

1973/111

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DEPARTMENT OF
MINERALS AND ENERGY



BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

Record 1973/111

020493



DIGITAL DATA ACQUISITION SYSTEM
IN
GEOPHYSICAL SURVEY AIRCRAFT VH-BMG

by

D.N. Downie

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SUMMARY

When BMR's new Twin Otter aircraft was being fitted out for geophysical surveying, an integrated system for acquisition of digital data was developed. The system records information from one magnetic channel, four gamma-ray spectrometer channels, and two Doppler navigation channels in addition to altitude and fiducial numbers. Sampling rate is one second except for magnetic data, which are sampled every 0.2 seconds.

The integrated system is built around a Hewlett-Packard 2114B general-purpose digital computer, interfaced to a 16-channel digital input multiplexer and magnetic tape recorder. A visible and permanent analogue record of the input data is maintained by chart recorders, to enable the operator to monitor data quality and to assist later in interpretation of the data. The chart drive motors can be run at five fixed speeds or coupled to the Doppler signal so that chart speed is proportional to ground speed. The Doppler signals are also coupled to a display unit which assists the pilot to follow the planned flight path.

The system is extremely reliable, and error-free flights are common.

1. INTRODUCTION

Towards the end of 1970 the Bureau of Mineral Resources (BMR) took delivery of a new geophysical survey aircraft, a twin Otter, VH-BMG. The aircraft replaced a DC3 that had been used for regional aeromagnetic and radiometric surveys throughout Australia since 1954. One of the tasks in preparing the new aircraft for survey work was the installation of an integrated digital data acquisition system. This Record gives a brief description of the system and the results obtained in two years' use.

Since 1960 the DC3 had operated with digital data acquisition equipment that recorded magnetometer readings and fiducial timing information on punched paper tape. This equipment had evolved through several stages in the succeeding years and had established a good record of reliability. The functions of the data acquisition system were controlled by a hardwired sequencer designed and constructed by BMR and built into the aircraft timer unit.

In the Twin Otter it was intended to record, in digital form, the geophysical and Doppler navigational data using one central acquisition system. As the Twin Otter was to carry more equipment than its predecessor, and also sample the magnetometer more frequently, a tenfold increase in data output had to be accommodated. It was decided to build the system around a compact, but powerful, general-purpose digital computer, suitably interfaced to a digital input multiplexer and magnetic tape recorder, rather than use a hardwire controller. This choice allows the acquisition, checking, and recording of data to be controlled by a computer program, which should be easy to produce and modify. It was expected that a computer-based system would prove more adaptable in the case of future additions to the geophysical equipment carried. Also, if needed, different types of airborne survey operation with different sets of equipment could be accommodated merely by loading a new computer program. Moreover, when not being used in this role the computer could be used on other data processing or computational work.

The initial intention was to have the necessary computer program written by a professional programming organization, working under contract to the BMR. While this arrangement was being organized a simple preliminary program was written in BMR to test some of the broad principles of system operation. By April 1971 it was apparent that the BMR program could be modified to meet the specification required by the proposed contract.

Consequently, the external contract proposal was abandoned, and by May 1971 the upgraded BMR data acquisition program was ready for airborne testing. This flight testing revealed no serious deficiencies, and the BMR program has come through the two succeeding years of survey use with only minor modification and additions.

A block diagram of the data acquisition system is displayed in Plate 1. A simplified flowchart, showing the main decisions and actions taken by the computer program, is displayed in Plate 2.

2. DATA INPUT

In the present configuration of the system the geophysical and navigational data channels and their respective sampling rates are as tabulated below:

<u>Data channel</u>	<u>Sample rate</u>	<u>Data format</u>
Magnetometer (2 channels)	0.2 sec	5 BCD* digits
Gamma-ray spectrometer		
Channel 1 (Total)	1 sec	4 " "
Channel 2 (K)	1 sec	4 " "
Channel 3 (U)	1 sec	4 " "
Channel 4 (Th)	1 sec	4 " "
Altitude	1 sec	3 " "
Doppler along track	1 sec	14 bit binary
Doppler cross track	1 sec	14 " "
Fiducial number	1 sec	4 BCD digits
Flight number	1 per flight	3 " "

*BCD - Binary Coded Decimal

All the above data channels are attached to the computer via a 16-channel digital input multiplexer. Five of the 16 channels are not required at present and are available for future growth.

As well as geophysical data the computer program requires certain timing and control information. Every 0.2 seconds a signal from the timer unit instructs the computer to take the readings required at that instant. Another timing signal, synchronized with the start of the 10-second fiducial interval, allows data acquisition to start and stop in step with

the fiducial system. A command to start or stop recording data on magnetic tape is generated when the equipment operator presses a button at the start or end of a survey line. Two additional logic signals control the operation of the pilot's Doppler position indicators as described in detail in section 4.

These auxiliary data inputs enter the computer via a 16-bit input-output interface.

The timing of the 'read' commands is arranged so that the digital outputs from the instruments have settled to a steady state when the computer takes a reading. The computer responds to a 'read' command, which has the highest internal priority, in less than 10 microseconds. This fast response eliminates any possibility of 'parallax errors' between geophysical readings and the fiducial timing system.

3. ANALOGUE CHART RECORDER OUTPUT

Incoming readings on all geophysical data channels are passed by the computer to the digital-to-analogue multiplexer. The resultant d.c. voltage analogues of the data are recorded on chart recorders, giving a visible and permanent record of the information input to the system. The charts are used to evaluate data quality during and after the survey flight and also for later interpretation of the geophysical information.

On a survey mission the chart records are the only monitor of data quality. The operator has to maintain a watch on the charts and, in the event of serious degradation of data quality, decide whether to abandon the flight. This procedure is simple and flexible and, provided the operator makes an intelligent assessment of the situation, works well. It is unlikely that any attempt will be made in the future to involve the computer in a significant real-time data validation role.

Zero and full-span outputs are displayed on the chart recorders automatically at the end of a survey line to allow the checking of recorder calibration. Recorder calibration outputs can be manually initiated by the operator, during intervals when data are not being recorded, by setting bit 1 on the computer switch register.

The paper drive on the chart recorders has two modes of operation. In TIME mode five fixed speed ranges from 0.6 cm/min to 12 cm/min are available. In DOPPLER mode the chart drive stepper motors are driven at a rate proportional to aircraft ground speed. Five switchable ranges

provide chart scales from 1:500 000 to 1:25 000. For DOPPLER mode operation the computer produces a control voltage on one channel of the digital-to-analogue multiplexer. This voltage, derived from along-track velocity, regulates the frequency of a voltage-controlled oscillator, which in turn governs the speed of the chart drive.

4. DOPPLER NAVIGATION

The Marconi AD560 Doppler navigation system installed in VH-BMG is essentially an analogue device. The standard equipment provides a digital readout of distances along and across track, in nautical miles, using a system of mechanical counters. Survey use requires a method of converting the Doppler co-ordinates to electronic digital form, with a much higher resolution. This is achieved by coupling a pair of commercially available synchro-to-digital converters, having a reading accuracy equivalent to a Doppler distance of approximately 3 cm, to the electrical signal lines that drive the standard Doppler display counters.

The computer simultaneously maintains two Doppler co-ordinate systems. The Doppler data recorded on magnetic tape are referred to one fixed origin for the duration of the survey flight. This origin can be set by the operator by flying the aircraft over some known reference point before starting the first survey line. If this procedure is not adopted and arbitrary origin is used, located at the point of commencement of the first survey line. Doppler position is recorded on magnetic tape every 10 seconds, the least significant digit being equivalent to a distance of 10 metres.

The other Doppler co-ordinate system provides the aircraft pilot with accurate navigational data for aircraft guidance along the required survey path. This system which is entirely controlled by the pilot from the flight compartment, produces a readout of distance across track (in the format 00.00 km) and along track (in the format 000.0 km) on a display, which is updated every second. An across-track analogue voltage is also produced on one digital-to-analogue converter channel. This signal is used to deflect the needle of a steering indicator on the pilot's instrument panel. Full-scale deflection of the needle to the left or right is equivalent to an across-track error of approximately 1 km. Two switches situated next to the Doppler display allow the pilot to tell the computer when to reset the Doppler distances to zero and when to

reverse the indication of left and right. The latter facility is required to maintain the correct sense of the steering data irrespective of whether the aircraft track is towards or away from the Doppler origin.

5. MAGNETIC TAPE RECORDING

Data are accumulated in the memory of the computer to form 10-second blocks for recording on magnetic tape. This block size was chosen mainly for compatibility with the 10-second fiducial timing system. With blocks of this size, the total loss of a block in the event of irrecoverable recording errors can be tolerated.

To simplify later processing of the field data tapes in a large-scale computer system (currently CSIRO's CDC 3600 and CYBER 76 computers), and also to lessen the dependence on a particular computer system, a simple binary format was chosen for the field tape. All data are recorded in the form of 24-bit binary words, with 116 words per record. A checksum word, being the arithmetic sum of all the data words in the block, is appended to the record and is used as a validity check when the record is read by the field data processing programs. Records having checksum errors are ignored. As error rates are very low it is generally not necessary to manually recover data contained in bad blocks.

A ten-second data record occupies approximately 7.5 cm of tape. A 1200-foot reel of tape would allow 13 hours of recording - double the maximum flight endurance.

One of the prime advantages of the computer-controlled acquisition system is the considerable amount of checking incorporated in the magnetic tape recording phase of the operations. Two levels of checking have been implemented. Firstly the Kennedy tape transport has a read-after-write facility ('flux check') that allows certain types of writing errors to be detected as writing takes place. On completion of a write operation the 'flux check' will indicate if any errors were detected in the recording of that block of data.

When a 'flux check' error occurs, the computer rewrites the data record on a new section of tape, leaving the incorrect record in situ. Three such attempts are allowed before a data block is abandoned. The computer notifies the operator of 'flux check' errors by incrementing a counter on the timer unit.

The second level of checking is done on a small sample of data blocks. After a record has been written, with no 'flux check' error, the

tape transport backspaces over the data record and reads the recorded information back into the computer memory, where it is checked bit by bit against the original version, still retained in the computer. If errors are detected the record is rewritten as in the case of a 'flux check' error. The check reading process is invoked from time to time by operator action (setting bit 0 of the computer switch register) but an option allows for automatic check reading at a predetermined sample rate.

6. RESULTS AND CONCLUSIONS

Two serious problems appeared in the first few months of operation. Both occur at infrequent intervals and affect the computer input/output system. The more common trouble produced a condition where all computer-controlled data transfers ceased. The other problem, almost as serious, prevented the recording of data onto magnetic tape because the tape recorder returned 'busy' status indefinitely to the computer. Small modifications to the computer program allow the computer to recognize the symptoms of both these problems and automatically re-initiate input/output with little or no loss of data.

After these problems were cleared up the operation of the system has been completely satisfactory. The reliability of individual system sub-units has been exceptionally high. Magnetic tape has proved to be a very reliable recording medium. A sample check on system performance showed that only 12 records out of 27 000 contained timing or recording errors. As this sample size is equivalent to the data produced in 75 hours of survey flying, error-free flights are common.

A number of small improvements to the acquisition system are currently planned. A light-weight thermal printer and keyboard has been acquired and will be interfaced to the computer. This will provide greatly increased communication and interaction between the system and the operator during flight and also allow better checking and playback of recorded data after a survey flight. It is also planned to increase the resolution of the recorded Doppler co-ordinates by a factor of 10 to give distances in metres. This may improve the accuracy of line/tie cross-over positions extracted from the Doppler data in the course of data reduction.

It is expected that further changes will be made from time to time as the system evolves and further experience accumulates.

The choice of employing a software-controlled data acquisition system, based on a digital computer, has been vindicated by the results obtained. The major advantages this system offers over a hardware-controlled system are:

- (a) The comprehensive checking of recorded data, making use of the 'flux check' facility and the backspace-and-read option.
- (b) The conversion of data to fixed-length binary words, and the inclusion of a checksum word when recording on magnetic tape.
- (c) The availability of the computer for Doppler navigation calculations.
- (d) The relative ease of making changes to the controlling software.

The current workload on the computer is very low; probably only one to two per cent of the available computer time is usefully spent. This unused computer time could be used for background tasks, but at present there does not appear to be much scope for this line of development in the aircraft environment.

Some disadvantages of this system are also apparent, mainly the higher initial cost and the large physical size and weight of the computer. Both these disadvantages are likely to disappear in the future, as mini-computers are rapidly becoming smaller and cheaper.

APPENDIX 1

TECHNICAL SPECIFICATIONS - DATA ACQUISITION EQUIPMENT

Digital computer

Make & model: Hewlett-Packard 2114B
Memory size: 8192 words
Word size: 16 bits
Cycle time: 2 microseconds

Digital input multiplexer

Make & model: Hewlett-Packard 12566A
Number of channels: 16
Word size: 16 bits

Digital-to-analogue multiplexer

Make & model: Hewlett-Packard 12555
Number of channels: 16
Word size: 10 bits including sign bit
Output voltage: -10 to +10 volts

Magnetic tape recorder

Make & model: Kennedy 1600, RH 7-track incremental recorder with 'flux check' option.
Recording: NRZI mode at 200 bpi, even or odd parity.
Writing rate: 500 characters per second.
Reading rate: 1000 characters per second.

