RSC-11-11

DSN RADIO SCIENCE SYSTEM ORIGINAL DATA RECORD (ODR) AND ORIGINAL DATA STREAM (ODS)

(Insert this module in Document 820-13; Rev. A.)

EFFECTIVE DATE: October 1992 EFFECTIVE SERVICE: Mars Observer
Initial Release Date: April 1, 1992 NOTE: This module supersedes RSC-11-10A.

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A. PURPOSE

This interface module defines and controls the format of the Radio Science Original Data Record (ODR) and Original Data Stream (ODS). This stream is composed of records generated by the Spectrum Processing Assembly (SPA) of the DSCC Spectrum Processing Subsystem (DSP), using the Radio Science software of the DSP, which is designated SPA-R. Additionally, this module details the standard format data unit (SFDU) header used in transmitting the Radio Science ODS records in real time to the Space Flight Operations Center (SFOC).

NOTE

This module is generated by SPA-R software versions beginning with OP-F as of the effective date stated above. Versions OP-A, OP-B, and OP-C generated the ODR format defined in Module RSC-11-10. Versions OP-D and OP-E generated the format defined in Module RSC-11-10A.

2. Applicable Documents

The interface requirements established in this module were derived from guidelines and criteria contained in the following documents:

820-13 (RSC-6-19)	Network-Level data Flow Standard
820-13 (GCF-10-11)	SFOC/GCF Interface Agreement
820-13 (RSC-11-4A)	Wideband GCF Radio Science Playback Blocks and DSN Radio Science System Interface
820-13 (IDR-12-1A)	DSN Interfaces - IDR Formats (Mark IVA)
890-201	Network-Level Data Flow Standard

B. REVISION AND CONTROL

Revisions or changes to the information herein presented may be initiated according to the procedures in Section I (Introduction) of this document.

C. GENERAL INFORMATION

The DSP-R is a computer-controlled subsystem that digitally samples a received spacecraft signal through the use of four analog-to-digital (A-D) converters. The digitized samples, along with the monitor data necessary to reconstruct the signal, are recorded on tape, and/or transmitted in real time to SFOC. Analysis of variations in the amplitude, phase, and frequency of the signal provides information on the ring structure, atmospheric density, magnetic field, and charged-particle environment of planets which occult the spacecraft. Additionally, this signal information is needed for gravity wave detection.

The Radio Science ODR tapes, also refered to as Original Data Stream (ODS) tapes in this document, are shipped to the Network Data Control (NDC) subsystem for delivery to the appropriate project Radio Science team, or they may be played back via wideband data lines (refer to Module RSC-11-4A of this document) to the Ground Communications Facility (GCF), where they can be processed in order to produce an Intermediate Data Record (IDR). (Refer to Module IDR-12-1A of this document.) Each record, when transmitted to SFOC in real time, also contains an SFDU header, which together are encased in Standard DSN Blocks (SDBs). The SFDU header is detailed in paragraph F below. The communication protocol, the header, and the trailer of the SDBs are defined and controlled by Modules OPS-6-19, GCF-10-11, and Document 890-201.

D. DATA RECORDS AND CONTENT

The DSP-R digitally samples the received spacecraft signal with 8-bit or 12-bit resolution and creates records of varying lengths, depending on the sample rate and resolution. Table 1 lists the record length for each sample rate. (Tables 2 and 3 list time consumption data and sample time offsets.) Each record is composed of (1) a header containing information on system configuration, time-tagged receiver local oscillator values, etc., and (2) a block of digital data from the four A-D converters.

The DSP-R records data on 9-track tapes with either (1) a tape density of 6250 bytes per inch (bpi), using the Group-Coded Recording (GCR) format with a 0.3-inch inter-record gap, or (2) a density of 1600 bpi, using the Phase Encoding (PE) format with an 0.6-inch inter-record gap. American National Standards Institute (ANSI) formats are used. Only one tape density may be used per recording session.

