C 45544052
03442 2450 04      BYTE  4
03443 2451 52454144  RDYMSG  ASCII  "READY"
03443 2455 59
03444 2456 04      BYTE  4
03445 2457 494E5041  SYNMSG  ASCII  "INVALID COMMAND"
03445 245B 4C494120
03445 245F 434F404D
03445 2463 414E41
03446 2466 04      BYTE  4
03447 2467 494C4045  BKERRMSG ASCII  "ILLEGAL BLOCK NUMBER!"
03447 246B 47414020
03447 246F 424C4043
03447 2473 48204055
03447 2477 4D424052
03447 247B 21
03448 247C 04      BYTE  4
03449 247D 494E5041  NUMERR  ASCII  "INVALID NUMBER"
03449 2481 4C494120
03449 2485 4E554042
03449 2489 4552
03450 248B 04      BYTE  4
03451 248C 4E4F2020  BLKMSG  ASCII  "NO. OF BLOCKS"
03451 2490 4F462042
03451 2494 4C4F404B
03451 2498 53
03452 2499 04      BYTE  4
03453 249A 43524120  CRCMSG  ASCII  "CRC ERROR AT BLOCK  : "
03453 249E 4552004F
03453 24A2 52204154
03453 24A6 2042404F
03453 24AA 434B2020
03453 24AE 202030
03454 24B1 04      BYTE  4
03455 24B2 20535141  STRMSG  ASCII  " STARTING ADDRESS? "
03455 24B6 5254404E
03455 24BA 47204114
03455 24BE 44524053
03455 24C2 533F20
03456 24C5 04      BYTE  4

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03457 2406 2042404F BLOCKMSG ASCII " BLOCK NUMBER? "
03457 240A 434B204E
03457 240E 554D4045
03457 24D2 523F20
03458 24D5 04
03459 24D6 4741404E GAINMSG ASCII "GAIN IN DEG/VOLT "
03459 24DA 20494020
03459 24DE 4445402F
03459 24E2 564F4054
03459 24E6 20
03460 24E7 04
03461 24E8 4F464053 OFSTMSG ASCII "OFFSET IN DEGREES "
03461 24EC 45542049
03461 24F0 4E204045
03461 24F4 47524045
03461 24F8 5320
03462 24FA 04
03463 24FB 20545041 TRACKMSG ASCII " TRACK NUMBER? "
03463 24FF 434B204E
03463 2503 554D4045
03463 2507 523F20
03464 250A 04
03465 250B 2A2A2044 DELMSG ASCII "****DEL****"
03465 250F 454C202A
03465 2513 2A
03466 2514 04
03467 2515 0D0A CRLFSTR WORD 0D0AH
03468 2517 04
03469 2518 54415045 FPMSG ASCII "TAPE IS WRITE PROTECTED"
03469 251C 20495020
03469 2520 57524054
03469 2524 45205052
03469 2528 4F544043
03469 252C 544540
03470 252F 04
03471 2530 41505020 APUERMSG ASCII "APU ERROR!!!!!"
03471 2534 4552504F
03471 2538 52212021
03471 253C 2121
03472 253E 04
03473
03474 253F 47412020 RADMSG ASCII "GA. TECH MILLIMETER RADIOMETER"
03474 2543 54454048
03474 2547 204D404C
03474 254B 4C494045
03474 254F 54455020
03474 2553 52414049
03474 2557 4F4D4054
03474 255B 4552
03475 255D 04
03476 255E 53595054 RADMSG1 ASCII "SYSTEM STATUS"
03476 2562 454D2053

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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	TIMMSG	ASCII	"TIME "
03482	2582	20			
03483	2583	04		BYTE	4
03484	2584	44415441	DATMSG	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	KLYMSG	ASCII	"KLYSTRON TEMP "

03501	25FF	54524F4E			
03501	2603	2054454D			
03501	2607	502020			
03502	260A	04		BYTE	4
03503	260B	4341402E	CALMSG	ASCII	"CAL. INTERVAL ? "
03503	260F	20494E54			
03503	2613	45525041			
03503	2617	4C203F20			
03504	261B	04		BYTE	4
03505	261C	52414449	RADMSG2	ASCII	"RADIOMETER IS VIEWING "
03505	2620	4F4D4554			
03505	2624	45522049			
03505	2628	53205049			
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	43414049	CALMSG1	ASCII	"CALIBRATION DATA"
03525	268F	42524154			
03525	2693	494F4E20			
03525	2697	44415441			

03526	269B	0D0A		WORD	0D0AH		
03527	269D	20202020		ASCII	"	GAIN (DEG/VOLT)	OFFSET (DEG) "
03527	26A1	20202020					
03527	26A5	20204741					
03527	26A9	494E2020					
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	26D8	41495220					
03534	26DF	39393020					
03534	26E3	5645522E					
03534	26E7	20322E30					
03535	26E8	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	NEWMMSG	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

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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	CALIBRATE
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 20313933		
03624 280D 00	BYTE	0
03625 280E 1AE2	WORD	SET183
03626 2810 44495350	ASCII	"DISP 94"
03626 2814 203934		
03627 2817 00	BYTE	0

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 2829 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	PRINVTOLT
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		

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03669 2893 00          BYTE  0
03670 2894 1B05        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 0000        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      ;KLYSTRON 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 0600        DATABUFF BLOCK  2048      ;2048 BYTE BUFFER FOR DATA COLLECTION
03711

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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	NMIIV --- 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	REYCODE 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
APUERMMSG 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 - 00C0	BLKMSG - 26D0	BLKNUM - 0001
BLKSMSG 240C	BLOCK1 - 1359	BLOCK11 135E	BLOCK2 - 1366	BLOCKEND 00E7
BLOCKMSG 24C6	BLOCKS - 00C0	BTEMP -- 00BC	BUFPNT - 00B8	BYCOUNT 00AC
CAL.CNTR 00DC	CAL.TIME 00D0	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
CH0AVG 005B	CH0TEMP 0012	CH0VAVG 004B	CH1GAIN 0143	CH1OFST 0147
CH1AVG 0060	CH1TEMP 0017	CH1VAVG 004F	CH2GAIN 014B	CH2OFST 014F
CH2AVG 0065	CH2TEMP 001C	CH2VAVG 0053	CH3GAIN 0153	CH3OFST 0157
CH3AVG 006A	CH3TEMP 0021	CH3VAVG 0057	CHANGE - 159E	CHAR.INS 1E0A
CHARINS1 1E18	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	COLD0FST 28D3	COLDTEMP 002B	CONMSG - 26D7	CONST -- 240A
CRC ---- 156A	CRC1 --- 1570	CRC2 --- 1577	CRC3 --- 158A	CRC01 -- 158E
CRC2 -- 159C	CRCH --- 00B6	CRCL --- 00B7	CRCMSG - 249A	CRLF --- 1A18
CRLFSTR 2515	CTSCNTR 00C9	CVDEC1 - 2320	CVDEC2 - 2323	CVDEC5 - 232E
DATABUFF 3000	DATMSG 2584	DATAPNTR 00DE	DAYMSG - 2579	DAYS.HI 0007
DAYS.L0 0008	DECBK - 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	DISPKLYS 1B28	DISPLAY 2145
DISPLY - 28EF	DISPNEXT 15DC	DISPREF 1B35	DISPSPC 15EC	DISPSTNG 15D3
DISPTMP 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	FILLBUF 1EFC	FLIGHT - 0006

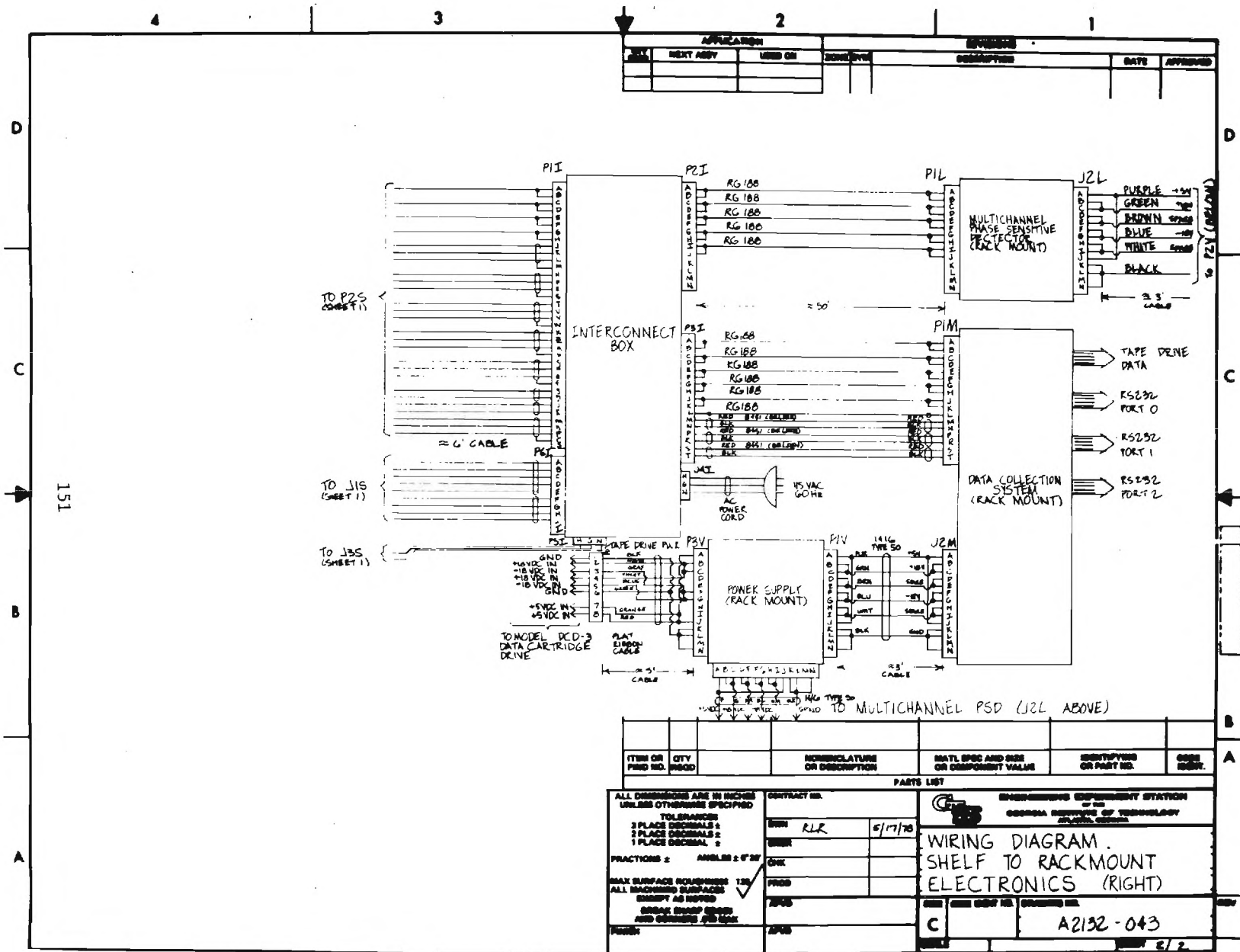
FLTD --- 23E2	FLTMSG - 256C	FLTS --- 23DA	FMUL --- 23CA	FORWD -- 121A
FPMMSG -- 2518	FPT1 --- 22D6	FPT2 --- 22DC	FPT3 --- 22E4	FPT32 -- 009C
FPT4 --- 22E9	FPT5 --- 22EB	FPT6 --- 22FD	FPT7 --- 2300	FPT8 --- 2314
FPTBCD - 22BC	FRAMTYPE 0003	FSADCWD 2428	FSUB --- 23C2	FTYPE -- 171A
GAINMSG 24D6	GETDATA 2035	GETDATA1 2046	GETONE - 1F48	GETSOME 2028
GETSOME1 202A	GNDMSG - 2637	GOFOR -- 140E	GOFORWD 1402	GSFCOK - 1A02
GSFCOK1 1A17	GSFCT0 - 00CF	HALT --- 1918	HEXPTR - 00C7	HOT ---- 1A6F
HOT1 --- 1A7E	HOT2 --- 1A84	HOTMSG - 25B7	HOTMSG1 25E6	HOURS --- 0009
HTCD32 - 0047	HTLDGAIN 28C7	HTLDOFST 28CB	HTLDTMP 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	INCBK - 14DA
INCRMNTX 224B	INIT --- 1AC9	INIT1 -- 1000	INIT11 -- 1008	INIT2 -- 105E
INIT3 -- 1073	INIT31 - 1087	INIT4 -- 109B	INIT5 -- 1088	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	KLYSMMSG 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 1DD8
OUTHEXR 1DE1	OUTPOS - 1D48	OUTQUES 19E5	OUTSIDE 1A25	OUTSPACE 1DCD
OUTSPC - 1DC0	OUTTEMP 1D42	PACK --- 234A	PATCH -- 23FF	POPF --- 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 - 1568	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	SAVER -- 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	SEEK5 -- 133D	SET183 - 1AE2	SET183A 1AEC
SET94 -- 1AF7	SET94A - 1AF1	SETADR - 1B08	SETCAL - 192B	SETCAL1 193B