APPENDIX 2

DATA ACQUISITION PROGRAM
ASSEMBLY LANGUAGE LISTING

```

0002 00000 NAM BMGV2
0003***
0004* GEOPHYSICAL DATA ACQUISITION PROGRAM FOR HEWLETT-PACKARD 2114B
0005* DIGITAL COMPUTER INSTALLED IN SURVEY AIRCRAFT VH-BMG
0006*
0007* SYSTEM HARDWARE CONFIGURATION -
0008*
0009* H-P 2114B DIGITAL COMPUTER WITH 8K MEMORY
0010* BMR AIRCRAFT TIMER NZA1
0011* H-P 16 CHANNEL DIGITAL INPUT MULTIPLEXER
0012* H-P 16 CHANNEL DIGITAL TO ANALOGUE OUTPUT MULTIPLEXER
0013* KENNEDY 1600 READ/WRITE INCREMENTAL MAGNETIC TAPE RECORDER
0014* H-P 40 BIT OUTPUT REGISTER
0015* 16 BIT INPUT/OUTPUT INTERFACE
0016*
0017* SIMPLE OUTLINE OF PROGRAM OPERATION -
0018*
0019* THE MAIN PROGRAM CONSISTS OF A LOOP THAT CONTINUALLY MONITORS THE
0020* CURRENT STATUS OF DATA ACQUISITION AND DATA OUTPUT ONTO MAGNETIC
0021* TAPE, IF THE AVAILABILITY OF DATA MEANS THAT WORK CAN BE DONE IN
0022* ONE OF THESE AREAS THAT JOB IS DONE. OTHERWISE CONTROL PASSES ON
0023* AROUND THE LOOP, NORMALLY THIS LOOP IS COMPLETED THOUSANDS OF
0024* TIMES PER SECOND - THAT IS THE COMPUTER SPENDS A LARGE PART OF ITS
0025* TIME WAITING FOR WORK,
0026*
0027* THE TIMER INTERRUPTS THE MAIN PROGRAM EVERY 0.2 SECONDS, A SPECIAL
0028* SUBROUTINE SEIZES CONTROL OF THE COMPUTER AND READS ALL REQUIRED
0029* DATA CHANNELS STORING THE READINGS IN THE INPUT BUFFER, THE
0030* MAGNETOMETER IS READ 5 TIMES PER SECOND BUT ALL OTHER CHANNELS ARE
0031* SAMPLED ONCE PER SECOND, A SPECIAL COUNTER IS INCREMENTED
0032* INDICATING TO THE MAIN PROGRAM THAT READINGS ARE AVAILABLE,
0033* CONTROL THEN RETURNS TO THE MAIN PROGRAM AT THE POINT OF INTERRUPT
0034*
0035* A SHORT TIME AFTER A TIMER INTERRUPT HAS OCCURED THE MAIN PROGRAM
0036* WILL DETECT THAT MORE READINGS ARE WAITING. THE READINGS ARE
0037* TRANSFERRED TO A CYCLIC HOLDING BUFFER. THE PROGRAM HAS FOUR OF
0038* THESE BUFFERS WHICH ARE USED ON A CYCLIC BASIS. EACH BUFFER HOLDS
0039* DATA ACQUIRED OVER A 10 SECOND FIDUCIAL PERIOD,
0040*
0041* AT THE SAME TIME MAGNETOMETER, GAMMA-RAY SPECTROMETER AND
0042* ALTIMETER READINGS ARE OUTPUT TO THE D/A CONVERTER PRODUCING
0043* VOLTAGE ANALOGUES OF THE GEOPHYSICAL DATA WHICH IS DISPLAYED ON
0044* CHART RECORDERS PROVIDING A USEFUL RECORD AS WELL AS BEING A
0045* VISUAL MONITOR OF SYSTEM OPERATION. DOPPLER ALONG AND CROSS TRACK
0046* COORDINATES ARE CALCULATED AND THE PILOTS DOPPLER DISPLAY IS
0047* UPDATED. DOPPLER POSITION AT THE START OF THE FIDUCIAL PERIOD IS
0048* STORED FOR INCLUSION ON THE MAGNETIC TAPE.

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0051*
0052* AT THE END OF A FIDUCIAL INTERVAL THE CURRENT CYCLIC BUFFER IS
0053* FULL UP AND IS FLAGGED FOR OUTPUT ONTO MAGNETIC TAPE, THE FLOW OF
0054* INPUT DATA IS SWITCHED TO START FILLING THE NEXT BUFFER, THE
0055* MAGNETIC TAPE OUTPUT ROUTINE NOTICES WHEN A FULL CYCLIC BUFFER IS
0056* AVAILABLE AND COMMENCES THE PROCESS OF OUTPUTTING THAT BLOCK OF
0057* DATA ONTO TAPE, DATA STORED IN BCD FORMAT IS CONVERTED TO 24 BIT
0058* BINARY FORMAT AND TRANSFERRED TO THE MAGNETIC TAPE OUTPUT BUFFER,
0059* A CHECKSUM WORD USED FOR CHECKING DURING PROCESSING IN CANBERRA
0060* IS ADDED AND THE BLOCK OF DATA IS WRITTEN ONTO TAPE AS ONE RECORD.
0061* ALL MT RECORDER OPERATIONS USE THE INTERRUPT SYSTEM,
0062* ALLOWING PROCESSING TO OVERLAP WITH INPUT/OUTPUT, WHEN THE WRITE
0063* OPERATION IS COMPLETE THE STATUS OF THE KENNEDY RECORDER
0064* FLUX-CHECK FACILITY IS USED TO DETECT IF ANY ERRORS WERE MADE IN
0065* WRITING THAT BLOCK, IF AN ERROR IS DETECTED ANOTHER ATTEMPT IS
0066* MADE AT RECORDING THE BLOCK, THREE ATTEMPTS ARE ALLOWED BEFORE
0067* THE BLOCK IS ABANDONNED, AS A FURTHER CHECK A RECORD CAN BE READ
0068* BACK INTO THE COMPUTER AND COMPARED WITH THE ORIGINAL DATA,

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0070* MULTIPLEXER CHANNEL ASSIGNMENTS AND CHART RECORDER SENSITIVITIES

0071*	CHANNEL	INPUT MULTIPLEXER	D/A MULTIPLEXER
0072*			
0073*			
0074*	1	MOST SIGNIFICANT MAG DIGIT	MAG 250 GAMMAS FSD
0075*	2	LOWER 4 MAG DIGITS	MAG 500 GAMMAS FSD
0076*	3	RADIO ALTIMETER	MAG 1000 GAMMAS FSD
0077*	4	FIDUCIAL NUMBER	ALTITUDE 500 METRES FSD
0078*	5	TOTAL COUNT	TOTAL COUNT 1000 FSD
0079*	6	POTASSIUM COUNT	K 250 COUNTS FSD
0080*	7	URANIUM COUNT	U 100 COUNTS FSD
0081*	8	THORIUM COUNT	TH 100 COUNTS FSD
0082*	9	DOPPLER ALONG TRACK	DOPPLER CROSS TRACK DC
0083*	10	DOPPLER CROSS TRACK	CHART SPEED CONTROL
0084*	11	FLIGHT NUMBER	

```

0086*
0087*  COMPUTER I/O SLOT ASSIGNMENTS

```

```
0088*
0089* 10 MICROCIRCUIT INTERFACE
0090* 11 INPUT MULTIPLEXER - NON INTERRUPT DEVICE
0091* 12 D/A MULTIPLEXER - NON INTERRUPT DEVICE
0092* 13 TELEPRINTER, UNIT REFERENCE 7
0093* 14 KENNEDY RECORDER, UNIT REFERENCE 10
0094* 15 PAPER TAPE READER, UNIT REFERENCE 11
0095* 16 40 BIT REGISTER - NON INTERRUPT DEVICE
```

0098***** MAGNETIC TAPE FORMAT *****

0099*

0100* ALL RECORDING IS IN ODD PARITY. THE FIRST INFORMATION ON THE TAPE
 0101* IS THE FLIGHT HEADER, THIS RECORD IS 80 CHARACTERS IN LENGTH AND
 0102* CONTAINS THE FLIGHT NUMBER, SURVEY DATA IS RECORDED IN 460
 0103* CHARACTER RECORDS, ONE RECORD IS PRODUCED EVERY 10 SECONDS, SURVEY
 0104* LINES ARE SEPARATED BY END-OF-FILE RECORDS AND THE FLIGHT IS
 0105* CONCLUDED BY 2 CONSECUTIVE EOF RECORDS

0106*

0107* DATA RECORDS HAVE A SIMPLE BINARY FORMAT WITH ALL INFORMATION
 0108* CONTAINED IN 24 BIT BINARY WORDS, THE ORDER OF INFORMATION WITHIN
 0109* A RECORD IS SET OUT BELOW,

0110*

0111*	WORD 1	BLOCK NUMBER
0112*	2	ATTEMPT NUMBER
0113*	3	DOPPLER ALONG TRACK
0114*	4	DOPPLER CROSS TRACK

0115*

0116* DATA FOR FIRST SECOND OF FIDUCIAL PERIOD

0117*

0118*	5	ALTITUDE
0119*	6	FIDUCIAL NUMBER
0120*	7	TOTAL COUNT
0121*	8	POTASSIUM COUNT
0122*	9	URANIUM COUNT
0123*	10	THORIUM COUNT
0124*	11	MAGNETOMETER READING AT 0.0 SEC
0125*	12	MAGNETOMETER READING AT 0.2 SEC
0126*	13	MAGNETOMETER READING AT 0.4 SEC
0127*	14	MAGNETOMETER READING AT 0.6 SEC
0128*	15	MAGNETOMETER READING AT 0.8 SEC

0129*

0130* DATA FOR NEXT 9 SECONDS IN WORDS 16-114 REPETITION OF
 0131* SEQUENCE FOR FIRST SECOND

0132*

0133* 115 CHECKSUM WORD

