National Aeronautics and Space Administration
Goddard Earth Science
Data Information and Services Center (GES DISC)

README Document for the Electrically Scanning Microwave Radiometer ESMR/Nimbus-5 Level-1 Calibrated Brightness Temperature Product

ESMRN5L1
ESMRN5IM

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1. Introduction

This document provides basic information on using the Electrically Scanning Microwave Radiometer ESMR/Nimbus-5 Level-1 Calibrated Brightness Temperature data. A short description of the ESMR image product is found in the Appendix.

1.1 Data Product Description

The ESMR/Nimbus-5 Level-1 Calibrated Brightness Temperature product contains the calibrated microwave radiances, expressed as brightness temperature, quality flags, geolocation, orbital, and housekeeping information. Each file typically contains one full orbit of data. Radiances are measured every 4 seconds at 12 wavelengths of 255.5, 273.5, 283.0, 287.6,, 292.2, 297.5, 301.9, 305.8, 312.5, 317.3, 331.2, 339.8 nm. The data are available from December 11, 1972 (day of year 100) through May 16, 1977 (day of year 126).

This product was previously available from the NASA National Space Science Data Center (NSSDC) under the name Electrically Scanning Microwave Radiometer (ESMR) Data, with the identifier ESAD-00219 (old id 70-025A-05B).

1.1.1 The Electrically Scanning Microwave Radiometer

The Electrically Scanning Microwave Radiometer (ESMR) was designed to (1) derive the liquid water content of clouds from brightness temperatures over oceans, (2) to observe differences between sea ice and the open sea over the polar caps, and (3) to test the feasibility of inferring surface composition and soil moisture. The ESMR instrument measured microwave radiation at 19.35 GHz (1.55 cm) emitted by the Earth surface and atmosphere. An 83.3- by 85.5-cm radiometer antenna system, deployed after launch, scanned perpendicular to the direction of the spacecraft at 78 positions from ±50° either side of nadir every 4 seconds. The spatial resolution of the instrument ranges from 25 km x 25 km at nadir to 160 km x 45 km at the edge of the scans. Accuracy of the radiometer was about ±1°C.

The ESMR experiment on Nimbus-5 was successful and returned data from December 11, 1972 through May 16, 1977. The Nimbus-5 ESMR mission was followed up by another ESMR instrument flown aboard Nimbus-6 in 1975.

The original principal investigator for the ESMR experiment was Dr.Thomas T. Wilheit, Jr.

1.1.2 Nimbus-5 Overview

The Nimbus 5 satellite was successfully launched on December 11, 1972. The primary experiments included: (1) a Temperature-Humidity Infrared Radiometer (THIR) for measuring day and night surface and cloud top temperatures, as well as the water vapor content of the upper atmosphere, (2) an Electrically Scanning Microwave Radiometer (ESMR) for mapping the microwave radiation from the Earth's surface and atmosphere, (3) an Infrared Temperature Profile Radiometer (ITPR) for obtaining vertical profiles of temperature and moisture, (4) the Nimbus-E Microwave Spectrometer (NEMS) for determining tropospheric temperature profiles, atmospheric water vapor abundances, and cloud liquid water contents, (5) a Selective Chopper Radiometer (SCR) for observing the global temperature structure of the atmosphere, and (6) a Surface Composition Mapping Radiometer (SCMR) for measuring the differences in the thermal emission characteristics of the Earth's surface.

The orbit of the satellite can be characterized by the following:

- circular orbit at 1100 km
- inclination of 99.9 degrees
- period of an orbit is about 107.2 minutes
- orbits cross the equator at 26 degrees of longitude separation
- sun-synchronous

1.2 Algorithm Background

The Nimbus-5 ESMR data were generated from the spacecraft telemetry, attitude and orbital data. The data were originally processed on IBM 360 computers. The intensity of microwave radiation centered at 19.35 GHz are converted to brightness temperatures are measured, along with geolocation, ancillary and other housekeeping data. Detailed information on the ESMR data processing can be found in the Nimbus-5 Users' Guide Section 4.

1.3 Data Disclaimer

The data should be used with care and one should first read the Nimbus-5 User's Guide, section 4 describing the ESMR experiment, as well as the Nimbus-5 Data Catalog sections on ESMR. Users should cite this data product in their research.