SETCAL11 1940	SETCAL2 1948	SETCAL3 194F	SETCOLD 1ACE	SETHEX - 1950
SETHEX1 1962	SETHOT - 1AD3	SETKLYS 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
SKIFG -- 13BE	SKIPG1 - 13C9	SKIPNEG 1378	SKIPP0S 1381	SKIPS -- 13CE
SKIPS1 - 13E5	SKIPS11 13DA	SKIP32 - 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	STRMSG 24B2	SYNMSG - 2457
TABPNT - 00BA	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	TESTCSFC 19EA	TESTHEX 11C5	TESTIME 1BC0
THB ---- 1DD1	THB1 --- 1DE3	THB2 --- 1DE9	TIME --- 1D1F	TIMMSG 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	ISTEND - 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

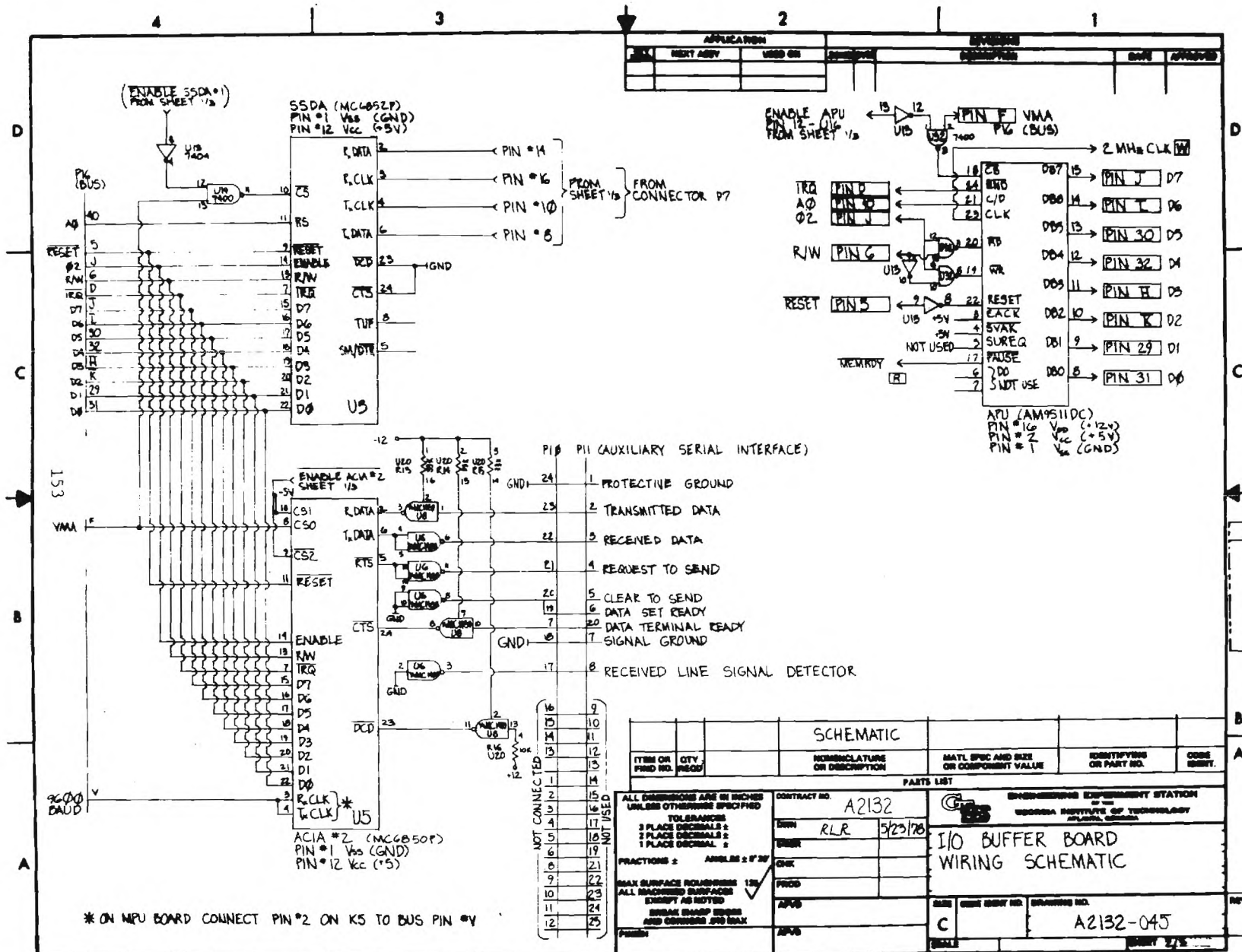
3711 Source Lines 3743 Assembled Lines 5782 Bytes available