```

0136          ENT BMG1
0137          EXT ,IOC,,DINIT,DOP00
0138          COM BUFIN(200),BUFA(170),BUFB(170),BUFC(170)
0139          COM BUFD(170),BUFY(235),BUFZ(235)
0140 00000 000000 BMG1 NOP
0141***
0142* RESET PROGRAM STARTING CONDITIONS
0143***
0144 00001 107710      CLC MCR,C      CLEAR MICROCIRCUIT INTERFACE
0145 00002 102100      STF 0          TURN ON INTERRUPT SYSTEM
0146 00003 016001X     JSB ,IOC,      CLEAR SYSTEM
0147 00004 000000      OCT 0
0148***
0149* SET INPUT AND OUTPUT POINTERS TO THE FIRST CYCLIC BUFFER
0150* SADD AND QADD CONTAIN BUFFER STARTING ADDRESS, P AND R
0151* CONTAIN ADDRESS OF BUFFER STATUS WORD, P1 POINTS TO
0152* STATUS WORD OF THE NEXT CYCLIC BUFFER
0153***
0154 00005 060014B     LDA POINT      INITIALISE CYCLIC HOLDING BUFFER
0155 00006 070026B     STA QADD       SET INPUT BUFFER ADDRESS
0156 00007 070027B     STA SADD       SET OUTPUT BUFFER ADDRESS
0157 00010 002004      INA
0158 00011 070020B     STA P          SET BUFFER STATUS WORD ADDRESS
0159 00012 070022B     STA R
0160 00013 042023R     ADA =D3
0161 00014 070021B     STA P1
0162 00015 002400      CLA
0163 00016 070002B     STA TAB+1      CLEAR BUFFER STATUS WORDS
0164 00017 070005B     STA TAB+4
0165 00020 070010B     STA TAB+7
0166 00021 070013B     STA TAB+10
0167 00022 070053B     STA LINE      LINE ON FLAG
0168 00023 070054B     STA LEC       LINE END CHART CALIBRATE FLAG
0169 00024 070062B     STA SFLAG     SHORT BLOCK FLAG
0170 00025 070063B     STA TOTAL     INTERRUPT DATA INPUT COUNTER
0171 00026 070050B     STA CAL1
0172 00027 070052B     STA CAL3
0173 00030 070066B     STA CALS
0174 00031 002004      INA
0175 00032 070061B     STA BEGIN
0176 00033 070073B     STA BOUT1
0177 00034 070071B     STA BLOUT
0178 00035 063166R     LDA WRITA      CLEAR MT OUTPUT ROUTINE
0179 00036 073164R     STA MTFN
0180 00037 002400      CLA
0181 00040 070103B     STA MTFLG
0182 00041 070074B     STA MTFN2
0183 00042 063274R     LDA READC
0184 00043 003004      CMA,INA
0185 00044 070072B     STA RUNTR
0186 00045 016002X     JSB DINIT     INITIALISE DOPPLER ROUTINE
0187 00046 000053R     DEF **5
0188 00047 000032B     DEF K3
0189 00050 000053B     DEF LINE
0190 00051 000035B     DEF INPUT
0191 00052 001746R     DISPA DEF DDATA

```

0194***

0195* EXAMINE SWITCH REGISTER, IF ZERO, TAPE IS REWOUND TO LOAD POINT
 0196* HEADER RECORD IS WRITTEN - THIS IS NORMAL STARTING PROCEDURE.
 0197* IF BIT 15 IS SET TAPE IS NOT REWOUND AND NO HEADER IS RECORDED.
 0198* THIS PROCEDURE IS USED FOR RESTARTING PROGRAM DURING A SURVEY
 0199* FLIGHT WITHOUT OVERWRITING PREVIOUSLY RECORDED DATA

0200***

0201	00053	102501	SWREG	LIA 1	
0202	00054	006400		CLB	
0203	00055	106601		OTB 1	CLEAR SWITCH REGISTER
0204	00056	052024R		CPA =B100000	IS BIT 15 OF SWITCH REG SET?
0205	00057	026142R		JMP AA1	YES CONTINUE RECORDING
0206	00060	002003		SZA,RSS	
0207	00061	026064R		JMP **3	
0208	00062	102000		HLT 0	ILLEGAL SWITCH REGISTER - SET
0209	00063	026053R		JMP SWREG	CORRECTLY AND TOUCH RUN TO GO
0210	00064	016001X	REWMT	JSB .100.	REWIND MT AND LOAD FORWARD TO
0211	00065	030410		OCT 030410	BEGINNING OF TAPE MARKER
0212	00066	102033		HLT 33B	REQUEST REJECTED
0213	00067	000000		NOP	
0214	00070	000000		NOP	
0215	00071	016001X		JSB .100.	GET STATUS
0216	00072	040010		OCT 040010	
0217	00073	002020		SSA	READY?
0218	00074	026071R		JMP **3	NO - KEEP LOOPING
0219	00075	103711		STC MPX,C	STORE DATA INTO MPX INPUTS
0220	00076	062025R		LDA =B2000	SELECT CHANNEL 11
0221	00077	102611		OTA MPX	
0222	00100	102511		LIA MPX	READ FLIGHT NO. FROM THUMBWHEEL
0223	00101	001727		ALF,ALF	
0224	00102	070001		STA 1	
0225	00103	012026R		AND =B17	ISOLATE FIRST DIGIT
0226	00104	032027R		IOR =B26400	MERGE IN CHARACTER T
0227	00105	042030R		ADA =B33	
0228	00106	073756R		STA FLNO	
0229	00107	060001		LDA 1	
0230	00110	001700		ALF	
0231	00111	070001		STA 1	
0232	00112	012026R		AND =B17	ISOLATE THIRD DIGIT
0233	00113	001727		ALF,ALF	
0234	00114	070041B		STA TT1	
0235	00115	060001		LDA 1	
0236	00116	001700		ALF	
0237	00117	012026R		AND =B17	ISOLATE SECOND DIGIT
0238	00120	030041B		IOR TT1	
0239	00121	042031R		ADA =B15433	
0240	00122	073757R		STA FLNO+1	STORE IN LABEL

0243***

0244* FLIGHT NUMBER IS PART OF 80 CHARACTER HEADER RECORD - CODE IS
 0245* CDC 7600 RCD. THE FIRST 10 CHARACTERS ARE FLIGHT 123. THE REST
 0246* OF THE RECORD IS BLANK CHARACTERS.

0247***

0248	00123 016001X	JSB .IOC.	WRITE HEADER RECORD ON MT
0249	00124 020110	OCT 20110	
0250	00125 102007	HLT 7B	REQUEST REJECTED BY .IOC.
0251	00126 001753R	DEF LABEL	- THIS SHOULD NOT OCCUR
0252	00127 177660	DEC -80	
0253	00130 016001X	JSB .IOC.	GET STATUS
0254	00131 040010	OCT 040010	
0255	00132 002020	SSA	READY?
0256	00133 026130R	JNP *-3	NO - KEEP LOOPING
0257	00134 001323	RAR,RAR	POSITION WRITE ENABLE BIT
0258	00135 000010	SLA	TEST
0259	00136 102011	HLT 11B	WRITE ENABLE RING MISSING
0260	00137 001200	RAL	POSITION FLUX CHECK BIT
0261	00140 000010	SLA	TEST
0262	00141 026064R	JNP REWIT	WRITE ERROR - KEEP TRYING
0263	00142 063745R AA1	LDA AJSHI	ESTABLISH INTERRUPT LINK
0264	00143 070010	STA MCR	
0265	00144 103710	STC MCR,C	SET CONTROL ON GPIO INTERFACE
0266	00145 026277R	JNP AAA	THEN ENTER MAIN PROGRAM LOOP

0270***

0271* PROCESSOR FOR TIMER INTERRUPTS - TIMER SETS FLAG ON MCR INTERFAC

0272* EVERY 0.2 SEC CAUSING INTERRUPT ROUTINE TO READ AND STORE DATA

0273***

0274	00146	000000	INTRR NOP	INTERRUPT PROCESSOR
0275	00147	070045H	STA SAVA	-----A
0276	00150	074046H	STB SAVB	-----B SAVE REGISTERS
0277	00151	001520	ERA,ALS	-----F
0278	00152	102201	SOC	-----0
0279	00153	002004	INA	-----
0280	00154	070047H	STA SAVED	
0281	00155	103711	STC MPX,C	OUTPUT READ COMMAND TO INPUT M
0282	00156	062276H	LDA TIMEF	RESET INTERRUPT FAIL COUNTER
0283	00157	072275H	STA TIMEC	
0284	00160	102510	LIA MCR	GET SYSTEM CONTROL DATA
0285	00161	001300	RAR	
0286	00162	070035H	STA INPUT	SAVE
0287	00163	002020	SSA	IS THE 10 SECOND BIT ON?
0288	00164	026200H	JMP STARB	YES
0289	00165	060071H	LDA BOUT	
0290	00166	002003	SZA,RSS	ARE READINGS TO BE ACCEPTED?
0291	00167	026224H	JMP READ	YES
0292	00170	060073H	LDA BOUT1	10 SEC SIGNAL HAS BEEN MISSED
0293	00171	002002	SZA	IS THIS 1ST TIME?
0294	00172	026261H	JMP RETRN	NO - WAIT FOR 10 SEC SIGNAL
0295	00173	002004	INA	YES - PRETEND THIS IS A 10 SEC
0296	00174	070073H	STA BOUT1	INTERRUPT AND CONTINUE ON PUT
0297	00175	060035H	LDA INPUT	ONLY ONCE, NO FURTHER BLOCKS
0298	00176	032024H	IOR =010000	UNTIL 10 SEC PULSE SEEN
0299	00177	070035H	STA INPUT	
0300	00200	002400	CLA	
0301	00201	026212	JMP BLOCK+2	
0302	00202	060071H	STARB LDA BOUT	LAST 10 SEC BLOCK COMPLETE
0303	00203	002002	SZA	
0304	00204	026211H	JMP BLOCK	YES
0305	00205	002400	CLA	NO - SET SHORT BLOCK FLAG
0306	00206	070063H	STA TOTAL	
0307	00207	002004	INA	
0308	00210	070062H	STA SFLAG	
0309	00211	002400	BLOCK CLA	
0310	00212	070073H	STA BOUT1	
0311	00213	070071H	STA BOUT	
0312	00214	060015H	LDA INUFF	SET ADDRESS POINTER TO START OF
0313	00215	070016H	STA INPUF	THE INTERRUPT BUFFER
0314	00216	062032H	LDA =0-50	
0315	00217	070030H	STA K1	SET 10 SEC TIMING COUNTER
0316	00220	003400	CCA	
0317	00221	070031H	STA K2	SET 1 SEC TIMING COUNTER
0318	00222	060035H	LDA INPUT	GET SYSTEM STATUS AT START OF
0319	00223	070064H	STA SSTAT	10 SEC BLOCK AND SAVE

0322	00224	034031B	READ	ISZ K2	IS IT A 1 SEC INTERRUPT?
0323	00225	026242R		JMP TSEC	
0324	00226	066033R		LDB #B4	YES
0325	00227	062034R		LDA #D-8	
0326	00230	070076B		STA AL00P	
0327	00231	106611	NCHAN	OTB MPX	SELECT MPX CHANNEL
0328	00232	005200		RBL	ROTATE BIT TO NEXT CHANNEL
0329	00233	102511		LIA MPX	READ SELECTED CHANNEL
0330	00234	170016B		STA INBUF,I	STORE IN INPUT BUFFER
0331	00235	034016B		ISZ INBUF	BUMP BUFFER ADDRESS
0332	00236	034076B		ISZ AL00P	
0333	00237	026231R		JMP NCHAN	BACK FOR NEXT CHAN
0334	00240	062035R		LDA #D-5	
0335	00241	070031B		STA K2	RESET 1 SEC COUNTER
0336	00242	006404	TSEC	CLB,INB	
0337	00243	106611		OTB MPX	SELECT CHANNEL 1
0338	00244	005200		RBL	
0339	00245	102511		LIA MPX	READ MAGNETOMETER CHAN 1
0340	00246	170016B		STA INBUF,I	STORE
0341	00247	034016B		ISZ INBUF	BUMP ADDRESS
0342	00250	106611		OTB MPX	SELECT CHANNEL 2
0343	00251	102511		LIA MPX	READ MAG CHANNEL 2
0344	00252	170016B		STA INBUF,I	STORE
0345	00253	034016B		ISZ INBUF	BUMP ADDRESS
0346	00254	034063B		ISZ TOTAL	INCREMENT DATA INPUT COUNTER
0347	00255	034030B		ISZ K1	50TH INTERRUPT SINCE 10 SEC?
0348	00256	026261R		JMP RETRN	NO - TAKE READINGS
0349	00257	002404		CLA,INA	YES - SET FLAG TO INDICATE 10
0350	00260	070071B		STA BLOUT	SEC SIGNAL EXPECTED NEXT TIME
0351	00261	060036B	RETRN	LDA OTPUT	GPIO SYSTEM CONTROL OUTPUT
0352	00262	102610		OTA MCR	
0353	00263	002400		CLA	
0354	00264	070036B		STA OTPUT	
0355	00265	060047B		LDA SAVE0	
0356	00266	103101		CL0	
0357	00267	000036		SLA,ELA	-----E
0358	00270	102101		STF 1	-----0 RESTORE REGISTERS
0359	00271	060045B		LDA SAVA	-----A
0360	00272	064046B		LDB SAVB	-----B
0361	00273	103710		STC MCR,C	RESET CONTROL ON GP INTERFACE
0362	00274	126146R		JMP INTRR,I	RETURN TO INTERRUPTED PROGRAM

0365* TIMEF IS A VARIABLE WHICH MUST BE ADJUSTED WHEN CHANGES ARE MADE
0366* EFFECTING THE BASIC LOOP FREQUENCY OF THE MAIN PROGRAM,

0367 00275 000000 TIMEC NOP
0368 00276 160000 TIMEF OCT 160000

0369***

0370* THE FOLLOWING SECTION OF THE PROGRAM CHECKS IF DATA IS
0371* WAITING IN THE INPUT BUFFER, IF SO THE DATA IS TRANSFERRED
0372* TO A CYCLIC HOLDING BUFFER AND ALSO OUTPUT TO D/A FOR CHART
0373* RECORDER

0374***

0375	00277	036275R	AAA	ISZ TIMEC	INTERRUPT FAIL COUNTER RUN DOWN?
0376	00300	026315R		JMP INTOK	NO
0377	00301	103100		CLF 0	YES - TIMER INTERRUPT OVERDUE
0378	00302	016001X		JSB ,IOC,	TURN OFF INTERRUPT SYSTEM AND
0379	00303	000000		OCT 0	CLEAR IOC
0380	00304	002404		CLA, INA	
0381	00305	070101B		STA GAPMT	RESET MT OUTPUT ROUTINE
0382	00306	063166R		LDA WRITA	TO RE-WRITE ANY PARTLY
0383	00307	073164R		STA MTFN	COMPLETED RECORD
0384	00310	060036B		LDA OUTPUT	
0385	00311	032036R		IOR =D2	BUMP ERROR COUNTER
0386	00312	070036B		STA OUTPUT	
0387	00313	102100		STF 0	TURN ON INTERRUPT SYSTEM
0388	00314	103710		STC MCR,C	AND SET CONTROL ON MCR
0389	00315	060062B	INTOK	LDA SFLAG	
0390	00316	002002		SZA	SHORT BLOCK?
0391	00317	026723R		JMP SHORT	YES - PROCESS SHORT BLOCK
0392	00320	060063B		LDA TOTAL	NEW DATA WAITING IN INPUT BUFFER
0393	00321	002003		SZA, RSS	
0394	00322	027120R		JMP MTO	NO - CONTINUE AROUND LOOP
0395	00323	042037R		ADA =D=1	YES
0396	00324	070063B		STA TOTAL	ADJUST DATA INPUT COUNTER
0397	00325	060061B		LDA BEGIN	
0398	00326	002003		SZA, RSS	START OF 10 SEC BLOCK?
0399	00327	026425R		JMP BLK1	NO
0400	00330	160026B		LDA QADD, I	YES - GET ADDRESS OF NEXT
0401	00331	070023B		STA Q	CYCLIC BUFFER
0402	00332	072675R		STA DOPAD	SAVE DOPPLER STORAGE ADDRESS
0403	00333	042033R		ADA =D4	SKIP OVER DOPPLER STORAGE
0404	00334	070024B		STA Q1	
0405	00335	070025B		STA Q2	
0406	00336	003400		CCA	
0407	00337	070033B		STA K4	SET 1 SEC COUNTER
0408	00340	062040R		LDA =D-2	
0409	00341	070056B		STA RESET	SCINTO RESET COUNTER
0410	00342	062032R		LDA =D=50	
0411	00343	070032B		STA K3	SET 10 SEC COUNTER
0412	00344	002400		CLA	
0413	00345	070061B		STA BEGIN	SET BLOCK IN PROGRESS FLAG
0414	00346	060015B		LDA Ibuff	
0415	00347	070017B		STA INBF2	INPUT BUFFER ADDRESS
0416	00350	060064B		LDA SSTAT	

0419	00351	000010	SLA	IS A LINE BEING FLOWN?
0420	00352	026407R	JMP SLINE	YES
0421	00353	060053B	LDA LINE	NO HAS LINE JUST ENDED?
0422	00354	002002	SZA	
0423	00355	026367R	JMP ENDLI	YES
0424	00356	102501	LIA 1	GET SWITCH REGISTER CONTENTS
0425	00357	052037R	CPA =D-1	ALL BITS SET?
0426	00360	002001	RSS	
0427	00361	026425R	JMP BLK1	NO
0428	00362	160022B	LDA R,I	YES - END THE FLIGHT
0429	00363	002002	SZA	WAIT FOR MT OUTPUT TO END
0430	00364	026425R	JMP BLK1	THEN
0431	00365	102601	OTA 1	CLEAR SWITCH REGISTER
0432	00366	027373R	JMP ENDIT	TERMINATE
0433	00367	002404	ENDLI CLA,INA	
0434	00370	070054B	STA LEC	SET LINE END CALIBRATE FLAG
0435	00371	003400	CCA	SET BUFFER STATUS TO -1
0436	00372	170020B	STA P,I	TO WRITE EOF AT END OF LINE
0437	00373	034020B	ISZ P	MOVE POINTERS TO NEXT BUFFER
0438	00374	160020B	LDA P,I	
0439	00375	070026B	STA QADD	
0440	00376	002004	INA	
0441	00377	070020B	STA P	
0442	00400	034021B	ISZ P1	
0443	00401	160021B	LDA P1,I	
0444	00402	002004	INA	
0445	00403	070021B	STA P1	
0446	00404	002400	CLA	
0447	00405	070053B	STA LINE	REMOVE LINE ON FLAG
0448	00406	026425R	JMP BLK1	
0449	00407	160021B	SLINE LDA P1,I	
0450	00410	002003	SZA,RSS	NEXT CYCLIC BUFFER FREE?
0451	00411	026413R	JMP **2	
0452	00412	002404	CLA,INA	NO, SET ABORT FLAG
0453	00413	070040B	STA ABORT	
0454	00414	060053B	LDA LINE	
0455	00415	002002	SZA	HAS LINE JUST STARTED?
0456	00416	026425R	JMP BLK1	NO
0457	00417	002404	CLA,INA	
0458	00420	070053B	STA LINE	
0459*				
0460*	KENNEDY IS PRONE TO ERRORS ON FIRST WRITE AFTER A LONG PAUSE -			
0461*	THIS PROBLEM IS OVERCOME BY WRITING A GAP BEFORE STARTING LINE			
0462*				
0463	00421	070101B	STA GAPMT	SET MT GAP FLAG
0464	00422	060036B	LDA OUTPUT	MAGNETOMETER CALIBRATE AT START
0465	00423	032033R	IOR =B4	OF LINE
0466	00424	070036B	STA OUTPUT	
0467	00425	034033B	BLK1 ISZ K4	ONE SECOND READING?
0468	00426	026450R	JMP ,2MAG	NO
0469	00427	062041R	LDA =D=6	
0470	00430	070034B	STA K5	

0473	00431	160017B	ONE,0	LDA INBF2,I	TAKE READING FROM INPUT BUFFER
0474	00432	170024B		STA Q1,I	AND STORE IN CYCLIC BUFFER
0475	00433	034017B		ISZ INBF2	BUMP ADDRESSES
0476	00434	034024B		ISZ Q1	
0477	00435	034034B		ISZ K5	
0478	00436	026431R		JMP ONE,0	
0479	00437	160017B		LDA INBF2,I	STORE DOPPLER SYNCHRO READINGS
0480	00440	034017B		ISZ INBF2	
0481	00441	070077B		STA LSYN	ALONG TRACK
0482	00442	160017B		LDA INBF2,I	
0483	00443	034017B		ISZ INBF2	
0484	00444	070100B		STA XSYN	CROSS TRACK
0485	00445	062035R		LDA =D=5	
0486	00446	070033B		STA K4	SET ONE SECOND COUNTER
0487	00447	070065B		STA ONES	
0488	00450	160017B	,2MAG	LDA INBF2,I	TRANSFER MAGNETOMETER READINGS
0489	00451	003000		CMA	COMPLEMENT DANA LOGIC
0490	00452	170024B		STA Q1,I	
0491	00453	034017B		ISZ INBF2	
0492	00454	034024B		ISZ Q1	
0493	00455	160017B		LDA INBF2,I	
0494	00456	003000		CMA	
0495	00457	170024B		STA Q1,I	
0496	00460	034017B		ISZ INBF2	
0497	00461	034024B		ISZ Q1	

0001***

0002* FOLLOWING SECTION CONTROLS DATA OUTPUT TO CHART RECORDERS, THE 3
0003* LEAST SIGNIFICANT DIGITS OF EACH DATA CHANNEL ARE CONVERTED TO
0004* BINARY AND OUTPUT TO D/A CONVERTER, CHART RECORDERS ARE ADJUSTED
0005* TO 4.89 VOLTS FOR FULL SPAN, CALIBRATE FACILITY IS PROVIDED
0006* WHEREBY ZERO AND FULL SCALE IS OUTPUT TO ALL RECORDERS TO ALLOW
0007* ADJUSTMENTS TO BE MADE WHEN BIT 1 OF SWITCH REGISTER IS SET, AT
0008* END OF LINE ZERO IS OUTPUT FOR 5 SEC FULL SCALE FOR 5 SEC.

0009***

0010	00462	060053H	LDA LINE	LINE IN PROGRESS?
0011	00463	002002	SZA	
0012	00464	026556H	JMP LIN1	YES
0013	00465	060054H	LDA LEC	
0014	00466	002003	SZA, RSS	LINE END CALIBRATE?
0015	00467	026477H	JMP CBCH	
0016	00470	002400	CLA	YES
0017	00471	070054H	STA LEC	
0018	00472	070050H	STA CAL1	
0019	00473	070052H	STA CAL3	
0020	00474	002004	INA	
0021	00475	070066H	STA CAL5	SET CALIBRATE FLAG
0022	00476	026514H	JMP CBCH0	
0023	00477	060066H	CBCH LDA CAL5	CALIBRATE IN PROGRESS?
0024	00500	002002	SZA	
0025	00501	026514H	JMP CBCH0	YES
0026	00502	060032H	LDA K5	
0027	00503	052032H	CPA =D=50	START OF 10 SEC BLOCK?
0028	00504	002001	RSS	
0029	00505	026556H	JMP LIN1	NO
0030	00506	102501	LIA 1	GET SWITCH REGISTER
0031	00507	052036H	CPA =D2	IS CALIBRATE BIT SET?
0032	00510	002001	RSS	
0033	00511	026556H	JMP LIN1	NO
0034	00512	002404	CLA, INA	
0035	00513	070066H	STA CAL5	SET CALIBRATE FLAG
0036	00514	060052H	CBCH0 LDA CAL3	
0037	00515	002002	SZA	
0038	00516	026535H	JMP CBCH5	DO FULL SCALE PART NOW
0039	00517	060050H	LDA CAL1	START OF CALIBRATE CYCLE?
0040	00520	002002	SZA	
0041	00521	026526H	JMP **5	NO
0042	00522	002404	CLA, INA	
0043	00523	070050H	STA CAL1	
0044	00524	062042H	LDA =D-25	
0045	00525	070051H	STA CAL2	SET 5 SECOND COUNTER
0046	00526	034051H	ISZ CAL2	5 SEC UP?
0047	00527	026533H	JMP CBCH1	
0048	00530	002404	CLA, INA	YES - START FULL SCALE CAL
0049	00531	070052H	STA CAL3	
0050	00532	026535H	JMP **3	
0051	00533	006400	CBCH1 CLB	OUTPUT ZERO ON ALL CHANNELS
0052	00534	026553H	JMP CALCH	

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0055 00535 060032R CBCH5 LDA K3
0056 00536 052032R CPA =D=50 START OF 10 SEC BLOCK?
0057 00537 002001 RSS
0058 00540 026551R JMP CBCH9 NO - CONTINUE CALIBRATE
0059 00541 006400 CLR YES - RESET CALIBRATE ZERO
0060 00542 074050R STB CAL1
0061 00543 074052R STB CAL3
0062 00544 102501 LIA 1 IS CALIBRATE BIT STILL ON?
0063 00545 052036R CPA =D2
0064 00546 026514R JMP CBCH9 YES - CONTINUE
0065 00547 074066R STB CAL5 NO - CLEAR CALIBRATE FLAG
0066 00550 026556R JMP LIN1
0067 00551 066043R CBCH9 LDB =D1000 OUTPUT FULL SCALE ON ALL PENS
0068 00552 026553R JMP CALCH
0069 00553 062037R CALCH LDA =D=1
0070 00554 016764R JSB ,DTA
0071 00555 026665R JMP BLKE1
0072***
0073* GEOPHYSICAL DATA OUTPUT TO CHART RECORDERS ****
0074***
0075 00556 060065R LIN1 LDA ONES ONE SECOND INTERVAL?
0076 00557 002003 SZA,RSS
0077 00560 026643R JMP MCHAR NO
0078 00561 062756R LDA LRD
0079 00562 072757R STA LRAD
0080 00563 034056R ISZ RESET
0081 00564 026572R JMP NOSET
0082 00565 002400 CLA
0083 00566 072760R STA LR SCALERS RESET IMMEDIATELY AFTER
0084 00567 072761R STA LR+1 10 SEC SO CLEAR LAST READINGS
0085 00570 072762R STA LR+2
0086 00571 072763R STA LR+3
0087 00572 160025R NOSET LDA Q2,I PICK UP RA READING
0088 00573 034025R ISZ Q2 BUMP ADDRESS
0089 00574 017011R JSB BCDH CONVERT TO BINARY
0090 00575 017042R JSB FS500 500 METRES FULL SCALE AND
0091 00576 007004 CMH,INB INVERT ALTITUDE PROFILE
0092 00577 046043R ADR =D1000
0093 00600 062023R LDA =D3
0094 00601 016764R JSB ,DTA OUTPUT TO CHART THROUGH D/A
0095 00602 034025R ISZ Q2 SKIP OVER FIDUCIAL NUMBER
0096 00603 160025R LDA Q2,I SPECTROMETER CHANNEL 1
0097 00604 034025R ISZ Q2 BUMP ADDRESS
0098 00605 017011R JSB BCDH CONVERT TO BINARY
0099 00606 016745R JSB DESCL TAKE DIFFERENCE
0100 00607 046044R ADR =D100 ADD 100 COUNTS TO SHIFT BASELIN
0101 00610 046045R ADR =D=10000
0102 00611 006020 SSB TEST IF NOW EXCEEDS 1000
0103 00612 046046R ADR =D10000
0104 00613 062033R LDA =D4 TOTAL COUNT 1000 FSD
0105 00614 016764R JSB ,DTA ON D/A CHANNEL 5

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0108	00615	160025B	LDA Q2,I	SPECTROMETER CHANNEL 2
0109	00616	034025B	ISZ Q2	
0110	00617	017011R	JSB BCDH	CONVERT TO BINARY
0111	00620	016745R	JSB DESCL	
0112	00621	017050R	JSB FS250	K COUNT 250 FSD
0113	00622	062047R	LDA =D5	ON
0114	00623	016764R	JSB ,DTA	D/A CHANNEL 6
0115	00624	160025B	LDA Q2,I	SPECTROMETER CHANNEL 3
0116	00625	034025B	ISZ Q2	
0117	00626	017011R	JSB BCDH	CONVERT TO BINARY
0118	00627	016745R	JSB DESCL	
0119	00630	046050R	ADR =D10	ADD 10 COUNTS TO SHIFT BASELIN
0120	00631	017057R	JSB FS100	U COUNT 100 FSD
0121	00632	062051R	LDA =D6	
0122	00633	016764R	JSB ,DTA	ON D/A CHANNEL 7
0123	00634	160025B	LDA Q2,I	SPECTROMETER CHANNEL 4
0124	00635	034025B	ISZ Q2	
0125	00636	017011R	JSB BCDH	CONVERT TO BINARY
0126	00637	016745R	JSB DESCL	
0127	00640	017057R	JSB FS100	TH COUNT 100 FSD
0128	00641	062052R	LDA =D7	ON D/A CHANNEL 8
0129	00642	016764R	JSB ,DTA	
0130	00643	160025B	MCHAR LDA Q2,I	GET MOST SIGNIFICANT MAG DIGIT
0131	00644	070057B	STA TPO	AND SAVE
0132	00645	034025B	ISZ Q2	BUMP ADDRESS
0133	00646	160025B	LDA Q2,I	GET 4 LEAST SIGNIFICANT MAG
0134	00647	070060B	STA TPO+1	DIGITS AND SAVE
0135	00650	034025B	ISZ Q2	BUMP ADDRESS
0136	00651	017011R	JSB BCDH	CONVERT
0137	00652	077072R	STR ,FST,	
0138	00653	062036R	LDA =D2	
0139	00654	016764R	JSB ,DTA	1000 GAMMAS ON D/A CHANNEL 3
0140	00655	067072R	LDB ,FST,	
0141	00656	017042R	JSB FS500	
0142	00657	002404	CLA ,IDAT	
0143	00660	016764R	JSB ,DTA	500 GAMMAS ON D/A CHANNEL 2
0144	00661	067072R	LDB ,FST,	
0145	00662	017050R	JSB FS250	
0146	00663	002400	CLA	
0147	00664	016764R	JSB ,DTA	250 GAMMAS ON D/A CHANNEL 1

0150	00665	060065B	BLKE1	LDA ONES	IS IT A ONE SEC INTERVAL?
0151	00666	002003		SZA,RSS	
0152	00667	026700R		JMP NODOP	NO
0153	00670	002400		CLA	
0154	00671	070065B		STA ONES	
0155	00672	060077B		LDA LSYN	
0156	00673	064100B		LDB XSYN	PICK UP DOPPLER READINGS AND
0157	00674	016003X		JSB DOP00	GO TO DOPPLER ROUTINE
0158	00675	000000	DOPAD	NOP	ADDRESS OF DOPPLER IN BUFFER
0159	00676	066052R		LDB DISPA	
0160	00677	017073R		JSB REG40	OUTPUT TO 40 BIT REGISTER
0161	00700	034032B	NODOP	ISZ K3	END OF 10 SEC BLOCK?
0162	00701	027120R		JMP MTO	NO
0163***					
0164* END OF 10 SEC PERIOD, IF FLYING LINE RELEASE FULL CYCLIC BUFFER					
0165* FOR MAGNETIC TAPE OUTPUT AND MOVE INPUT POINTERS TO NEXT BUFFER					
0166***					
0167	00702	060053B		LDA LINE	FLYING LINE?
0168	00703	002003		SZA,RSS	
0169	00704	026720R		JMP BLKE5	NO
0170	00705	002404	BLKE2	CLA,INA	YES - FLAG BUFFER FOR OUTPUT
0171	00706	170020B		STA P,I	
0172	00707	034020B		ISZ P	
0173	00710	160020B		LDA P,I	MOVE INPUT POINTERS TO NEXT
0174	00711	070026B		STA GADD	CYCLIC BUFFER
0175	00712	002004		INA	
0176	00713	070020B		STA P	
0177	00714	034021B		ISZ P1	
0178	00715	160021B		LDA P1,I	
0179	00716	002004		INA	
0180	00717	070021B		STA P1	
0181	00720	002404	BLKE5	CLA,INA	SET START NEW BLOCK FLAG
0182	00721	070061B		STA BEGIN	
0183	00722	027120R		JMP MTO	GO TO MT OUTPUT CONTROL SECTION

0186***

0187* SHORT BLOCK PROCESSOR, IF LESS THAN FIFTY 0.2 SEC INTERRUPTS
0188* BETWEEN 10 SEC PULSES UNUSED PART OF CYCLIC BUFFER IS FILLED WITH
0189* ZEROS AND RELEASED FOR OUTPUT.

0190***

0191	00723	002400	SHORT	CLA	
0192	00724	0700628		STA SFLAG	CLEAR
0193	00725	0600538		LDA LINE	
0194	00726	002003		SZA, RSS	
0195	00727	026720R		JNP BLKE5	IGNORE IF LINE OFF
0196	00730	1600218		LDA P1, I	
0197	00731	002002		SZA	
0198	00732	026720R		JNP BLKE5	IGNORE IF BUFFERS FULL
0199	00733	0600238		LDA Q	
0200	00734	003004		CMA, INA	
0201	00735	0400248		ADA Q1	CALCULATE NUMBER OF UNUSED
0202	00736	042053R		ADA =D-164	WORDS IN RECORD
0203	00737	006400		CLB	
0204	00740	1740248	BFILL	STB Q1, I	FILL UNUSED PART WITH ZEROS
0205	00741	0340248		ISZ Q1	
0206	00742	034000		ISZ 0	
0207	00743	026740R		JMP BFILL	
0208	00744	026705R		JMP BLKE2	

0211***

0212***** VARIOUS SUBROUTINES *****

0213***

0214***

0215*** DESCL CALCULATES 1 SECOND COUNT RATES BY TAKING SUCCESSIVE

0216*** DIFFERENCES OF SCALER READINGS

0217***