1.4 Known Issues

During review of the data, it was determined that in some data files, the records are not written in chronological order. This was discovered while determining the start and end date/times of the data files. The first record may not be the actual start of the data, and the last record may not be the end of the data. Four files where the end date is not the last record are:

- Nimbus5-ESMR_1976m0118t200728_DS99.TAP
- Nimbus5-ESMR_1976m0415t122848_DS104.TAP
- Nimbus5-ESMR_1976m0909t000004_DS114.TAP
- Nimbus5-ESMR_1977m0402t121518_DS128.TAP

Please check the time stamp of each data record to determine the correct sequence of the data in each file.

2. Data Organization

The ESMR/Nimbus-5 Level-1 Calibrated Brightness Temperature product spans the time period from December 11, 1972 to May 16, 1977. Each file typically contains one full orbit of data.

2.1 File Naming Convention

The data product files are named according to the following convention:

<Platform>-<Instrument>_<Level>_<Date>_<Tape>.<Suffix>

where:

- Instrument = name of the instrument (always ESMR)
- Platform = name of the platform or satellite (always Nimbus4)
- Level = processing level of data (always L1)
- Date = Data start date and time in UTC in format <YYYY>m<MMDD>t<hhmm> where
    1. YYYY = 4 digit year (1970 or 1971)
    2. MM = 2 digit month (01-12)
    3. DD = 2 digit day of month (01-31)
    4. hh = 2 digit hour of day (01-23)
    5. mm = 2 digit minute of hour (01-59)
- Tape = tape number (DR primary tape, DS backup tape plus 3 digit number)
- Suffix = the file format (always dat, indicating binary data)

```
File name example: Nimbus5-ESMR_L1_1972m1211t163724_DS28.TAP
```

2.2 File Format and Structure

The data are stored as they were originally written in IBM binary (big-endian) record oriented structured files. The files were written on the original 1600 bpi 9-track tapes using a FORTRAN block format, each block with a maximum size of 28000 bytes (some may be shorter). Within each block are up to 50 data records of size 560 bytes (280 x 2-byte words).

Figure 1: ESMR Level-1 File Structure

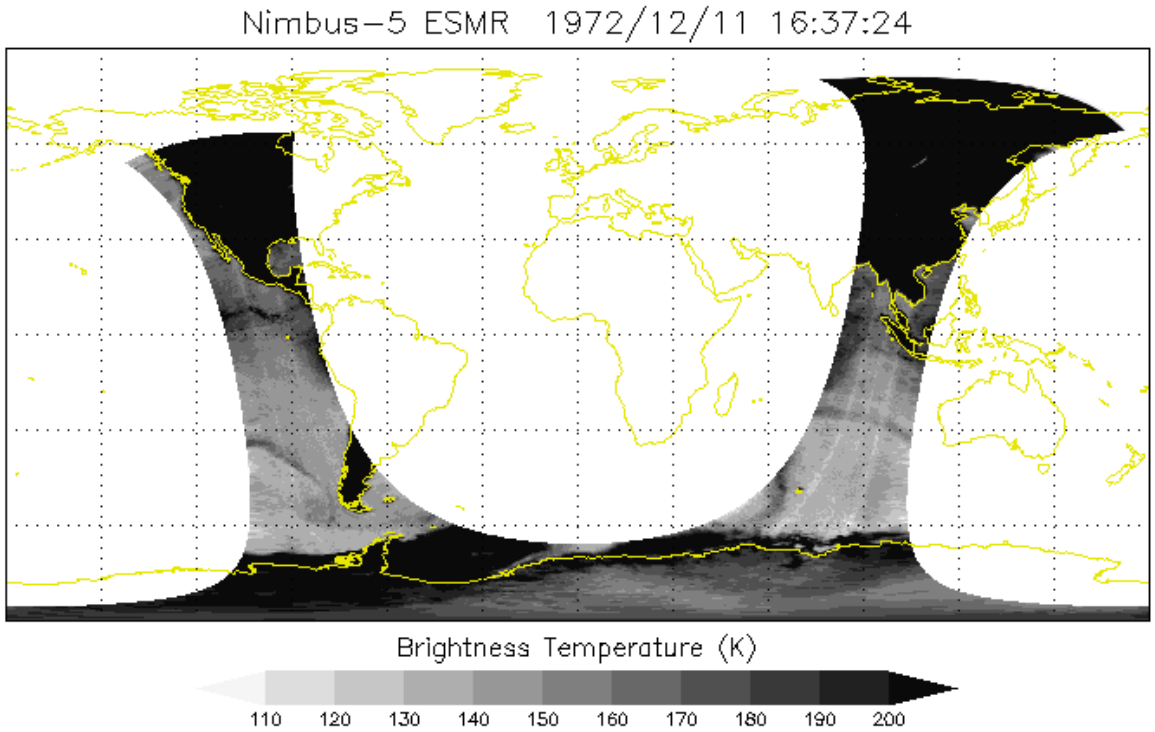
Begin Block Size (4 bytes)	
Block (28,000 bytes)	
Record 1	280 x 2 byte words
Record 2	280 x 2 byte words
⋮	⋮
Record 50	280 x 2 byte words
End Block Size (4 bytes)	