>>> No assembly errors detected <<<

APPENDIX B
ELECTRONIC SCHEMATICS

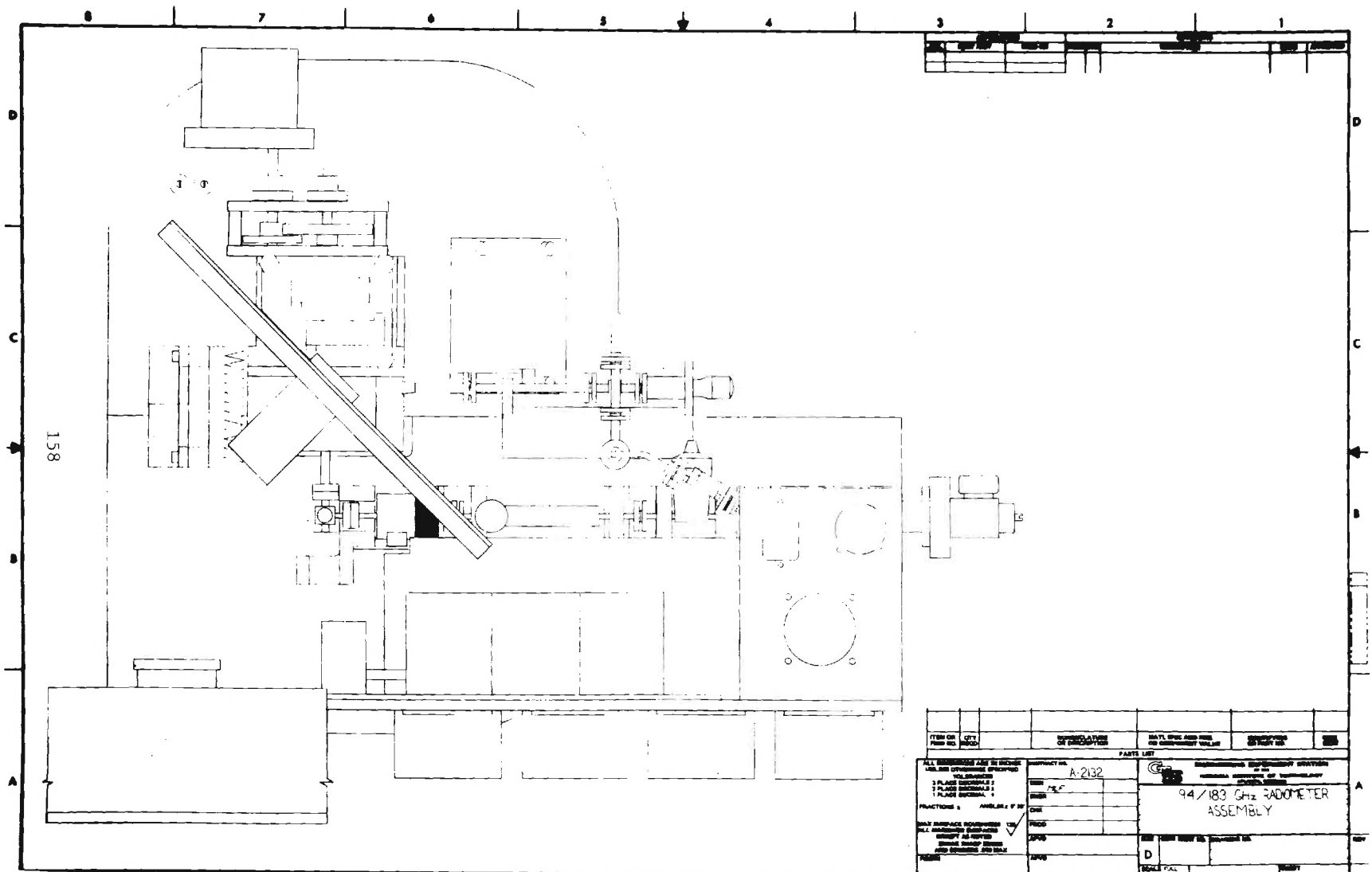


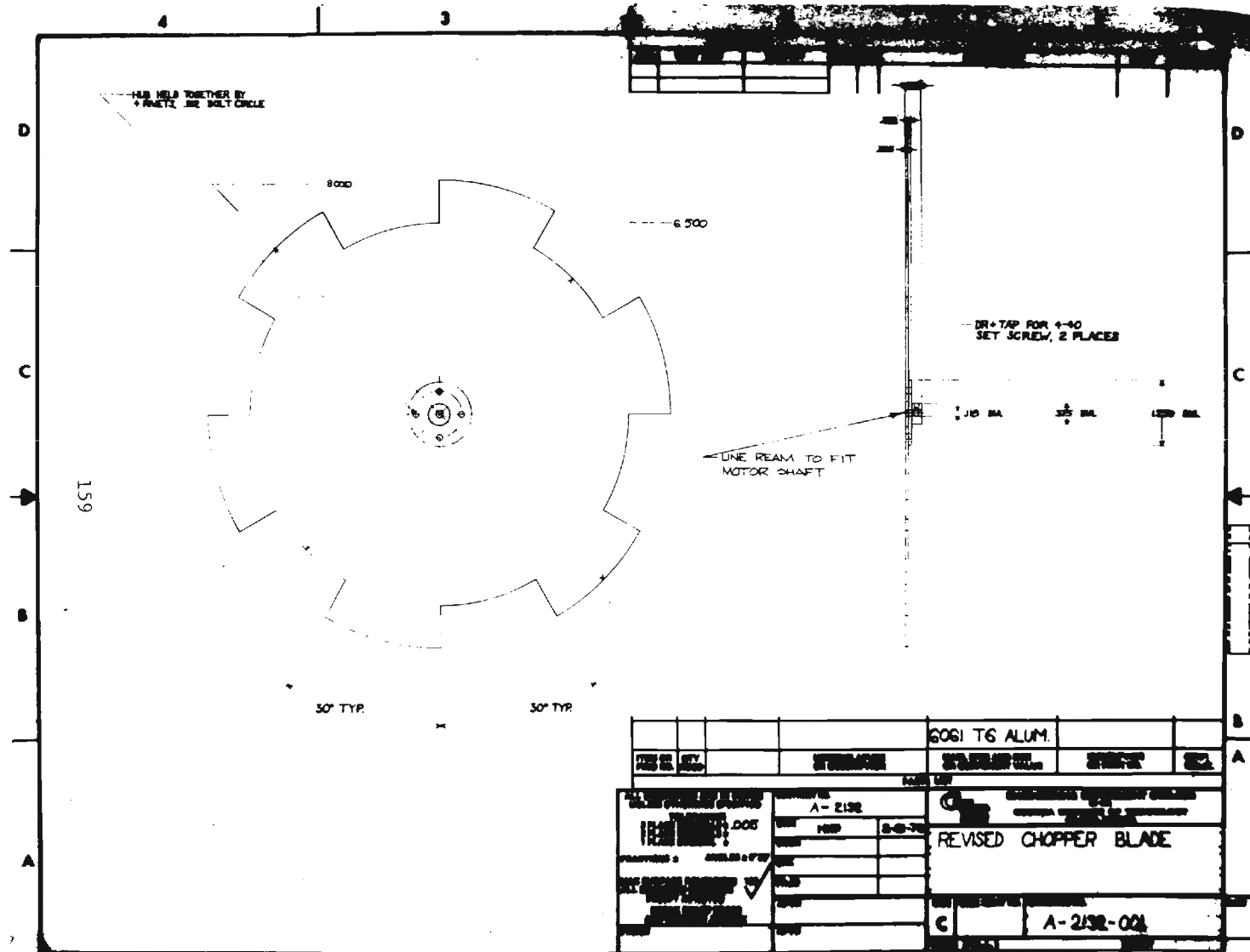
A-2152-945

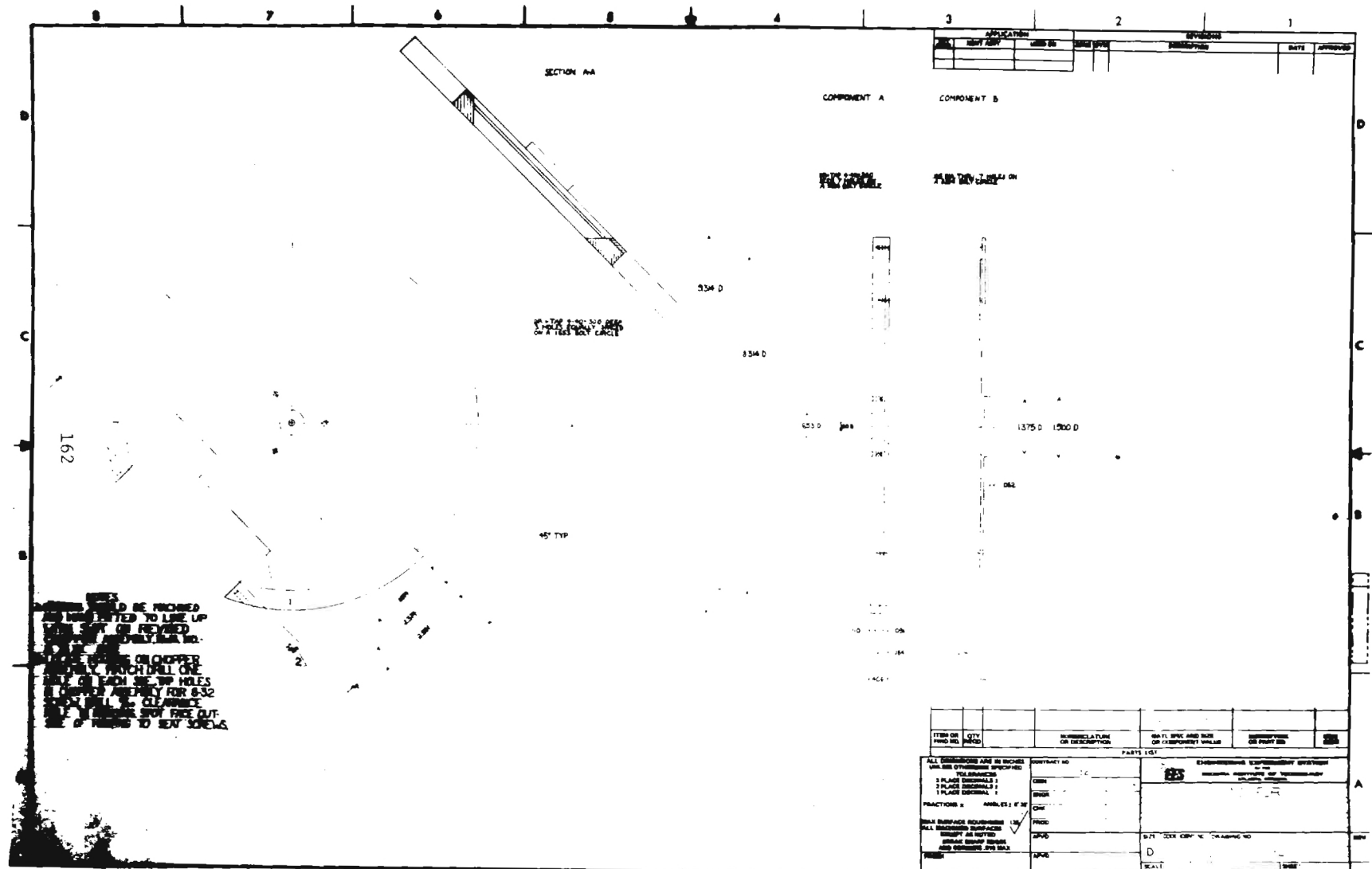


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APPENDIX C
MECHANICAL DRAWINGS



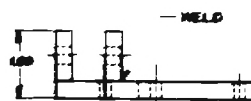
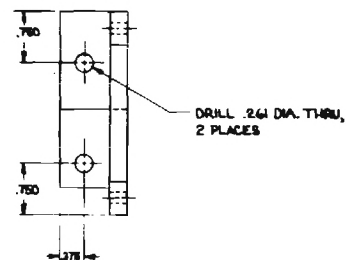
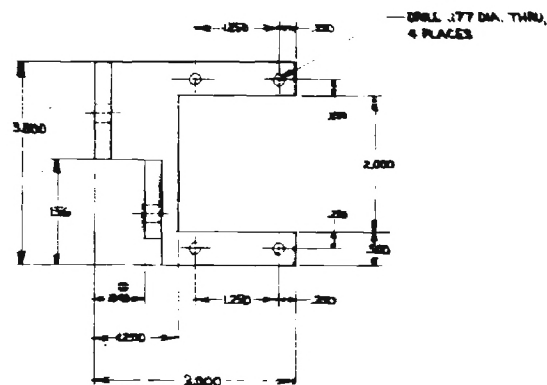




APPLICATION				DIVISION			
DATE	BY	APP'D	DATE	DATE	BY	APP'D	DATE

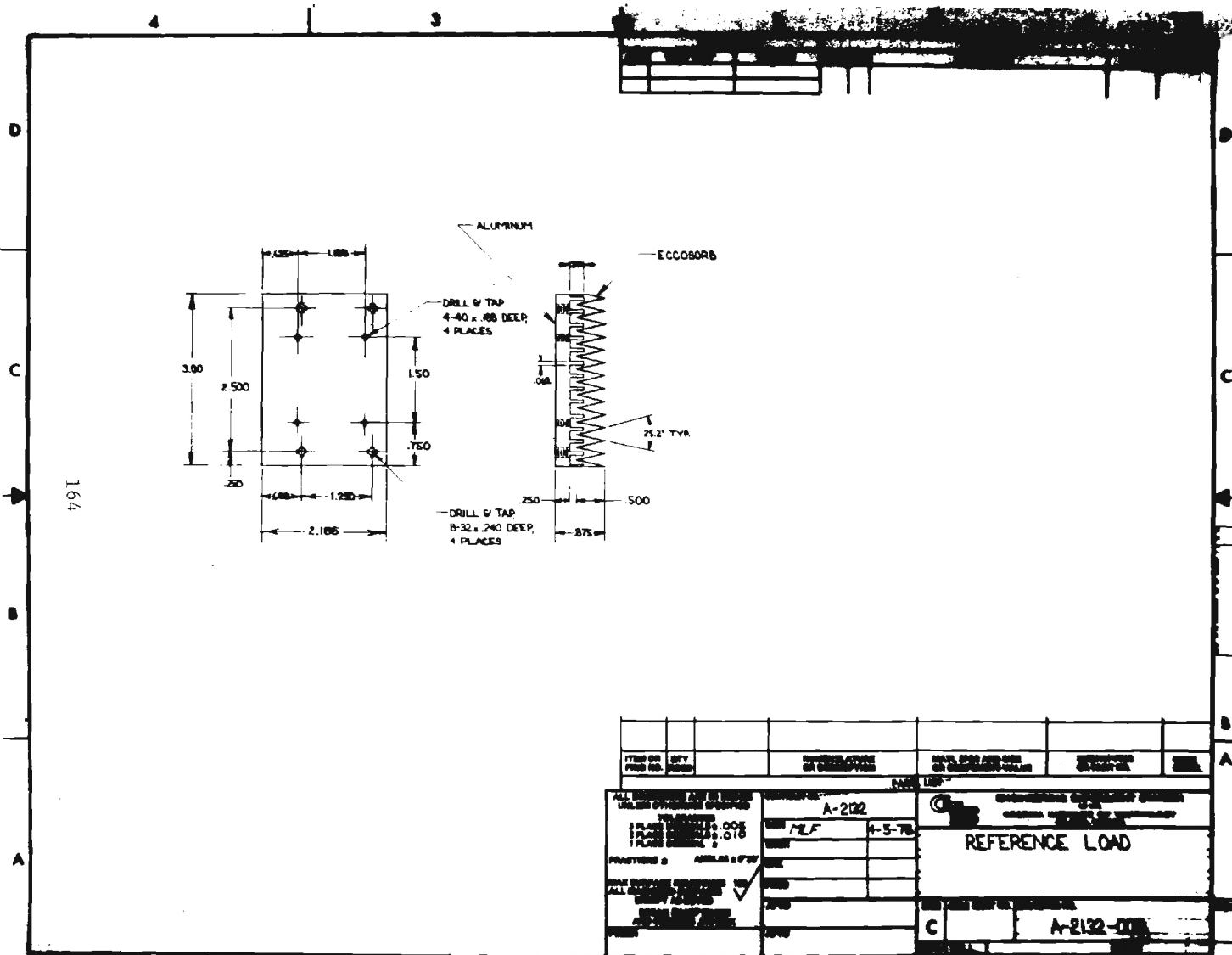
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1	1	1375 D 1900 D			
2	1	334 D			
3	1	45° TYP			
4	1	162			
5	1	SECTION AA			
6	1	COMPONENT A			
7	1	COMPONENT B			
8	1	334 D			
9	1	1375 D 1900 D			
10	1	45° TYP			
11	1	162			
12	1	SECTION AA			
13	1	COMPONENT A			
14	1	COMPONENT B			
15	1	334 D			
16	1	1375 D 1900 D			
17	1	45° TYP			
18	1	162			
19	1	SECTION AA			
20	1	COMPONENT A			
21	1	COMPONENT B			
22	1	334 D			
23	1	1375 D 1900 D			
24	1	45° TYP			
25	1	162			
26	1	SECTION AA			
27	1	COMPONENT A			
28	1	COMPONENT B			
29	1	334 D			
30	1	1375 D 1900 D			
31	1	45° TYP			
32	1	162			
33	1	SECTION AA			
34	1	COMPONENT A			
35	1	COMPONENT B			
36	1	334 D			
37	1	1375 D 1900 D			
38	1	45° TYP			
39	1	162			
40	1	SECTION AA			
41	1	COMPONENT A			
42	1	COMPONENT B			
43	1	334 D			
44	1	1375 D 1900 D			
45	1	45° TYP			
46	1	162			
47	1	SECTION AA			
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49	1	COMPONENT B			
50	1	334 D			
51	1	1375 D 1900 D			
52	1	45° TYP			
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54	1	SECTION AA			
55	1	COMPONENT A			
56	1	COMPONENT B			
57	1	334 D			
58	1	1375 D 1900 D			
59	1	45° TYP			
60	1	162			
61	1	SECTION AA			
62	1	COMPONENT A			
63	1	COMPONENT B			
64	1	334 D			
65	1	1375 D 1900 D			
66	1	45° TYP			
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68	1	SECTION AA			
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71	1	334 D			
72	1	1375 D 1900 D			
73	1	45° TYP			
74	1	162			
75	1	SECTION AA			
76	1	COMPONENT A			
77	1	COMPONENT B			
78	1	334 D			
79	1	1375 D 1900 D			
80	1	45° TYP			
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93	1	1375 D 1900 D			
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166	1	SECTION AA			
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169	1	334 D			
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171	1	45° TYP			
172	1	162			
173	1	SECTION AA			
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176	1	334 D			
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179	1	162			
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185	1	45° TYP			
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200	1	162			