```

0218 00745 000000 DESCL NOP
0219 00746 074000 STB 0
0220 00747 146757R ADB LRAD,I
0221 00750 003004 CMA,INA
0222 00751 172757R STA LRAD,I
0223 00752 036757R ISZ LRAD
0224 00753 006020 SSH
0225 00754 046043R ADR =D1000
0226 00755 126745R JMP DESCL,I
0227 00756 000760R LRQ DEF LR
0228 00757 000000 LRAD BSS 1
0229 00760 000000 LR BSS 4
    
```

0230***

0231*** ,DTA WORKS THE D/A MULTIPLEXER, ON ENTRY B CONTAINS THE OUTPUT

0232*** DATA AND A CONTAINS THE CHANNEL. IF A IS NEGATIVE OUTPUT IS

0233*** PRODUCED ON CHANNELS 1-8

0234***

```

0235 00764 000000 ,DTA NOP
0236 00765 002020 SSA OUTPUT ON ALL CHANNELS?
0237 00766 026775R JMP IO3 YES
0238 00767 001727 ALF,ALF
0239 00770 001700 ALF POSITION CHANNEL NO,
0240 00771 030001 IOR 1 MERGE IN DATA
0241 00772 102612 DTA DASC
0242 00773 103712 STC DASC,C
0243 00774 126764R JMP ,DTA,I
    
```

```

0245 00775 062034R IO3 LDA =D-8
0246 00776 073010R STA CC1 OUTPUT ON CHANS 0 TO 7
0247 00777 106612 LP8 CTB DASC
0248 01000 103712 STC DASC,C
0249 01001 005700 BLF
0250 01002 006004 INB
0251 01003 005727 BLF,BLF
0252 01004 005700 BLF
0253 01005 037010R ISZ CC1
0254 01006 026777R JMP LP8 NEXT CHANNEL
0255 01007 126764R JMP ,DTA,I
0256 01010 000000 CC1 NOP
    
```

0259***

0260*** BCDH CONVERTS A THREE DIGIT BCD QUANTITY TO BINARY

0261***

0262	01011	000000	BCDH	NOP	
0263	01012	001727		ALF,ALF	POSITION FIRST CHAR
0264	01013	073040R		STA TXX	
0265	01014	012026R		AND =B17	
0266	01015	064000		LDB 0	
0267	01016	017032R		JSB MUL	
0268	01017	063040R		LDA TXX	
0269	01020	001700		ALF	POSITION SECOND CHAR
0270	01021	073040R		STA TXX	
0271	01022	012026R		AND =B17	
0272	01023	044000		ADB 0	
0273	01024	017032R		JSB MUL	
0274	01025	063040R		LDA TXX	
0275	01026	001700		ALF	POSITION THIRD CHAR
0276	01027	012026R		AND =B17	
0277	01030	044000		ADB 0	
0278	01031	127011R		JMP BCDH,I	RETURN WITH BINARY IN R
0279	01032	000000	MUL	NOP	
0280	01033	005000		BLS	
0281	01034	077041R		STB TXY	
0282	01035	005020		BLS,BLS	
0283	01036	047041R		ADB TXY	
0284	01037	127032R		JMP MUL,I	
0285	01040	000000	TXX	BSS 1	
0286	01041	000000	TXY	BSS 1	

0289***

0290*** THE FOLLOWING GROUP OF SUBROUTINES PROVIDE 500,250 AND 100 UNIT
0291*** FULL SCALE OUTPUT ON THE CHART RECORDERS.

0292***

0293	01042	000000	FS500	NOP	500 UNITS FULL SCALE
0294	01043	046054R		ADB =D-500	
0295	01044	006020		SSB	
0296	01045	046055R		ADB =D500	
0297	01046	005000		BLS	
0298	01047	127042R		JMP FS500,I	

0300	01050	000000	FS250	NOP	250 UNITS FULL SCALE
0301	01051	046056R		ADB =D-250	
0302	01052	006021		SSB,RSS	
0303	01053	027051R		JMP *-2	
0304	01054	046057R		ADB =D250	
0305	01055	005020		BLS,BLS	
0306	01056	127050R		JMP FS250,I	

0308	01057	000000	FS100	NOP	100 UNITS FULL SCALE
0309	01060	046060R		ADB =D-100	
0310	01061	006021		SSB,RSS	
0311	01062	027060R		JMP *-2	
0312	01063	046044R		ADB =D100	
0313	01064	005000		BLS	
0314	01065	077071R		STB ,FSTM	
0315	01066	005020		BLS,BLS	
0316	01067	047071R		ADB ,FSTM	
0317	01070	127057R		JMP FS100,I	
0318	01071	000000	,FSTM	NOP	
0319	01072	000000	,FST,	NOP	

0322	01073	000000	REG40	NOP	40 BIT OUTPUT REGISTER DRIVER
0323	01074	106716		CLC REGSC	PRESET INTERFACE LOGIC
0324	01075	002400		CLA	
0325	01076	102616		OTA REGSC	OUTPUT CONTROL WORD
0326	01077	160001		LDA 1,I	
0327	01100	102616		OTA REGSC	OUTPUT 1ST 8 BITS
0328	01101	006004		INB	
0329	01102	160001		LDA 1,I	
0330	01103	102616		OTA REGSC	OUTPUT 2ND 8 BITS
0331	01104	006004		INB	
0332	01105	160001		LDA 1,I	
0333	01106	102616		OTA REGSC	OUTPUT 3RD GROUP
0334	01107	006004		INB	
0335	01110	160001		LDA 1,I	
0336	01111	102616		OTA REGSC	OUTPUT 4TH GROUP
0337	01112	006004		INB	
0338	01113	160001		LDA 1,I	
0339	01114	102616		OTA REGSC	OUTPUT FINAL 8 BITS
0340	01115	103716		STC REGSC,C	GIVE ENCODE COMMAND
0341	01116	127073R		JMP REG40,I	
0342	01117	000000	REGCW	OCT 0	

```

0001***
0002* MAGNETIC TAPE OUTPUT CONTROL ROUTINE*****
0003***
0004 01120 160022B MT0 LDA R,I FULL CYCLIC BUFFER WAITING IN
0005 01121 002003 SZA,RSS OUTPUT QUEUE?
0006 01122 026277R JMP AAA NO
0007 01123 016001X JSB ,IOC, GET MT RECORDER STATUS
0008 01124 040010 OCT 040010
0009 01125 002021 SSA,RSS MT BUSY?
0010 01126 027157R JMP MT02 NO
0011 01127 060103B LDA MTFLG YES
0012 01130 002002 SZA JUST STARTING NEW OPERATION?
0013 01131 027142R JMP MT01 NO
0014 01132 002004 INA YES - SET FLAG AND COUNTER TO
0015 01133 070103B STA MTFLG ALLOW APPROX 3 SECONDS FOR
0016 01134 060032B LDA K3 OPERATION TO BE COMPLETED
0017 01135 042061R ADA =D18
0018 01136 002021 SSA,RSS
0019 01137 042032R ADA =U=50
0020 01140 070102B STA MTIME
0021 01141 026277R JMP AAA
0022 01142 060102B MT01 LDA MTIME HAS THE 3 SECOND TIME LIMIT
0023 01143 050032B CFA K3 EXPIRED?
0024 01144 002001 RSS
0025 01145 026277R JMP AAA NO - GO BACK TO START OF LOOP
0026 01146 016001X JSB ,IOC, YES - CLEAR TAPE RECORDER AND
0027 01147 000010 OCT 000010 RESTART THE OPERATION
0028 01150 002400 CLA
0029 01151 070103B STA MTFLG
0030 01152 070074B STA MTFN2
0031 01153 002004 INA
0032 01154 070101B STA GAPMT
0033 01155 027167R JMP WRITA*1
0034 01156 027161R JMP **3
0035 01157 070067B MT02 STA MTSTF SAVE MT STATUS
0036 01160 074070B STB XLOG AND TRANSMISSION LOG
0037 01161 002400 CLA
0038 01162 070103B STA MTFLG
0039 01163 127164R JMP **1,I JUMP TO APPROPRIATE MT ROUTINE
0040 01164 000000 MTFN NOP ADDRESS STORED HERE
0041 01165 177775 ATNUM DEC =3 NUMBER OF WRITE ATTEMPTS ALLOW

```

```

0044***
0045* INITIATE WRITE OPERATION AND SET JUMP ADDRESS TO CHECK ROUTINE
0046***
0047 01166 001167R WRITA DEF **1
0048 01167 160022B LDA R,I
0049 01170 002020 SSA
0050 01171 027242R JMP ENDF
0051 01172 060101B LDA GAPMT
0052 01173 002003 SZA,RSS
0053 01174 027200R JMP **4
0054 01175 002400 CLA
0055 01176 070101B STA GAPMT
0056 01177 102614 OTA MTRSC
0057 01200 063165R LDA ATNUM
0058 01201 070037B STA ATTNO
0059 01202 160027B LDA SADD,I
0060 01203 067235R LDB BUFFO
0061 01204 017423R JSB BUFFI
0062 01205 063274R LDA READC
0063 01206 002020 SSA
0064 01207 027231R JMP RETRY
0065 01210 002003 SZA,RSS
0066 01211 027222R JMP WRIT2
0067 01212 034072B ISZ RCNTR
0068 01213 027222R JMP WRIT2
0069 01214 063274R LDA READC
0070 01215 003004 CMA,INA
0071 01216 070072B STA RCNTR
0072 01217 002404 WRIT1 CLA,INA
0073 01220 070074B STA MTFN2
0074 01221 027231R JMP RETRY
0075 01222 102501 WRIT2 LIA 1
0076 01223 052062R CPA =01
0077 01224 002001 RSS
0078 01225 027231R JMP RETRY
0079 01226 002400 CLA
0080 01227 102601 OTA 1
0081 01230 027217R JMP WRIT1
0082 01231 036136C RETRY ISZ BUFZ+3
0083 01232 016001X JSB ,IOC,
0084 01233 020110 OCT 020110
0085 01234 102033 HLT 33B
0086 01235 002133C BUFFO DEF BUFZ
0087 01236 177064 DEC -460
0088 01237 063252R LDA MTRCK
0089 01240 073164R STA MTFN
0090 01241 026277R JMP AAA
0091 01242 016001X ENDF JSB ,IOC,
0092 01243 030110 OCT 030110
0093 01244 102033 HLT 33B
0094 01245 000000 NOP
0095 01246 000000 NOP
0096 01247 063252R LDA MTRCK
0097 01250 073164R STA MTFN
0098 01251 026277R JMP AAA

```

DATA RECORD OR E-O-F?
WRITE END-OF-FILE
FIRST RECORD OF LINE?
NO
CLEAR WRITE SELECT BIT ON MT
INTERFACE? WILL CAUSE A GAP
AUTOMATICALLY ON NEXT WRITE
ALLOW THREE WRITE ATTEMPTS
GET ADDRESS OF CYCLIC BUFFER
ADDRESS OF OUTPUT BUFFER
CONVERT TO BINARY, ADD CHECKSUM
GET READBACK CONTROL WORD
NEGATIVE?
YES - NO READBACK POSSIBLE
ZERO?
YES - NO AUTO CHECK READ
IS IT THE NTH RECORD?
NO
YES?
RESET RECORD COUNTER?
SET CHECK READ FLAG
HAVE A LOOK AT SWITCH REGISTER
IF BIT 0 SET READ BACK AND
CHECK THIS RECORD
INSERT ATTEMPT NUMBER
INITIATE WRITE
REQUEST REJECTED?
SET JUMP ADDRESS TO NEXT
MT PROCESSOR ROUTINE
WRITE END-OF-FILE
REQUEST REJECTED BY ,IOC,?

