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DATA USERS' NOTES

The University of Michigan Radio Astronomy Experiment Aboard the OGO-V Spacecraft

Technical Report
NASA Contract NAS5-9099

Submitted by:

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April 20, 1970

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TABLE OF CONTENTS

INCLUDED DOCUMENTS:

A. INSTRUMENTATION FOR RADIO ASTRONOMY MEASUREMENTS ABOARD THE OGO-V SPACECRAFT (B. D. MacRae) (the final engineering report)

B. Data Logger (D. R. McCreery and W. H. Potter)

LIST OF ILLUSTRATIONS

I. INTRODUCTION

The purpose of this report is to serve as a Users' Guide for the study of the 35 mm film containing plots of data from experiment 20 aboard the OGO-V spacecraft. The memo itself is not detailed in any areas which are covered by existing documents. It will, however, expand on pertinent areas that are not explained elsewhere. Work on the data processing and analysis has been supported under NASA Contract NAS5-9099.

The primary reference document is the final engineering report, which is included. It supercedes an earlier instrument report (OGO-V Instrument Report, B. G. Finch and B. D. MacRae, 1966), which was written and submitted to NASA according to the original contract stipulations. A description of the Data Logger facility used for the calibration is also included.

Reports on the data processing software together with program listings are included in Appendices D and E.

The interpretation of the data is still being carried out, with final results yet to be published. An early result, published in "Sky and Telescope" in October 1968, is included in Appendix B.

Section II contains general information concerning the instrument, launch, operation, and objectives.

Section III contains calibration curves and correction factors, with a general outline of the preflight calibration procedure. A more detailed report is given in the final engineering report, pp 32-37 (Included Document A).

Section IV describes the data acquisition methods and the format of the reduced data both on 35 mm film and on CalComp plots (California Computer Products incremental plotter).

II. GENERAL DESCRIPTION

A. OGO-V INSTRUMENT DESCRIPTION

The low-frequency radiometer built by the Radio Astronomy Observatory for the OGO-V satellite consists of a stepping superheterodyne receiver with a center frequency tunable from 50 kHz to 3.5 MHz in eight discrete steps: 50 kHz, 100 kHz, 200 kHz, 350 kHz, 600 kHz, 900 kHz, 1.8 MHz, and 3.5 MHz. An alternate mode of operation is the nonstepping mode, in which observations are made at a single frequency selected from the eight available. This mode gives a time resolution at the selected frequency which is eight times that available in the stepping mode. The receiver bandwidth is 10 kHz and the post-detection filter time constant is 0.21 sec.

The antenna is a 30 ft long, 0.5 in. diameter self-erecting monopole mounted on the outer end of a solar array and, when deployed, extending out in the +X direction.

B. SPACECRAFT HISTORY

The OGO-V instrument package was successfully launched on board the OGO-V spacecraft on 4 March 1968 from the Eastern Test Range at Cape Kennedy, Florida. Soon after the launch the highly elliptical orbit had the following parameters: perigee 292 km; apogee 147,000 km; inclination to the equator 31°; period 63 hr, 25 minutes. The Radio Astronomy instrument was turned on soon after launch and operated normally. The antenna was deployed on the fourth revolution at 1825 U.T., 14 March 1968. On 3 April 1968 the wideband "A" transmitter failed causing the playback coverage to drop from the planned 100% to less than 45%. To compensate for this failure, the real time data coverage was increased but not enough to result in 100% coverage at the 1 kilobit/sec (kbs) data rate.

During the period 24 April to 18 June 1968 the radiometer operated in a nonstepping mode, at 3.5 MHz.

Operations for the rest of 1968 and most of 1969 continued normally, with two exceptions. These two exceptions were two "spin periods" into which the spacecraft was commanded for two days each in September and December 1969. During these spin periods, 12-14 September and 15-17 December 1969, the radiometer was fixed at a frequency of 600 kHz.

C. SCIENTIFIC OBJECTIVES

There are two principal scientific objectives of the OGO-V experiment:

1. To measure radio emission from the sun and Jupiter at each of the eight frequencies. Ground based observations have detected such emission at frequencies as low as 5.0 MHz. The OGO-I and OGO-III experiments detected and measured many bursts at frequencies as low as 2.0 MHz. The OGO-V experiment will extend the frequency range to 50 kHz. Distrubances in the solar corona at distances up to and beyond the planet Mercury are thought to cause the solar bursts. The mechanisms for the Jovian bursts are not yet well determined. Measurements at the low frequencies will add more insight into the processes of the production of these bursts.

2. To measure the relative average level of cosmic background radiation at each of the eight frequencies. This will extend the existing low-frequency measurements by a factor of four. The low values of the measured electron densities in the vicinity of the OGO-V orbit suggest that observations of the cosmic background radiation on all channels may be attainable.

III. PREFLIGHT CALIBRATION

As explained in the final engineering report, pp 32-37, the preflight calibration of the OGO-V radiometer can be divided into three categories:

1. determining the input impedance of the radiometer at the eight operating frequencies,
2. determining the noise parameters at the eight operating frequencies,
3. measuring the overall system response.

Each of these three categories will now be explained further.

In Table I, the components of the input impedance of the radiometer as measured on a Wayne-Kerr impedance bridge are given for each of the eight frequencies.

TABLE I

RADIOMETER INPUT IMPEDANCE

FREQUENCY	R_s	C_s
50 kHz	105. kΩ	33.8 pf
100 kHz	122.	27.2
200 kHz	88.2	24.4
350 kHz	87.7	24.2
600 kHz	92.3	24.2
900 kHz	102.	24.2
1.8 MHz	560.	24.2
3.5 MHz	1. MΩ	25.0

R_s = Shunt resistive component of the preamplifier input impedance

C_s = Shunt capacitive component of the preamplifier input impedance

It was found that the dummy antenna used in the OGO-V preflight calibration did not satisfactorily represent the antenna used in flight (see Appendix A). The corrections that should be applied to the radiometer calibration data - in free space - to account for the differences between the calibration transfer function and the actual transfer function are listed in Table II. The correction factors are applied by multiplying the RT products of the radiometer dynamic response curve (one for each frequency) by the correction factors.

TABLE II

CORRECTION FACTORS FOR ALL EIGHT FREQUENCIES

FREQUENCY	CORRECTION FACTOR
50 kHz	1.206
100	1.128
200	1.107
350	1.099
600	1.089
900	1.097
1.8 MHz	1.097
3.5 MHz	1.104

In Table III are given the values of the parameters F_o, B_o, G_o, R_n which define the noise performance of the radiometer at each of the eight operating frequencies.

TABLE III

NOISE PARAMETERS FOR ALL EIGHT FREQUENCIES

Frequency	F_o	B_o (mhos)	G_o (mhos)	R_n (ohms)
50 kHz	1.8[illegible]	-0.023×10^{-3}	0.113×10^{-3}	3083.
100 kHz	2.66	-0.023×10^{-3}	0.312×10^{-3}	2510.
200 kHz	1.73	-0.052×10^{-3}	0.121×10^{-3}	2387.
350 kHz	1.65	-0.066×10^{-3}	0.110×10^{-3}	2370.
600 kHz	1.68	-0.107×10^{-3}	0.117×10^{-3}	2397.
900 kHz	1.82	-0.176×10^{-3}	0.157×10^{-3}	2282.
1.8 MHz	2.08	-0.326×10^{-3}	0.227×10^{-3}	2418.
3.5 MHz	2.36	-0.457×10^{-3}	0.240×10^{-3}	2320.

The overall system response throughout the anticipated temperature and input signal operating ranges was determined during the preflight calibration.

There were eleven parameters measured. These were:

1. radiometer output,
2. supply voltage,
3. 18 volt monitor,
4. frequency ID,
5. noise diode current,
6. detector bias voltage,
7. mixer zener voltage,
8. noise diode temperature,
9. regulator temperature,
10. preamp zener voltage,
11 IF zener voltage.

All eleven parameters were measured at five spacecraft supply voltages using four internal noise calibration levels and at one supply voltage using eighty-two different external noise voltage levels for each of the eight frequencies and for seventeen temperatures, from -20°C to +60°C in 5°C increments. These measurements were made with the University of Michigan Radio Astronomy Observatory (UM/RAO) Data Logger facility which operated the radiometer in an automatic mode and wrote the output voltages in digital form on magnetic tape. (See the Data Logger Report for a description of the Data Logger Facility. It is INCLUDED DOCUMENT B in this report).

The calibration output voltages were recorded on a magnetic tape, with each file containing the data from one temperature. This tape was then processed on an XDS 930 computer to produce a print out of all the output voltages for each of the eleven channels. In addition, a set of CalComp plots was made of the characteristic (dynamic) curves for each radiometer frequency at any selected temperatures. A sample set of characteristic response curves is given in Figure 1

For the actual data reduction procedure, a mean curve was drawn for each frequency. Each of these mean curves lies between the lowest and the highest values given by the curves for the temperatures -15°C, +5°C, and +30°C. The values for these mean curves are given in Table IV.