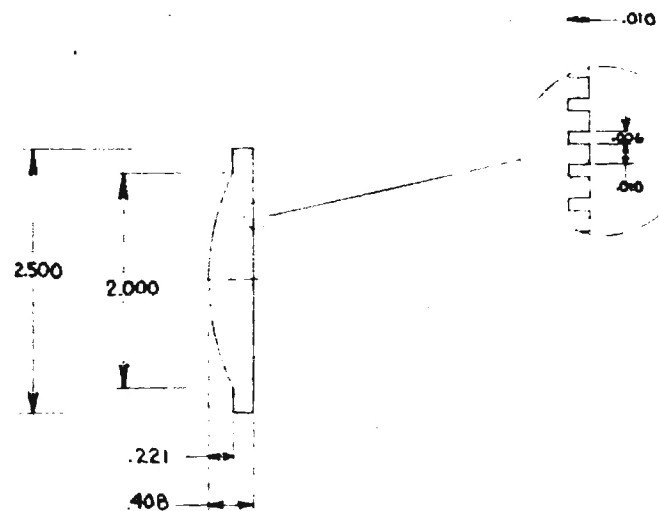
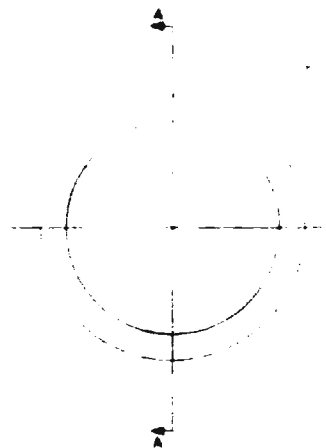
163



NOTES:
1. DIMENSIONS IN
2. PREFERRED: 25 THRU .601 TO .401

REV.	BY	DATE	DESCRIPTION	APPROVED	DATE
1			BRACKET FOR REFERENCE LOAD		
2					
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SECTION A-A

NOTES:

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

				ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA	
				LENS	
NO.	DESCRIPTION OF CHANGE	CH.	DATE	DR. MLF	DRAWING NO.
SCALE:	FULL		DATE: 4-14-78	ENGR.	
CONTRACT NO.		A-2132		CH.	
PROJECT NO.				APP.	A-2132-018

APPLICATION		REVISIONS	
NEXT ASBY	USED BY	DESCRIPTION	DATE

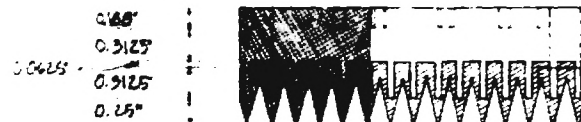
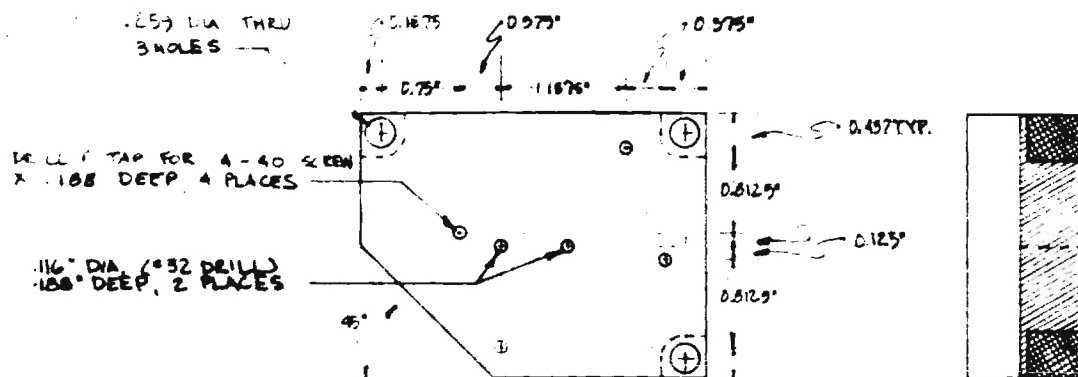
1.600

1.350

NOTES:

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

ITEM OR FNO NO.	QTY (REQD)	NOMENCLATURE OR DESCRIPTION	MATERIAL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFIER OR PART NO.	CODE REMARKS
PARTS LIST					
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED		CONTRACT NO. A-2132		ENGINEERING EXPERIMENT STATION of the GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA MODIFICATION TO COLD LOAD MIRROR	
TOLERANCES		DATE MLF 4-6-78			
3 PLACE DECIMALS ± .005		DWN			
2 PLACE DECIMALS ± .01		CHK			
1 PLACE DECIMAL ± .1		PRD		REV	
FRACTIONS ±		APVD		SIZE CODE IDENT NO. DRAWING NO.	
ANGLES ± 9° 30'		APVD		C 000000 000000	
MAX SURFACE ROUGHNESS 125		APVD		A-032-022	
ALL MACHINED SURFACES EXCEPT AS NOTED		APVD		SCALE FULL SHEET	
BREAK SHARP EDGES AND CORNERS .010 MAX		APVD			
FINISH		APVD			

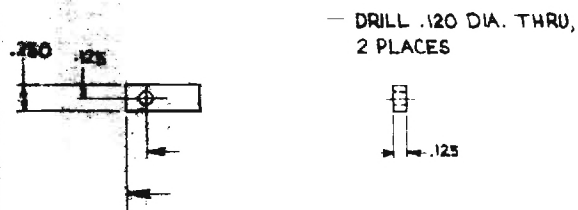
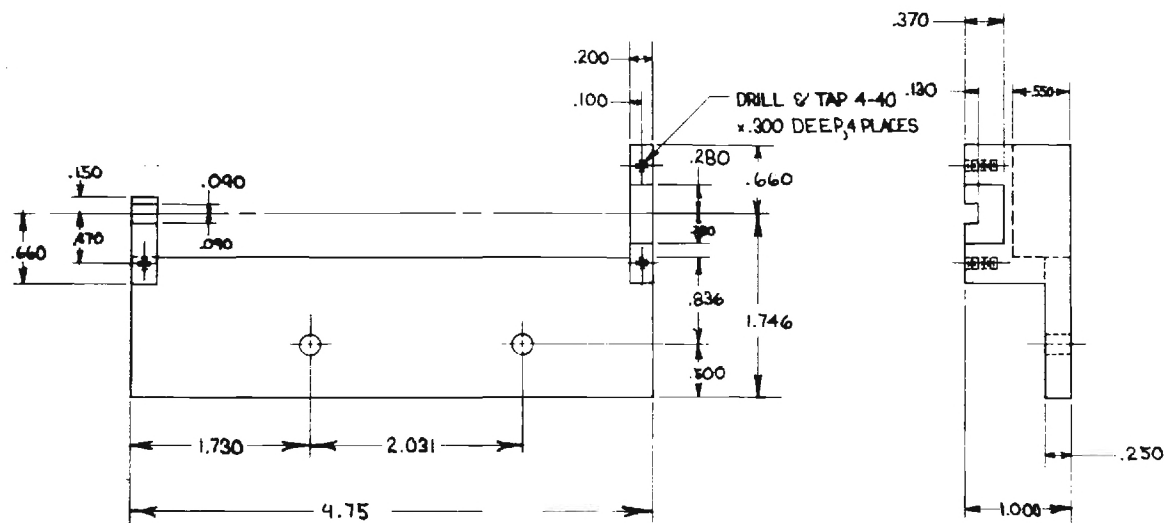


NOTES:
1. MODIFY EXISTING PART (DWG. NO.
SK-1866-018)

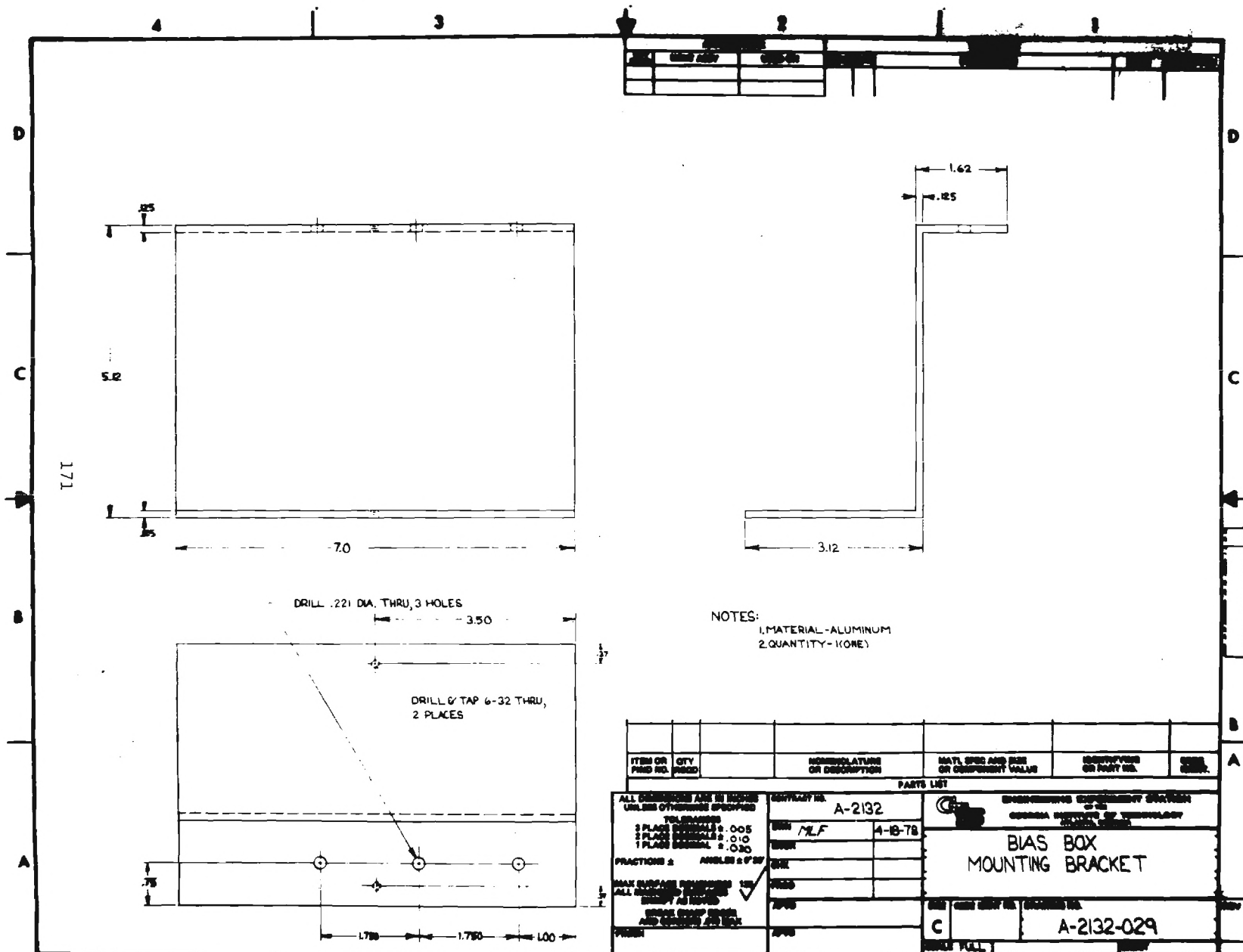
ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA			
HOT LOAD MODIFICATION			
NO.	DESCRIPTION OF CHANGE	ENL.	DATE
A	HOLE RELOCATIONS		
B	45° CUT TO CORNER		
SCALE: 1" = 1"		DATE: 4/10/78	
CONTRACT NO.		DRAWING NO. A2132-023	
PROJECT NO.		DR. RLR ENGR. CH. APP.	

