789

HAWKEYE

MASTER SCIENCE FILE

74-040A-01A, 02A, 03A

Table of Contents

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP’s).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents — To find associated documents you will need to know the document ID number and then click here.
http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

HAWKEYE

MASTER SCIENCE FILE

74-040A-01A, 02A, 03A, SPMS-00423

THIS DATA SET CONSISTS OF 15 MAGNETIC TAPES. THE D TAPES ARE 4MM, AND THE C TAPES ARE 8MM BPI WRITTEN IN ASCII BACK-UP FORMAT, AND CREATED ON THE VAX COMPUTER. A COPY OF THE TAPE FORMAT HAS BEEN * INCLUDED IN THE CATALOG. THE D AND C NUMBER ALONG WITH THE TIME SPANS ARE LISTED BELOW.

D#	C#	FILES	LABEL	TIME SPAN
D103935	C032469	2	E52K01	06/03/74 - 07/27/74
D103936	C032470	2	E52K02	08/02/74 - 10/08/74
D103937	C032471	2	E52K03	10/10/74 - 12/06/74
D103938	C032472	2	E52K04	12/09/74 - 04/27/75
D103939	C032473	2	E52K05	04/29/75 - 10/12/75
D103940	C032474	2	E52K06	10/14/75 - 03/29/76
D103941	C032475	2	E52K07	03/31/76 - 06/02/77
D103942	C032476	2	E52K08	03/10/78 - 04/24/78
D103943	C032477	2	E52K09	09/03/74 - 01/16/75
D103944	C032478	2	E52K10	01/18/75 - 06/10/75
D103945	C032479	2	E52K11	06/12/75 - 08/18/75
D103946	C032480	2	E52K12	08/20/75 - 02/17/76
D103947	C032481	2	E52K13	02/19/76 - 10/29/76
D103948	C032482	2	E52K14	10/31/76 - 03/16/77
D103949	C032483	2	E52K15	03/19/77 - 04/27/78

* Since the tape is self documented in SFDU format, no hard copy is submitted to scanning. (CYN, 9/96)

74-040A-01A
02A
03A

```
$ show device $1$mua

Device                         Device           Error    Volume          Free  Trans Mnt
 Name                          Status           Count     Label         Blocks Count Cnt
$1$MUA0:          (HSC2)       Online               0
$1$MUA1:          (HSC2)       Online               0
$1$MUA2:          (HSC2)       Online             370
$1$MUA4:          (HSC1)       Online               0
$1$MUA5:          (HSC1)       Online               0
$1$MUA7:          (HSC2)       Mounted alloc      509                          0     1
                               foreign
$1$MUA40:         (HSC1)       Mounted alloc        2                          0     1
                               foreign
$1$MUA41:         (HSC1)       Mounted alloc        0    ADLOUT                0     1
                               foreign
$1$MUA80:         (HSC1)       Online               0
$1$MUA81:         (HSC1)       Online               0
$1$MUA82:         (HSC2)       Online alloc         1                          0     0
$1$MUA83:         (HSC2)       Online               0
$ if f$getdvi("$1$mua83:","all") .ne. "true" then -
   allocate $1$mua83:
%DCL-I-ALLOC, _$1$MUA83: allocated
$ if f$getdvi("$1$mua83:","mnt") .ne. "true" then -
   mount/for $1$mua83: HAWKout1
%MOUNT-I-OPRQST, Please mount volume HAWKOUT1 in device _$1$MUA83: (HSC2)
%MOUNT-I-MOUNTED, E52K01 mounted on _$1$MUA83: (HSC2)
%MOUNT-I-RQSTDON, operator request canceled - mount completed successfully
$!use the following command to get the listing after the tape is created
$ BACKUP/list $1$mua83:*.*
Listing of save set(s)

Save set:               17JUN92.
Written by:             RANDALL
UIC:                    [001400,002000]
Date:                   17-JUN-1992 11:47:47.14
Command:                BACKUP/LOG/LIST=DISK$FARM4:[PIONEER]17JUN92.BDAT/LABEL=E52K0
Operating system:       VAX/VMS version V5.5
BACKUP version:         V5.5
CPU ID register:        0B000006
Node name:              _IOWA4::
Written on:             _IOWA4$MUC0:
Block size:             8192
Group size:             10
Buffer count:           230

[PIONEER]HK_7415423.DAT;1                            68591   27-JAN-1992 14:4
[PIONEER]HK_7415703.DAT;1                            62383   23-JAN-1992 13:4
[PIONEER]HK_7415906.DAT;1                            58478   23-JAN-1992 14:0
[PIONEER]HK_7416109.DAT;1                            68799   23-JAN-1992 14:2
[PIONEER]HK_7416313.DAT;1                            66996   27-JAN-1992 15:0
[PIONEER]HK_7416518.DAT;1                            73026   23-JAN-1992 15:0
[PIONEER]HK_7416722.DAT;1                            70503   23-JAN-1992 15:2
[PIONEER]HK_7417000.DAT;1                            62944   29-JAN-1992 14:5
[PIONEER]HK_7417202.DAT;1                            65496   29-JAN-1992 13:3
[PIONEER]HK_7417405.DAT;1                            69609   29-JAN-1992 15:0
[PIONEER]HK_7417608.DAT;1                            70178   29-JAN-1992 14:3
[PIONEER]HK_7417812.DAT;1                            75271   30-JAN-1992 10:1
[PIONEER]HK_7418015.DAT;1                            74636   30-JAN-1992 10:2
[PIONEER]HK_7418221.DAT;1                            68784   30-JAN-1992 07:3
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06/03/74

6/03/74

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[PIONEER]HK_7418423.DAT;1                                  70797  30-JAN-1992 11:3
[PIONEER]HK_7418701.DAT;1                                  72029  31-JAN-1992 07:1
[PIONEER]HK_7418905.DAT;1                                  71671  31-JAN-1992 07:3
[PIONEER]HK_7419107.DAT;1                                  57787  31-JAN-1992 08:0
[PIONEER]HK_7419311.DAT;1                                  75015  31-JAN-1992 08:3
[PIONEER]HK_7419517.DAT;1                                  71148  31-JAN-1992 09:0
[PIONEER]HK_7419720.DAT;1                                  70576  31-JAN-1992 09:4
[PIONEER]HK_7419922.DAT;1                                  73384  31-JAN-1992 10:2
[PIONEER]HK_7420200.DAT;1                                  65046   4-FEB-1992 08:5
[PIONEER]HK_7420403.DAT;1                                  71201   4-FEB-1992 07:0
[PIONEER]HK_7420606.DAT;1                                  71381   4-FEB-1992 07:2
[PIONEER]HK_7420810.DAT;1     07|27|74                     71787   4-FEB-1992 07:4
%BACKUP-E-READERRS, excessive error rate reading $1$MUA83:[000000]*.*;
-BACKUP-E-SHORTBLOCK, save-set block too short
%BACKUP-I-OPERSPEC
%BACKUP-I-OPERASSIST, operator assistance has been requested
%BACKUP-I-OPREPLY, operator reply is "QUIT"
%BACKUP-F-ABORT, operator requested abort on fatal error
$ exit:
$ set magtape/rewind $1$mua83:
$ dismount $1$mua83::
%SYSTEM-W-NONLOCAL, device is not a local device
$ set noverify
  ALOPEZ       job terminated at  8-FEB-1996 14:27:57.99

  Accounting information:
  Buffered I/O count:            421      Peak working set size:    2216
  Direct I/O count:           129163      Peak page file size:      8062
  Page faults:                 14389      Mounted volumes:             1
  Charged CPU time:     0 00:03:08.83      Elapsed time:      0 06:43:48.94
```