```

0101***
0102* CHECK WRITE ON COMPLETION OF OPERATION THEN IF READING BACK
0103* REQUIRED INITIATE BACKSPACE
0104***
0105 01252 001253R MTCHK DEF **1
0106 01253 160022B LDA R,I
0107 01254 002020 SSA DATA RECORD OR EOF?
0108 01255 027311R JMP OKAY EOF
0109 01256 060067B LDA MTSTF GET STATUS
0110 01257 012063R AND =B40 TEST END-OF-TAPE BIT
0111 01260 002002 SZA
0112 01261 102055 HLT 55B *****END-OF-TAPE *****
0113 01262 060067B LDA MTSTF
0114 01263 001323 RAR,RAR POSITION WRITE ENABLE BIT
0115 01264 000010 SLA TEST
0116 01265 102044 HLT 44B WRITE ENABLE RING MISSING
0117 01266 001200 RAL POSITION PARITY ERROR BIT
0118 01267 002011 SLA,RSS TEST
0119 01270 060074B LDA MTFN2
0120 01271 002002 SZA
0121 01272 027324R JMP CHECKR
0122 01273 027311R JMP OKAY
0123 01274 000000 READC OCT 0
0124 01275 060036B NXTRY LDA OPUT BUMP ERROR COUNTERS
0125 01276 032062R IOR =B1
0126 01277 070036B STA OPUT
0127 01300 034037B ISZ ATTNO ANOTHER ATTEMPT?
0128 01301 002001 RSS
0129 01302 027306R JMP QUIT GIVE UP
0130 01303 060040B LDA ABORT
0131 01304 002003 SZA,RSS ALL BUFFERS FULL?
0132 01305 027231R JMP RETRY NO - TIME FOR ANOTHER TRY
0133 01306 060036B QUIT LDA OPUT YES - FORGO FURTHER ATTEMPTS
0134 01307 032036R IOR =D2 AND BUMP ERROR COUNTER 2
0135 01310 070036B STA OPUT
0136 01311 002400 OKAY CLA
0137 01312 070040B STA ABORT CLEAR POSSIBLE ABORT FLAG
0138 01313 170022B STA R,I RELEASE BUFFER
0139 01314 034022B ISZ R MOVE POINTERS TO NEXT BUFFER
0140 01315 160022B LDA R,I
0141 01316 070027B STA SADD
0142 01317 002004 INA
0143 01320 070022B STA R
0144 01321 063166R LDA WRITA SET JUMP ADDRESS
0145 01322 073164R STA MTFN
0146 01323 026277R JMP AAA

```