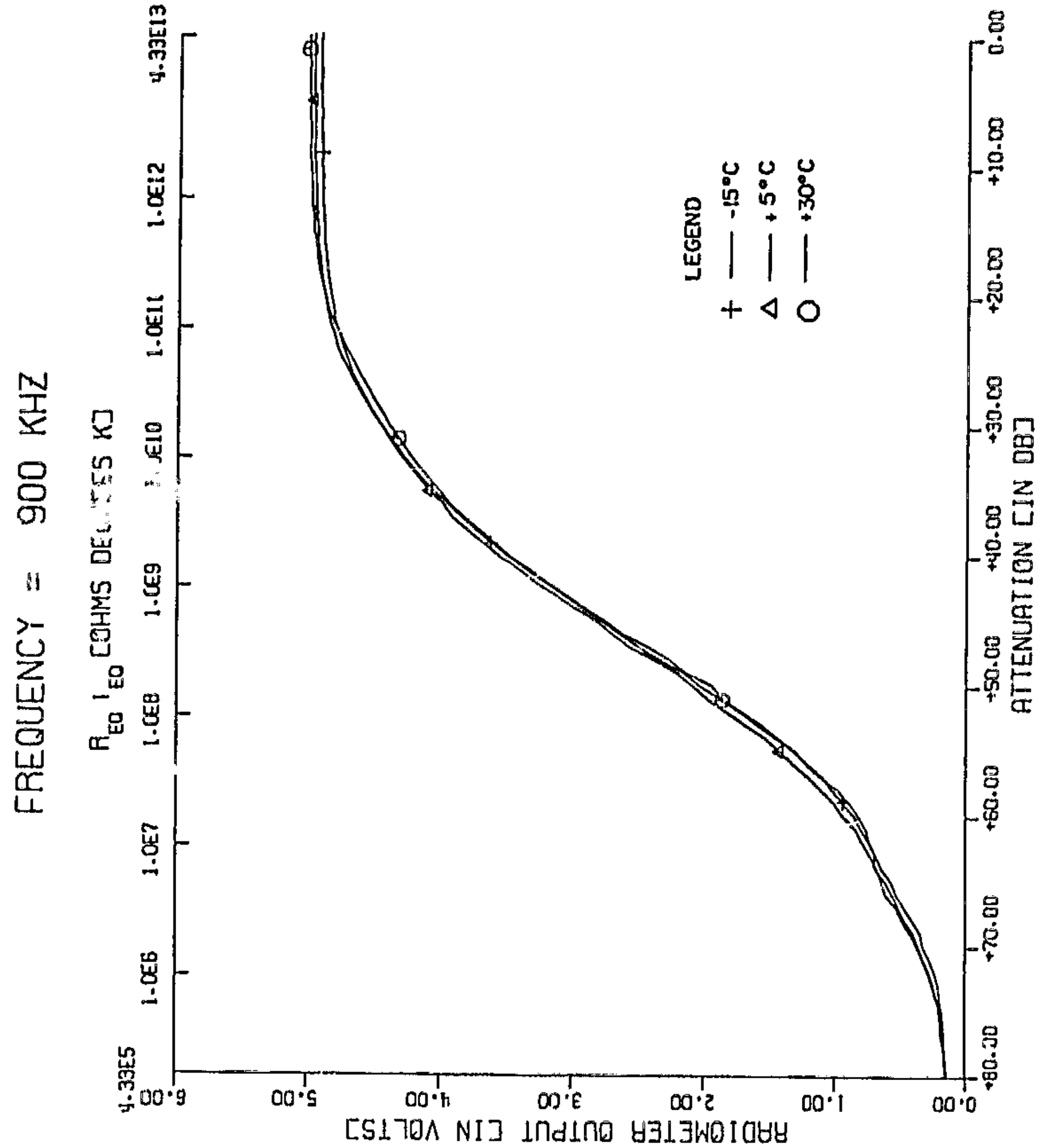

Figure 1. Preflight Calibration Response Plot

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TABLE IV

MEAN RADIOMETER RESPONSE OUTPUT VOLTAGE
VS ANTENNA TR PRODUCT
(CORRECTION FACTORS APPLIED)

RT	MHz Voltage 3.5	MHz Voltage 1.8	kHz Voltage 900	kHz Voltage 600	kHz Voltage 350	kHz Voltage 200	kHz Voltage 100	kHz Voltage 50
4×10^{13}	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
10^{13}	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98
4×10^{12}	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96
10^{12}	4.91	4.92	4.92	4.92	4.91	4.91	4.91	4.91
4×10^{11}	4.81	4.83	4.82	4.82	4.85	4.82	4.82	4.80
10^{11}	4.55	4.60	4.60	4.60	4.61	4.59	4.58	4.53
4×10^{10}	4.35	4.40	4.38	4.35	4.39	4.36	4.36	4.29
10^{10}	3.80	3.90	3.88	3.85	3.91	3.85	3.86	3.75
4×10^{9}	3.35	3.45	3.45	3.42	3.46	3.40	3.39	3.28
2×10^{9}	2.95	3.10	3.05	3.02	3.09	3.00	3.02	2.90
10^{9}	2.55	2.67	2.65	2.62	2.70	2.60	2.62	2.52
4×10^{8}	2.05	2.16	2.12	2.11	2.15	2.10	2.10	2.06
10^{8}	1.40	1.50	1.45	1.45	1.47	1.43	1.52	1.49
4×10^{7}	1.10	1.15	1.12	1.10	1.15	1.11	1.24	1.24
10^{7}	0.75	0.78	0.73	0.65	0.72	0.72	0.96	1.02
4×10^{6}	0.60	0.60	0.52	0.45	0.52	0.54	0.80	0.96
10^{6}	0.45	0.40	0.30	0.27	0.32	0.42	0.65	0.92

IV. DATA DESCRIPTION

A. DATA ACQUISITION

The data from the OGO-V experiment was collected by eight Goddard Space Flight Center (GSFC) ground stations and sent to GSFC, where decommutated data tapes were prepared for each experimenter. These decommutated data tapes contain words from the telemetry main frame as well as from subcommutators No. 1, 2, and 3. One frame of telemetry data consists of 128 9-bit words. Some of these words are devoted to housekeeping functions and spacecraft data handling ID words and also include two radiometer samples (main commutator words 77 and 125) as well as a frequency ID word (main commutator word 13).

The telemetry format for subcommutator No. 1 includes the eleven parameters measured during the preflight calibration process (see page 7). The main frame and subcommutator words are then merged by GSFC into one data record on the decommutated data tape. (See Appendix C for these data record formats. Also included in Appendix C is the location within an array in the 930 computer core of each of the words in the data record, the main frame telemetry format, and the subcommutator #1 telemetry format.)

For convenience, let "data sequence" refer to one occurrence of main com words 77 and 125, a time word, a frequency ID word, and the six other words which are related to the time word. There are then 128 data sequences per record (see Appendix C).

The data is of two types, real time and playback. The bit rates in use during real time transmissions were 1, 8, and 64 kbs, whereas onboard tape recorders recorded data at 1 kbs.

At the 1 kbs data rate, one data sequence occurs every 1.152 sec, with the radiometer stepping to the next frequency before the next data sequence. This results in a 9.216 sec interval between consecutive samples of the same main com word at one frequency. For 8 kbs data, there are eight data sequences in 1.152 sec and for 64 kbs data, there are 64 data sequences in the same time interval, resulting in an 8 and 64-fold increase in the amount of data that is received at these bit rates over that which is received at the 1 kbs rate for the same time interval.

Each decommutated data tape consists of up to fifteen real time data files or as many as forty playback data files. Each file begins with a label record, which is the same for all experimenters and contains information identifying the data records to follow. The data record formats vary for each experimenter. Our data records contain two radiometer output words (main commutator words 77 and 125) which are repeated 128 times per record, as well as eight experiment subcommutator words.

B. INSTRUMENT OUTPUT

The RAO instrument on the OGO-V spacecraft is designed to work over an 82 db dynamic range with a useful range of around 60 db, starting at an RT product of 0.5×10^5 ohm-degrees K, and producing a dc output signal of 0.0 - 5.1 volts. Eight bits are used per channel with 256 discrete output levels, resulting in a sensitivity of 0.02 volts per level.

C. DATA PROCESSING PLAN

The data we are submitting to the National Space Science Data Cent-r (NSSDC) consists of 35 mm film, produced in the "MONITORING" stage of processing. The format of this film, as well as that of supplementary CalComp plots of the same data, will now be explained.

1. 35 mm Film Format

The major stage of processing the OGO-V data is called the "Monitoring" stage and the software to handle the date is called the MONITOR program. The purpose of this stage is to scan and get a quick look at all the 1 kbs and at selected 8 kbs data, with detailed analyses of smaller portions of the data to be carried out in another phase.

This can be termed the mass batch processing phase. The input to the MONITOR program consists of the data tapes received from GSFC, as well as an optional second set of tapes containing attitude and orbit information. If the attitude-orbit (A/O) tapes had not arrived by the time we wished to process the raw data, then the processing went ahead without them.

The output of the MONITOR stage is 35 mm film containing plots of each of the eight frequencies in terms of voltage versus time. A sample piece of film is given in Figure 2, with Figure 3 showing the composition of each frame of film. All numbers in inches are given with respect to a 10 x 10-in. plotting area on the direct view CRT, which is ten times greater than the 1 x 1-in. plotting area on one frame of 35 mm film. One inch along the CRT ordinate equals two volts.

The OGO-V MONITOR program reads the GSFC data tape, unpacks each of the eight frequencies, converts each channel into display coordinates, transfers the data to the buffer core and then to the photographic CRT, where all eight channels are plotted simultaneously and are photographed on-line by the 35 mm automatic camera.