DSC 789

74-040A-01A
02A
03A

HAWKEYE SPACECRAFT DOCUMENTATION

June 1992

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PREV_VOL: FOURTEEN

/* VOLUME INFORMATION END */

CCSD$$MARKERMRK**001

/* DATASET INFORMATION START */

CCSD3SS00002MRK**002
/* USING ENGLISH DESCRIPTION */

DATA_SET_NAME: HAWKEYE 1 SPACECRAFT SCIENCE DATA

DATA_SET_SOURCES: HAWKEYE 1 SPACECRAFT

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SOURCE_CHARACTERISTICS:

SPACECRAFT_DESCRIPTION:

The Hawkeye 1 (Explorer 52) carried a payload of 3 scientific instruments having a total mass of 6 kg. It was designed and built by the University of Iowa and also tracked for the most part by Iowa. The spacecraft was spin stabilized and had a mass of 26.6 kg. There were two booms extending in opposite directions and perpendicular to the rotational axis. One boom had at its end, the flux gate magnetometer and the other had a magnetic search coil antenna. Perpendicular to this axis and also to the spin axis were electric dipole antenna elements, extending in opposit directions. The tip-to-tip length was 42.45 m. The spacecraft had a rotational period of approximately 11 seconds after the deployment of the booms and antennas, and the axis of rotation was directed to a fixed point on the celestial sphere at right ascension 299.4 (+/- 1.1) degrees and declination +7.8 (+/- 1.5) degrees.

The spacecraft was launched from the Vandenberg/Air Force Western Test Range in California June 3, 1974 by a five-stage Scout vehicle. It re-entered the dense atmosphere and disappeared on April 28, 1978 after 667 orbits or nearly four years of continuous operation. The radial distance of apogee was between 20.9 and 28.3 Re. During the flight period, the inclination of the plane of the spacecraft's orbit to the earth's equator decreased monotonically from 89.81 to 81.85 degrees; the right ascension of the ascending node of the orbit decreased monotonically from 299.1 to 274.3 degrees; and the argument of perigee decreased monotonically from 274.3 to 225.3 degrees.

INVESTIGATION_OBJECTIVES:

The investigation objectives of the Hawkeye 1 spacecraft were in principle to survey the polar regions of the earth's magnetosphere at large radial distances (5-15 Re). Some specific matters are:

1) Topology of the polar magnetic field under varying interplanetary and geophysical conditions.

2) Configurations of the bow shock and the magnetopause and fluctuations thereof.

3) The distribution functions of thermal and quasi-thermal electrons and ions at high altitudes along magnetic lines of force that lead into the polar caps and auroral zones on the one hand and into the sunward magnetosphere and the magnetotail on the other hand.

4) Plasma instabilities in the polar magnetosphere and electrostatic and electromagnetic fields associated therewith.