Blocks repeat multiple times

2.3 Key Science Data Fields

The primary science data fields in this data product are the calibrated microwave radiances expressed as brightness temperatures in units of degrees Kelvin.

Figure 2: Typical data coverage for a Nimbus-5 ESMR Level-1 orbit file.



3. Data Contents

The granularity of this data collection is one orbit (approximately 107 minutes).

3.1 Data Records

The Level-1 data files only contain a series of data records (there is no header record). Each data record is of size 560 bytes (280 x 2-byte integer words). See the Nimbus-5 ESMR Data Products User's Guide – Section 4-4, Table 4-6 for a full description of the ESMR CBTT data file format. A sample FORTRAN program to read the data files can be found in the Appendix.

Table 3-1-1: Data Record

Word	Field Name	Units	Scale	Comments
1	Year			
2	Day			
3	Hour			
4	Minute			
5	Second			
6	PGM ID			Unique identifier number assigned to program that prepared tapes
7	Pitch Fine Error	degrees	10	
8	Roll Fine Erro	degrees	10	
9	RMP Indicated Rate High	degrees	10	
10	Subsatellite Latitude	degrees	10	(-90 to +90)
11	Subsatellite Longitude	degrees	10	westward (0-360)
12	Height	km	1	The height of the spacecraft
13	Hot Load Mean		10	
14	rms of Hot Load		100	
15	Cold Load Mean		10	
16	rms of Cold Load		100	
17	MUX 1		1	Average antenna temperature

18	MUX 2		1	Average phaseshift temperature
19	MUX 3		1	Ferrite switch block temperature
20	MUX 4		1	Ambient load temperature
21	MUX 5		1	Hot load temperature
22	MUX 6		1	AGC
23	ANALOG 0			
24	ANALOG 1			
25	ANALOG 2			
26	ANALOG 3			
27	ANALOG 4			
28	ANALOG 5			
29	ANALOG 6			
30	ANALOG 7			
31	ANALOG 8			
32	ANALOG 9			
33	ANALOG 10			
34	ANALOG 11			
35	ANALOG 12			
36	ANALOG 13			
37	ANALOG 14			
38	ANALOG 15			
39	DIGITAL B			low order 8 bits: b_8 – ephemeris 0 = estimated 1 = data b_7 – radiometer power on/off b_6 – load power on/off b_5 – antenna scan on/off b_4 – AGC clear on/off b_3 – AGC inhibit on/off b_2 – temperature TLM power on/off b_1 – data cycle first half/second half