To the viewer it appears as though each frequency has its own origin, with the ordinate range 0.0-5.1 volts for each. In the program, however, there is just one origin, the lower left corner. The 50 kHz channel is plotted using the actual values from the data record; for the 100 kHz channel, 2.0 volts is added to each of the radiometer output samples before it is plotted; at 200 kHz, 4.0 volts is added to each radiometer output sample before

OGO-V MONITORING PROGRAM
SAMPLE 35 MM FILM

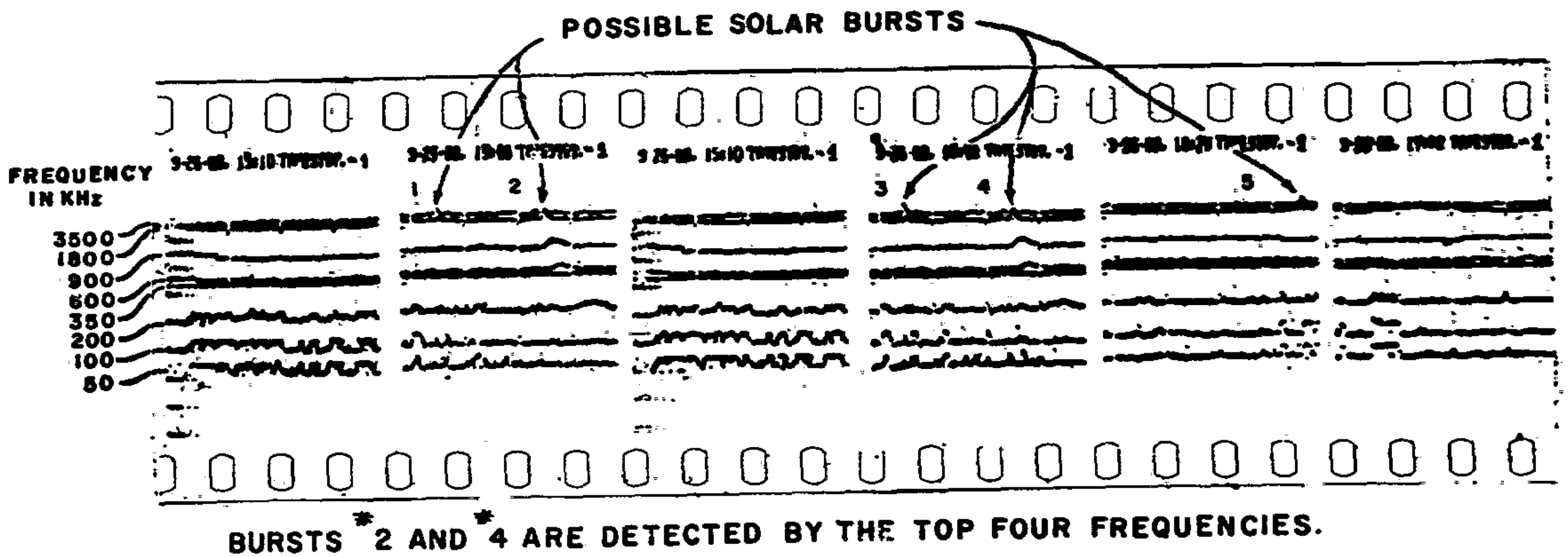
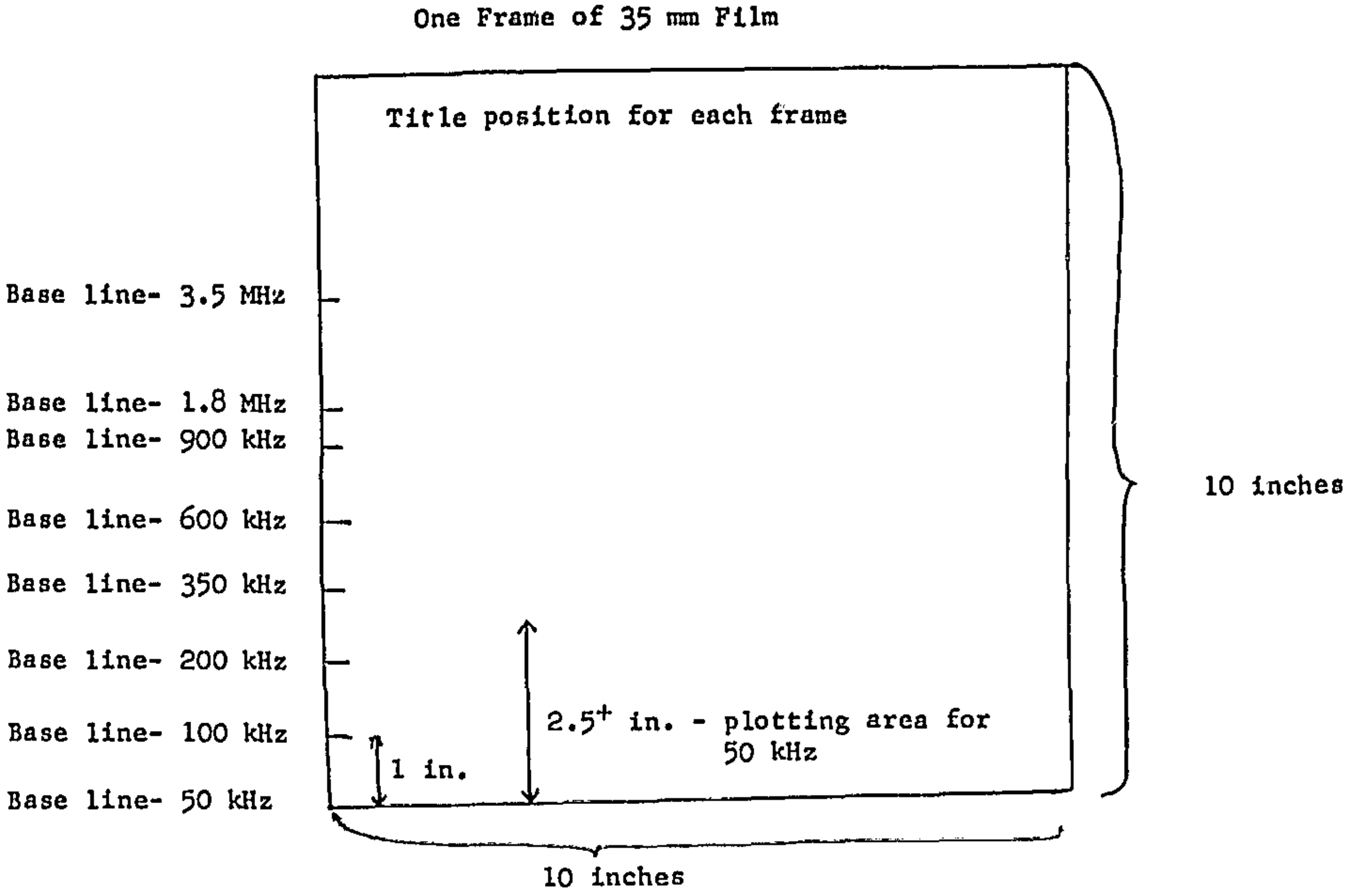


Figure 2. OGO-V Monitoring Program sample 35 mm film.



Scale: 1 inch = 2 volts

The plotting region for any one frequency is 5.1 volts, or about 2.5 inches.

The 1.8 MHz channel was lowered in order to avoid overlap with the 3.5 MHz channel.

Figure 3 Description of One Frame of 35 mm Film it is plotted. This continues for each frequency except 1.8 MHz, with the number of volts added to the radiometer output for these seven frequencies determined as follows:

for frequency i- add 2 x(i-1) volts,
i=1,..., 6, 8.

The exception is 1.8 MHz. In order to avoid overlaps with 3.5 MHz, the 1.8 MHz channel was lowered by 1.0 volt (0.5 in.) (it has only 11.0 volts added to the radiometer output instead of the expected 12.0 volts). On the 10 x 10-in. CRT, this results in eight horizontal plotting areas, each 2.5^{+} in. wide (5.1 volts) and each overlapping the plotting areas of the frequencies above and below it. Tic marks are placed along the ordinate to indicate the beginning of the plotting area for each frequency.

The time axis runs continuously with fill data not plotted. Each frame of film contains 39.0216 min of data and requires 2.5 min of XDS 930 running time. The date and time for the start of the frame, input data tape number, and input tape file number are labeled at the top of each frame. A tic mark along the left side (Y axis) indicates the base line for each of the eight frequencies, a tic mark along the time axis (X axis) indicates half hours, i.e., 12:00, 12:30, 13:00.

If A/O tapes were used during the processing, then the film contains notations for six particular events or positions of the spacecraft. These include:

EVENT	FILM NOTATION
Apogee	A
Perigee	P
Beginning of Eclipse	B
End of Eclipse	E
Equator Crossing Northbound	N
Equator Crossing Southbound	S

If any one or more of these events occurred within the time included in the frame, then the appropriate letter is added at the bottom of the frame, with a tic mark at the time of its occurrence.

The secondary output of the program consists of printed information for each input file processed. The label record and all frame times and A/O events for each file are listed. A sample print out is given in Figure 4. A table of all files processed during one processing session is printed at the end of each run. The print out is not included in our shipment, for it merely backs up the information contained on the film and is used if any problems arise in the operation of the program. The table of files processed is included as APPENDIX F.