5) Implications of all of the above on the acceleration of auroral particles, the distribution (both general and detailed) of their precipitation patterns on the earth and the relationship of such phenomena to the polar cusp, the polar mantle, the plasma sheet, and other phenomenological features of the magnetosphere.

6) Magnetic field and plasma distribution measurements in the solar wind.

7) Detection and direction-finding measurements on Type III radio emissions caused by solar electron streams in the interplanetary medium.

SPACECRAFT_ATTRIBUTES:

SPACECRAFT_DESCRIPTION:

SPACECRAFT_NAME:	=HAWKEYE 1/EXPLORER 52
SPACECRAFT_TYPE:	=FREE-FLIGHT
PI:	=JAVANALLEN
BUILD_DATE:	=1974-06-3
SPACECRAFT_MASS:	=26.63 kg
SPACECRAFT_HEIGHT:	=0.923 mt
SPACECRAFT_LENGTH:	=0.762 mt
SPACECRAFT_WIDTH:	=0.762 mt
SPACECRAFT_MANUFACTURER_NAME:	=THE UNIVERSITY OF IOWA
SPACECRAFT_SERIAL_NUMBER:	=SUI-06-01

The HAWKEYE spacecraft was designed specifically to support the three main experiments. The spacecraft subsystems included the telemetry, command, power and optical aspect plus various mechanical and electromechanical subsystems and devices.

The telemetry subsystem provided the data handling and RF transmission of all experiments, optical aspect, and housekeeping data to the ground via two RF links. The command subsystem was a tone sequential system that provided twenty-six command outputs plus one arming command to control the spacecraft in flight. The power subsystem provided various regulated supply voltages with isolated and common returns to the subsystems and experiments. The optical aspect subsystem provided the sun angle, sun pulse, and earth pulse data for aspect determination. The optical aspect system failed to turn on after the 43rd orbit.

The analog data from the experiments and subsystems was routed through an analog multiplexer and an analog-to digital converter before being merged into the PCM down link. Each experiment and the optical aspect subsystem had its own unique interface in the data system (data encoder). These interfaces provided experiment timing functions as well as all digital clock and gating lines. Pulse data from LEPEDEA and the optical aspect subsystem was processed in the interface prior to being merged into the PCM down link. The second RF down link was normally used to directly transmit VLF wideband analog data to the ground.

The 136 MHz RF link served as the primary PCM down link and was used instead of a separate tracking beacon to provide a tracking source for the ground data acquisition and tracking network. A diplexer was inserted between the 136 MHz transmitter and the turnstile antenna to enable the antenna to be used for both the 136 MHz down link and the 148 MHz command up link. The 400 MHz down link was the prime link for the VLF wideband data but could serve as a backup for the PCM data.

Regulated power to operate the experiments and subsystems was provided by the spacecraft power supply. The raw power for the supply was generated by a N/P type solar array. A storage battery was provided to share the load during temporary shadow conditions and provide the raw power during orbit night.

The spacecraft was controlled in orbit with a tone sequential command subsystem. The system was designed to work with the signals below the noise level and provided virtually error free operation under worst case conditions.

Optical aspect data required for spacecraft attitude determination was provided with a wide angle digital sensor and three earth telescopes with their associated electronics. The operation of this subsystem was controlled completely by the optical aspect interface in the data encoder.

The sensor for the Magnetometer experiment and the magnetic search coil for the VLF experiment were located at opposite ends of a telescopic boom system that was deployed by command after separation of the spacecraft from the Scout launch vehicle.

A pyrotechnic initiated release system was employed by the spacecraft to release the 136/148 MHz turnstile antenna elements just prior to separation from the Scout launch vehicle.

The spacecraft was designed for manual operation from the ground but had designed in safety features to prevent most catastrophic failures in the event ground control was lost even for relatively long periods of time.

Data Encoder

The Hawkeye data encoder operated at a bit rate of 100/sec and had a basic frame consisting of 64 9-bit words. The ninth bit of each word, except words 0-3, was odd parity on the preceding eight bits. Words 0-3 contain most of the 30 bit fixed synchronization word and therefore do not include parity. Input data which were digital in nature were formatted and processed directly except for the addition of the parity bits as required. Analog data were converted to digital by an 8-bit analog-to-digital (A/D) converter, and thereafter treated as the other digital data.

Some of the main frame words, specifically words 22-25 were subcommutated to allow more inputs to be processed, but at a correspondingly lower rate. Words 22 and 23 consist of optical aspect data and command status data both of which are digital in nature. The data are sub-commutated into eight sub-words (the details are given in the format section). Words 24 and 25 consist of engineering or housekeeping data all of which are analog in nature. Word 24 is subcommutated into 16 sub-words and word 25 into 32 sub-words. For the most part these sub-words consist of voltage, current and temperature measurements of the subsystems, all preconditioned to the 0 to 5 VDC range.