40	Status Indicators			low order 15 bits: b_{15} – primary comstor verify yes/no b_{14} – redundant comstor verify yes/no b_{13} – ITPR electronics on/off b_{12} – NEMS data unit on/off b_{11} – NEMS data channel 1 on/off b_{10} – NEMS data channel 2 on/off b_9 – NEMS data channel 3 on/off b_8 – NEMS data channel 4 on/off b_7 – NEMS data channel 5 on/off b_6 – ESMR radiometer power on/off b_5 – SCMR electronics on/off b_4 – THIR electronics on/off b_3 – S-Band A on/off b_2 – S-Band B on/off b_1 – SCMR S-Band on/off
41	Status Indicators (cont.) Data Source			low order 15 bits: b_{15} – SCR power on/off b_{14} – SCR chopper MTR on/off b_{13} – ITPR chopper MTR on/off b_{12} – ESMR antenna scan on/off b_{11} – spare b_{10} – spare b_9 – spare b_8 – SCMR monitor on/off b_7 – Satellite day/ night indicator 1 = day 0 = night b_6 – ephemeris data comp bit care input 1 = uncompensated 0 = compensated b_5 – beacon XMTR A on/off b_4 – beacon XMTR B on/off b_3 – spare b_2 and b_1 00 HDRSS A 01 HDRSS B 10 Real-Time
42	Beam Position 79			
43-46	Spares			
47-124	Latitude	degrees	10	at 78 scan positions
125-202	Longitude	degrees	10	at 78 scan positions
203-280	Brightness Temperature	°K	10	at 78 scan positions

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3.2 Metadata

The metadata are contained in a separate XML formatted file having the same name as the data file with .xml appended to it.

Table 3-2: Metadata attributes associated with the data file.

Name	Description
LongName	Long name of the data product.
ShortName	Short name of the data product.
VersionID	Product or collection version.
GranuleID	Granule identifier, i.e. the name of the file.
Format	File format of the data file.
CheckSumType	Type of checksum used.
CheckSumValue	The value of the calculated checksum.
SizeBytesDataGranule	Size of the file or granule in bytes.
InsertDateTime	Date and time when the granule was inserted into the archive. The format for date is YYYY-MM-DD and time is hh-mm-ss.
ProductionDateTime	Date and time the file was produced in format YYYY-MM-DDThh:mm:ss.ssssssZ
RangeBeginningDate	Begin date when the data was collected in YYYY-MM-DD format.
RangeBeginningTime	Begin time of the date when the data was collected in hh-mm-ss format.
RangeEndingDate	End date when the data was collected in YYYY-MM-DD format.
RangeEndingTime	End time of the date when the data was collected in hh-mm-ss format.
PlatformShortName	Short name or acronym of the platform or satellite
InstrumentShortName	Short name or acronym of the instrument
SensorShortName	Short name or acronym of the sensor
GPolygon: PointLatitude	Latitudes of the polygon (rectangle) points that represent the satellite coverage. Each point is identified by its latitude and longitude pair.
GPolygon: PointLongitude	Longitudes of the polygon (rectangle) points that represent the satellite coverage. Each point is identified by its latitude and longitude pair.
Elapsed_Min_Time	Duration in minutes of data collected during an orbit

4. Reading the Data

The data are written in a binary record-oriented format. Using the record format specification in the section above, users can write software to read the data files. Please note that the data were originally written using a big-endian format, therefore users on little-endian machines will need to swap bytes for the words. Also, the floating point data were written using IBM 360 machines, and must be converted if reading on a machine that understands IEEE floats (integers are not affected).

A sample FORTRAN program is included in the Appendix section which will read the data files.

5. Data Services

Please see the ESMR/Nimbus-5 Level-1 Calibrated Brightness Temperature data landing page at http://disc.gsfc.nasa.gov/datacollection/ESMRN5L1_001.html for a list of services for accessing these data, including:

5.1 HTTP Access

The data are available for users to download directly using HTTP access:

http://acdisc.gesdisc.eosdis.nasa.gov/data/Nimbus5_ESMR_Level1/ESMRN5L1.001/

The data are organized in directories by year with subdirectories by day of year. This README, User's Guide and other documentation are located under the doc directory.

5.2 Earthdata Search Client

The EOSDIS Earth data search client (EDSC) interface at https://search.earthdata.nasa.gov provides users with the ability to search for data archived at various data centers. It offers various download options that suit users with different preferences and different levels of technical skills. To search for the ESMR/Nimbus-5 Level-1 Calibrated Brightness Temperature data enter ESMRN5L1 in the keyword field (optional spatial region and time period may also be specified).