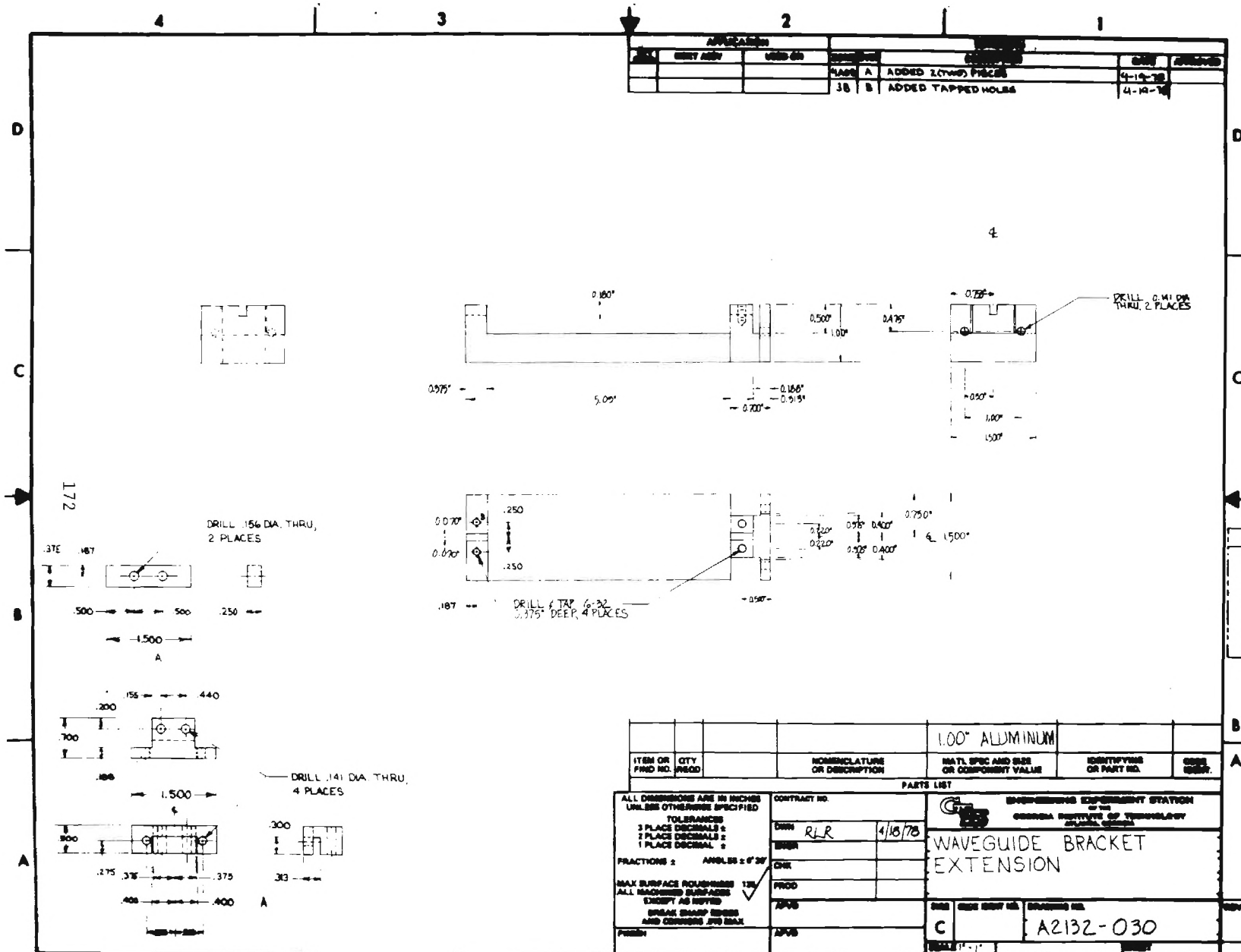
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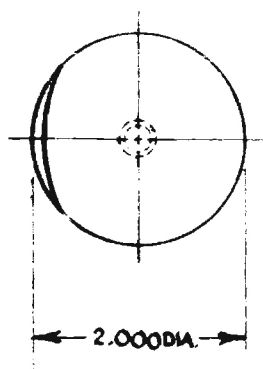
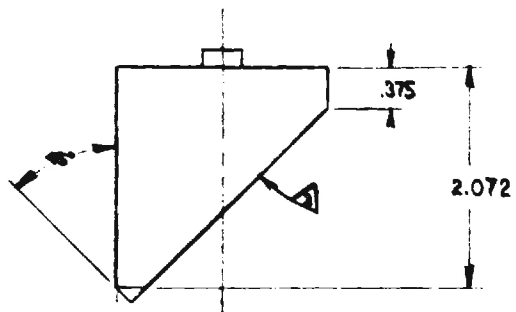
170



				ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA	
				WAVEGUIDE BRACKET	
B		MLF	5-18-78		
A	REDRAWN	MLF	5-9-78		
NO.	DESCRIPTION OF CHANGE	EN.	DATE		
SCALE: FULL		DATE: 5-9-78		EN. MLF	
CONTRACT NO.		PROJECT NO. A-2132		DRAWING NO. A-2132-027	
				ENR. EN. APP.	



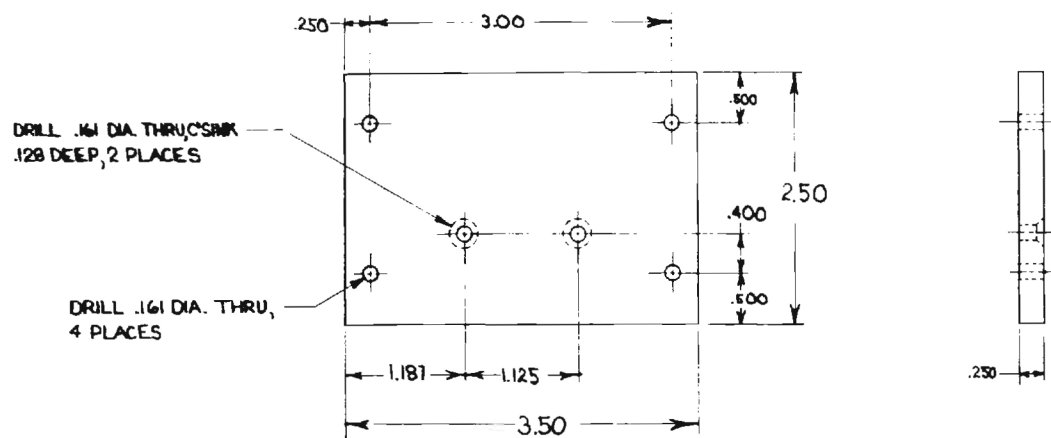




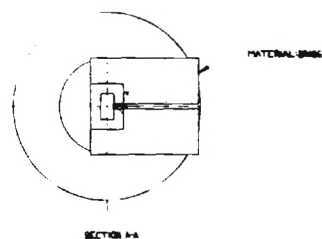
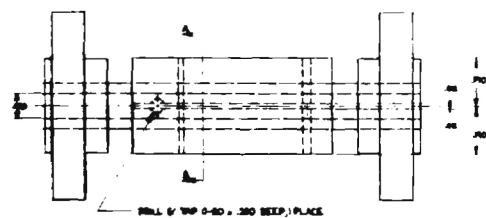
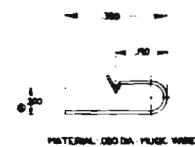
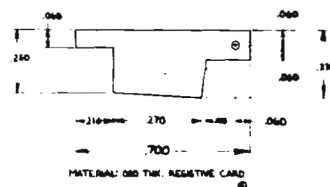
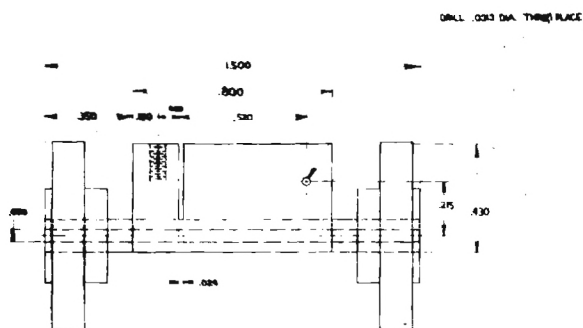
NOTES:

1. TOLERANCES - $\pm .002$
2. MODIFY EXISTING PART (DWG. NO. SK-1866-006)
3. MIRROR SURFACE MUST BE PROTECTED

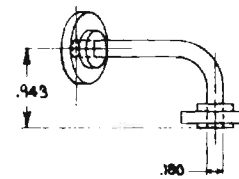
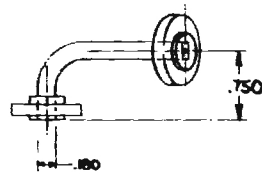
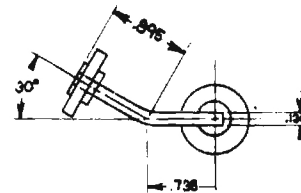
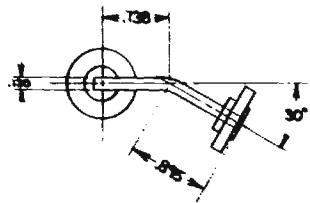
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				MODIFICATION OF ROTATING MIRROR	
NO.	DESCRIPTION OF CHANGE	CH.	DATE	DR. MLF	DRAWING NO.
SCALE	FULL	DATE	5-9-78	ENGR.	A-2132-033
CONTRACT NO. A-2132				CH.	
PROJECT NO.				APP.	



				ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA	
				TRIPLEXER MOUNTING PLATE	
NO.	DESCRIPTION OF CHANGE	CH.	DATE		
SCALE: FULL		DATE: 5-8-78		DR. MLF	
CONTRACT NO.				REVIS.	
PROJECT NO. A-2132				CH.	
				APP.	
				DRAWING NO. A-2132-034	

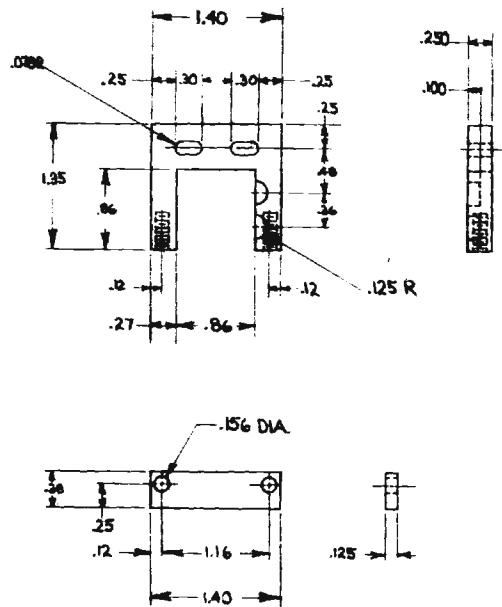


FORM NO. 104 REV. 6-6		INVESTIGATION OF DISSEMINATION		MULTI-SITE AND/OR INTERAGENCY WORK		INVESTIGATOR		DATE	
PARTY LIST									
ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED DATE 10-10-2001 BY 60322 UCBAW/STP						DOMESTIC SECURITY DIVISION FEDERAL BUREAU OF INVESTIGATION U.S. DEPARTMENT OF JUSTICE			
1. NAME: [REDACTED] 2. ADDRESS: [REDACTED] 3. PHONE: [REDACTED] 4. OCCUPATION: [REDACTED]				5. DATE OF BIRTH: [REDACTED] 6. SEX: [REDACTED] 7. RACE: [REDACTED] 8. HEIGHT: [REDACTED] 9. WEIGHT: [REDACTED] 10. EYES: [REDACTED] 11. HAIR: [REDACTED] 12. SKIN: [REDACTED]		13. DATE OF INTERVIEW: [REDACTED] 14. INTERVIEWER: [REDACTED] 15. DATE OF REPORT: [REDACTED] 16. REPORTER: [REDACTED]			
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				ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA	
				SPECIAL WAVEGUIDE BENDS	
NO.	DESCRIPTION OF CHANGE	BY	DATE		
SCALE	FULL	DATE	5-11-78		
DRAWING NO.		A-2132		DRAWING NO.	
PROJECT NO.				A-2132-036	

177



				ENGINEERING EXPERIMENT STATION OF THE GEORGIA INSTITUTE OF TECHNOLOGY ATLANTA, GEORGIA	
				MIXER BRACKET	
NO.	DESCRIPTION OF CHANGE	BY	DATE		
1	FULL	5-30-78			
PROJECT NO. A-2132				DR. T. F. F.	DRAWING NO. A-2132-044

APPENDIX D

SEASAT GULF OF ALASKA EXPERIMENT PLAN



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

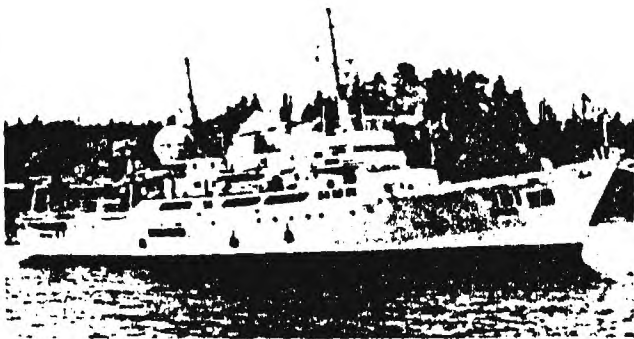


Figure 3-1. The OSS Oceanographer

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.