INSTRUMENT_ATTRIBUTES:

A. LEPEDEA_INSTRUMENT_DESCRIPTION:

INSTRUMENT_NAME:	=LEPEDEA EXPERIMENT
INSTRUMENT_TYPE:	=ELECTROSTATIC ANALYZER
PI:	=LAFRANK
BUILD_DATE:	=1974-01-01
INSTRUMENT_MASS:	=1.41 kg
INSTRUMENT_HEIGHT:	=0.076 mt
INSTRUMENT_LENGTH:	=0.254 mt
INSTRUMENT_WIDTH:	=0.210 mt
INSTRUMENT_MANUFACTURER_NAME:	=THE UNIVERSITY OF IOWA
INSTRUMENT_SERIAL_NUMBER:	=LEP-06

The LEPEDEA experiment consisted of a collimator, electrostatic analyzer, two continuous channel electron multipliers, a Geiger-Mueller tube, associated detector power supplies, and experiment electronics. The instrument was located in the belt line of the spacecraft and had a look direction perpendicular to the spin axis and at -43 degrees in the X-Y plane with respect to the + X axis.

The electrostatic analyzer consisted of three cylindrically curved concentric plates with approximate radii of curvature of 12.4 cm, 12.8 cm, and 13.5 cm. These formed two 45 degree analyzers for analyses of proton (ion) and electron spectrums, separately. The two outer plates were tied to circuit ground and the center plate was supplied with a variable, positive potential Vp from the instrument high-voltage programmer ranging from 3.5 V to 2130 V. Hence the outer analyzer accepted electrons of the appropriate energy and the inner analyzer performed analysis of positive ion differential energy spectrums. In order to suppress the solar ultraviolet and electron scattering along the analyzer plates into the entrance apertures of the electron multipliers the concave surfaces of the two outer plates were machined with sawtooth serrations of 1-mm depth facing the entrance apertures of the electrostatic analyzers. A collimator with knife-edged light baffles was also included to reduce this scattering and to define an approximately rectangular field-of-view with dimensions 8 by 30 degrees. All interior surfaces of the electrostatic analyzer and of the collimator were platinum-blackened in order to reduce further the analyzer responses to solar UV.

The continuous electron multipliers (Mullard Model B 330 AL) were positioned such that the normals to the surfaces of their entrance apertures form approximately a 30 degree angle with the normals to the exit apertures of the respective electrostatic analyzers. The entrance apertures of the multipliers were biased at 150 V and -3800V for post acceleration of electrons and protons, respectively. Electron pluses arriving at the exit apertures of the two multipliers were accelerated into charge -collecting cups by a potential difference of +30 V. The cup for for the multiplier associated with the electron channel of the analyzer was at a potential +3800 V and was coupled into a pulse amplifier via a capacitor.

An EON type 6213 G. M. tube with a collimated field-of-view directed parallel to those of the LEPEDEA was included in the instrument package in order to provide background measurements of energetic, penetrating charged particles in support of the electrostatic analyzers and to survey directional, integral intensities of protons $E_p > 600$ keV and electrons $E_e > 45$ keV.

The analyzer section of the instrument contained the two continuous-channel electron multipliers and their individual high-voltage bias supplies and pulse amplifiers, the electrostatic analyzer plates and the variable high-voltage bias supply, and the Geiger-Mueller tube with its pulse amplifier and high-voltage bias supply.

The low-voltage power converter provided the instrument with regulated voltages at +6.0 VDC and +12.0 VDC, and unregulated voltages at +27 VDC and -12 VDC, as referred to the data common. The three detector high-voltage DC-to-DC bias supplies were directly powered by the spacecraft regulated +12.0 VDC bus through an RF filter network which retards the propagation of switching noise into the spacecraft power converter. The primary sides of the high-voltage power supplies were referenced to the power common in order to eliminate the power losses associated with the DC-to-DC conversion referenced to the data common.

Five resettable electronic current trips were included within the power converter to isolate the large current loads within the instrument and to protect the spacecraft power converter from excessive current loads.

The electronics for analog and digital data handling were designed to provide the maximum allowable degree of protection from single-point failures compatible with the severe weight restrictions placed upon the design. The digital data lines from the pulse amplifiers were buffered in order to isolate the instrument D/A converters from the digital accumulators of the spacecraft data encoder. A failure at the input of either the converter or accumulator would not affect the operation of the other device. Digital signals at each of the three digital data outputs were cyclically sampled by two accumulators. The loss of any one accumulator would have reduced by 50% the digital sampling of one of the the three particle detectors. Digital signals from the detector amplifiers were also directed into individual D/A converters and transmitted as analog data.

The major elements of the instrument data handling and signal generator electronics were the analog and digital signal input buffers, two identical logic and gating sections operating in parallel, mode control electronics and the signal output selection relays. Each of the identical logic and gating sections was capable of generating the control-voltage wave forms for the analyzer high-voltage bias supply, subcommutation of eight instrument performance parameters into the stream of analog sampling of the analyzer responses, and processing of the spacecraft data processor. All command, digital timing and analog inputs were securely buffered to provide isolation between the two redundant logic and gating sections. The timing signals supplied to the LEPEDEA by the spacecraft data encoder were LW9, LW24, LW34, LW41-D68, LW57, and LF15-M16. A failure of a given analog input gate would have been reflected in a voltage offset at the input of its complementary gate in the other logic and gating section, but would not affect the operations of the other input gates. Similarly, the failure of a timing-signal input gate in one logic and gating section would in no way affect the operation of the other section. This redundancy was also available for the 16/32 step mode-select function.