6. More Information

6.1 Web Resources

For other Nimbus data products, please see the GES DISC's Nimbus heritage data web page at:
http://disc.gsfc.nasa.gov/nimbus/

To search for other related data, please visit NASA's Global Change Master Directory at:
http://gcmd.nasa.gov.

6.2 Point of Contact

Name: GES DISC Help Desk
URL: http://disc.gsfc.nasa.gov/
E-mail: gsfc-help-disc@lists.nasa.gov
Phone: 301-614-5224
Fax: 301-614-5228
Address: Goddard Earth Sciences Data and Information Services Center
Attn: Help Desk
Code 610.2
NASA Goddard Space Flight Center
Greenbelt, MD 20771, USA

6.3 References

T. Wilheit, "The Nimbus-5 User's Guide - Section 4: The Electrically Scanning Microwave Radiometer (ESMR) Experiment", NASA Goddard Space Flight Center, November 1972, Pages 59-106

7. Appendices

7.1 Acknowledgements

The Nimbus data recovery task at the GES DISC is funded by NASA's Earth Science Data and Information System program.

7.2 Acronyms

EOS: Earth Observing System

ESDIS: Earth Science and Data Information System

GES DISC: Goddard Earth Sciences Data and Information Services Center

GSFC: Goddard Space Flight Center

ESMR: Electrically Scanning Microwave Radiometer

CBTT: Calibrated Brightness Temperature Tape Product

L1: Level-1 Data

NASA: National Aeronautics and Space Administration

EDSC: Earthdata Search Client

QA: Quality Assessment

UT: Universal Time

7.3 Image Product

The ESMR/Nimbus-5 Images of Brightness Temperature on 70 mm film or ESMRN5IM data product contains scanned negatives of photofacsimile 70mm film strips. Each frame contains a geographic grid and two groups of three parallel strips of imagery, each containing one-half the orbital data. The spatial coverage is identical in each group, but each strip has a different dynamic range for its gray scale: 100-200 K, 190-270 K, and 250-300 K, respectively. The images are saved as JPEG 2000 digital files, and about 7 days of images are archived into a TAR file.
The images are publically available, see section 5 above by searching for ESMRN5IM.
The image files can be viewed with any application that supports the JPEG 2000 format.