```

0149 01324 016001X CHECK JSB ,IOC,      ISSUE BSP COMMAND
0150 01325 031010      OCT 31010
0151 01326 102033      HLT 33B          REQUEST REJECTED?
0152 01327 000000      NOP
0153 01330 000000      NOP
0154 01331 063336R     LDA READR        SET JUMP ADDRESS
0155 01332 073164R     STA MTFN
0156 01333 002400      CLA              RESET FLAG TO READ ONLY
0157 01334 070074R     STA MTFN2
0158 01335 026277R     JMP AAA
0159***
0160* INITIATE READ ON COMPLETION OF BACKSPACE
0161***
0162 01336 001337R READR DEF **1
0163 01337 016001X     JSB ,IOC,      READ BACK THE RECORD
0164 01340 010010      OCT 10010
0165 01341 102033      HLT 33B          REQUEST REJECTED?
0166 01342 001560C BINY DEF BUFR
0167 01343 177064      DEC -460
0168 01344 063347R     LDA VERFY        SET JUMP ADDRESS
0169 01345 073164R     STA MTFN
0170 01346 026277R     JMP AAA
0171***
0172* CHECK READ OPERATION AND COMPARE DATA READ BACK WITH DATA IN
0173* OUTPUT BUFFER
0174***
0175 01347 001350R VERFY DEF **1
0176 01350 064070R     LDB XLOG          GET TRANSMISSION LOG
0177 01351 005665      ELR,CLE,ERB     CLEAR MODE BIT
0178 01352 056064R     CPB =D460       CHECK FOR CORRECT LENGTH
0179 01353 002001      RSS
0180 01354 027275R     JMP NXTRY        WRONG TRY AGAIN
0181 01355 062065R     LDA =D=230
0182 01356 073737R     STA INX1
0183 01357 063342R     LDA BINY
0184 01360 073740R     STA INX2
0185 01361 067235R     LDB BUFR0
0186 01362 163740R CMPAR LDA INX2,I
0187 01363 150001      CPA 1,I
0188 01364 002001      RSS
0189 01365 027275R     JMP NXTRY        ERROR
0190 01366 006004      INB
0191 01367 037740R     ISZ INX2
0192 01370 037737R     ISZ INX1
0193 01371 027362R     JMP CMPAR
0194 01372 027311R     JMP OKAY        NO ERRORS

```

0197***

0198* AT END OF FLIGHT WRITE 3 EOFS THEN REWIND AND UNLOAD TAPE

0199***

0200	01373	062066R	ENDIT	LDA	=D-3	
0201	01374	073737R		STA	INX1	
0202	01375	016001X	EOFS	JSB	,IOC,	WRITE EOF
0203	01376	030110		OCT	30110	
0204	01377	102033		HLT	33B	REQUEST REJECTED?
0205	01400	000000		NOP		
0206	01401	000000		NOP		
0207	01402	016001X		JSB	,IOC,	
0208	01403	040010		OCT	40010	
0209	01404	002020		SSA		
0210	01405	027402R		JMP	*-3	
0211	01406	037737R		ISZ	INX1	
0212	01407	027375R		JMP	EOFS	
0213	01410	016001X		JSB	,IOC,	UNLOAD TAPE
0214	01411	030510		OCT	30510	
0215	01412	102033		HLT	33B	REQUEST REJECTED?
0216	01413	000000		NOP		
0217	01414	000000		NOP		
0218	01415	016001X		JSB	,IOC,	
0219	01416	040010		OCT	40010	
0220	01417	002020		SSA		
0221	01420	027415R		JMP	*-3	
0222	01421	102077		HLT	77B	THE END
0223	01422	027421R		JMP	*-1	

0226***

0227* TRANSFER DATA FROM CYCLIC BUFFER AND AFTER CONVERSION TO 24 BIT

0228* BINARY STORE IN OUTPUT BUFFER, CALCULATE 24 BIT CHECKSUM AND

0229* STORE WITH DATA

0230***

0231	01423	000070	BUFF1	NOP	CONVERT BCD TO BINARY AND
0232	01424	073731R		STA BUFRX	IN THE MT OUTPUT BUFFER
0233	01425	077735R		STB BUFAD	
0234	01426	063736R		LDA BLNUM	
0235	01427	002034		INA	INCREMENT THE BLOCK NUMBER
0236	01430	073736R		STA BLNUM	
0237	01431	012067R		AND =B170000	
0238	01432	001700		ALF	
0239	01433	170001		STA 1,I	STORE UPPER FOUR BITS
0240	01434	006074		INB	
0241	01435	063736R		LDA BLNUM	
0242	01436	012070R		AND =B7777	
0243	01437	170001		STA 1,I	STORE LOWER 12 BITS
0244	01440	006004		INB	
0245	01441	002400		CLA	CLEAR ATTEMPT NUMBER
0246	01442	170001		STA 1,I	
0247	01443	006004		INB	
0248	01444	170001		STA 1,I	
0249	01445	006004		INB	
0250	01446	077732R		STB BUFR1	SAVE START ADDRESS OF CKSUM
0251	01447	062071R		LDA =D-4	
0252	01450	073737R		STA INX1	
0253	01451	163731R	DOP50	LDA BUFRX,I	TRANSFER DOPPLER COORDS
0254	01452	170001		STA 1,I	ALREADY IN BINARY
0255	01453	037731R		ISZ BUFRX	
0256	01454	006074		INB	
0257	01455	037737R		ISZ INX1	
0258	01456	027451R		JMP DOP50	
0259	01457	077734R		STB BUFR0	
0260	01460	062072R		LDA =D-10	
0261	01461	073737R		STA INX1	
0262	01462	062041R	FID1	LDA =D-6	
0263	01463	073740R		STA INX2	
0264	01464	163731R	NXT	LDA BUFRX,I	GET A BCD WORD
0265	01465	017576R		JSB BCDI1	CONVERT TO BINARY
0266	01466	017664R		JSB BPACK	STORE IN OUTPUT BUFFER
0267	01467	037731R		ISZ BUFRX	BUMP ADDRESS
0268	01470	037740R		ISZ INX2	
0269	01471	027464R		JMP NXT	
0270	01472	062035R		LDA =D-5	
0271	01473	073740R		STA INX2	
0272	01474	163731R	MAGZ	LDA BUFRX,I	
0273	01475	070041B		STA TI1	SAVE MOST SIGNIFICANT DIGIT
0274	01476	037731R		ISZ BUFRX	
0275	01477	163731R		LDA BUFRX,I	
0276	01500	017576R		JSB BCDI1	CONVERT 4 LSD TO BINARY
0277	01501	002400		CLA	
0278	01502	070042B		STA TI2	
0279	01503	060041B		LDA TI1	
0280	01504	017634R		JSB BCDI2	CONVERT MSD TO BINARY

0283	01505	017664R		JSB BPACK	
0284	01506	037731R		ISZ BUFRX	
0285	01507	037740R		ISZ INX2	
0286	01510	027474R		JMP MAGZ	
0287	01511	037737R		ISZ INX1	FINISHED BLOCK?
0288	01512	027462R		JMP FID1	
0289	01513	063732R	CHEKS	LDA BUFR1	CALCULATE 24 BIT CHECKSUM
0290	01514	002004		INA	
0291	01515	073733R		STA BUFR2	
0292	01516	002400		CLA	
0293	01517	073741R		STA SUM	
0294	01520	017544R		JSB CKSUM	ADD BITS 0-11
0295	01521	063732R		LDA BUFR1	
0296	01522	073733R		STA BUFR2	
0297	01523	063742R		LDA SUM1	
0298	01524	073741R		STA SUM	ADD CARRY FROM PREVIOUS ADD
0299	01525	017544R		JSB CKSUM	ADD BITS 12-23
0300	01526	062065R		LDA =D-230	
0301	01527	073737R		STA INX1	
0302	01530	163735R	PK232	LDA BUFR1,I	UNPACK 12 BIT WORDS TO FORM
0303	01531	012073R		AND =B7700	TWO 6 BIT BYTES FOR MT
0304	01532	001222		RAL,RAL	
0305	01533	070041R		STA TT1	
0306	01534	163735R		LDA BUFR1,I	
0307	01535	012074R		AND =H77	
0308	01536	030041R		JOR TT1	
0309	01537	173735R		STA BUFR1,I	
0310	01540	037735R		ISZ BUFR1	
0311	01541	037737R		ISZ INX1	
0312	01542	027530R		JMP PK232	
0313	01543	127423R		JMP BUFR1,I	
0315	01544	000000	CKSUM	NOP	
0316	01545	002400		CLA	
0317	01546	073743R		STA CARRY	
0318	01547	062075R		LDA =D-112	SET WORD COUNTER
0319	01550	073744R		STA SNUM	
0320	01551	163733R	LOOPS	LDA BUFR2,I	
0321	01552	000040		CLE	
0322	01553	043741R		ADA SUM	
0323	01554	002040		SEZ	CARRY FROM BIT 15?
0324	01555	037743R		ISZ CARRY	YES BUMP CARRY COUNTER

0327	01556	073741R	STA SUM	
0328	01557	037733R	ISZ BUFR2	INCREMENT ADDRESS BY 2
0329	01560	037733R	ISZ BUFR2	
0330	01561	037744R	ISZ SNUM	FINISHED?
0331	01562	027551R	JMP LOOPS	NO
0332	01563	063741R	LDA SUM	
0333	01564	012067R	AND =B170000	ISOLATE CARRIES FROM BIT 11
0334	01565	001700	ALF	POSITION IN LOWER WORD
0335	01566	067743R	LDB CARRY	GET ANY CARRIES FROM BIT 15
0336	01567	005700	BLF	MULTIPLY BY 16
0337	01570	040001	ADA 1	FORM TOTAL CARRY FROM 12 BIT
0338	01571	073742R	STA SUM1	ADDITION
0339	01572	063741R	LDA SUM	
0340	01573	012070R	AND =B7777	
0341	01574	173733R	STA BUFR2,1	
0342	01575	127544R	JMP CKSUM,1	

0344***

0345* SUBROUTINES USED IN DATA CONVERSION FOR MT OUTPUT

0346***

0347	01576	000000	BCDI1	NOP	CONVERTS 4 DIGIT BCD TO BINARY
0348	01577	001700	ALF		POSITION FIRST CHARACTER
0349	01600	070042B	STA TT2		
0350	01601	012026R	AND =B17		
0351	01602	064000	LDB 0		
0352	01603	017626R	JSB BY10		
0353	01604	060042B	LDA TT2		
0354	01605	001700	ALF		POSITION SECOND CHARACTER
0355	01606	070042B	STA TT2		
0356	01607	012026R	AND =B17		
0357	01610	044000	ADB 0		
0358	01611	017626R	JSB BY10		
0359	01612	060042B	LDA TT2		
0360	01613	001700	ALF		POSITION THIRD CHARACTER
0361	01614	070042B	STA TT2		
0362	01615	012026R	AND =B17		
0363	01616	044000	ADB 0		
0364	01617	017626R	JSB BY10		
0365	01620	060042B	LDA TT2		
0366	01621	001700	ALF		POSITION 4TH CHARACTER
0367	01622	012026R	AND =B17		
0368	01623	044000	ADB 0		
0369	01624	002400	CLA		
0370	01625	127576R	JMP BCDI1,1		RETURN WITH BINARY IN AB
0371	01626	000000	BY10	NOP	
0372	01627	005000	BLS		
0373	01630	074044B	STB TT4		
0374	01631	005020	BLS,BLS		
0375	01632	044044B	ADB TT4		
0376	01633	127626R	JMP BY10,1		

0379	01634	000000	BCD12	NOP	
0380	01635	012026R		AND =B17	
0381	01636	070043B		STA TT3	
0382	01637	042072R		ADA =D-10	
0383	01640	002021		SSA,RSS	CHARACTER LENGTH
0384	01641	027661R		JMP ERRAS	NO
0385	01642	060043B		LDA TT3	
0386	01643	001000		ALS	
0387	01644	043704R		ADA SS4	FORM ADDRESS OF BINARY EQUIV.
0388	01645	070043B		STA TT3	
0389	01646	000040		CLE	
0390	01647	144000		ADB 0,1	ADD 16 LEAST SIGNIF BITS
0391	01650	002040		SEZ	OVERFLOW?
0392	01651	034042B		ISZ TT2	YES
0393	01652	074041B		STB TT1	
0394	01653	060043B		LDA TT3	
0395	01654	002004		INA	
0396	01655	160000		LDA 0,1	GET MOST SIGNIF BITS
0397	01656	040042B		ADA TT2	
0398	01657	064041B		LDB TT1	
0399	01660	127634R		JMP BCD12,1	RETURN WITH BINARY IN AB
0400	01661	002400	ERRAS	CLA	
0401	01662	006400		CLB	
0402	01663	127634R		JMP BCD12,1	ERROR - SET RESULT TO ZERO
0404	01664	000000	BPACK	NOP	UNPACK AB REGISTER AND STORE
0405	01665	074041B		STB TT1	AS TWO 12 BIT WORDS
0406	01666	012076R		AND =B777	
0407	01667	001700		ALF	
0408	01670	070042B		STA TT2	
0409	01671	060001		LDA 1	
0410	01672	012067R		AND =B170000	
0411	01673	001700		ALF	
0412	01674	030042B		IOR TT2	
0413	01675	173734R		STA BUFR0,1	
0414	01676	037734R		ISZ BUFR0	
0415	01677	060041B		LDA TT1	
0416	01700	012070R		AND =B7777	
0417	01701	173734R		STA BUFR0,1	
0418	01702	037734R		ISZ BUFR0	
0419	01703	127664R		JMP BPACK,1	

0422***

0423* LOOK UP TABLE FOR CONVERTING TENS OF THOUSANDS TO BINARY

0424***

0425 01704 001705R SS4 DEF **1

0426 01705 000000 OCT 0,0,23420,0,47040,0,72460,0,116100,0

01706 000000

01707 023420

01710 000000

01711 047040

01712 000000

01713 072460

01714 000000

01715 116100

01716 000000

0427 01717 141520 OCT 141520,0,165140,0,10560,1,34200,1,57620,1

01720 000000

01721 165140

01722 000000

01723 010560

01724 000001

01725 034200

01726 000001

01727 057620

01730 000001

0428 01731 000000 BUFRX NOP

0429 01732 000000 BUFR1 NOP

0430 01733 000000 BUFR2 NOP

0431 01734 000000 BUFR0 NOP

0432 01735 000000 BUFRD NOP

0433 01736 000000 BLNUM NOP

0434 01737 000000 INX1 NOP

0435 01740 000000 INX2 NOP

0436 01741 000000 SUM NOP

0437 01742 000000 SUM1 NOP

0438 01743 000000 CARRY NOP

0439 01744 000000 SNUM NOP

0442	00010	MCR	EQU	10B	16 BIT I/O INTERFACE SELECT CODE
0443	00011	MPX	EQU	11B	INPUT MPX SELECT CODE
0444	00012	DASC	EQU	12B	D/A MPX SELECT CODE
0445	00014	MTRSC	EQU	14B	KENNEDY SELECT CODE
0446	00016	REGSC	EQU	16B	40 BIT REGISTER SELECT CODE
0447	01745	114000B	AJSBI	JSB LINK, I	
0448	00000		ORB		
0449	00000	000146R	LINK	DEF INTRR	INTERRUPT LINK

0450***

0451* CYCLIC BUFFER ADDRESS TABLE AND BUFFER STATUS WORDS ***

0452* NUMBER OF BUFFERS CAN BE INCREASED BY EXPANDING THE BUFFER TABLE

0453***

0454	00001	000310C	TAB	DEF BUFA	ADDRESS OF BUFFER 1
0455	00002	000000		NOP	STATUS WORD FOR BUFFER 1
0456	00003	000004B		DEF **1	POINTER TO BUFFER 2
0457	00004	000562C		DEF BUFB	ADDRESS OF BUFFER 2
0458	00005	000000		NOP	AND SO ON
0459	00006	000007B		DEF **1	
0460	00007	001034C		DEF BUFC	
0461	00010	000000		NOP	
0462	00011	000012B		DEF **1	
0463	00012	001306C		DEF BUFD	
0464	00013	000000		NOP	
0465	00014	000001B	POINT	DEF TAB	POINTER BACK TO BUFFER 1
0466	00015	000000C	IBUFF	DEF BUFIN	
0467	00016	000000	INBUF	NOP	
0468	00017	000000	INBF2	NOP	
0469	00020	000000	P	NOP	
0470	00021	000000	P1	NOP	
0471	00022	000000	R	NOP	
0472	00023	000000	Q	NOP	
0473	00024	000000	Q1	NOP	
0474	00025	000000	Q2	NOP	
0475	00026	000000	QADD	NOP	
0476	00027	000000	SADD	NOP	
0477	00030	000000	K1	NOP	
0478	00031	000000	K2	NOP	
0479	00032	000000	K3	NOP	
0480	00033	000000	K4	NOP	
0481	00034	000000	K5	NOP	
0482	00035	000000	INPUT	NOP	
0483	00036	000000	OUTPUT	NOP	
0484	00037	000000	ATTNO	NOP	
0485	00040	000000	ABORT	NOP	
0486	00041	000000	TT1	NOP	
0487	00042	000000	TT2	NOP	
0488	00043	000000	TT3	NOP	
0489	00044	000000	TT4	NOP	
0490	00045	000000	SAVA	NOP	
0491	00046	000000	SAVB	NOP	
0492	00047	000000	SAVEU	NOP	
0493	00050	000000	CAL1	NOP	
0494	00051	000000	CAL2	NOP	
0495	00052	000000	CAL3	NOP	
0496	00053	000000	LINE	NOP	
0497	00054	000000	LEC	NOP	
0498	00055	000000	COUNT	NOP	

0499	00056	000000	RESET	NOP	
0500	00057	000000	TP0	BSS	2
0501	00061	000000	BEGIN	NOP	
0502	00062	000000	SFLAG	NOP	
0503	00063	000000	TOTAL	NOP	
0504	00064	000000	SSTAT	NOP	
0505	00065	000000	ONES	NOP	
0506	00066	000000	CALS	NOP	
0507	00067	000000	MTSTF	NOP	
0508	00070	000000	XLOG	NOP	
0509	00071	000000	BLOUT	NOP	
0510	00072	000000	RCNTR	NOP	
0511	00073	000000	BOUT1	NOP	
0512	00074	000000	MTFN2	NOP	
0513	00075	000000	BLEND	NOP	
0514	00076	000000	ALOP	NOP	
0515	00077	000000	LSYN	NOP	
0516	00100	000000	XSUN	NOP	
0517	00101	000000	GAPUT	NOP	
0518	00102	000000	MTIME	NOP	
0519	00103	000000	MTFLG	NOP	
0520	01746			ORR	
0521	01746	000000	DDATA	BSS	5
0522	01753	003014	LABEL	OCT	3014,4407,4024
	01754	004407			
	01755	004024			
0523	01756	000000	FLNO	NOP	FLIGHT NO INSERTED HERE
0524	01757	000000		NOP	
0525	01760	026455		OCT	26455,26455,26455,26455,26455
	01761	026455			
	01762	026455			
	01763	026455			
	01764	026455			
0526	01765	026455		OCT	26455,26455,26455,26455,26455
	01766	026455			
	01767	026455			
	01770	026455			
	01771	026455			
0527	01772	026455		OCT	26455,26455,26455,26455,26455
	01773	026455			
	01774	026455			
	01775	026455			