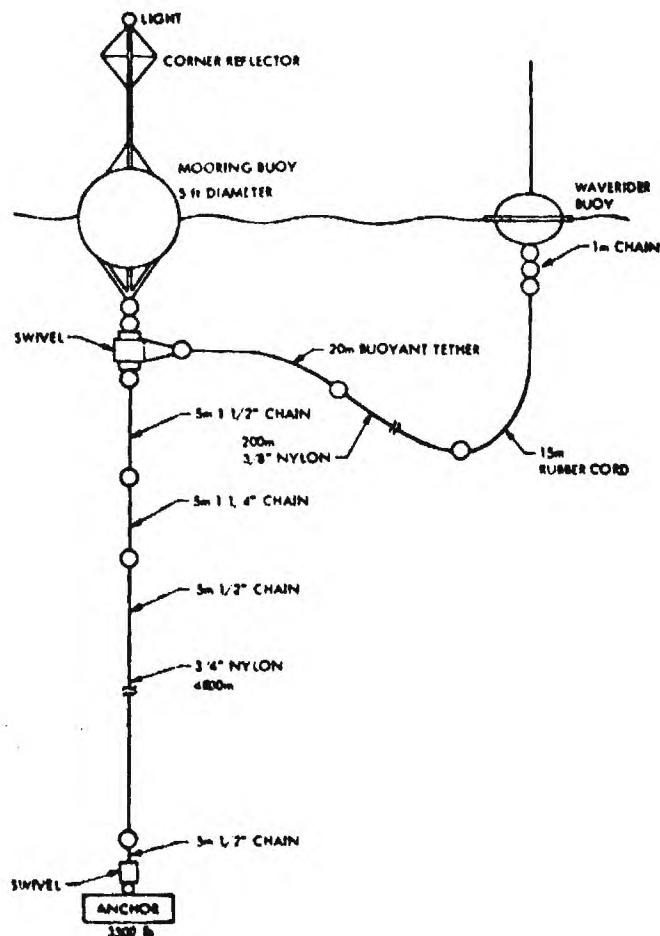


Figure 3-2. Waverider Buoy Mooring Configuration

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

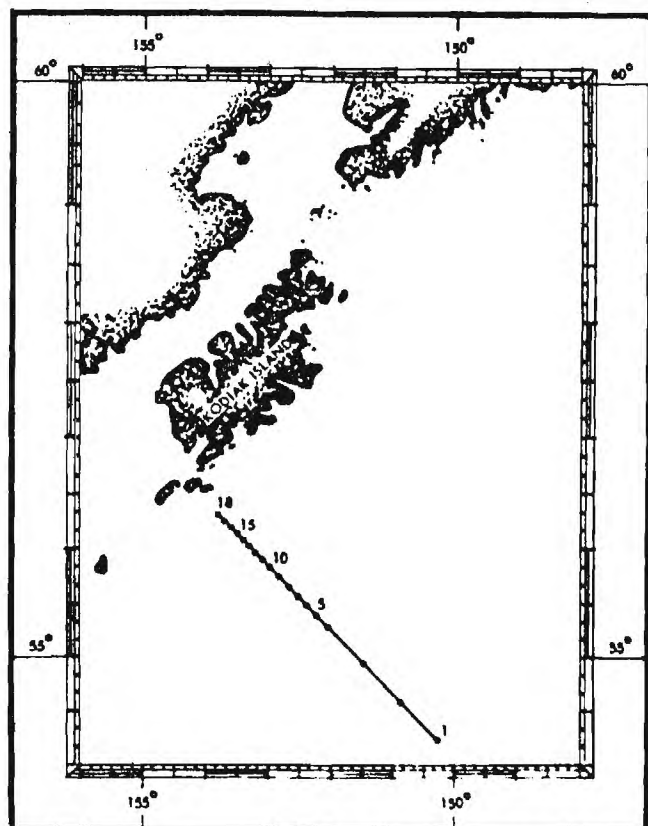


Figure 3-3. CTD Stations - Section 1

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'

should provide sufficient information to describe the large-scale field of motion and the sea level slope in the region.

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

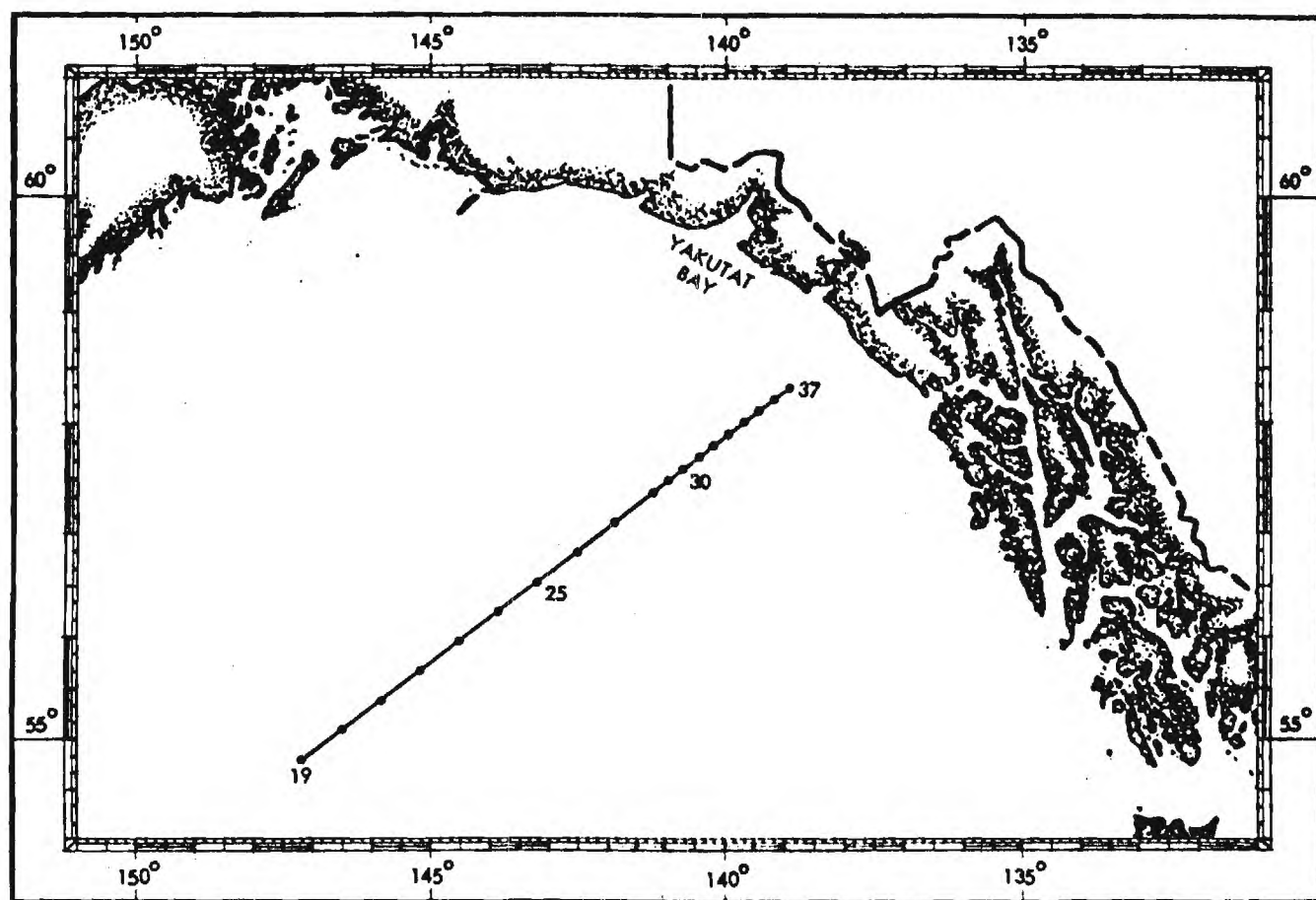


Figure 3-4. CTD Stations — Section 2

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 |

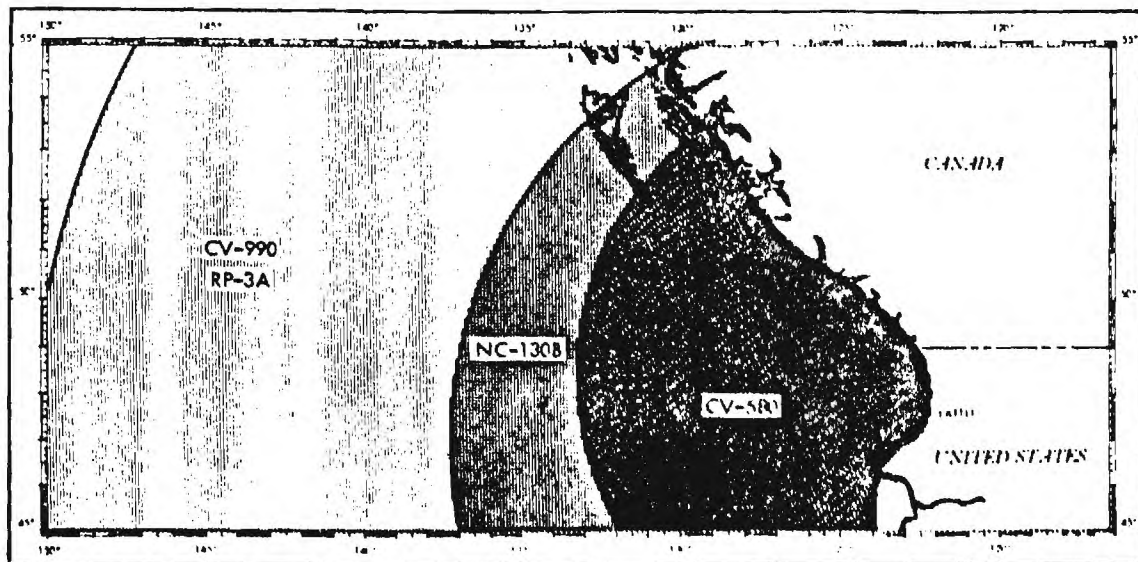


Figure 3-5. Aircraft Operating Regions

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



Figure 4-12. NASA CV-990A

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.