7.4 FORTRAN Code

```
C-----------------------------------------------------------------------
C ^NAME: READ_ESMR
C
C ^DESCRIPTION:
C     This program opens and reads a Nimbus-5 ESMR level-1 data file
C     and prints the contents of the file to the screen. Data files
C     consist blocks of data records (usually 28,000 bytes) containing
C     up to 50 data records each of 280 x 2-byte integer words. See the
C     Nimbus-5 User's Guide, Section 4 for a description of ESMR.
C
C ^MAJOR VARIABLES:
C     FNAME  - name of input file
C
C ^NOTES:
C     Compile: gfortran -o READ_ESMR.EXE READ_ESMR.FOR
C
C ^ORGANIZATION: NASA/GSFC, Code 610.2
C
C ^AUTHOR:  James Johnson
C
C ^ADDRESS: james.johnson@nasa.gov
C
C ^CREATED: May 20, 2016
C-----------------------------------------------------------------------

      CHARACTER          FNAME*1024
      CHARACTER          BLOCK(28000)  ! Record block buffer = 28000 bytes
      CHARACTER          DREC(280*2)   ! Data record buffer = 2*280 bytes
      CHARACTER          BUFF(4)       ! Buffer to hold 4-byte word
      INTEGER*4          WORD          ! 4-byte word
      INTEGER*4          IBLKSZ        ! Block size header
      INTEGER*4          NRECS         ! Number of data records in block
      INTEGER*4          IOS           ! I/O status number
      EQUIVALENCE        (BUFF, WORD)

C     Get the name of the input data file to read
      PRINT *, 'Enter the name of the input file:'
      READ (5,'(A)') FNAME
      PRINT '("FILE: ",A)',TRIM(FNAME)

C     Open the specified input file
      OPEN (UNIT=1, FILE=FNAME, STATUS='OLD', ACCESS='DIRECT',
     &      FORM='UNFORMATTED', RECL=1, ERR=99, IOSTAT=IOS)

C     Initialize M (block number), N (record) and IOFF (byte offset in file)
      M=1
      N=1
      IOFF=0
```

```
C     Loop through the file reading all blocks of data
      DO

C       Read the first 4-byte word or block size header
        DO I=1,4
          READ (1, REC=IOFF+I, IOSTAT=IOS, ERR=90) BUFF(I)
        END DO
        IBLKSZ = WORD
        IOFF=IOFF+I-1

C       End-of-Tape (EOT) mark
        IF (IBLKSZ .EQ. 0) THEN
          GOTO 20
        ENDIF

C       Bad block size
        IF (IBLKSZ .GT. 28000) THEN
          PRINT '("WARN: BAD BLOCK ",I4,", SIZE ",I10)',N,IBLKSZ
          IBLKSZ = 28000
        ENDIF

C       Next read the block of records
        DO I=1,IBLKSZ
          READ (1, REC=IOFF+I, IOSTAT=IOS) BLOCK(I)
          IF (IOS .NE. 0) THEN
            PRINT '("ERROR: BLOCK ",I4,X,I4,", IOSTAT: ",I6)', N,I-1,IOS
            IBLKSZ = I-1
            GOTO 10
          ENDIF
        END DO
        IOFF=IOFF+I-1

        NRECS = IBLKSZ/(2*280)
   10   DO J=1,NRECS
          DREC = BLOCK((J-1)*280*2+1:J*280*2)
          PRINT '(/,"********************")'
          PRINT '("RECORD = ",X,I10)', N
          PRINT '("********************")'
          CALL PRDREC(DREC)
          N=N+1
        END DO

C       Finally read the last 4-byte word (should match first block size)
   20   DO I=1,4
          READ (1, REC=IOFF+I, IOSTAT=IOS, ERR=90) BUFF(I)
        END DO
        IF (IBLKSZ .NE. WORD) THEN
          PRINT '("WARN: BLOCK ",I4,", "I10," != ",I10)', N,WORD,IBLKSZ
        ENDIF
        IOFF=IOFF+I-1

        M=M+1

      END DO
```

```
C     Close the input file
   90 CLOSE(1)
      GOTO 100

   99 PRINT '("ERROR: OPEN FILE, IOSTAT: ",I6)', IOS

  100 STOP
      END


C-----------------------------------------------------------------------
C ^SUBROUTINE: PRDREC
C
C     This Subroutine will Print the Data Record Values
C-----------------------------------------------------------------------