Selection of the plate control-voltages from either of the logic and gating sections was accomplished with relays, thereby eliminating the possibility of a failure of a single output gate impairing the instrument dynamic ranges by spurious voltage offsets.

During each spacecraft frame, the responses of the proton and electron analyzers were simultaneously accumulated in separate registers for 0.99 seconds for each of two energy bandpasses (steps i, and i + 1). The corresponding register lengths were 20 bits. During these accumulation periods the responses of the G.M. tube were accumulated in two 16-bit registers G1 and G2. The instrument was subsequently programmed into a logarithmic ramp mode during which 16 consecutive analog samples of the responses of the proton and electron analyzer were transmitted. This mode allowed less sensitive, but well timed-resolved determinations of proton and electron energy spectrums. Sampling of proton and electron analyzers in this ramp mode was alternated for consecutive spacecraft frames (i.e.,electron sampled during even numbered frames, protons during odd frames). This slow (digital) - fast (analog) sampling of detector responses also allowed the instrument to obtain good angular distribution over a wide range of spacecraft spin rates. The directions of the field-of-view were determined via the optical aspect and/or magnetometer sensors. The length of the instrument cycle in the 16-step mode was (16 energy bandpasses)

/(2 energy band-passes per frame) = 8 frames, or 46 seconds. The instrument cycle time in the 32-step mode was 92 seconds.

The analog performance parameters were telemetered during words 17 and 33 of each spacecraft frame, and during word 58 of every even-numbered spacecraft frame. Words 17 and 33 were the values of the analyzer center-plate voltage monitor (LOG AMP) for each step in the sequence of 16 or 32 voltage steps corresponding to the energy bandpasses of the LEPEDEA. Word 58 (even frames only) was subcommutated among the following analog performance parameters.

S/C FRAME	Performance Parameter	Equation
0	LOG AMP at ramp High Step	V = Va +0.04
2	Current trip monitor	V = Va +0.04
4	+27 VDC voltage monitor	V = 9.05(Va+0.04)
6	+12.0 VDC voltage monitor	V = 4.02(Va+0.05)
8	+6.0 VDC voltage monitor	V = 2.0(Va +0.04)
10	-12 VDC voltage monitor	V =-4.77(Va+0.04)
12	Mode Monitor	V = Va
14	Logic A or B temperature	S/C conversion

The LEPEDEA utilized the spacecraft 12.0 VDC power bus to drive its internal low-voltage power converter and the detector high_voltage bias supplies. The average power in either the 16- or 32-step mode was 1.1 watts and the peak power, at step 31 and ramp initiate, was 1.6 watts.

One power relay command was required for power on/off to the LEPEDEA low-voltage power converter. The power-switching circuit and relay were included within the spacecraft low-voltage power converter. The second command required by the instrument was a toggle command which was used for cycling between the two identical logic and gating systems (A and B) and between the 16- and 32-step modes of the electrostatic analyzer. The sequence of functions cyclically available with this single toggle command were:

Logic A, 16-step mode	V = 0.75
Logic A, 32-step mode	V = 1.25
Logic B, 16-step mode	V = 1.75
Logic B, 32-step mode	V = 2.25

B. LEPEDA_PARAMETERS_MEASURED:

16- and 32-Step Modes

Step # 16	Step # 32	LOG AMP	Center-Plate Potential	Energy eV	Energy Width	Geometric Factor P	Geometric Factor E
0	0	4.75	3.5	66.9	12.2	18	5.0E4
	1	4.63	4.0	76.5	13.8	20	3.6E4
1	2	4.49	4.5	86.0	15.3	21	2.7E4
	3	4.35	5.2	99.4	17.5	23	1.9E4
2	4	4.20	6.2	119	20.5	25	1.2E4
	5	4.05	7.5	143	24.3	28	7.5E3
3	6	3.90	8.9	170	28.3	31	4.9E3
	7	3.77	10.8	206	33.7	35	3.0E3
4	8	3.61	13.2	252	40.3	39	1.6E3
	9	3.46	16.2	310	49.2	43	784
5	10	3.34	19.6	375	80.5	48	467
	11	3.19	24.3	465	158	50	260
6	12	3.03	30.3	579	241	52	145
	13	2.89	37.7	721	356	52	96

7	14	2.74	46.1	881	485	52	66
	15	2.60	57.6	1101	687	51	48
8	16	2.45	74.0	1415	956	47	37
	17	2.30	92.8	1774	1298	43	29
9	18	2.16	114	2179	1719	37	24
	19	2.02	143	2734	2144	31	20
10	20	1.87	180	3441	2684	26	16.5
	21	1.72	226	4321	3350	22	14.0
11	22	1.59	278	5315	4100	18	12.2
	23	1.44	350	6691	5133	16	10.5
12	24	1.28	442	8450	6445	13	9.1
	25	1.14	556	10630	8060	11	7.8
13	26	1.01	686	13115	9900	8.7	6.8
	27	0.86	863	16499	12380	7.0	5.9
14	28	0.70	1080	20647	15000	5.6	5.1
	29	0.56	1370	26192	17700	4.6	4.4
15	30	0.42	1700	32501	20600	3.8	3.8
	31	0.27	2130	40721	24100	3.2	3.3