1. Beginning of Tape Header

A special 16-word record is written at the beginning of each tape as part of the tape-initialization process. The first 10 words of the record are ASCII characters, identifying the program and version currently in use; e.g., DMO-5205-OP-E v 8.04. The remaining six words are nulls. This information does not appear in the data transmitted to SFOC.

2. Time Tag Offset

The sampled data are later than the reported time tag by two intervals of the sample rate of a single A-D converter. This means that in each record the ADC data which corresponds with the time tag is the third set of ADC samples in the record, not the first set. (See Words 7 and 8 in paragraph E below.)

Table 1. Record Length Tabulation

Rate[1] (Samples/second per A-D Converter)	Samples[2] per Record per A-D Converter	Records per Second	Data Words [3] per Record	Total Words per Record
8-Bit Resolution				
50,000[4]	1000	50	2000	2083
31,250[4]	625	50	1250	1333
25,000[4]	1000	25	2000	2083
20,000	1000	20	2000	2083
15,625	625	25	1250	1333
12,500	625	20	1250	1333
10,000	1000	10	2000	2083
6,250	625	10	1250	1333
5,000	1000	5	2000	2083
4,000	1000	4	2000	2083
3,125	625	5	1250	1333
2,500	625	4	1250	1333
2,000	1000	2	2000	2083
1,250	625	2	1250	1333
1,000	500	2	1000	1083
500	250	2	500	583
400	200	2	400	483
250	125	2	250	333
200	100	2	200	283
12-Bit Resolution				
10,000	500	20	1500	1583
5,000	500	10	1500	1583
2,000	500	4	1500	1583
1,000	250	4	750	833
200	50	4	150	233

NOTES

(1) Maximum effective sampling rate of 4 times the individual converter rate is obtained when all four A-D converters sample the same input channel sequentially, but separated by 1/4 cycle.

(2) The total number of samples per record is 4 times the number of samples per record per A-D converter.

(3) A word contains 16 bits.

(4) Only available when recording at 6250-bpi density.