2. Discussion of the Data

The film we are sending represents all the 1 kbs data we have received at this time and covers the time period 5 March 1968 through December 1969. The satellite was launched on 4 March 1968 but the antenna was not deployed until 14 March 1968. It was initially assumed that only playback data would be processed in the monitoring stage, since there was to be 100% playback coverage. However,

```
** OGO-E MONITORING PROGRAM **                  11-18-68

INPUT TAPE NO. 5796, FILE  2

SATELLITE  OGO-E , YEAR 68 , STA NO 020, ANALOG FILE NO 01, ANALOG TAPE NO 0889,
A DAY OF DIGITIZATION    , 01 KILOBIT, DAY OF YEAR 080 AND SECONDS OF DAY 13663 FOR START TIME,
DAY    ,SEC        FOR STOP TIME, EQUIP GROUP 2,MASTER BINARY TAPE  7001,  MASTER BINARY FILE 01,
A/D LINE OP ID     , A/D LINE ID    , REEL SEQ NO 01, RUN NO 053, EXP NO 20.

START TIME OF FILE=  3:48,  FIRST FRAME TIMES ARE  3:48,  4:28  [   13731.    13731.    16090.]

FRAME TIMES =  4:28,  5: 7  [   16090.    18450.]

A/D EVENT  B    OCCURRED AT TIME   4:32  [   16346.]

A/D EVENT  P    OCCURRED AT TIME   4:33  [   16440.]
FRAME TIMES =  5: 7,  5:46  [   18450.    20809.]
FRAME TIMES =  5:46,  6:26  [   20809.    23168.]
FRAME TIMES =  6:26,  7: 5  [   23168.    25527.]
FRAME TIMES =  7: 5,  7:44  [   25527.    27887.]
FRAME TIMES =  7:44,  8:24  [   27887.    30246.]
FRAME TIMES =  8:24,  9: 3  [   30246.    32605.]
FRAME TIMES =  9: 3,  9:42  [   32605.    34965.]
FRAME TIMES =  9:42, 10:22  [   34965.    37324.]
FRAME TIMES = 10:22, 11: 1  [   37324.    39683.]
FRAME TIMES = 11: 1, 11:40  [   39683.    42043.]
FRAME TIMES = 11:40, 12:20  [   42043.    44402.]
FRAME TIMES = 12:20, 12:59  [   44402.    46761.]
FRAME TIMES = 12:59, 13:38  [   46761.    49120.]
FRAME TIMES = 13:38, 14:17  [   49120.    51480.]
FRAME TIMES = 14:17, 14:57  [   51480.    53839.]

INPUT TAPE NO. 5796, FILE  3

SATELLITE  OGO-E , YEAR 68 , STA NO 020, ANALOG FILE NO 01, ANALOG TAPE NO 0922,
A DAY OF DIGITIZATION    , 01 KILOBIT, DAY OF YEAR 080 AND SECONDS OF DAY 53652 FOR START TIME,
DAY    ,SEC        FOR STOP TIME, EQUIP GROUP 2,MASTER BINARY TAPE  7006,  MASTER BINARY FILE 01,
A/D LINE OP ID     , A/D LINE ID    , REEL SEQ NO 01, RUN NO 053, EXP NO 20.

START TIME OF FILE= 14:52,  FIRST FRAME TIMES ARE 14:17, 14:57  [   53544.    51480.    53839.]

FRAME TIMES = 14:57, 15:36  [   53839.    56198.]
FRAME TIMES = 15:36, 16:15  [   56198.    58558.]
FRAME TIMES = 16:15, 16:55  [   58558.    60917.]

INPUT TAPE NO. 5796, FILE  4

SATELLITE  OGO-E , YEAR 68 , STA NO 020, ANALOG FILE NO 01, ANALOG TAPE NO 0922,
A DAY OF DIGITIZATION    , 01 KILOBIT, DAY OF YEAR 080 AND SECONDS OF DAY 60304 FOR START TIME,
DAY    ,SEC        FOR STOP TIME, EQUIP GROUP 2,MASTER BINARY TAPE  7007,  MASTER BINARY FILE 01,
A/D LINE OP ID     , A/D LINE ID    , REEL SEQ NO 01, RUN NO 053, EXP NO 20.

START TIME OF FILE= 16:43,  FIRST FRAME TIMES ARE 16:15, 16:55  [   60180.    58558.    60917.]

FRAME TIMES = 16:55, 17:34  [   60917.    63276.]
```

Figure 4. OGO-V Monitoring Program sample print out.

due to the failure on 3 April 1968 of the wideband "A" transmitter, the playback coverage dropped to less than 45% and the real time coverage increased accordingly. So we have processed all the 1 kbs real time data and selected 8 kbs real time data.

There is very little film for the period 24 April - 18 June 1968, for during this time the radiometer was operating in a nonstepping mode. We also cannot process the data routinely with the MONITOR program when the satellite is in a spin mode, as it was for two days each in September and December 1969.

Some of the film was produced while the MONITOR program was still in a check-out phase. One error was uncovered - the program did not correctly find the frequency which started a file. This resulted in film on which the frequencies were out of order - i.e., film which did not have 50 kHz at the bottom and 3.5 MHz at the top. Unless there were possible solar bursts during these time periods, we did not rerun the GSFC input tapes. Times during which this occurred and for which the frequencies on the film are out of order are:

6-20-68 - 23:40 to midnight

6-21-68 - 00:00 - 4:20
8:00 -10:25

6-30-68 11:08 -12:30

8-15-68 1:30 - 2:49

There were several instances during which the film did not advance properly, causing multiple exposures. The data was not rerun if there were no potential solar bursts. The times for which multiple exposures are present on the film are:

6-28-68 - two frames, those for 2:50 and 3:29

7-5-68 - three frames, those for 6:59, 7:39, 8:18.

One idiosyncrasy of the program is that the file counter is incremented before a picture is taken. This results in the last frame of every file being labeled as file n when it really is still file n-1.

Table V gives a summary of the amount of data we have processed for each month.

Our processing usually was up-to-date. That is, we processed each batch of tapes as soon as a shipment arrived. This resulted in 35 mm film which was entirely unordered as far as the dates of the data were concerned. So we cut the film into units which covered one particular time period and then spliced all the pieces together (playback, 1 kbs real time and 8 kbs real time) so that it is now in chronological order.

Because of the need to process both playback and real time data, the resulting film does contain some small duplications of data. This occurs when one kind of coverage starts a few minutes before the other has ended, i.e., playback data through 12:30 and real time coverage beginning 12:19. We have made no attempt to cut out this duplication.

A lot of time has been spent in editing and cleaning up the film. A great deal more time could be spent inserting blank film whenever a time gap occurs in the data. We decided at this point that the extra effort was not needed, since the film is all in chronological order and any gaps can be detected by reading the title lines. However, some of the time gaps have been marked by the use of blank film. Another indication of a time gap between frames is a mark drawn between the title lines of the two frames involved.

TABLE V

TOTAL AMOUNT OF PROCESSED OGO-V DATA

	Hours of Data	% of Total Coverage in Month
March 1968	609.3*	95.20*
April	371.	51.53
May	10.3	1.38
June	290.6	40.36
July	711.	95.57
August	691.75	92.98
September	511.33	71.02
October	552.	74.19
November	552.	76.67
December	507.	68.15
January 1969	519.	69.76
February	348.33	51.83
March	476.5	64.05
April	411.5	57.15
May	401.36	53.95
June	460.75	63.99
July	364.	48.92
August	445.65	59.90
September	253.	35.14
October	503.	67.68
November	223.8	31.08
December	33.84	4.55

* This is measured from the 5th of the month, the time at which we first received data.

There are 22 rolls of film, each of varying length and each covering one month of time. The film used in the MONITOR stage of processing was Kodak Recordak Dacomatic A Film, Product Number 01601, Type 5461-62-36. The original film was then copied onto Kodak Recordak Fine Grain Print Safety Film, Product Number 1896, Type 5464-677-39, which is being sent to NSSDC.

3. CalComp Plotting Program

Once the monitoring stage of processing has produced film of all the data, special intervals of interest are selected from the film for further analysis. The software package which plots any or all of the frequencies on a CalComp Model 565 plotter is called the MC125 V & RT PLOT package. Actual plots are not included in the data being submitted to NSSDC; however, sample plots are given in Figures 5 and 6 and a description of the software is included in APPENDIX G. This should allow anyone who so desires to use the plotting software. A brief summary is given below.

The MC125 V & RT PLOT program reads the GSFC data tape, unpacks each of the eight frequencies, and plots the main commutator word 125 for the desired frequency. The time scale for plotting is completely variable and is determined by one of the input parameters. The scale along the ordinate can be expressed as either volts or as an RT product and is also determined by an input parameter. The response curves used to convert the instrument output voltages to RT products are given in Table III.