	01776	026455			
0528	01777	026455		OCT	26455,26455,26455,26455,26455
	02000	026455			
	02001	026455			
	02002	026455			
	02003	026455			
0529	02004	026455		OCT	26455,26455,26455,26455,26455
	02005	026455			
	02006	026455			
	02007	026455			
	02010	026455			
0530	02011	026455		OCT	26455,26455,26455,26455,26455
	02012	026455			
	02013	026455			
	02014	026455			

0531 02015 026455
 02016 026455
 02017 026455
 02020 026455
 02021 026455
 02022 026455
 02023 000003
 02024 100000
 02025 002000
 02026 000017
 02027 026400
 02030 000033
 02031 015433
 02032 177716
 02033 000004
 02034 177770
 02035 177773
 02036 000002
 02037 177777
 02040 177776
 02041 177772
 02042 177747
 02043 001750
 02044 000144
 02045 154360
 02046 023420
 02047 000005
 02050 000012
 02051 000006
 02052 000007
 02053 177534
 02054 177014
 02055 000764
 02056 177406
 02057 000372
 02060 177634
 02061 000022
 02062 000001
 02063 000040
 02064 000714
 02065 177432
 02066 177775
 02067 170000
 02070 007777
 02071 177774
 02072 177766
 02073 007700
 02074 000077
 02075 177620
 02076 000777

OCT 26455,26455,26455,26455,26455

0532

** NO ERRORS*

END 8PG1

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0002***
0003* THE DOPPLER SUBROUTINE HAS TWO ENTRY POINTS. DINIT IS CALLED ONCE
0004* TO SET UP INITIAL CONDITIONS, DOP00 IS CALLED EVERY SECOND TO
0005* COMPUTE THE PRESENT DOPPLER COORDINATES AND TO UPDATE THE PILOTS
0006* DISPLAY. ADDITIONALLY AT THE START OF EACH FIDUCIAL DOPPLER ALONG
0007* AND CROSS TRACK COORDINATES ARE RETURNED TO THE MAIN PROGRAM FOR
0008* INCLUSION ON THE MAGNETIC TAPE.
0009***
0010 00000          NAM DOP00
0011          ENT DOP00,DINIT
0012 00000 000000  DINIT NOP
0013 00001 062000H LDA DINIT
0014 00002 164000H LDB 0,I          GET RETURN ADDRESS
0015 00003 076000H STB DINIT          AND STORE
0016 00004 002004H INA
0017 00005 164000H LDB 0,I          PICK UP PARAMETER ADDRESSES
0018 00006 074030H STB DK3          AND STORE LOCALLY
0019 00007 002004H INA
0020 00010 164000H LDB 0,I
0021 00011 074026H STB LINE
0022 00012 002004H INA
0023 00013 164000H LDB 0,I
0024 00014 074027H STB INPUT
0025 00015 002004H INA
0026 00016 164000H LDB 0,I
0027 00017 074040H STB REG40
0028 00020 002400H CLA          CLEAR ALL INTERNAL COUNTERS AND
0029 00021 070001H STA ORIGN          FLAGS
0030 00022 070016H STA LPKM0
0031 00023 070017H STA LFKM0
0032 00024 070014H STA XPKM0
0033 00025 070015H STA XFKM0
0034 00026 070021H STA LPKM1
0035 00027 070022H STA LFKM1
0036 00030 070023H STA XPKM1
0037 00031 070024H STA XFKM1
0038 00032 070000H STA ISTOP
0039 00033 070042H STA ISTRS
0040 00034 070036H STA DSPRS
0041 00035 070020H STA ISTLN
0042 00036 070010H STA LPART
0043 00037 070011H STA LFULL
0044 00040 070012H STA XPART
0045 00041 070013H STA XFULL
0046 00042 126000H JMP DINIT,I          RETURN TO MAIN PROGRAM

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0049***

0050* THE DOPPLER PROGRAM INPUT DATA IS TAKEN FROM 14 BIT SYNCHRO TO
 0051* DIGITAL CONVERTERS THAT LOOK AT THE 3 LINE OUTPUT FROM SYNCHRO
 0052* CONTROL TRANSMITTERS ON THE ALONG AND CROSS TRACK OUTPUTS OF THE
 0053* DOPPLER COMPUTER, ONE REVOLUTION OF THESE OUTPUTS, EQUIVALENT TO
 0054* A CHANGE IN SYNCHRO READING OF 16384, IS EQUAL TO 10/3 NAUTICAL
 0055* MILES, THE PROGRAM KEEPS TRACK OF THE TOTAL CHANGE IN SYNCHRO
 0056* POSITION, STORING THE RESULT IN TWO PARTS - INTEGRAL KILOMETRES
 0057* EQUAL TO APPROX 29500 SYNCHRO UNITS AND A FRACTIONAL PART IN
 0058* SYNCHRO UNITS

0059***

0060	00043	000000	DOP00	NOP	
0061	00044	070002H	STA	LSYN	STORE ALONG TRACK
0062	00045	074003H	STB	XSYN	CROSS TRACK READINGS
0063	00046	060000H	LDA	ISTDP	FIRST READING OF FLIGHT?
0064	00047	002002	SZA		
0065	00050	026062H	JMP	DOP01	NO
0066	00051	002004	INA		YES - SAVE INITIALSYNCHRO
0067	00052	070000H	STA	ISTDP	READINGS THEN RETURN
0068	00053	060002H	LDA	LSYN	TAKE ALONG TRACK DOPPLER SYNCHRO
0069	00054	003004	CMA,INA		READING AND STORE
0070	00055	070004H	STA	LSYNO	
0071	00056	060003H	LDA	XSYN	TAKE CROSS TRACK DOPPLER SYNCHRO
0072	00057	003004	CMA,INA		READING AND STORE
0073	00060	070005H	STA	XSYNO	
0074	00061	026402H	JMP	DOP31	

0077***

0078* INTERNAL DOPPLER ALONG AND CROSS TRACK COORDINATES ARE BASED ON
0079* ARBITRARY ORIGIN LOCATED AT POINT OF STARTING DATA ACQUISITION
0080* PROGRAM.

0081***

0082***** PROCESS ALONG TRACK SYNCHRO DATA *****

0083***

0084	00062	060002B	DOP01	LDA LSYN	TAKE ALONG TRACK SYNCHRO READING
0085	00063	064002B		LDB LSYN	
0086	00064	040004B		ADA LSYN0	SUBTRACT PREVIOUS READING
0087	00065	007004		CMB, INB	
0088	00066	074004B		STB LSYN0	SAVE CURRENT READING
0089	00067	070006B		STA LSYN1	SAVE DIFFERENCE
0090	00070	002020		SSA	TEST SIGN OF SYNCHRO CHANGE
0091	00071	026101R		JMP DOP02	NEGATIVE
0092	00072	042702R		ADA =D-8000	
0093	00073	002020		SSA	IS CHANGE GT 8000?
0094	00074	026107R		JMP DOP03	NO
0095	00075	060006B		LDA LSYN1	YES - SYNCHRO CROSSED ZERO POINT
0096	00076	042703R		ADA =D-16384	- SUBTRACT 16384 TO GIVE
0097	00077	070006B		STA LSYN1	- SMALL NEGATIVE CHANGE
0098	00100	026107R		JMP DOP03	
0099	00101	042704R	DOP02	ADA =D8000	IS CHANGE LT -8000?
0100	00102	002021		SSA, RSS	
0101	00103	026107R		JMP DOP03	NO
0102	00104	060006B		LDA LSYN1	YES - SYNCHRO HAS CROSSED ZERO
0103	00105	042705R		ADA =D16384	- ADD 16384 TO GET SMALL
0104	00106	070006B		STA LSYN1	- POSITIVE CHANGE
0105	00107	060006B	DOP03	LDA LSYN1	
0106	00110	001100		ARS	DIVIDE BY 2
0107	00111	040010B		ADA LPART	ADD DIFFERENCE TO PART KM COUNT
0108	00112	064011B		LDB LPFULL	
0109	00113	016624R		JSB DPSUM	NORMALISE FULL AND PART KM
0110	00114	070010B		STA LPART	COUNTERS AND SAVE
0111	00115	074011B		STB LPFULL	

0114***

0115***** PROCESS CROSS TRACK SYNCHRO DATA *****

0116***

0117	00116	060003B	LDA XSYN	TAKE CROSS TRACK SYNCHRO READIN
0118	00117	064003B	LDB XSYN	
0119	00120	040005B	ADA XSYN0	SUBTRACT PREVIOUS READING
0120	00121	007004	CMB, INB	
0121	00122	074005B	STB XSYN0	SAVE CURRENT READING
0122	00123	070007B	STA XSYN1	SAVE DIFFERENCE
0123	00124	002020	SSA	TEST SIGN OF CHANGE
0124	00125	026135B	JMP DOP04	NEGATIVE
0125	00126	042702B	ADA =D=8000	
0126	00127	002020	SSA	IS CHANGE GT 8000?
0127	00130	026143B	JMP DOP05	NO
0128	00131	060007B	LDA XSYN1	YES - SYNCHRO HAS CROSSED ZERO
0129	00132	042703B	ADA =D=16384	- SUBTRACT 16384 TO GET
0130	00133	070007B	STA XSYN1	- SMALL POSITIVE CHANGE
0131	00134	026143B	JMP DOP05	
0132	00135	042704B	DOP04 ADA =D8000	IS CHANGE LT -8000?
0133	00136	002021	SSA, RSS	
0134	00137	026143B	JMP DOP05	NO
0135	00140	060007B	LDA XSYN1	YES - SYNCHRO HAS CROSSED ZERO
0136	00141	042705B	ADA =D16384	- ADD 16384 TO GET
0137	00142	070007B	STA XSYN1	- SMALL POSITIVE CHANGE
0138	00143	060007B	DOP05 LDA XSYN1	
0139	00144	001100	APS	DIVIDE BY 2
0140	00145	040012B	ADA XPART	ADD TO PART KM COUNTER
0141	00146	064013B	LDB XFULL	
0142	00147	016624B	JSR DPSUM	
0143	00150	070012B	STA XPART	NORMALISE RESULT AND SAVE
0144	00151	074013B	STB XFULL	

0147***

0148***** DOPPLER CHART SPEED CONTROLLER*****

0149***

0150* VOLTAGE CONTROLLED OSCILLATOR REQUIRES +10V FOR ZERO SPEED

0151* AND +7.5V FOR 200 KNOTS

0152***

0153	00152	060026H	LDA LSYN1	GET ALONG TRACK SYNCHRO CHANGE
0154	00153	002020	SSA	- APPROX 1500 AT 100 KNOTS
0155	00154	003004	CMA, INA	GET ABSOLUTE VALUE
0156	00155	006400	CLB	
0157	00156	016001X	DIV =D6	DIVIDE BY 6 AND COMPLEMENT
	00157	000706H		
0158	00160	003004	CMA, INA	TO GET V=-250 AT 100 KNOT
0159	00161	042707H	ADA =D2047	CALCULATE X=2047+V
0160	00162	070031B	STA DTMP1	AND SAVE RESULT
0161	00163	003004	CMA, INA	
0162	00164	040043B	ADA MAXSP	CHECK IF SPEED TOO GREAT
0163	00165	002020	SSA	
0164	00166	026171H	JMP **3	OK
0165	00167	060043B	LDA MAXSP	USE MAX ALLOWED SPEED
0166	00170	026201H	JMP DOP08+1	
0167	00171	060031B	LDA DTMP1	
0168	00172	003004	CMA, INA	
0169	00173	040044B	ADA MINSP	CHECK IF SPEED LESS THAN
0170	00174	002021	SSA, RSS	40 KNOTS
0171	00175	026200H	JMP DOP08	
0172	00176	060044B	LDA MINSP	USE MIN ALLOWED SPEED
0173	00177	026201H	JMP DOP08+1	
0174	00200	060031B	DOP08 LDA DTMP1	
0175	00201	070001	STA 1	AND PUT IN B REGISTER
0176	00202	062710H	LDA =D9	
0177	00203	016673H	JSB ,DTA	OUTPUT TO VCO ON D/A CHANNEL 10

0001***

0002***** PILOT S DOPPLER DISPLAY PROCESSOR *****

0003***

0004	00204	060040B	DOP11	LDA REG40	GET ADDRESS OF PILOTS DISPLAY
0005	00205	070041B		STA DDATA	BUFFER
0006	00206	160027B		LDA INPUT,1	GET 16 BIT INPUT REGISTER
0007	00207	012711R		AND #D2	ISOLATE DOPPLER RESET BIT
0008	00210	002003		SZA,RSS	IS IT ON?
0009	00211	026245R		JMP DOP13	NO
0010	00212	060012B		LDA XPART	YES - SAVE INITIAL COORDINATES
0011	00213	003004		CMA,INA	IF RESET CROSS TRACK DISPLAY
0012	00214	070014B		STA XPKM0	
0013	00215	060013B		LDA XFULL	
0014	00216	003004		CMA,INA	
0015	00217	070015B		STA XFKM0	
0016	00220	060042B		LDA ISTRS	FIRST RESET?
0017	00221	002002		SZA	
0018	00222	026226R		JMP **4	
0019	00223	002004		INA	
0020	00224	070042B		STA ISTRS	
0021	00225	026237R		JMP DOP12+2	
0022	00226	060036B		LDA DSPRS	CHECK IF RESET ON FOR 5 SEC
0023	00227	002002		SZA	
0024	00230	026235R		JMP DOP12	
0025	00231	002004		INA	
0026	00232	070036B		STA DSPRS	
0027	00233	062712R		LDA #D=5	INITILISE COUNTER
0028	00234	070037B		STA DNTR	
0029	00235	034037B	DOP12	ISZ DNTR	COUNT NUMBER OF SECONDS
0030	00236	026247R		JMP DOP13+2	
0031	00237	060010B		LDA LPART	RESET ON FOR 5 SEC SO
0032	00240	003004		CMA,INA	RESET ALONG TRACK DISPLAY
0033	00241	070016B		STA LPKM0	
0034	00242	060011B		LDA LFULL	
0035	00243	003004		CMA,INA	
0036	00244	070017B		STA LFKM0	
0037	00245	002400	DOP13	CLA	RESET COUNTER FLAG
0038	00246	070036B		STA DSPRS	
0039	00247	060010B		LDA LPART	SUBTRACT INITIAL ALONG TRACK
0040	00250	040016B		ADA LPKM0	POSITION FROM PRESENT POSITION
0041	00251	064011B		LDB LFULL	
0042	00252	044017B		ADB LFKM0	
0043	00253	016624R		JSB DPSUM	NORMALISE THE RESULT
0044	00254	070031B		STA DTMP1	THIS IS ALONG TRACK DISTANCE
0045	00255	074032B		STB DTMP2	TO BE DISPLAYED
0046	00256	006400		CLB	
0047	00257	002020		SSA	
0048	00260	007000		CMR	
0049	00261	016001X		DIV SCL01	DIVIDE TO GET 0.1 S OF KM
	00262	000045B			

0052	00263	070031B	STA DIMP1	
0053	00264	060032B	LDA DIMP2	
0054	00265	001020	ALS	MULTIPLY KM BY 10
0055	00266	070001	STA 1	
0056	00267	001020	ALS,ALS	
0057	00270	040001	ADA 1	
0058	00271	040031B	ADA DIMP1	ADD ON 0.1 S
0059	00272	002020	SSA	IF NEGATIVE ADD 10000
0060	00273	042713R	ADA =D10000	
0061	00274	016560R	JSB ENCOD	ENCODE RESULT TO 1-2-4-8 BCD
0062	00275	174041B	STA DDATA,I	AND STORE IN 40 BIT BUFFER
0063	00276	034041B	ISZ DDATA	
0064	00277	174041B	STB DDATA,I	
0065	00300	034041B	ISZ DDATA	
0066	00301	060012B	LDA XPART	SUBTRACT INITIAL CROSS TRACK
0067	00302	040014B	ADA XPKM0	FROM PRESENT POSITION
0068	00303	064013B	LDB XFULL	
0069	00304	044015B	ADB XPKM0	
0070	00305	016624R	JSB DPSUM	NORMALISE RESULT
0071	00306	070031B	STA DIMP1	THIS IS CROSS TRACK RESULT
0072	00307	074032B	STB DIMP2	FOR DISPLAY OUTPUT
0073	00310	006400	CLB	
0074	00311	002020	SSA	
0075	00312	007000	CMR	
0076	00313	016001X	DIV SCL02	DIVIDE TO GET 0.01 S OF KM
	00314	000046B		
0077	00315	070031B	STA DIMP1	
0078	00316	060032B	LDA DIMP2	MULTIPLY CROSS KM BY 100
0079	00317	001020	ALS,ALS	
0080	00320	070001	STA 1	
0081	00321	001020	ALS,ALS	
0082	00322	001000	ALS	
0083	00323	044000	ADB 0	
0084	00324	001000	ALS	
0085	00325	044000	ADB 0	
0086	00326	044031B	ADB DIMP1	ADD ON 0.01 S KM
0087	00327	160027B	LDA INPUT,I	CHECK ON POSITION OF FORWARD/
0088	00330	012714R	AND =D8	REVERSE SWITCH
0089	00331	002002	SZA	IF ON COMPLEMENT RESULT
0090	00332	007004	CMR,INB	
0091	00333	060001	LDA 1	
0092	00334	070031B	STA DIMP1	SAVE FOR PETER OUTPUT
0093	00335	006400	CLB	
0094	00336	002021	SSA,RSS	IS IT POSITIVE?
0095	00337	026342R	JMP ++3	YES
0096	00340	003004	CMA,INA	MAKE POSITIVE AND CHANGE
0097	00341	007000	CMR	OVER THE LEFT/RIGHT LIGHT
0098	00342	074032B	STB DIMP2	
0099	00343	016560R	JSB ENCOD	GET 4 DECIMAL DIGITS
0100	00344	170041B	STA DDATA,I	AND STORE IN 40 BIT BUFFER
0101	00345	034041B	ISZ DDATA	
0102	00346	174041B	STB DDATA,I	
0103	00347	034041B	ISZ DDATA	
0104	00350	060032B	LDA DIMP2	
0105	00351	170041B	STA DDATA,I	

0108***

0109*** OUTPUT CROSS TRACK ANALOGUE VOLTAGE FOR LEFT-RIGHT

0110*** INDICATOR IN FRONT OF PILOT -10V TO +10V EQUIV

0111*** TO APPROX 1 KILOMETER

0112***

0113	00352	060031B	LDA DTMP1	PICK UP CROSS TRACK DISTANCE
0114	00353	001000	ALS	MULTIPLY BY 20 TO GIVE APPROX
0115	00354	070001	STA 1	1 KM FULL SCALE DEFLECTION
0116	00355	001000	ALS,ALS	ON THE METER
0117	00356	040001	ADA 1	
0118	00357	001000	ALS	
0119	00360	070031B	STA DTMP1	
0120	00361	002020	SSA	
0121	00362	026370R	JMP DOP21	
0122	00363	042715R	ADA =D-2048	TEST IF GT 2048
0123	00364	002020	SSA	
0124	00365	026375R	JMP DOP22	
0125	00366	062707R	LDA =D2047	YES - SET EQUAL TO MAX POSSIBLE
0126	00367	026376R	JMP DOP22+1	
0127	00370	042716R DOP21	ADA =D2048	TEST IF LT -2048
0128	00371	002021	SSA,RSS	
0129	00372	026375R	JMP DOP22	
0130	00373	062715R	LDA =D-2048	YES - SET EQUAL TO MIN POSSIBLE