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

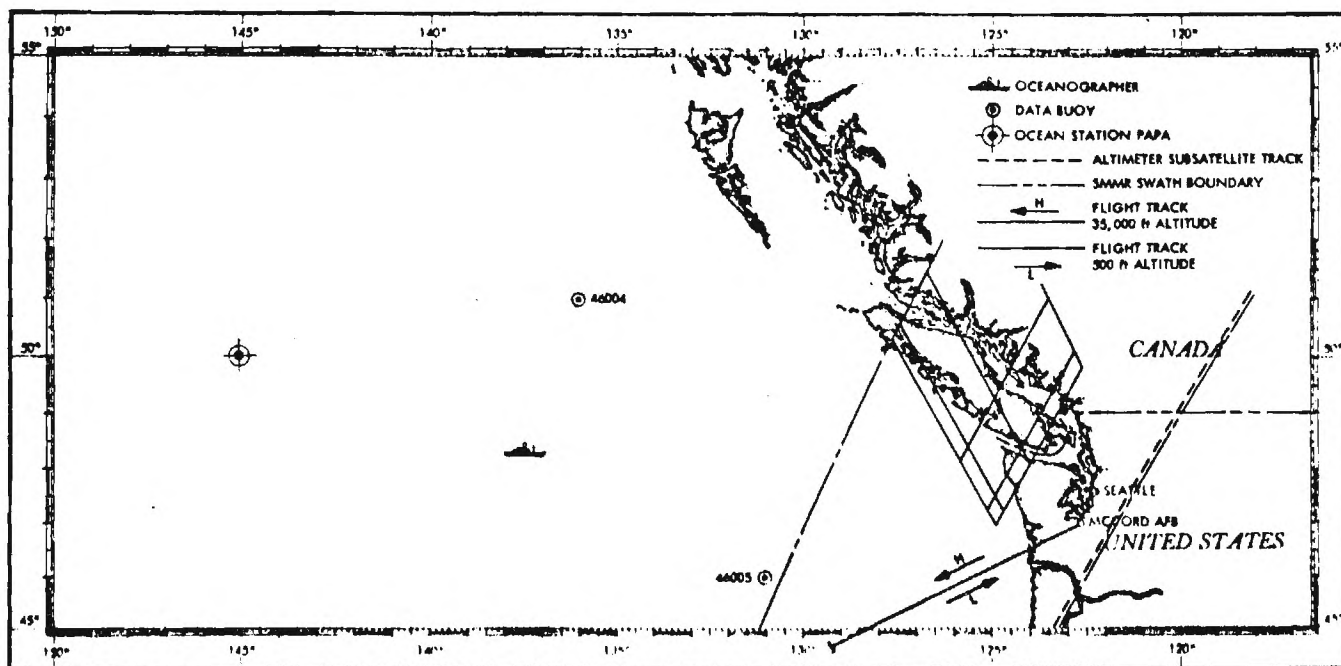


Figure 4-13. Flight Plan for CV-990A, Option 1

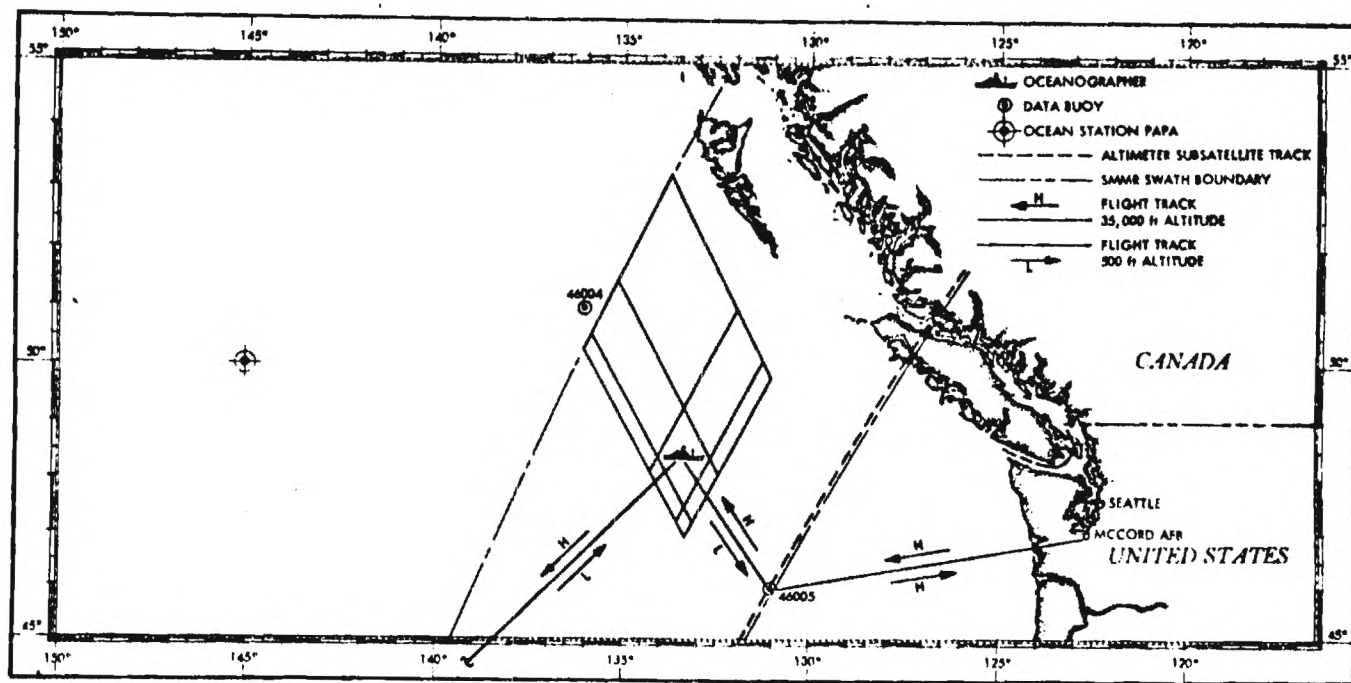


Figure 4-14. Flight Plan for CV-990A, Option 2

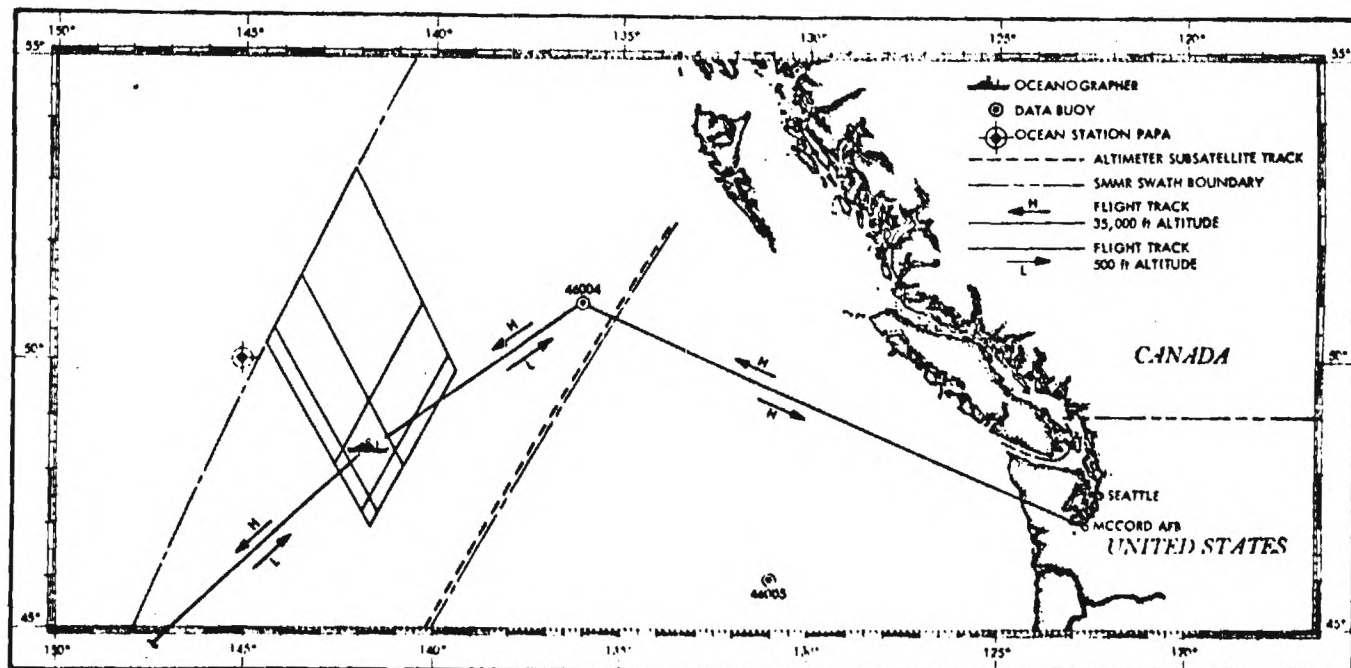


Figure 4-15. Flight Plan for CV-990A, Option 3

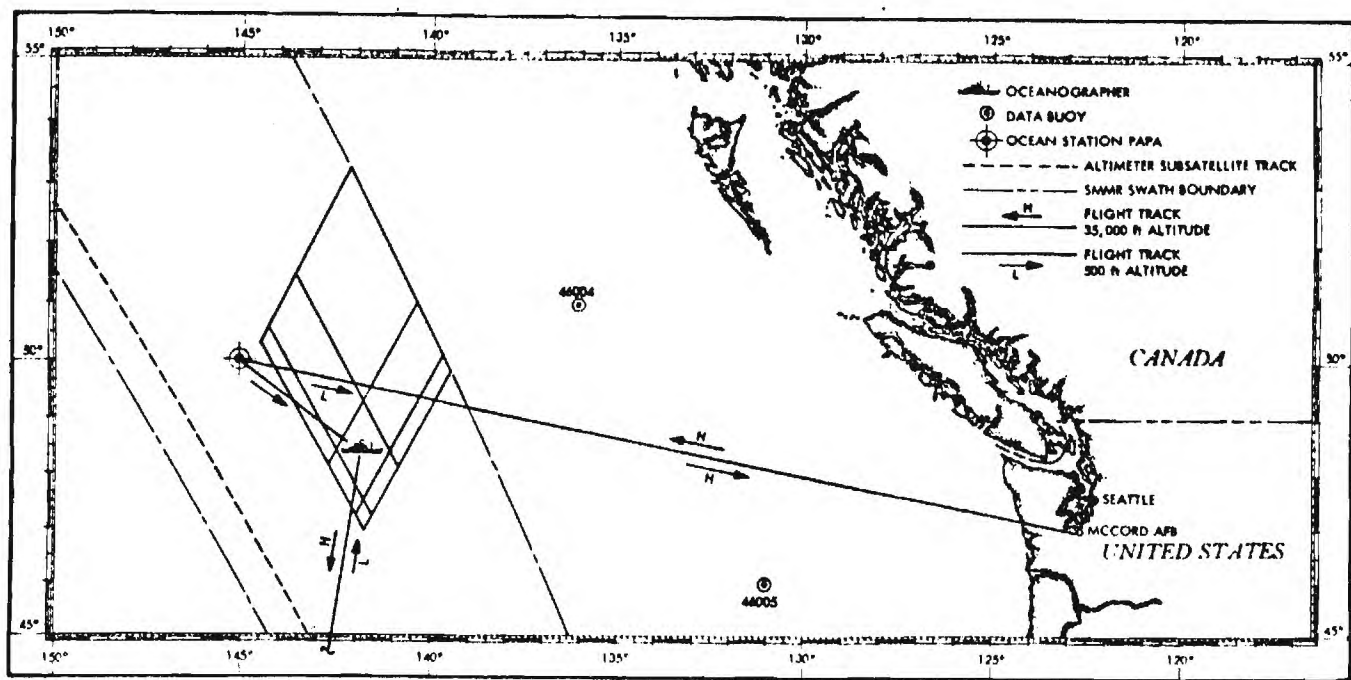


Figure 4-16. Flight Plan for CV-990A, Option 4

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.

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.

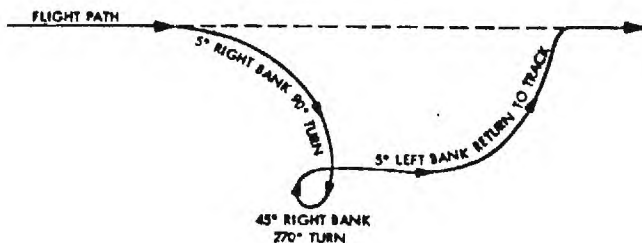


Figure 4-17. Inertial Navigation System Calibration Maneuver

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.

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,

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

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

Ames Research Center
Moffett Field, California
94035

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 overflowed 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):

<u>Flight #</u>	<u>October</u>	
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.
	<u>November</u>	
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.

<u>Flight #</u>	<u>November</u>	
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.

<u>Flight #</u>	<u>November</u>	
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 Alaska, 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

Distribution:
Attached

DISTRIBUTION LIST

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Ottawa, Canada

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Bergen, Norway

O. Johonnessen

APPENDIX F

CALIBRATION ERROR CORRECTION

PROBLEM

Warmer temperatures ($\sim 30^\circ\text{K}$) 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 $\sim 100^\circ\text{K}$.

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,

$$\begin{aligned}\text{Observed Gain} &= \frac{336^{\circ}\text{K} - 260^{\circ}\text{K}}{8.44\text{v} - 7.24\text{v}} \\ &= 63.33^{\circ}\text{K per volt} .\end{aligned}$$