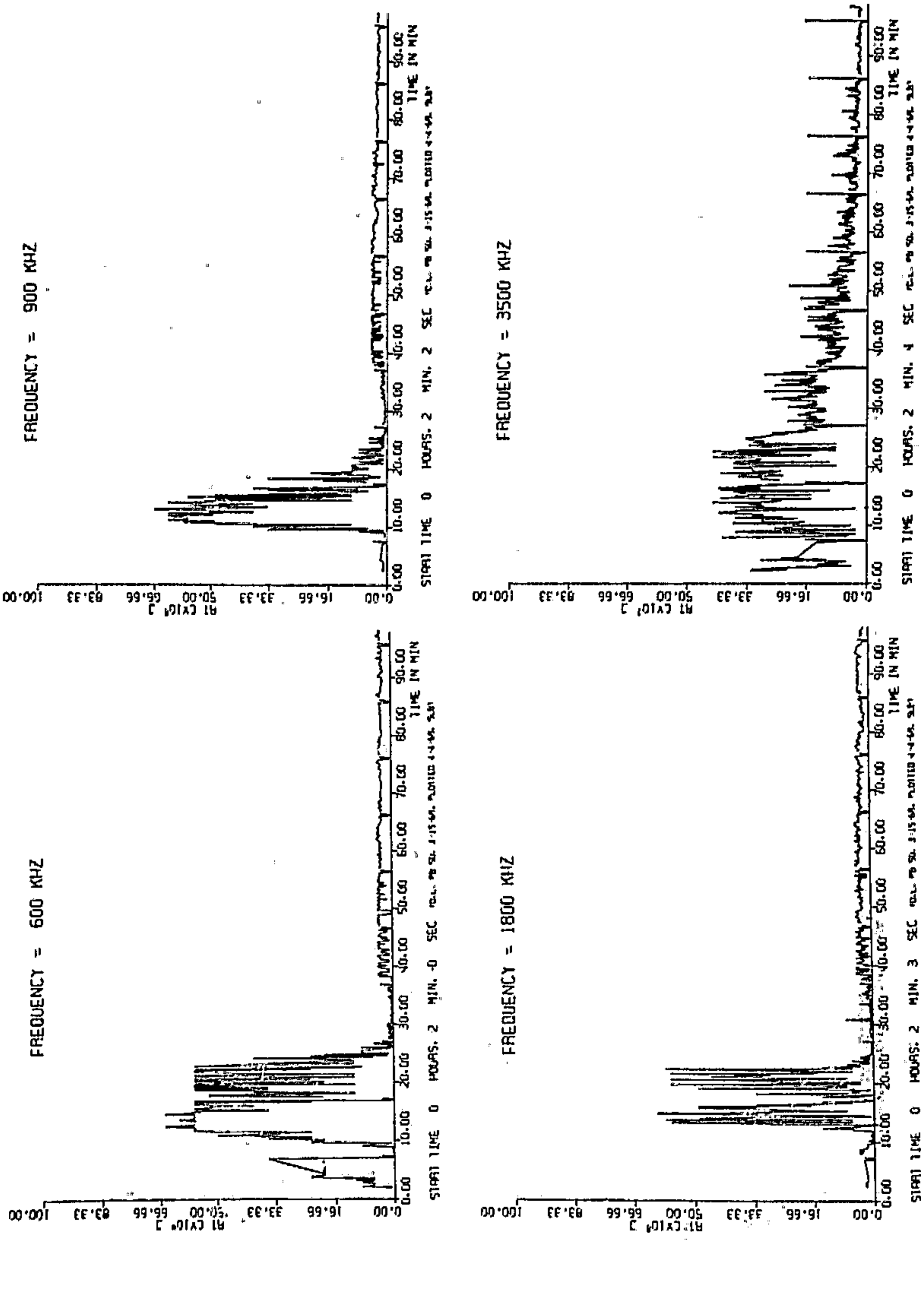
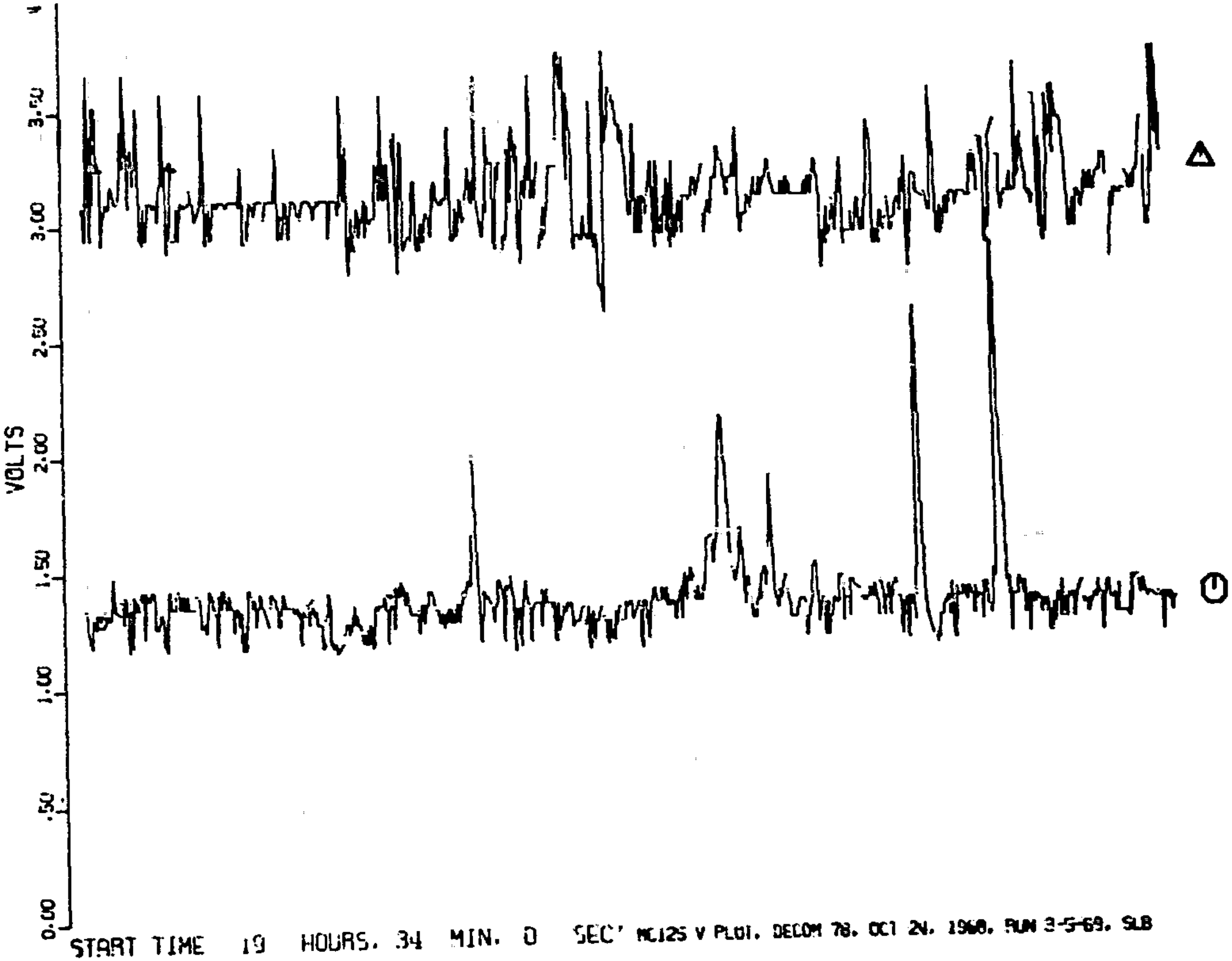


Figure 5. Sample plot of four frequencies of OGO-V data.

TAPE NUM 8888

FREQUENCY
[IN KHZ]
Z 50
X 100
+ 200
◇ 350
X 600
+ 900
△ 1800
⊙ 3500



SCALE:
15 MIN.

Figure 6. Sample plot of OGO-V data in volts.

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Two versions of the basic program are required in order to handle both 1 and 8 kbs data. The outputs from each are identical. At the 8 kbs data rate, a sample occurs every 0.144 secs with 8 samples per frequency before the radiometer steps to the next frequency. However, at the 8 kbs data rate only one of the eight samples per frequency is plotted. The sample S_i selected out of the 128 samples per record is given by

$$S_i = 8 + 8N + J \qquad 0 \leq N \leq 15, \quad 1 \leq i \leq 128$$

J - the number of samples in a record proceeding the first complete frequency.

This gives a time increment between plotted smaples of 9.216 seconds, which is the same time resolution as that for the 1 kbs data rate.

D. HARDWARE FACILITIES

1. Description of Hardware

The processing of any OGO-V data is contingent upon the satisfactory operation of the hardware currently in existence at the Radio Astronomy Observatory. The basic unit of this system is a Xerox Data Systems Model 930 computer with a core storage of 8192 twenty-four bit words and a Random Access Device (RAD) with 262,144 twenty-four bit words. The 930 computer is equipped with 24 special programmable input/output lines (sense/set lines), 16 priority interrupts, and a real time clock. The input/output (I/O) devices connected to the computer include 2 seven-track magnetic tape units, a paper tape reader and punch, a card reader, a teletype, an unbuffered line printer, and a CalComp plotter.

In addition to the above, the Radio Astronomy Observatory has built and interfaced to the Y buffer of the computer a special purpose buffer-display system which allows the OGO-V data to be photographed on 35 mm film in an on-line operation. The special purpose buffer-display system which the OGO-V processing uses includes a 4096 thirty-six bit word buffer core, a stored program I/O channel which can transfer data both ways between the buffer core and the 930 core (to the buffer core from the 930 core, and to the 930 core from the buffer core), a direct view CRT display, and a photographic CRT display with an automatic 35 mm camera.

2. Operation of the Hardware Facility

The XDS MONARCH operating system which the OGO-V processing system employs is resident on the RAD; all the systems programs, library routines, and links for the eight core load Monitoring program are stored on the RAD; the binary programs for each core load are stored on a magnetic tape; the instructions to the loader are on punched cards. The attitude-orbit tapes and the data tapes make use of both tape units. The typewriter and printer are used for secondary output and for error messages.

As each record from the data tape is processed, it is sent to the buffer core. After 17 records have been processed, a picture is taken automatically on the photographic CRT display and the film advances. The only remaining step in the MONITORING processing is developing the film. All other steps involved in producing the 35 mm film are executed in an on-line production manner with the photographic CRT and camera operating in an automatic mode.

Once the film is developed, two direct viewers are available for inspecting the film. One of the viewers also has the capability of producing a hard copy of any interval of interest.

3. Software for the Data System

The operating system used for the OGO-V data processing centers on the XDS MONARCH Operating System. Systems routines in the SYMBOL assembly language have been written to make use of the special purpose buffer-display system. Other programs used in the OGO-V processing are written in both SYMBOL and FORTRAN II.

APPENDIX A

September 23, 1968

UM/RAO OGO-E MEMO NO. 144

FROM: R.G. Yorks

SUBJECT: Transfer function corrections to antenna power input-output curves.

In the course of Tom Graedel's solar burst work of correlating OGO-B and OGO-E data, he discovered that the dummy antenna used in the OGO-E calibration did not satisfactorily represent the antenna used in flight. For the purpose of taking into account this difference, I have calculated below, the corrections that should be applied to the OGO-E radiometer calibration data - in free space - to account for the difference between the calibration transfer function and the actual transfer function.

The dummy antenna circuit used in the radiometer calibrations is shown in Figure 1.

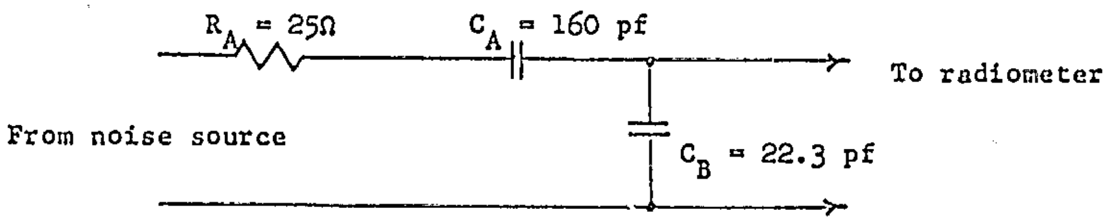


Figure 1. Dummy antenna circuit - calibration.

The antenna circuit, in free space, as deduced from measurements of antenna base capacitance (see UM/RAO OGO-E Memo No. 133, February 12, 1968) and theoretical antenna capacitance (same memo) according to the equation $C_A = 2\pi E_o h \,/\, \left(\ln(h/a) - 1\right)$ is shown in Figure 2.