Ramp Mode Electrons

Step #	Center-Plate Potential	Energy eV	Energy Width	Geometric Factor
15	1998	38200	22400	3.4
14	999	19100	14000	5.3
13	466	8900	6920	9.0
12	220	4200	3290	14
11	99.4	1900	1470	27
10	50.2	960	611	56
9	29.8	570	274	150
8	19.9	380	124	440
7	16.0	306	56.8	820
6	13.8	264	42.1	1500
5	11.6	222	36.2	2500
4	10.0	191	31.1	3700
3	8.4	160	27.3	5700
2	7.1	136	22.5	8500
1	6.0	115	20.2	13000
0	0.0	000	0.0	0.0

Ramp Mode Protons

Step #	Center-Plate Potential	Energy eV	Energy Width	Geometric Factor
15	2343	44800	26200	2.9
14	1172	22400	16300	5.2
13	549	10500	8160	11
12	256	4900	3890	20
11	115	2200	1710	37
10	58.6	1120	703	40
9	35.0	670	317	40
8	23.5	450	148	40
7	18.7	358	68.8	40
6	16.2	309	49.2	40
5	13.6	260	42.1	60
4	11.7	224	36.1	40
3	9.8	188	32.3	40
2	8.3	159	26.9	29

1	7.0	134	21.3	27
0	6.1	116	17.4	25

The ramp data counting rates were logarithmically compressed using a rate meter and sent to the encoder as an analog voltage. The conversion to counts/second is a two step process. The binary data from the encoder is converted to centavolts using

V = RAW * 1.96 + 0.5.

This value is then between 0 and 500. The count rate is then given by:

```
r = V / 2                                        for        V <  21

  = EXP ( 0.319789 + 0.120312 * V
        - 1.05861E-03 * V * V )                  for  20 < V <  51

  = EXP ( 2.96631 + 1.44514E-02 * V )            for  50 < V < 121

  = EXP ( 2.59958 + 1.75075E-02 * V )            for 120 < V < 207

  = EXP ( 3.22967 + 1.44514E-02 * V )            for 206 < V < 301

  = EXP ( 2.32386 + 1.75075E-02 * V )            for 300 < V < 422

  = EXP ( 3.59943 + 1.44514E-02 * V )            for 421 < V < 501
```

For r less than 200, R = r and otherwise
R = r / (1.- 1.82263E-05 * r).

Note: LOG AMP and Center-Plate Potential units are volts. Energy Width has units of eV and Geometric Factor has has units of 1/(cm*cm-sr)

Timing for LEPEDEA within frame of 0 to 63 words.

CHANNEL		WORD	TIME FROM START OF FRAME
LEP-1	midpoint	4.5	0.405
LEP-2	midpoint	19.5	1.755
RAMP-15		43	3.87
RAMP-14		44	3.96
RAMP-13		45	4.05
RAMP-12		46	4.14
RAMP-11		47	4.23
RAMP-10		48	4.32
RAMP-9		49	4.41
RAMP-8		50	4.50
RAMP-7		51	4.59
RAMP-6		52	4.68
RAMP-5		53	4.77
RAMP-4		54	4.86
RAMP-3		55	4.95
RAMP-2		56	5.04
RAMP-1		57	5.13
RAMP-0		58	5.22

Geiger-Mueller Tube

The GM data are read out twice per frame for a period of 0.99 seconds each. The mid point word of these readouts are

4.5 and 19.5 respectively.

The GM tube has a conical field of view with a half angle of 15 degrees. This detector is sensitive to protons with energies greater than 600 keV and has a geometric factor of 0.0168 cm*cm-sr for ions. It is also sensitive to electrons with energies greater than 45 keV and has a geometric factor of 0.0147 cm*cm-sr for these.

This detector began to malfunction on 12 April 1975 and the data from detector should not be used after this time.

C. VLF_INSTRUMENT_DESCRIPTION:

INSTRUMENT_NAME:	=VLF EXPERIMENT
INSTRUMENT_TYPE:	=ELECTRIC AND MAGNETIC FIELD RADIO FREQUENCY SPECTRUM ANALYZER
PI:	=DAGURNETT
BUILD_DATE:	=1974-01-01
INSTRUMENT_MASS:	=1.23 (LESS BOOMS) kg
INSTRUMENT_HEIGHT:	=0.058 mt
INSTRUMENT_LENGTH:	=0.140 mt
INSTRUMENT_WIDTH:	=0.140 mt
INSTRUMENT_MANUFACTURER_NAME:	=THE UNIVERSITY OF IOWA
INSTRUMENT_SERIAL_NUMBER:	=VLF-05

Electric Antenna

The electric antenna on HAWKEYE consisted of two extendible beryllium copper elements 0.025 inch in diameter which could be extended to a maximum tip-to-tip length of 42.7 m. Except for the outermost 6.1 m of each element, which had a conducting surface, the antenna was coated with Pyre-ML to electrically insulate the antenna from the surrounding plasma. The insulating coating was required to insulate the antenna from the perturbing effects of the plasma sheath surrounding the spacecraft body. At high altitudes, the thickness of the plasma sheath surrounding the spacecraft body was quit large, on the order of 9 m. Since the conducting portion of the antenna must extend beyond the plasma sheath, it was necessary that the antenna be rather long, at least 30 m. tip-to-tip.