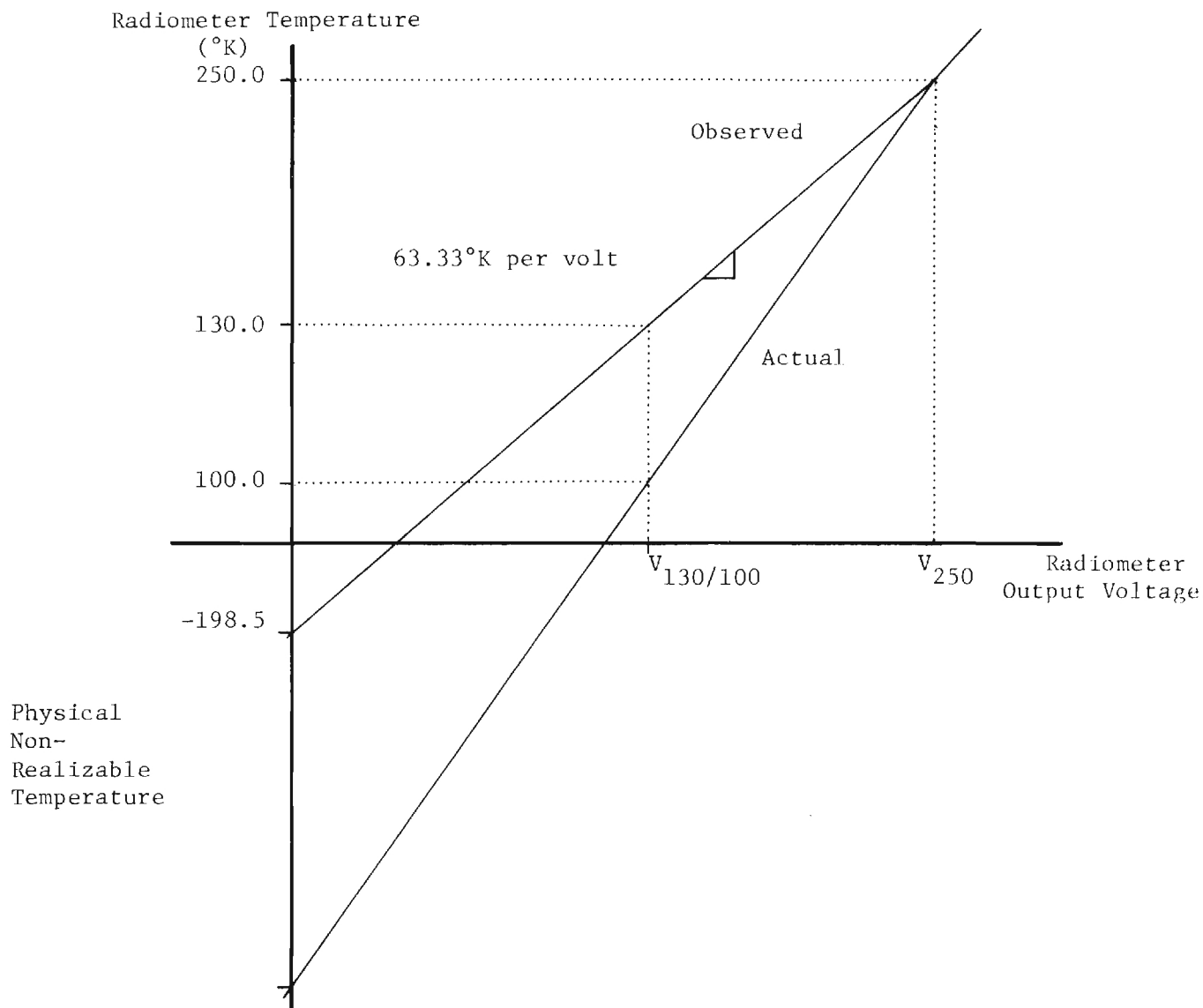
Using Equation [B] on Figure F1,

$$\begin{aligned}\text{Observed Output} &= 336^{\circ}\text{K} - (8.44\text{v})(63.33^{\circ}\text{K per volt}) \\ &= -198.5^{\circ}\text{K}\end{aligned}$$

Using Equation [C] on Figure F1,

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

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}).



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

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

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

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,

$$\begin{aligned}\text{Actual Gain} &= \frac{250^{\circ}\text{K} - 100^{\circ}\text{K}}{7.08\text{v} - 5.19\text{v}} \\ &= 79.37^{\circ}\text{K per volt}\end{aligned}$$

Using Equation [B] on Figure F1,

$$\begin{aligned}\text{Actual Offset} &= 250^{\circ}\text{K} - (7.08\text{v})(79.37^{\circ}\text{K per volt}) \\ &= -311.9^{\circ}\text{K}\end{aligned}$$

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

Using Equation [D],

$$\text{Actual Temperature} = (79.37^{\circ}\text{K per volt})(\text{Observed Output Voltage}) - 311.9^{\circ}\text{K}$$

Typical temperatures are tabulated below for output voltages observed.

<u>Observed Output (volts)</u>	<u>Actual Radiometer Temperature (°K)</u>
+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 ANSI 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 ANSI 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 ANSI 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.

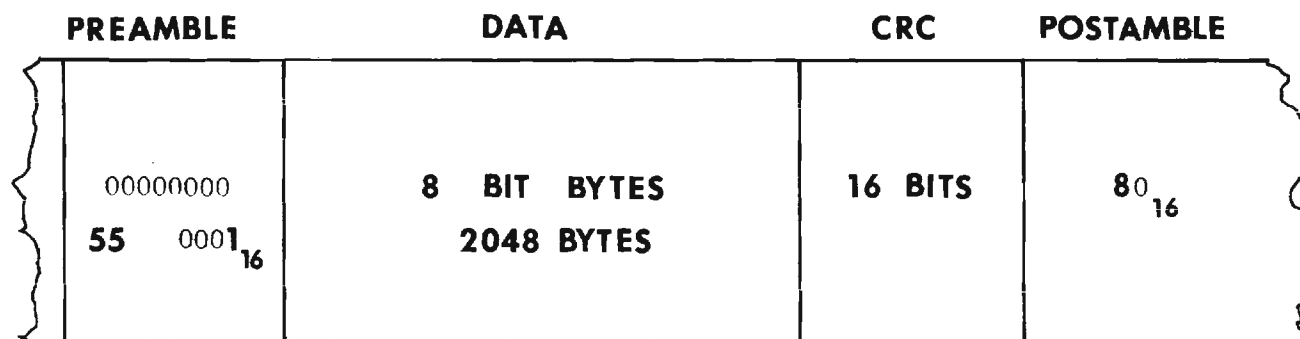


Figure G1. Magnetic Cartridge Tape Format.

TABLE G1
CONVAIR 990 183/94 GHz RADIOMETER DATA BLOCK FORMAT

<u>BYTE NO.</u>	<u>CONTENTS</u>	<u>COMMENT</u>
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

<u>BYTE NO.</u>	<u>CONTENTS</u>	<u>COMMENT</u>
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

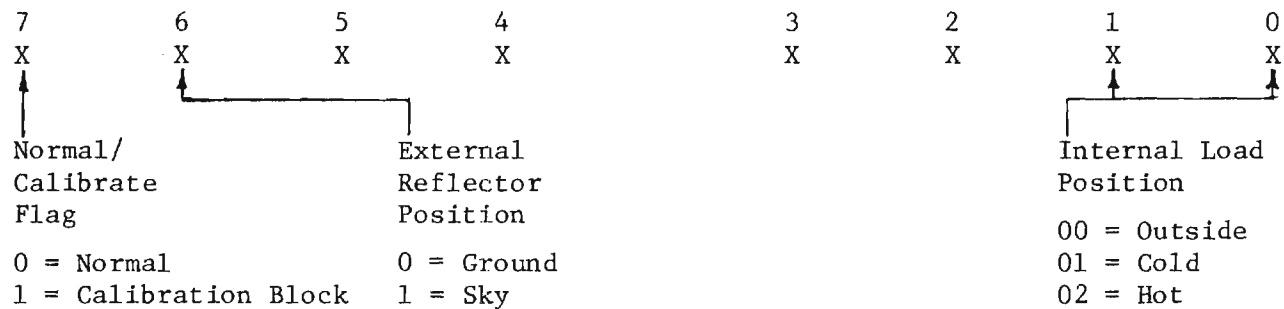
This byte indicates where the radiometer was looking during a particular block. Table G2 illustrates possible values of block ID and their meaning. Note that during normal operation a block ID of 80_{16} indicates a calibration block containing hot load, cold load and "outside" temperature data.

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 desirable 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 = $05D8_{16} = 1496$

$1496 \times 2.44 \text{ mV/BIT} = 3.65 \text{ Volts}$

$(3.65 \text{ Volts} \times -10 \text{ °K/Volt}) + 373\text{°K} = 336.5\text{°K}$

```

00 05 02 78 17 23 28 57 00 05 08 07 51 0B 72 09
8D 08 4A 0A F5 0B 8B 0B 05 09 3D 0A EC 0B 84 0A
FL 09 39 0A E4 0B 8D 0A F9 09 3B 0A EA 0B 85 0A
F9 09 3A 0A F8 0B 8A 0A F3 09 3D 0A F0 0B 83 0A
F3 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 3A 0A DE 0B 85 0B
1F 09 37 0A DA 0B 8A 0B 1A 09 3B 0A 15 0B 8A 0B
1B 09 3B 0A D1 0B 8A 0B 10 09 3B 0A 85 0B 8F 0B
07 09 3C 0A D2 0B 8A 0B 05 09 3B 0A AD 0B 87 0B
05 09 3B 0A D1 0B 85 0B 0A 09 39 0A F2 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 D2 0B 85 0B
02 09 3B 0A C1 0B 8D 0A FE 09 3A 0A DE 0B 83 0B
09 09 3B 0A DA 0B 81 0B 0C 09 35 0A E5 0B 8A 0B
0D 09 37 0A F4 0B 85 0B 09 09 3B 0A F7 0B 83 0B
09 09 3B 0A FB 0B 85 0B 01 09 3B 0A F8 0B 8B 0A
FF 09 3A 0A FE 0B 86 0B 0A 09 3A 0A F2 0B 8A 0B
0A 09 39 0A D0 0B 87 0B 0A 09 3B 0A B8 0B 8A 0B
05 09 3C 0A BA 0B 84 0B 0B 09 3D 0A BA 0B 83 0B
0B 09 3D 0A BC 0B 8A 0B 05 09 3C 0A BA 0B 83 0B
01 09 3D 0A BA 0B 83 0B 02 09 3E 0A C0 0B 81 0B
0A 09 3B 0A D0 0B 81 0B 0C 09 3E 0A BE 0B 82 0B
0E 09 3C 0A BC 0B 82 0B 0A 09 3F 0A DF 0B 83 0B
0A 09 3B 0A E3 0B 85 0A 1C 09 3B 0A E1 0B 81 0A
F9 09 39 0A F2 0B 86 0A F9 09 3A 0A DF 0B 84 0A
FF 09 3A 0A DE 0B 84 0B 03 09 3B 0A E1 0B 83 0B

```

BLOCK NUMBER: 0005

JULIAN DATE: 278

FLIGHT NUMBER: 17

TIME (GMT): 23:28:57

BLOCK ID: 00

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

Cold Load Voltage: $0751_{16} = 1873 \times 2.44 \text{ mV/BIT} = 4.57 \text{ Volts}$

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

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

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

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})

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

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

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

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 Hurricane Cora	16:08:59	Take Off
			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-Homestead	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
				descent 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° W0 looking at sky
				Saw temperature rise on 183 GHz, left spiral
			6:39:30	Fly at low altitude (1,000 feet)
			7:11:00	Switch Radiometer to viewing ground
				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
12 A,B	9/14/78	Moffett-McCord	8:59:30	Data collection off. Tape status: Track 01, Block 00
			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
13	9/15/78	McCord-McCord	Before Takoff	Terminal is repaired, no problems
			04:40:10	Data collection on, data tape #5, looking down
			05:13:10	Radar shows rain
			05:34:00	Going through thick clouds, data plot, no RFI interference
			06:27:37	30° roll left looking down
			06:32:30	Switch to look up at sky
			06:48:34	Begin spiral descent into 20% cloud cover from 31,000 feet, left bank 90° WO
			06:49:38	Begin left bank spiral at 30° roll tape track 00, block 0120
			06:58:00	Looking up at 1,000 feet
			07:07:00	Pass under rain cell
			07:13:29	Rain
			07:34:00	Rain, very intense
			07:41:30	Rain
			07:55:30	Rain, very intense
			08:50:50	Look at ground
			09:13:15	Data collection off, track 01, block 012D
17	10/5/78	Hurricane Rosa Moffet-San Diego-Rosa	14:10:07	Take off, return to Moffett, nose gear is stuck. No data, bad line-feed solenoid in terminal, rubber-band repair works
			19:40:39	Take off #2, using tape #5, track 2
			19:50:00	Power dropped, restart system
			20:25:00	Gain of 94 GHz is 254, tried adjusting video gain, shut down

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
				<u>94 GHz</u> <u>183/1 GHz</u> <u>183/5 GHz</u> <u>183/10 GHz</u>
				30° 62° 50° 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
<u>NIMBUS-G FLIGHTS</u>				
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 W0
			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	W0 at 88°, look at sky, 94 GHz = 29° low temperature
			18:15:00	Switch radiometer to look at ground altitude 500 feet
05	10/29/78	Thule-Thule	19:48:00	Shut off front-end, last data block track 02, block 004A
			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 W0
			17:04:00	Calibrate
			17:05:00	Start left W0, 30°K temperature
			17:06:00	Start right W0, 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 W0, 45°, Temperature drops to 90°
			16:53:45	System bombs, back on, block 48
			17:42:00	Switch to sky to prepare for W0
			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	Bodo-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)
			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
			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 W0
			21:47:45	W0 Temperature = 24°C
14	11/11/78	Fairbanks to Fairbanks		Voltage = 8 volts
				Gain = -51.75
				Offset = 396.85°K
			21:11:44	System down for landing
			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 W0. Switch to looking up.
			23:40:46	W0. 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.
16	11/13/78	Fairbanks to Hilo		W0 (Up looking).
			19:50:00	Take off.
			02:17:00	Tape #9. Start on track 01. 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

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