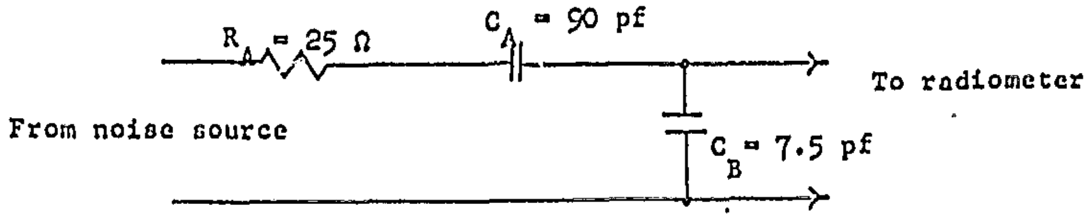


Figure 2. Free space antenna equivalent circuit.

The input impedance of the OGO-E radiometer is listed in Table 1 below for the eight frequencies of operation. R_s and C_s are shunt values as measured on the Wayne - Kerr impedance bridge.

TABLE 1. RADIOMETER INPUT IMPEDANCE

Frequency	R_s	C_s
50 KHz	105 kΩ	33.8 pf
100	122	27.2
200	88.2	24.4
350	87.7	24.2
600	92.3	24.2
900	102	24.2
1.8 MHz	560	24.2
3.5	1.0 MΩ	25.0

R_s = Resistive component of preamplifier input impedance
C_s = Capacitive component of preamplifier input impedance

The power transfer function is obtained by placing the shunt values of the radiometer input impedances (Table 1) in parallel with C_B in the above figures 1 and 2, calling this Y_L, then converting to $Z_L = \frac{1}{Y_L}$ and calculating the power transfer functions

$$PTF = \frac{R_L^2 + X_L^2}{(R_A + R_L)^2 + (X_A + X_L)^2} \quad \text{for Figure 3.}$$

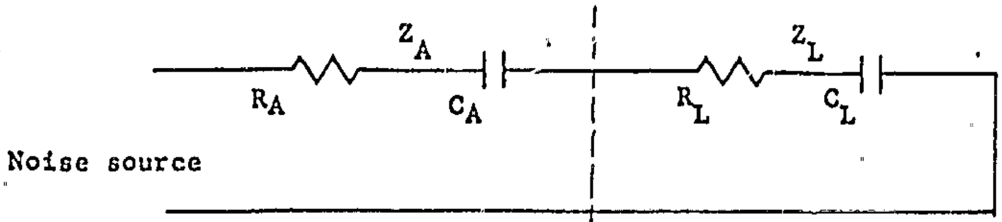


Figure 3/ Equivalent antenna-radiometer circuit.

Table 2 lists the values of Z_A and Z_L for both figures 1 and 2.

TABLE 2. Z_A and Z_L Tabulations.

	Figure 1		Figure 2	
Frequency	Z_A	Z_L	Z_A	Z_L
50 KHz	25 - j 19,900	23,810 - j 43,961	25 - j 35,355	36,778 - j 50,030
100	25 - j 9,950	7,898 - j 30,059	25 - j 17,677	15,088 - j 40,171
200	25 - j 4,975	3,189 - j 16,491	25 - j 8,838	6,531 - j 23,096
350	25 - j 2,842	1,077 - j 9,657	25 - j 5,051	2,288 - j 13,965
600	25 - j 1,658	358 - j 5,683	25 - j 2,946	752 - j 8,298
900	25 - j 1,105	142 - j 3,802	25 - j 1,964	304 - j 5,561
1.8 MHz	25 - j 553	6 - j 1,901	25 - j 982	14 - j 2,789
3.5	25 - j 284	.92 - j 961	25 - j 505	2 - j 1,399

The power transfer functions for the antenna parameters of figures 1 and 2 are listed in Table 3. Listed in table 4 is the ratio of these transfer functions, which is the correction factor to multiply $T_A R_A$ by on the radiometer calibration curves.

TABLE 3. POWER TRANSFER FUNCTIONS.

Frequency	Figure 1	Figure 2
50 KHz	.538	.446
100	.581	.515
200	.599	.541
350	.600	.546
600	.600	.551
900	.600	.547
1.8 MHz	.600	.547
3.5	,596	.540

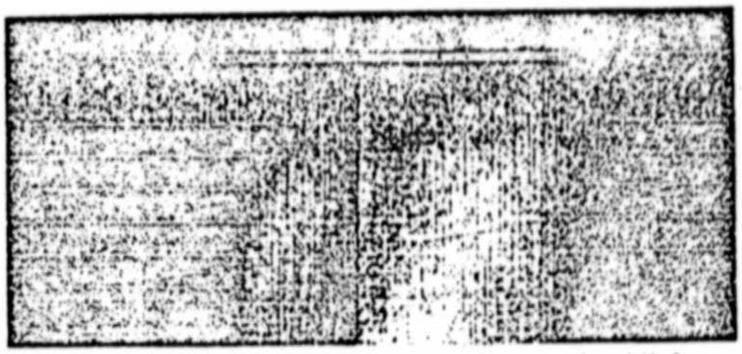
TABLE 4. Correction Factor.

Frequency	Correction Factor
50 KHz	1.206
100	1.128
200	1.107
350	1.099
600	1.089
900	1.097
1.8 MHz	1.097
3.5	1.104

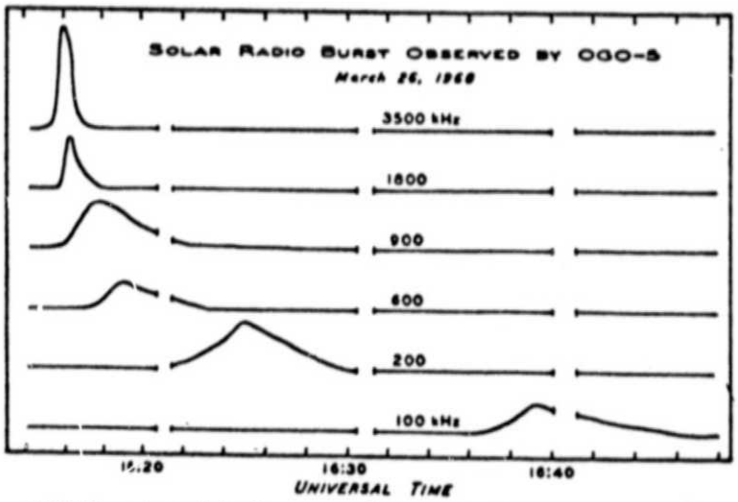
RCY/pbk-

APPENDIX B
RADIO BURSTS IN THE OUTER CORONA*

SKY AND TELESCOPE, October, 1968



A solar radio burst (bright display) of June 25, 1966, appeared to drift from high to low frequencies. The chart's lower edge is at 4 MHz, the upper horizontal line at 2 MHz. At top are ticks for each minute of Universal time, from 15:35 (left edge) to 15:45. University of Michigan chart.



A Michigan chart of simultaneous receiver records, showing the drift in frequency with time, and lengthening of the burst at lower frequencies.

Radio Bursts in the Outer Corona

Spacecraft are becoming increasingly useful to investigators of the sun's corona. For example, University of Michigan radio astronomers have flown equipment aboard OGO satellites (the orbiting geophysical series) in order to detect solar radio bursts at very low frequencies. Some results from this work are reported by Fred T. Haddock and Thomas E. Graedel.

They used a sweep-frequency receiver on OGO 3 to record solar bursts at frequencies from 4 to 2 megahertz (wavelengths 75 to 150 meters), well below the ionospheric cutoff for ground-based observations. The receiver sweeps over the reception band once every two seconds. Over 200 bursts were detected from June, 1966, through September, 1967, mostly Type III (fast-drift). Ninety percent of the low-frequency solar events could be confirmed by higher-frequency ground-based observations, and more than half could be related to a visible solar flare.

Current theories of solar radio bursts indicate that the emission at such frequencies originates in the corona at a distance of 5.3 to 6.3 solar radii from the sun's center: 1.9 to 2.3 million miles above the photospheric surface. The measured rate of drift in frequency is one megahertz in eight seconds. The bursts last longer at lower frequencies, typically 40 seconds at 4 MHz and 70 seconds at 2 MHz. These results indicate that the outward stream of electrons producing a burst is moving at 10 to 15 percent of the speed of light. Further, the temperature in the outer corona is at least 440,000° Kelvin at 5.3 solar radii and 26,000° or more at 6.3 radii.

The same experiment has also detected "reverse-drift" bursts, in which the burst frequency increases with time, rather than decreases. Such events may be explained as due to the action of magnetic fields on the electron stream.

When OGO 5 was launched in March of this year, it carried the University of Michigan's receiver-antenna system for monitoring solar radio bursts at eight frequencies from 3.5 to 0.05 MHz, corresponding to wavelengths of 85 meters to 6.0 kilometers! Preliminary processing of 20 hours of selected data has resulted in the detection of a dozen bursts. Several extend to 0.60 MHz, and one has been detected in the 0.20-0.10-MHz band in addition to higher-frequency channels.

The explanation of where this very low-frequency emission originates depends on the electron density at different distances from the sun's surface. These density values are not well known, especially over the solar active regions where the radio bursts are presumably initiated. An extrapolation of an electron-density model used for higher frequencies indicates that the 0.20-MHz emission originates at about 35 solar radii and the 0.10-MHz at about 75. This is much farther out in the corona than any previously observed solar bursts, and close to the mean distance of Mercury from the sun (83 solar radii).

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APPENDIX C

REVISION #3 UM/RAO OGO-E Memo No. 84

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

February 12, 1968

AIR MAIL

Mr. Barry McRae
Radio Astronomy Observatory
University of Michigan
Ann Arbor, Michigan 48104

Dear Barry:

Enclosed you will find the revised data tape format for E-20. I have inserted the experimenter subcom information and have moved the day of year into new characters. I hope the format meets your approval.