The antenna mechanism used on HAWKEYE was the Dual-Tee extendible antenna manufactured by Fairchild Industries. The antenna length was 42.49 meters after final deployment until the last orbit, when an attempt was made to retract the antenna to reduce the spacecraft drag.

Magnetic Antenna

The magnetic antenna for this experiment consisted of a search coil with a high permeability core mounted on a boom approximately 1.5 m. from the centerline of the spacecraft body. The boom was a three element telescoping device developed at the University of Iowa. The boom supporting the flux gate magnetometer on the opposite side of the spacecraft was the same type. Both booms were extended simultaneously by an electric motor.

The search coil core was .305 m. long and was wound with approximately 20,000 turns of copper wire. The axis of the search coil was parallel to the spin axis of the spacecraft. A preamplifier was located with the sensor to provide low-impedance signals to the main electronics package in the spacecraft body. The frequency range of the search coil antenna was from 1.0 Hz to 10.0 kHz.

Electronics

The potential difference between the electric antenna elements was amplified by a high input impedance differential amplifier to provide a 0 to 5 volt analog voltage, V-Diff, to the spacecraft encoder. As the spacecraft rotated the potential difference between the antenna elements varied sinusoidally at the spacecraft rotation rate, with an amplitude proportional to the electric field strength and a phase determined by the direction of the electric field. The frequency response of the differential amplifier was 0.05 Hz to 10 Hz and included the entire range of spin rates expected as the antenna was deployed. The V-Diff signal was sampled 6 times each frame by the encoder. The gain of the differential amplifier could be controlled by command to provide dynamic ranges of +/-0.5 and +/-8.0 volts for the antenna potential difference measurements.

Signals from the electric antenna in the frequency range from 10 kHz to 200 kHz were analyzed by the narrow band step frequency receiver. The primary purpose of this receiver was to provide very good frequency resolution in the neighborhood of the electron plasma frequency and upper hybrid resonance frequency. The step frequency receiver consisted of 8 narrow band filters (+/-5% band-width) which were sequentially switched into a log compressor. The log compressor provided a 0 to 5 volt analog voltage, SFR, to the spacecraft encoder. The switch (S4) position was controlled by clock lines from the spacecraft encoder and was stepped through 8 frequencies, 13.3, 17.8, 23.7, 31.1, 42.2, 56.2, 100, and 178 kHz, at a rate of four frequencies per telemetry frame (5.76 seconds). The log compressor provided a 0 to 5 volt analog voltage, SFR, to the spacecraft encoder which was proportional to the logarithm of the signal strength over a dynamic range of 100 db.

The 8-channel spectrum analyzer provided relatively coarse frequency spectrum measurements of both electric and magnetic fields over a broad frequency range of 1.0 Hz to 10.0 kHz. The primary purpose of the 8-channel spectrum analyzer was to provide field strength measurements to complement the high-resolution frequency-time spectra from the wide-band receiver.

Switches S1 and S2 were controlled by clock lines from the spacecraft encoder and commutate the filter outputs to two log compressors which provided field strength measurements SA-1 and SA-2 (0 to 5 volts) to the spacecraft encoder. These outputs were sampled twice per telemetry frame. Switch S3, which was controlled by a clock line, commutates the electric and magnetic field signals to the 8-channel spectrum analyzer.

Approximately every 5 minutes the impedance of the electric antenna was determined at a frequency of 17 Hz by driving a small AC current into the antennas and measuring the resultant voltage on the antennas with the 8-channel spectrum analyzer. The 17 Hz oscillator was gated on for 1 frame out of every 64 frames by a clock line.

Immediately following the impedance measurement the pulser circuit produced a 10 volt pulse with a duration of 20 micro-seconds. This pulse was to stimulate local plasma resonances, such as plasma oscillation, from which the electron density could be determined. A pulse of +10 volts was applied to one antenna element and a -10 volt pulse was applied to the opposite antenna element. The pulser was switched on by command. The pulser was on when the experiment was in VLF45 mode and off when the experiment was in the VLF10 mode. The pulser voltage was coupled to the antenna through a 220 pf capacitor which would have allowed some meaningful data to be obtained from the experiment even if the pulser output were to short to ground. The pulse was applied at the end of the impedance measurement frame.

Analog Outputs

1. V-Diff, 0-5 volts, 8 bit A/D conversion
2. SFR, 0-5 volts, 8 bit A/D conversion
3. SA-1, 0-5 volts, 8 bit A/D conversion
4. SA-2, 0-5 volt, 8 bit A/D conversion
5. LVM, 0-5 volt, low voltage power supply monitor, 8 bit A/D conversion, engineering performance parameter
6. PSS, 0-5 volt, power supply status, 8 bit A/D conversion, engineering performance parameter
7. SCT, 0-5 volt, search coil temperature, 8 bit A/D conversion, engineering performance parameter

Clock Lines

All clock lines for the VLF experiment are shifted to start at word 8 of the spacecraft main frame.