      SUBROUTINE PRDREC(IWORD)

      INTEGER*2          IWORD(280)     ! Word array
      INTEGER*2          I2SWAP         ! Function to swap 2-byte words


      PRINT '("YEAR      =",3X,I6)',   I2SWAP(IWORD( 1))
      PRINT '("DAY       =",3X,I6)',   I2SWAP(IWORD( 2))
      PRINT '("HOUR      =",3X,I6)',   I2SWAP(IWORD( 3))
      PRINT '("MINUTE    =",3X,I6)',   I2SWAP(IWORD( 4))
      PRINT '("SECOND    =",3X,I6)',   I2SWAP(IWORD( 5))
      PRINT '("PGM ID    =",3X,I6)',   I2SWAP(IWORD( 6))
      PRINT '("PITCH ERR =", X,F8.2)', I2SWAP(IWORD( 7))/10.0
      PRINT '("ROLL ERR  =", X,F8.2)', I2SWAP(IWORD( 8))/10.0
      PRINT '("RMP RATE  =", X,F8.2)', I2SWAP(IWORD( 9))/10.0
      PRINT '("NADIRLAT  =", X,F8.2)', I2SWAP(IWORD(10))/10.0
      PRINT '("NADIRLON  =", X,F8.2)', I2SWAP(IWORD(11))/10.0
      PRINT '("HEIGHT    =", X,F8.2)', I2SWAP(IWORD(12))/1.0
      PRINT '("HOT MEAN  =", X,F8.2)', I2SWAP(IWORD(13))/10.0
      PRINT '("HOT RMS   =", X,F8.2)', I2SWAP(IWORD(14))/100.0
      PRINT '("COLD MEAN =", X,F8.2)', I2SWAP(IWORD(15))/10.0
      PRINT '("COLD RMS  =", X,F8.2)', I2SWAP(IWORD(16))/100.0
      PRINT '("MUX 1     =", X,F8.2)', I2SWAP(IWORD(17))/1.0
      PRINT '("MUX 2     =", X,F8.2)', I2SWAP(IWORD(18))/1.0
      PRINT '("MUX 3     =", X,F8.2)', I2SWAP(IWORD(19))/1.0
      PRINT '("MUX 4     =", X,F8.2)', I2SWAP(IWORD(20))/1.0
      PRINT '("MUX 5     =", X,F8.2)', I2SWAP(IWORD(21))/1.0
      PRINT '("MUX 6     =", X,F8.2)', I2SWAP(IWORD(22))/1.0
      PRINT '("ANALOG  0 =",3X,I6)',   I2SWAP(IWORD(23))
      PRINT '("ANALOG  1 =",3X,I6)',   I2SWAP(IWORD(24))
      PRINT '("ANALOG  2 =",3X,I6)',   I2SWAP(IWORD(25))
      PRINT '("ANALOG  3 =",3X,I6)',   I2SWAP(IWORD(26))
      PRINT '("ANALOG  4 =",3X,I6)',   I2SWAP(IWORD(27))
      PRINT '("ANALOG  5 =",3X,I6)',   I2SWAP(IWORD(28))
      PRINT '("ANALOG  6 =",3X,I6)',   I2SWAP(IWORD(29))
      PRINT '("ANALOG  7 =",3X,I6)',   I2SWAP(IWORD(30))
```

```
      PRINT '("ANALOG  8 =",3X,I6)',   I2SWAP(IWORD(31))
      PRINT '("ANALOG  9 =",3X,I6)',   I2SWAP(IWORD(32))
      PRINT '("ANALOG 10 =",3X,I6)',   I2SWAP(IWORD(33))
      PRINT '("ANALOG 11 =",3X,I6)',   I2SWAP(IWORD(34))
      PRINT '("ANALOG 12 =",3X,I6)',   I2SWAP(IWORD(35))
      PRINT '("ANALOG 13 =",3X,I6)',   I2SWAP(IWORD(36))
      PRINT '("ANALOG 14 =",3X,I6)',   I2SWAP(IWORD(37))
      PRINT '("ANALOG 15 =",3X,I6)',   I2SWAP(IWORD(38))
      PRINT '("DIGITAL B =",X,B8.8)',  I2SWAP(IWORD(39))
      PRINT '("STAT IND1 =",X,B15.15)',I2SWAP(IWORD(40))
      PRINT '("STAT IND2 =",X,B13.13)',ISHFT(I2SWAP(IWORD(41)),-2)
      PRINT '("DATA SRC  =",X,B2.2)',IAND(I2SWAP(IWORD(41)),Z'03')
      PRINT '("BEAM POS  =",3X,I6)',   I2SWAP(IWORD(42))
C     PRINT '("SPARE     =",4(X,I6))',(I2SWAP(IWORD(K)),K=43,46)
      PRINT '("LAT       =")'
      PRINT '(8(X,F8.2)))',(I2SWAP(IWORD(K))/10.0,K=47,124)
      PRINT '("LON       =")'
      PRINT '(8(X,F8.2)))',(I2SWAP(IWORD(K))/10.0,K=125,202)
      PRINT '("BT        =")'
      PRINT '(8(X,F8.2)))',(I2SWAP(IWORD(K))/10.0,K=203,280)

      RETURN
      END


C-----------------------------------------------------------------------
C ^FUNCTION: I2SWAP
C
C     This function will swap the bytes of a 2-byte word
C-----------------------------------------------------------------------

      INTEGER*2 FUNCTION I2SWAP(BUFF)

      CHARACTER          BUFF*2         ! Input data buffer
      CHARACTER          TEMP*2         ! Output swapped buffer
      INTEGER*2          I2BUFF
      EQUIVALENCE        (TEMP, I2BUFF)

      TEMP(1:1) = BUFF(2:2)
      TEMP(2:2) = BUFF(1:1)
      SWPBYT = I2BUFF

      RETURN
      END
```