Sincerely,

Henry G. Linder

Henry G. Linder
Telemetry Computation Branch - 565
Information Processing Division
Tracking and Data Systems Directorate

Enclosure - 1

APPENDIX C

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Telemetry Computation Branch - 565
Information Processing Division
Tracking and Data Systems Directorate

Enclosure - 1

REVISION 2 2-11-68

DATA FORMAT E-20
RADIO ASTRONOMY EXPERIMENT

CHARACTER	REPRESENTATION		
1 - 2 3 - 4	D(98,42) D(98,106)	A 10 Yaw Error Signal	
5 - 6	D(98,24)	All Array Error Signal	
7 - 8 9 - 10	D(98,7) D(98,8)	A 12 sine A 13 cosine	Array Shaft Angle
11 - 12 13 - 14	D(98,49) D(98,113)	A 16 Array,, OPEP Drive Motors	
15 - 16 17 - 18	D(98,50) D(98,114)	A 17 Roll Tach	
19 - 20 21 - 22	D(98,51) D(98,115)	A 18 Pitch Tach	
23 - 24 25 - 26	D(98,52) D(98,116)	A 19 Yaw Tach	
27 - 28	D(98,54)	A 23 ACS Mode Logic	
29 - 30 31 - 32	D(98,41) D(98,105)	A 7 Horizon Track Check Signal	
33 - 34 35 - 36 37 - 38 39 - 40	D(98,81) D(98,23) D(98,6) D(98,72)	A 40 Head "A" A 41 Head "B" A 42 Head "C" A 43 Head "D"	Horizon Scanner Angles

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CHARACTER	REPRESENTATION
41 - 42	D(98,36) C5 WB-TX #A fwd.
43 - 44	D(98,1) C6 WB-TX #A rev.
45 - 46	D(98,80) C7 WB-TX #B fwd.
47 - 48	D(98,2) C8 WB-TX #B rev.
49 - 50	D(98,68) C9 SP-TX fwd.
51 - 52	D(98,19) D4 Array 1 current
53 - 54	D(98,20) D5 Array 2 current
55 - 56	D(98,21) D10 Load bus voltage
57 - 58	D(99,30) E26 Temp SOEP #1 (-X)
59 - 60	D(98,82) In flight calibrations
61 - 62	D(99,81) In flight calibrations
63 - 64	D(98,83) In flight calibrations
65 - 66	D(99,82) In flight calibrations
67 - 68	D(98,84) In flight calibrations
69 - 70	D(99,83) In flight calibrations
71 - 72	D(98,85) In flight calibrations
73 - 74	D(98,79) F42 Subsystem Data Handling
75 - 76	D(98,95) F43 Subsystem Data Handling
77 - 78	D(97,65) Solar Aspect Indicator
79 - 80	D(97,121) Range + Range Rate Indicator
81 - 82	D(97,17) Exp. subcomm data
83 - 84	D(97,57) Exp. subcomm data
85 - 86	D(97,58) Exp. subcomm data
87 - [illegible]	D(97,59) Exp. subcomm data
[illegible] - [illegible]	D(97,89) Exp. subcomm data
91 - 92	D(97,90) Exp. subcomm data
[illegible] - 94	D(97,91) Exp. subcomm data
[illegible] - 96	D(97,92) Exp. subcomm data
97 - 98	D(97,116) Exp. subcomm data

2·17·68

CHARACTER	REPRESENTATION		
99 - 154	Spares		
155 - 156	D(98,57)	C11	Tracking - Tx (FWD)
157 - 158	D(98,121)	C12	Tracking - Tx (REV)
159 - 160	D(98,111)	F44	Subsystem Data Handling
161 - 162	D(98,127)	F45	Subsystem Data Handling
163 - 164	D(98,128)	F46	Subsystem Data Handling
165 - 166	D(98,127)	F47	Subsystem Data Handling
167 - 168	D(98,128)	F48	Subsystem Data Handling
169 - 178	Spares		
179 - 180	Day of Year		
181 - 182 + 24N	D(65,j) S/C ID		
183 - 184 + 24N	Flag Field F1		
185 - 186 + 24N	D(97,j) Experimenter Subcom		
187 - 192 + 24N	Millisecond of Day		
193 - 198 + 24N	D(33,j) D(34,j) S/C Clock D(35,j)		
199 - 204 + 24N	D(13,j) D(77,j) Experimenter Data D(125,j)		

Where $0 < N < 127$ and $1 < j < 128$.

There will be a label record at the beginning of each file of data describing that data. It will be 120 characters in length and although written in odd parity, will be formatted in BCD.

Following the label record will be the data records until an end-of-file (EOF) is reached. There will be multiple files on a tape until termination of data is reached which is denoted by two (2) successive EOF's.

Each data record will contain 3252 six-bit characters/record. (542 thirty-six bit words or 813 twenty-four bit words). Each record will contain 128 frames of data (a subcommutator sequence.) If, for some reason, the data does not contain a full sequence (e.g., data drop-out), unique flags - octal 4000 - will be inserted in place of the missing data so that the record will retain the same format.

OGO-E Label Record Format

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Position in IVFC array	Character	Description
1	none	count of the number of words in the following record; =30
2	1-4	satellite ID
3	5-8	satellite ID, blank, year
4	9-12	blank, station number (10-12)
5	13-16	blank, analog file number (14,15), blank
6	17-20	analog tape number (17-20)
7	21-24	blank
8	25-28	blank
9	29-32	blank, day of digitization (30-32)
10	33-36	blank, satellite ID
11-17	37-64	characters 34-66 are identical to characters 1-33 unless an error was found in those characters. This then contains the corrected values.
18	65-68	repeat of characters 32,33, (65,66), bit rate (67)
19	69-72	day of year (69-71), start time (72)
20	73-76	seconds of day for start time (73-76)
21	77-80	seconds of day for start time (77), space, flex format in use (79), blank
22	81-84	flex format number (81,82), experiment indicators (83,84)
23	85-88	experiment indicators (85-88)
24	89-92	equipment group (89), blank, master binary tape number (91,92)
25	93-96	master binary tape number (93,94), master binary file number (96)
26	97-100	master binary file number (97), balnk, A/D line operator ID (99,100)
27	101-104	A/D line ID (102,103), day of year for stop time (104)
28	105-108	day of year for stop time (105,106), blank, seconds of day for stop time (108)
29	109-112	seconds of day for stop time (109-112)
30	113-116	reel sequence number (114,115), run number (116)
31	117-120	run number (117,118), experiment number (119,120)

Location of Characters in IVEC
For Data Record

CHARACTERS	IVEC	
1 - 2	2	
3 - 4	3	
5 - 6	4	
.	.	
.	.	
.	.	
81 - 82	42	Radiometer output (Sub Com 17)
83 - 84	43	Noise diode temperature (Sub Com 57)
85 - 86	44	Detector Bias (Sub Com 58)
87 - 88	45	Noise diode current (Sub Com 59)
89 - 90	46	Frequency I.D. (Sub Com 89)
91 - 92	47	Radiometer output (Sub Com 90)
93 - 94	48	Mixer zener (Sub Com 91)
95 - 96	49	Regular Monitor (Sub Com 92)
97 - 98	50	Radiometer output (Sub Com 116)
.	.	
.	.	
.	.	
179 - 180	91	Day of year
181 - 182	92	D(65, j) S/C ID
183 - 184	93	Flag field F1
185 - 186	94	D(97, j) experimenter subcom
187 - 188	95	Milliseconds of day
189 - 190	96	
191 - 192	97	
193 - 194	98	S/C Count
195 - 196	99	
197 - 198	100	

Sub com wa

CHARACTER	IVEC	
199 - 200	101	Frequency ID
201 - 202	102	M/C 77
203 - 204	103	M/C 125
205 - 206	104	S/C ID
207 - 208	105	Flag field F1
209 - 210	106	D(97, j) experimenter subcom
211 - 212	107	Millisecond time word
213 - 214	108	
215 - 216	109	
217 - 222	110- 112	S/C count
223 - 224	113	Frequency ID
225 - 226	114	M/C 77
227 -228	115	M/C 125

j = 2

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.
.
.
.