1.	VWR/32	2 cycles/frame
2.	VFR	1 cycle/frame
3.	VFR/2	2 frames/cycle
4.	VFR/4	4 frames/cycle
5.	VFR/8	8 frames/cycle
6.	VFR2M64	Positive every Frame 2 Module 64 (used to control the impedance measurement and pulser circuit)

STEP FREQUENCY TIMING SEQUENCE

Clock Line State			Frequency
VWR/32	VFR	VFR/2	kHz
0	0	0	13.3
1	0	0	17.8
0	1	0	23.7
1	1	0	31.1
0	0	1	42.2
1	0	1	56.2
0	1	1	100.0
1	1	1	178.0

SPECTRUM ANALYZER TIMING SEQUENCE

Clock Line State			Frequency		Antenna
VFR	VFR/2	VFR/4	SA1	SA2	
0	0	0	17.8 Hz	1.78 kHz	Magnetic
1	0	0	56.2 Hz	5.62 kHz	Magnetic
0	1	0	1.78 Hz	178.0 Hz	Magnetic
1	1	0	5.62 Hz	560.0 Hz	Magnetic
0	0	1	17.8 Hz	1.78 kHz	Electric
1	0	1	56.2 Hz	5.62 kHz	Electric

0	1	1	1.78 Hz	178.0 Hz	Electric
1	1	1	5.62 Hz	560.0 Hz	Electric

Commands

1. Electric/Magnetic antenna selection for wide-band receiver (toggle command).
2. V-Diff Gain Control (toggle command).
3. Special wide-band mode and pulser On/Off (toggle command).

D. VLF_PARAMETERS_MEASURED:

Electric Antenna Calibrations

The signal from the two elements of the electric antenna were fed into an operational amplifier and this signal then went to the Step Frequency Receiver (SFR) which had 8 channels and to the Spectrum Analyzer (SA) which also had 8 channels. Each of these systems, consisted of 8 band pass filters (one for each channel) followed by a log compressor circuit.

Both systems were calibrated using a sinewave at the center frequency of each channel. This signal was attenuated in 2 db steps from an initial 1 volt rms value until the log compressor output no longer changed.

The effective bandwidth and noise levels of each channel were determined using random noise generators. The amplitudes were set by monitoring the voltage spectral density in the 10k to 15k Hz frequency range. This was done by measuring the true rms voltage through a General Radio Model 1952 band pass filter set at 10k and 15k Hz lower and upper band cut off frequencies respectively. The band width and noise levels are given in the following tables. The noise level is defined as the input voltage which produces a 0.1 volt increase in the output voltage above the output voltage with no signal input. The conversions through the log compressor circuits are given in the software.

Spectrum Analyzer (SA)

f (Hz)	Band Width (Hz)	Noise V**2/Hz
1.78	2.80	3.566E-08
5.62	1.51	8.871E-10
17.8	13.25	2.254E-11
56.2	26.46	3.779E-12
178	69.98	1.516E-12
562	302.8	3.303E-13
1780	830.3	1.516E-13
5620	2356	1.060E-13

Step Frequency Receiver (SFR)

f (k Hz)	Band Width (Hz)	Noise V**2/Hz
13.3	878	1.015E-13
17.8	987	7.166E-14
23.7	1557	3.612E-14
31.1	1162	4.840E-14
42.2	1559	6.414E-14
56.2	2259	3.131E-14
100.0	4929	1.279E-14

178.0	5609	1.752E-14

The electric spectral density as a function of frequency for each channel is given by:

SD (f) = Vin ** 2 / (Band Width * L (eff) ** 2) (V/m)**2/ Hz

where L (eff) = L (tip-to-tip) / 2 m (A.C. measurements)

= L (tip-to-tip) - 6.10 m (D.C. measurements)

V-Diff Calibrations

The V-Diff outputs were sampled six times per frame and was operated in two modes. The calibrations were accomplished by using square wave inputs which could be accurately measured by a digital voltmeter and recording the output from the spacecraft system. The potential difference in volts is given by:

V (+y) - V (-y) = - (V-Diff - Vo) / G Volts

Low gain: G = 0.31342 Vo = 2.4875
High gain: G = 4.96819 Vo = 2.4779

Magnetic Antenna Calibrations

The magnetic antenna senses varying magnetic fields and produces a voltage which is proportional to the magnetic field. This signal is amplified by a differential amplifier with a gain of 15. The output of this was fed into an RC integrator circuit with a 5.62k ohm resistor on each output and a 7.5 E-08 farad capacitor between these outputs. The output from this circuit is then fed into the Spectrum Analyzer which had 8 band pass filters and log compressor circuits. The input/output conversions of the log compressor circuits have been extensively calibrated in the same manner as the electric antenna and the conversions are given in the demonstration program for this experiment. The relationship between the fluctuating magnetic field and the output of the RC integrator are given by:

V rms (out) = C (V/nT) * B rms nT .

The band width and noise levels of each channel is also given in the following table. The noise level is defined as the input magnetic field spectral density which produces a 0.1 volt increase in the output voltage above the output voltage with no signal input.

Magnetic Spectrum Analyzer

f (Hz)	C (V/nT)	Band Width (Hz)	Noise (nT**2/Hz)
1.78	7.5713E-05	3.13	4.425E-03
5.62	2.4658E-04	1.98	4.853E-05
17.8	8.1129E-04	13.28	7.793E-07
56.2	2.2664E-03	24.08	5.720E-08
178.0	5.5082E-03	73.13	8.993E-09
562.0	7.6013E-03	309.8	8.854E-10
1780.0	7.8801E-03	1034.0	3.912E-10