0131	00374	026376R	JMP DOP22+1	
0132	00375	060031B DOP22	LDA DTMP1	OUTPUT CROSS TRACK TO INDICATOR
0133	00376	012717R	AND =B7777	METER
0134	00377	070001	STA 1	
0135	00400	062714R	LDA =D8	ON CHANNEL 9 OF
0136	00401	016673R	JSB ,DTA	D/A MPX

0139***

0140*** DOPPLER COORDINATES FOR OUTPUT ON MAGNETIC TAPE. ORIGIN FOR
0141*** FLIGHT CAN BE ESTABLISHED BY SETTING BIT 4 OF SWITCH REGISTER
0142*** BEFORE THE COMMENCEMENT OF RECORDING. OTHERWISE ORIGIN IS SET
0143*** AT START OF FIRST LINE

0144***

0145	00402	160030H	DOP31	LDA DK3,I	IS IT START OF 10 SEC BLOCK?
0146	00403	052720R		CMA =0-50	
0147	00404	002001		RSS	
0148	00405	026472R		JMP EXDOP	NO
0149	00406	162043R		LDA DOP00,I	PICK UP ADDRESS OF MT BUFFER
0150	00407	070025R		STA DOPAD	AND STORE
0151	00410	060020R		LDA ISTLN	HAS RECORDING FOR FLIGHT STARTED
0152	00411	002002		SZA	
0153	00412	026447R		JMP DOP34	YES
0154	00413	160026R		LDA LINE,I	NO - IS FIRST LINE STARTING NOW?
0155	00414	002002		SZA	
0156	00415	026427R		JMP DOP32	YES
0157	00416	102501		LIA 1	NO - GET SWITCH REGISTER
0158	00417	052721R		CMA =04	IS DOPPLER ORIGIN BIT ON?
0159	00420	002001		RSS	
0160	00421	026447R		JMP DOP34	NO
0161	00422	002400		CLA	YES
0162	00423	102601		OTA 1	CLEAR SWITCH REGISTER
0163	00424	002004		INA	
0164	00425	070031R		STA ORIGN	SET ORIGIN FLAG
0165	00426	026433R		JMP DOP33	
0166	00427	070020R	DOP32	STA ISTLN	
0167	00430	060001R		LDA ORIGN	ORIGIN ALREADY SET?
0168	00431	002002		SZA	
0169	00432	026447R		JMP DOP34	YES
0170	00433	060010R	DOP33	LDA LPART	SET ORIGIN FOR MT DOPPLER
0171	00434	003004		CMA,INA	
0172	00435	070021R		STA LFKH1	SAVE STARTING ALONG TRACK
0173	00436	060011R		LDA LFULL	
0174	00437	003004		CMA,INA	
0175	00440	070022R		STA LFKH1	
0176	00441	060012R		LDA XPART	SAVE STARTING CROSS TRACK
0177	00442	003004		CMA,INA	
0178	00443	070023R		STA XPKH1	
0179	00444	060013R		LDA XFULL	
0180	00445	003004		CMA,INA	
0181	00446	070024R		STA XPKH1	

0184	00447	060010H	DOP54	LDA LPART	SUBTRACT INITIAL ALONG TRACK
0185	00450	040021H		ADA LPKM1	FROM PRESENT DISTANCE
0186	00451	064011H		LDB LFULL	
0187	00452	044022H		ADB LFKM1	
0188	00453	016624H		JSB DPSUM	NORMALISE RESULT
0189	00454	016474H		JSB DUPXY	GET 24 BIT BINARY RESULT
0190	00455	170025H		STA DOPAD,I	AND STORE IN BUFFER
0191	00456	034025H		ISZ DOPAD	
0192	00457	174025H		STB DOPAD,I	
0193	00460	034025H		ISZ DOPAD	
0194	00461	060012H		LDA XPART	SUBTRACT INITIAL CROSS TRACK
0195	00462	040023H		ADA XPKM1	FROM PRESENT DISTANCE
0196	00463	064013H		LDB XFULL	
0197	00464	044024H		ADB XFKM1	
0198	00465	016624H		JSB DPSUM	NORMALISE RESULT
0199	00466	016474H		JSB DUPXY	GET 24 BIT BINARY RESULT
0200	00467	170025H		STA DOPAD,I	AND STORE IN BUFFER
0201	00470	034025H		ISZ DOPAD	
0202	00471	174025H		STB DOPAD,I	
0203	00472	036043H	EXDOP	ISZ DOP00	BUMP RETURN ADDRESS
0204	00473	126043H		JMP DOP00,I	

0001***

0002***** THE FOLLOWING SUBROUTINES ARE USED BY THE DOPPLER PROGRAM **

0003***

0004*** DOPXY FORMATS THE DOPPLER COORDS FOR HT OUTPUT. THE RESULT IS A

0005*** 24 BIT BINARY NUMBER WITH BITS 0-12 FORMING A SIGNED QUANTITY I

0006*** TWOS COMPLEMENT MODE. BITS 20-23 ARE ALWAYS ZERO. WHEN

0007*** PROCESSING IN LARGE COMPUTER NEGATIVE NUMBERS ARE EXTRACTED

0008*** USING THE RELATION IF(N.GT,524287)N=N-1048576

0009***

0010	00474	000000	DOPXY NOP	
0011	00475	070031B	STA DTMP1	PART KM
0012	00476	074033B	STB DTMP3	KM
0013	00477	006400	CLB	
0014	00500	002020	SSA	
0015	00501	007000	CMB	
0016	00502	016001X	DIV SCL02	DIVIDE BY SCALE FACTOR TO GET
	00503	000040B		
0017	00504	070031B	STA DTMP1	0.01 S OF KM
0018	00505	006400	CLB	CONVERT TO DOUBLE PRECISION
0019	00506	002020	SSA	
0020	00507	007000	CMB	
0021	00510	074032B	STR DTMP2	
0022	00511	060033B	LDA DTMP3	CONVERT KM TO DOUBLE PRECISION
0023	00512	006400	CLB	
0024	00513	002020	SSA	
0025	00514	007000	CMB	
0026	00515	016541R	JSB DMV10	DOUBLE PRECISION MPY BY 100
0027	00516	016541R	JSB DMV10	
0028	00517	000040	CLE	ADD ON 0.01 S OF KM
0029	00520	040031B	ADA DTMP1	
0030	00521	002040	SEZ	
0031	00522	006004	INR	
0032	00523	044032B	ADB DTMP2	32 BIT RESULT IN BA
0033	00524	070031B	STA DTMP1	
0034	00525	012717R	AND =B7777	ISOLATE LOWER 12 BITS
0035	00526	070032B	STA DTMP2	AND SAVE
0036	00527	060031B	LDA DTMP1	
0037	00530	001700	ALF	
0038	00531	012722R	AND =B17	ISOLATE BITS 12-15
0039	00532	070033B	STA DTMP3	AND SAVE
0040	00533	062723R	LDA =B360	
0041	00534	005700	BLF	SHIFT B 4 PLACES LEFT
0042	00535	010001	AND 1	
0043	00536	030033B	IOR DTMP3	MERGE IN BITS 12-15
0044	00537	064032B	LDB DTMP2	
0045	00540	126474R	JMP DOPXY,1	24 BIT RESULT IN AB

0048***

0049	00541	000000	DAY10	NOP	DOUBLE PRECISION HPY BY 10
0050	00542	000066		CLE,ELA	
0051	00543	005600		ELB	
0052	00544	070034H		STA DTMP4	
0053	00545	074035H		STB DTMP5	
0054	00546	000066		CLE,ELA	
0055	00547	005600		ELB	
0056	00550	000066		CLE,ELA	
0057	00551	005600		ELB	
0058	00552	000040		CLE	
0059	00553	040034H		ADA DTMP4	
0060	00554	002040		SEZ	
0061	00555	006004		INB	
0062	00556	044035H		ADR DTMP5	
0063	00557	126541R		JMP DAY10,1	

0065***

0066*** THIS SUBROUTINE CONVERTS AN INTEGER QUANTITY IN THE RANGE
0067*** 0 TO 9992 TO 8-4-2-1 BCD

0068***

0069	00560	000000	ENCOD	NOP	RESULT RETURNED IN AB
0070	00561	070001		STA 1	
0071	00562	006000		SSR	CHECK IF NEGATIVE
0072	00563	026621R		JMP TOBIG	REJECT
0073	00564	046724R		ADR =0-10000	
0074	00565	006001		SSR,SSS	CHECK IF TOO LARGE
0075	00566	026621R		JMP TOBIG	REJECT
0076	00567	006400		CLB	
0077	00570	042725R		ADA =0-1000	GET 1000 S
0078	00571	002020		SSA	
0079	00572	026575R		JMP *+3	
0080	00573	006004		INB	
0081	00574	026570R		JMP *-4	
0082	00575	042726R		ADA =01000	
0083	00576	005727		BLF,BLF	
0084	00577	042727R		ADA =0-100	GET 100 S
0085	00600	002020		SSA	
0086	00601	026604R		JMP *+3	
0087	00602	006004		INB	
0088	00603	026577R		JMP *-4	
0089	00604	042730R		ADA =0100	
0090	00605	074035H		STB DTMP5	
0091	00606	006400		CLB	
0092	00607	042731R		ADA =0-10	GET 10 S
0093	00610	002020		SSA	
0094	00611	026614R		JMP *+3	
0095	00612	006004		INB	
0096	00613	026607R		JMP *-4	
0097	00614	042732R		ADA =010	

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0100 00615 005727      BLF,BLF
0101 00616 044000      ADB 0          AND UNITS
0102 00617 060035B     LDA DTMP5
0103 00620 126560R     JMP ENCOD,I
0104 00621 002400      TORIG CLA      TOO BIG SO OUTPUT ZEROS
0105 00622 006400      CLB
0106 00623 126560R     JMP ENCOD,I
0107**
0108** THIS ROUTINE CHECKS FOR OVERFLOW OF THE PART KM COUNTER, IF THIS
0109** OCCURS THE WHOLE KM COUNTER IS INCREMENTED AND THE PART COUNTER
0110** SUITABLY REDUCED, THE SIGN OF BOTH PARTS IS ALWAYS KEPT THE SAME
0111**
0112 00624 000000      DPSUM NOP
0113 00625 070031B     STA DTMP1      FRACTION OF KM IN SYNCHRO UNITS
0114 00626 074032B     STB DTMP2      INTEGRAL KILOMETRES
0115 00627 002021      SSA,RSS        POSITIVE OR NEGATIVE?
0116 00630 026641R     JMP DOP41      POSITIVE
0117 00631 040047B     ADA SCL03      NEGATIVE - MORE THAN 1 KM?
0118 00632 002021      SSA,RSS
0119 00633 026647R     JMP DOP42      NO
0120 00634 002004      INA            YES - SAVE ADJUSTED PART KM
0121 00635 070031B     STA DTMP1      AND ADJUST WHOLE KM
0122 00636 046733R     ADB =D-1
0123 00637 074032B     STB DTMP2
0124 00640 026647R     JMP DOP42
0125 00641 040050B     DOP41 ADA SCL04  MORE THAN 1 KM?
0126 00642 002020      SSA
0127 00643 026647R     JMP DOP42      NO
0128 00644 070031B     STA DTMP1      YES - SAVE ADJUSTED PART KM
0129 00645 006004      INB            AND ADJUST WHOLE KM
0130 00646 074032B     STB DTMP2
0131 00647 060031B     DOP42 LDA DTMP1  CHECK THE SIGNS AND MAKE THEM
0132 00650 064032B     LDB DTMP2      THE SAME
0133 00651 002003      SZA,RSS
0134 00652 026672R     JMP DOP46
0135 00653 002020      SSA
0136 00654 026664R     JMP DOP44
0137 00655 006003      SZB,RSS
0138 00656 026672R     JMP DOP46
0139 00657 006021      SSB,RSS
0140 00660 026672R     JMP DOP46
0141 00661 006004      INB
0142 00662 040050B     ADA SCL04
0143 00663 026672R     JMP DOP46
0144 00664 006003      DOP44 SZR,RSS
0145 00665 026672R     JMP DOP46
0146 00666 006020      SSH
0147 00667 026672R     JMP DOP46
0148 00670 046733R     ADB =D-1
0149 00671 040047B     ADA SCL03
0150 00672 126624R     DOP46 JMP DPSUM,I

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0153	00673	000000	,DTA	NOP	D/A DRIVER FOR DOPPLER PROGRAM
0154	00674	001727		ALF,ALF	POSITION CHANNEL NUMBER
0155	00675	001700		ALF	
0156	00676	030001		ICR 1	MERGE IN DATA
0157	00677	102612		OTA DASC2	AND OUTPUT
0158	00700	103712		STC DASC2,C	
0159	00701	126673H		JHP ,DTA,I	
0160	00012			DASC2 EQU 12B	

0161***

0162***** CONSTANTS,SCALE FACTORS AND TEMPORARY STORAGE AREA *****

0163***

0164	00000			ORB
0165	00000	000000	ISTOP	NOP
0166	00001	000000	ORIGN	NOP
0167	00002	000000	LSYN	NOP
0168	00003	000000	XSYN	NOP
0169	00004	000000	LSYN0	NOP
0170	00005	000000	XSYN0	NOP
0171	00006	000000	LSYN1	NOP
0172	00007	000000	XSYN1	NOP
0173	00010	000000	LPART	NOP
0174	00011	000000	LFULL	NOP
0175	00012	000000	XPART	NOP
0176	00013	000000	XFULL	NOP
0177	00014	000000	XPK10	NOP
0178	00015	000000	XPKM0	NOP
0179	00016	000000	LPKM0	NOP
0180	00017	000000	LFKM0	NOP
0181	00020	000000	ISTLN	NOP
0182	00021	000000	LPKM1	NOP
0183	00022	000000	LFKM1	NOP
0184	00023	000000	XPKM1	NOP
0185	00024	000000	XFKM1	NOP
0186	00025	000000	DOPAD	NOP
0187	00026	000000	LINE	NOP
0188	00027	000000	INPUT	NOP
0189	00030	000000	DR3	NOP
0190	00031	000000	DTMP1	NOP
0191	00032	000000	DTMP2	NOP
0192	00033	000000	DTMP3	NOP
0193	00034	000000	DTMP4	NOP
0194	00035	000000	DTMP5	NOP
0195	00036	000000	DSPRS	NOP
0196	00037	000000	DCNTR	NOP
0197	00040	000000	REG40	NOP
0198	00041	000000	UDATA	NOP
0199	00042	000000	ISTR5	NOP

PAGE 0017 03 ***** DOPPLER SUBROUTINE 11/5/73 *****

0202***** DOPPLER CONSTANTS*****

0203***

0204*** THE DOPPLER SCALE FACTOR IS SET BY SCL01-SCL04

0205***

0206	00043	003000	MAXSP	DEC 1536	MAX SPEED 200 KNOTS
0207	00044	003633	MINSP	DEC 1947	MID SPEED 40 KNOTS
0208	00045	002702	SCL01	DEC 1474	SYNCHRO UNITS PER 1/10 KM
0209	00046	000223	SCL02	DEC 147	SYNCHRO UNITS PER 1/100 KM
0210	00047	004616	SCL03	DEC 14734	SYNCHRO UNITS PER KILOMETER
0211	00050	143161	SCL04	DEC -14735	

0212*

0213*****

00702 160300

00703 140000

00704 017500

00705 040000

00706 000000

00707 003777

00710 000011

00711 000002

00712 177773

00713 023420

00714 000010

00715 174000

00716 004000

00717 007777

00720 177716

00721 000004

00722 000017

00723 000360

00724 154360

00725 176030

00726 001750

00727 177634

00730 000144

00731 177766

00732 000012

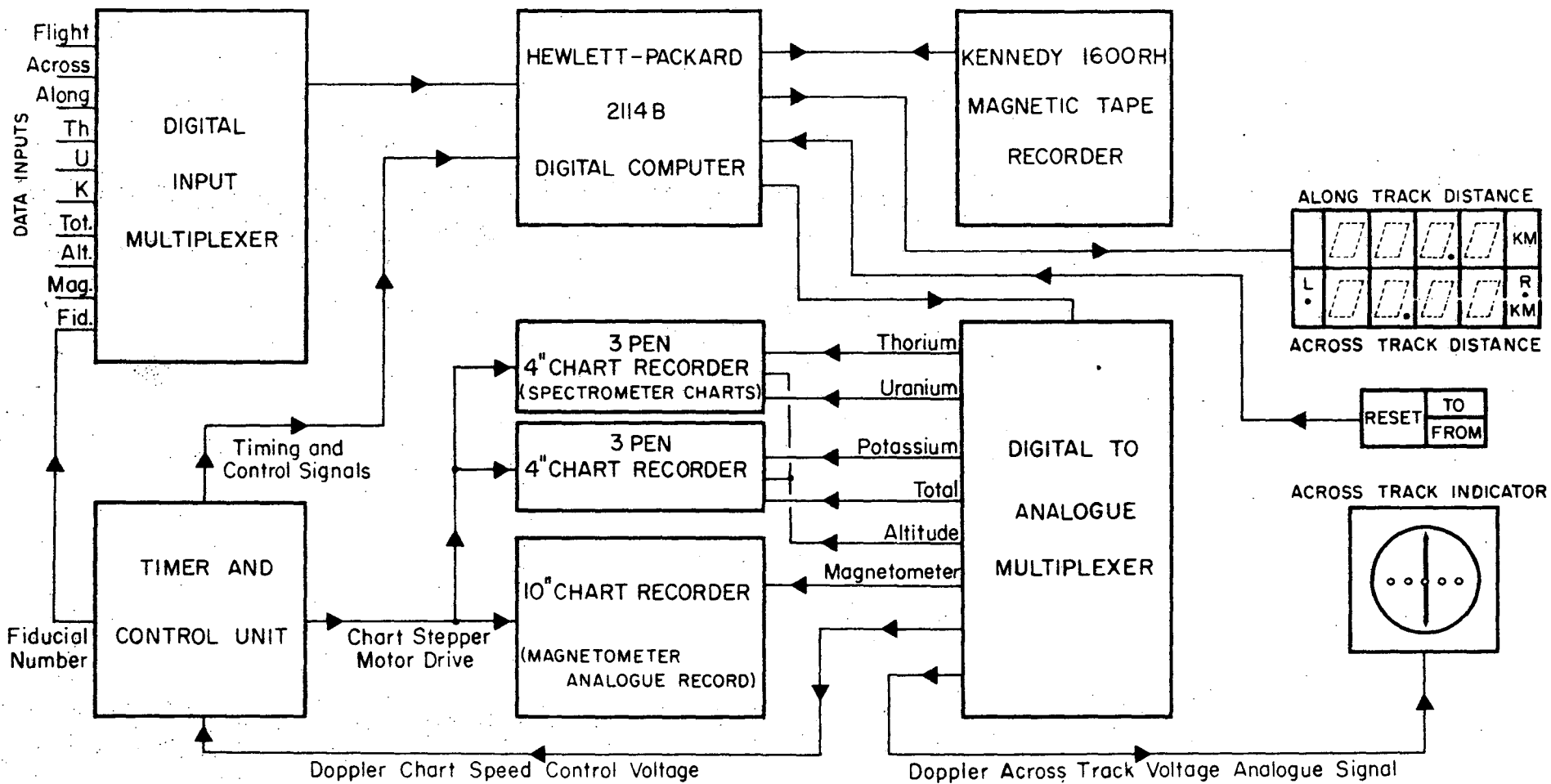
00733 177777

0214

** NO ERRORS*

END

To Accompany Record No. 1729111



DIGITAL DATA ACQUISITION SYSTEM

BMGV2

CLEAR ALL EXTERNAL DEVICES
RESET PROGRAM FLAGS AND POINTERS
REWIND MAGNETIC TAPE TO LOAD POINT

READ FLIGHT NUMBER SET ON
TIMER.WRITE MT HEADER RECORD

READINGS
WAITING IN
INPUT BUFFER?

Readings are taken when a signal generated in the timing unit causes a special interrupt subroutine to take control of the computer. The required readings are taken and stored in the memory and then control returns to the main program at the point of interrupt. The readings in memory are "found" later by the main program.

START OF 10 SECOND
FIDUCIAL PERIOD?

FLYING
SURVEY LINE?

ALL
SWITCH REGISTER
BITS ON?

WRITE 3 EOF
RECORDS ON MT.
UNLOAD MT

END

TRANSFER ONE SECOND READINGS
TO CURRENT CYCLIC BUFFER
(FIDUCIAL NO., ALTITUDE, SPECTROMETER
AND DOPPLER)

TRANSFER 0.2 SECOND
READING (MAGNETOMETER)

FLYING
SURVEY LINE?

10 SEC CHART
CALIBRATE CYCLE
IN PROGRESS?

SURVEY LINE
JUST COMPLETED?

BIT
1 OF SWITCH
REGISTER ON?

CHART RECORDER CALIBRATE CYCLE.
OUTPUT ZERO FOR 5 SEC.
THEN FULL SCALE FOR 5 SEC

START
OF 1 SECOND
PERIOD?

OUTPUT ONE SECOND READINGS
TO CHART RECORDERS
VIA D/A MULTIPLEXER

OUTPUT MAGNETOMETER READING
TO CHART RECORDER
VIA D/A MULTIPLEXER

START
OF 1 SECOND
PERIOD?

CALCULATE NEW DOPPLER ALONG AND
ACROSSTRACK CO-ORDINATES IN PILOT'S
REFERENCE SYSTEM AND SURVEY SYSTEM.
UPDATE PILOT'S READOUT. OUTPUT REVISED
CHART SPEED CONTROL VOLTAGE

START
OF 10 SECOND
PERIOD?

STORE SURVEY SYSTEM ALONG AND ACROSS
TRACK CO-ORDINATES IN MT OUTPUT BUFFER

END
OF FIDUCIAL
PERIOD?

FLYING
SURVEY LINE?

CURRENT CYCLIC BUFFER IS FULL AND
JOINS OUTPUT QUEUE. INPUT DIRECTED
TO NEXT CYCLIC BUFFER

FULL
CYCLIC BUFFER
IN MT OUTPUT
QUEUE?

MAGNETIC
TAPE RECORDER
BUSY?

STARTING
RECORDING OF NEXT
DATA BLOCK?

WAITING
FOR COMPLETION
OF WRITE
OPERATION?

WAITING
FOR COMPLETION
OF BACKSPACE
OPERATION?

WAITING FOR
COMPLETION OF
READ OPERATION

END-OF-FILE
RECORD?

END-OF-FILE
RECORD?

INITIATE
E-O-F
RECORD

CONVERT READINGS
TO 24 BIT BINARY
WORDS STORE IN
MT BUFFER. CALCULATE
CHECKSUM WORD

INITIATE WRITE
OPERATION

FLUX
CHECK ERROR
ON PREVIOUS
WRITE?

THIS
BLOCK TO
BE CHECK
READ?

INITIATE BACKSPACE
OPERATION

THIRD
FAILURE TO
RECORD THIS
BLOCK?

CHECK DATA READ BACK
FROM TAPE WITH
ORIGINAL VERSION
RETAINED IN MEMORY

ERRORS?

AIRBORNE DATA ACQUISITION PROGRAM SIMPLIFIED FLOW DIAGRAM