j = 128

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OGO-E MAIN TELEMETRY FORMAT

EQUIPMENT GROUPS I AND 2

1 000 SYNC WORD #1	2 001 SYNC WORD #2	3 002 SYNC WORD #3	4 003 14 [illegible] Axis Fine	5 004 14 Z Axis Med	6 005 14 Z Axis Coarse	7 006 24 [illegible] Field Meas.	8 007 24 B Field Meas.	9 010 9 Anti Coincidence Differential 92 PHA	10 011 6 Commutated Digital Data	11 012 9 Rate D3 PHA	12 013 23/SAI 2-9 Kev	13 014 20 Freq Id Calib.	14 015 16 X Axis Waveform	15 016 16 Y Axis Waveform	16 017 16 Z Axis Waveform
17 020 4 [illegible] Kev X-Ray [illegible]	18 021 4 [illegible] Kev X-Ray [illegible]	19 022 4 [illegible] Kev X-Ray [illegible]	20 023 4 [illegible]-12 Kev X-Ray [illegible] 40 Kev X-Ray	21 024 16 X Axis Waveform Analysis	22 025 16 Y Axis Waveform Analysis	23 026 16 Z Axis Waveform Analysis	24 027 3 Electrometer Output	25 030 4 Energy Channels	26 031 11 Energy Levels	27 032 6 Commutated Digital Data	28 033 9 Rate Data	29 034 13 Detector #1 Output	30 035 15 X Axis Fluxgate	31 036 15 Y Axis Fluxgate	32 037 15 Z Axis Fluxgate
33 040 ACCUMULATED TIME (SECS)	34 041	35 042	36 043 13 Detector #[illegible] Output	37 044 13 Detector #[illegible] Output	38 045 13 Detector #4 Output	39 046 13 Detector #5 Output	40 047 13 Detector #6 Output	41 050 15 Rb Magnetometer Output	42 051 15	43 052 7 Digital Data (MS)	44 053 7 Digital Data (LS)	45 054 A14 OPEP Sine	46 055 5 Commutated Analog Data	47 056 5 Commutated Analog Data	48 057 5 Commutated Analog Data
49 060 5 [illegible]	50 061 6 Commutated Digital Data	51 062 22 Prescaler Output	52 063 22 Master Scaler Output Error Pos.	53 064 22 Filament Status	54 065 22 Shutter & Cal Status	55 066 6 House keeping & Sync	56 067 3 Electrometer Output	57 070 17 SOLP Detector Alt. Words Alt	58 071 17 Main Body Alt. Words 1st	59 072 17 SOLP Alt. Words [illegible]	60 073 17 Main Body Alt. Words [illegible]	61 074 21 Channel A TV X 1.0	62 075 21 Channel B TV X 1.0	63 076 18 Electrometer Output	64 ✲ 077 FIN. Sweep Voltage [illegible] Log Amp Output
65 100 [illegible]	66 101 [illegible]	67 102 [illegible]	68 103 14 X Axis Fine	69 104 14 Y Axis - Medium	70 105 14 Y Axis - Coarse	71 106 24 Axis In Use [illegible]	72 107 24 Calib., Filter, F Peak,	73 110 8 Microphone Bank D1 Alternates 6 Gains	74 111 8 Microphone Bank D2 Alternates 6 Gains	75 112 8 Microphone Bank D3 Sev. Event and Mode	76 113 23/SAI 9-20 Kev X-Ray	77 114 20 Radiometer Output	78 115 16 X Waveform	79 116 16 Y Waveform	80 117 16 Z Waveform
81 120 12 [illegible]	82 121 12 [illegible] PHA	83 122 12 [illegible] PHA	84 123 12 PHA & [illegible]	85 124 2 Positive Amplifier Output	86 125 2 Negative Amplifier Output	87 126 2 Neg. Sensor Program	88 127 3 Electrometer Output	89 130 6 Commutated Digital Data	90 131 15 X Fluxgate Field	91 132 15 Y Fluxgate Field	92 133 15 Z Axis Fluxgate	93 134 2 Positive Sensor Program	94 * 135 X Axis Fluxgate [illegible]	95 * 136 Y Axis Fluxgate [illegible] Spect Anal & Mode	96 * 137 Z Axis Fluxgate [illegible] Log Amp Output
97 140 SUBCOM 1 DATA WORD HERE	98 141 SUBCOM 2 DATA WORD HERE	99 142 SUBCOM 3 DATA WORD HERE	100 143 1 500 Hz Amplitude	101 144 1 3.2 KHz Amplitude	102 145 1 RF RMS Current	103 146 1 Sweep Monitor (PS) Mod. Depth (RT)	104 147 A15 OPEP COS	105 150 15 Rubidium Output	106 151 15	107 152 9 All Detector Rates	108 153 6 Commutated Digital Data	109 154 25 Scan Position	110 155 11 e- Analyzer #1 Output	111 156 11 e- Analyzer #2 Output	112 157 11 e- Analyzer #[illegible] Output
113 160 10 PHA [illegible]	114 161 10 Redundant [illegible]	115 162 10 PHA Detectors	116 163 10 Redundant [illegible]	117 164 14 X Axis-Fine	118 165 14 X Axis - Medium	119 166 14 X Axis - Coarse	120 167 3 Electrometer Output	121 170 10 PHA Detectors	122 171 10 Redundant [illegible]	123 172 10 Rates [illegible]	124 173 10 Redundant [illegible]	125 174 20 Radiometer Output	126 ✲ 175 [illegible] Output	127 ✲ 176 Sweep Rate Spectrum Anal & Mode	128 ✲ 177 Electrometer Eng Log Amp Output

* 15/26 ✲ 18/26

Main Frame Telemetry Format

OGO-E EXPERIMENT TELEMETRY FORMAT

SUBCOM I EQUIPMENT GROUPS I AND 2

1 / 200	2 / 201 27 PIIA 1	3 / 202 27 PIIA 2	4 / 203 27 [illegible] PIIA 2 [illegible]	5 / 204 27 [illegible]	6 / 205	7 / 206	8 / 207
9 / 210 1 Sweep Monitor	10 / 211 1 Probe Voltage Monitor	11 / 212 1 Pedestal Flag	12 / 213 1 Neutralizing Flag	13 / 214 1 +6.5 Volt Monitor	14 / 215 1 +6.5 Volt Monitor	15 / 216 1 Temp - MB	16 / 217 1 Temp. Mode Signal
17 / 220 20 Radiometer Output	18 / 221 3 Voltage Program Monitor	19 / 222 3 Voltage Program Monitor	20 / 223 13 Command Status ...	21 / 224 13 Sequence Status, 1 Level	22 / 225 13 Temp. Det No. 2	23 / 226 13 Temp. Det No. 4	24 / 227 13 Temp Det No. 1
25 / 230 26 Ant Eject Relay Status	26 / 231 7 Temp. LEMDIA A	27 / 232 7 Temp. LEMDIA B	28 / 233 7 Temp Signal Conditioner	29 / 234 7 Temp-Power Converter	30 / 235 2 Boom Deploy Status & Position Indicator	31 / 236 24 Temp-Preamp	32 / 237 22 Cal Lamp Current
33 / 240 20 Ant Deploy Status	34 / 241 15 Rb A Photocell 1 Sig Amplitude	35 / 242 15 Rb A Photocell 2 Sig Amplitude	36 / 243 15 Rb B Photocell 1 Sig Amplitude	37 / 244 15 Rb B Photocell 2 Sig Amplitude	38 / 245 15 Rb A Heater Status	39 / 246 15 Rb B Heater Status	40 / 247 20 Ant Eject Relay Status
41 / 250 12 +2.5 Volt Monitor	42 / 251 12 +10 Volt Monitor	43 / 252 12 +10 Volt Monitor	44 / 253 8 Top Ig In Use	45 / 254 8 +8.0 Volt Monitor	46 / 255 8 Temp-Spark Chamber	47 / 256 16 Waveform Anal. Freq. Status	48 / 257 16 X Wideband Spectrum
49 / 260 16 Y Spectrum	50 / 261 16 Z Spectrum	51 / 262 16 Waveform & Anal. Gain	52 / 263 16 Bandwidth and IFC Status	53 / 264 14 Mb Elec. Temp	54 / 265 14 Sensor Temp	55 / 266 14 +2.5 Volt Monitor	56 / 267 14 Heater Status ON/OFF
57 / 270 20 Temp-Noise Diode	58 / 271 20 Detector Bias	59 / 272 20 Noise Diode Current	60 / 273 24 Temp-MB	61 / 274 21 Channel A UV X10	62 / 275 21 Channel B UV X10	63 / 276 21 Channel A HV	64 / 277 21 Channel B HV
65 / 300 SAI Coded Sun Angle	66 / 301 4 20-80 Mev n	67 / 302 4 80-170 Mev n	68 / 303 4 7-20 Mev p	69 / 304 4 20-40 kev e*	70 / 305 4 40-80 kev e*	71 / 306	72 / 307
73 / 310 8 Pressure Monitor	74 / 311 10 Voltage Monitor	75 / 312 10 Temp Lo E Detector	76 / 313 10 Temp Med E Detector	77 / 314 10 Temp Hi E Detector	78 / 315 18 +5.5 & +20 Volt Monitor	79 / 316 18 -4KV & +20V Monitor	80 / 317 18 +700V & +20V Monitor
81 / 320 17 Temp-MB	82 / 321 1 Deployment Monitor	83 / 322 RBRR Status	84 / 323 22 Cal Lamp Current	85 / 324 22 HVPS Monitor	86 / 325 22 Temp-PM Tube	87 / 326 5 Gain and 3 Temp. FCN's	88 / 327 26 Index, Voltages, MB Temp, +X Preamp Temp, Deploy, Status, Gain
89 / 330 20 Freq Id Cal	90 / 331 20 Radiometer Output	91 / 332 20 Ant. Deploy & Zener Voltage	92 / 333 20 Regulator Monitor	93 / 334 24 IC Status	94 / 335 24 MB Sensor Field Output	95 / 336 21 +15V Monitor	96 / 337 21 -15V Monitor
97 / 340 1 Power Command Status	98 / 341 2 Power Supply Temp	99 / 342 3 Temp Monitor	100 / 343 4 Power Command Status	101 / 344 5 Temp + 3 Engrg.	102 / 345 6 +6.0 Volt Mon.	103 / 346 7 Power Command Status	104 / 347 8 Power Command Status
105 / 350 9 Power Command Status	106 / 351 10 Command Status	107 / 352 11 Converter Voltages	108 / 353 12 1.4KV Monitor	109 / 354 13/14 Power Command Status	110 / 355 15 Rb Pwr Status & Dig. Scaler	111 / 356 15 Fluxgate & Pwr. Status	112 / 357 16 Power & SCO Status
113 / 360 17 Command Status	114 / 361 18 Command Status	115 / 362 18/26 Data Switch	116 / 363 20 Radiometer Output	117 / 364 21 Command Status	118 / 365 22 Power Command Status	119 / 366 23 Power Supply Status	120 / 367 24 Power Status & Deployment Indicator
121 / 370	122 / 371	123 / 372	124 / 373 26 -X Ant. DC (E)	125 / 374 26 +X Ant. DC (E)	126 / 375 27 Temp Monitor	127 / 376 Heater Status (P-1 (E-13) (E-01) (P-2 (E-07) (P-3 (E-05)	128 / 377 Heater Status Off P-1 Off P-2 (P-4 (E-07) (-26 Preamp (+X)

Format of Subcommutator No. 1