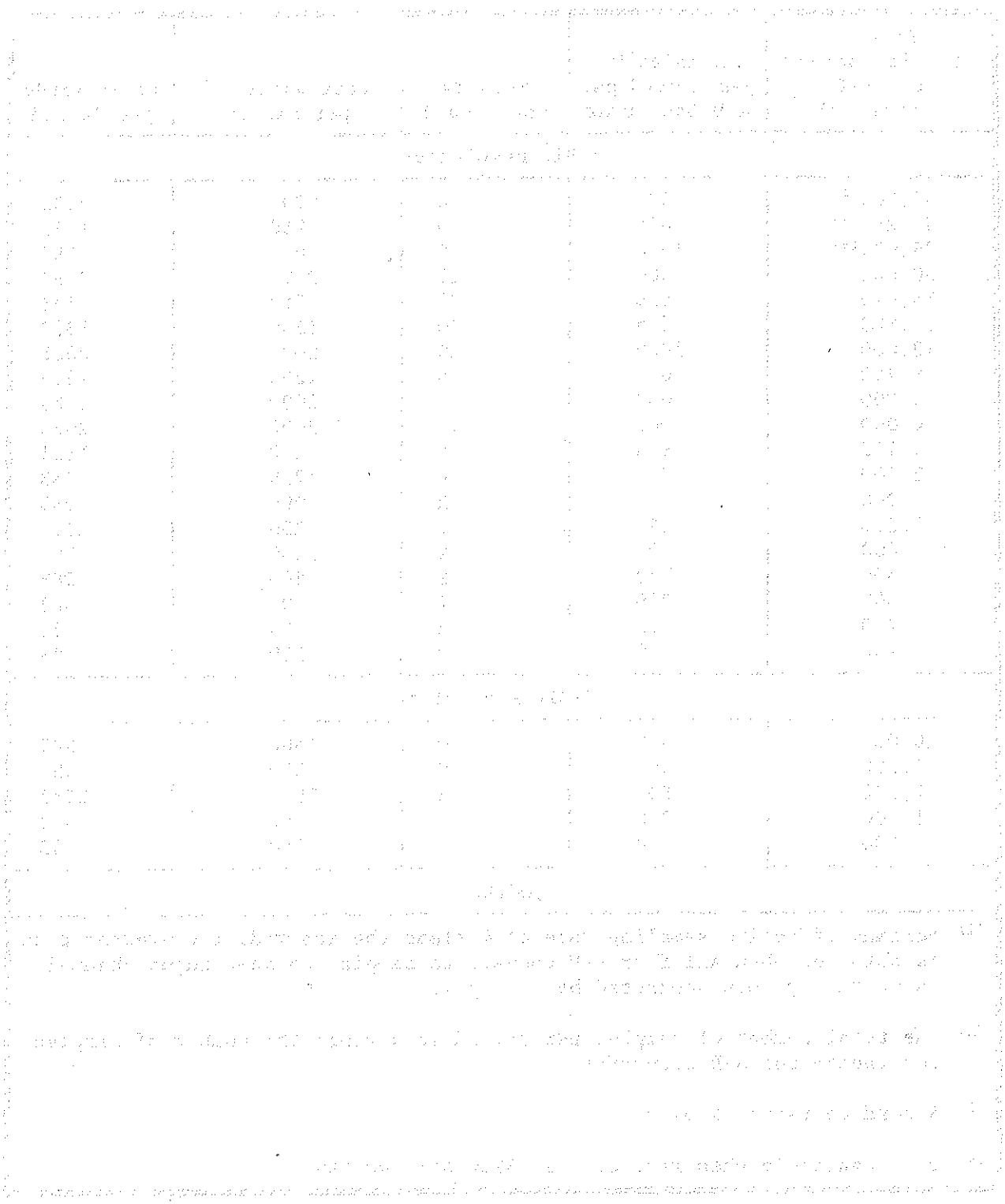


Table 2. Time Consumption for 6250-bpi Tape

Samples/Second (Rate)	Samples/ Record per A-D Converter	Record/ Second	Record/Tape	Time Used to Fill/Tape (minutes)
8-Bit Resolution				
50,000	1000	50	24,000	8
31,250	625	50	30,000	10
25,000	1000	25	24,000	16
20,000	1000	20	24,000	20
15,625	625	25	30,000	20
12,500	625	20	30,000	25
10,000	1000	10	24,000	40
6,250	625	10	30,000	50
5,000	1000	5	24,000	80
4,000	1000	4	24,000	100
3,125	625	5	30,000	100
2,500	625	4	30,000	125
2,000	1000	2	24,000	200
1,250	625	2	30,000	250
1,000	500	2	36,000	300
500	250	2	36,000	300
400	200	2	55,000	458.3
250	125	2	55,000	458.3
200	100	2	55,000	458.3
12-Bit Resolution				
10,000	500	20	30,000	25
5,000	500	10	30,000	50
2,000	500	4	30,000	125
1,000	250	4	41,000	170.83
200	50	4	58,000	241.6

Table 3. Time Consumption for 1600-bpi Tape

Samples/Second (Rate)	Samples/ Record per A-D Converter	Record/ Second	Record/Tape	Time Used to Fill/Tape (minutes)
8-Bit Resolution				
50,000	N/A			
31,250	N/A			
25,000	N/A			
20,000	1000	20	7,000	5.83
15,625	N/A			
12,500	625	20	7,000	5.83
10,000	1000	10	7,000	11.6
6,250	625	10	7,000	11.6
5,000	1000	5	7,000	23.3
4,000	1000	4	7,000	29.16
3,125	625	5	7,000	23.3
2,500	625	4	7,000	29.16
2,000	1000	2	7,000	58.3
1,250	625	2	7,000	58.3
1,000	500	2	12,000	100
500	250	2	12,000	100
400	200	2	20,000	166.6
250	125	2	20,000	166.6
200	100	2	20,000	166.6
12-Bit Resolution				
10,000	500	20	9,000	7.5
5,000	500	10	9,000	15
2,000	500	4	9,000	37.5
1,000	250	4	14,000	58.3
200	50	4	25,000	104.16

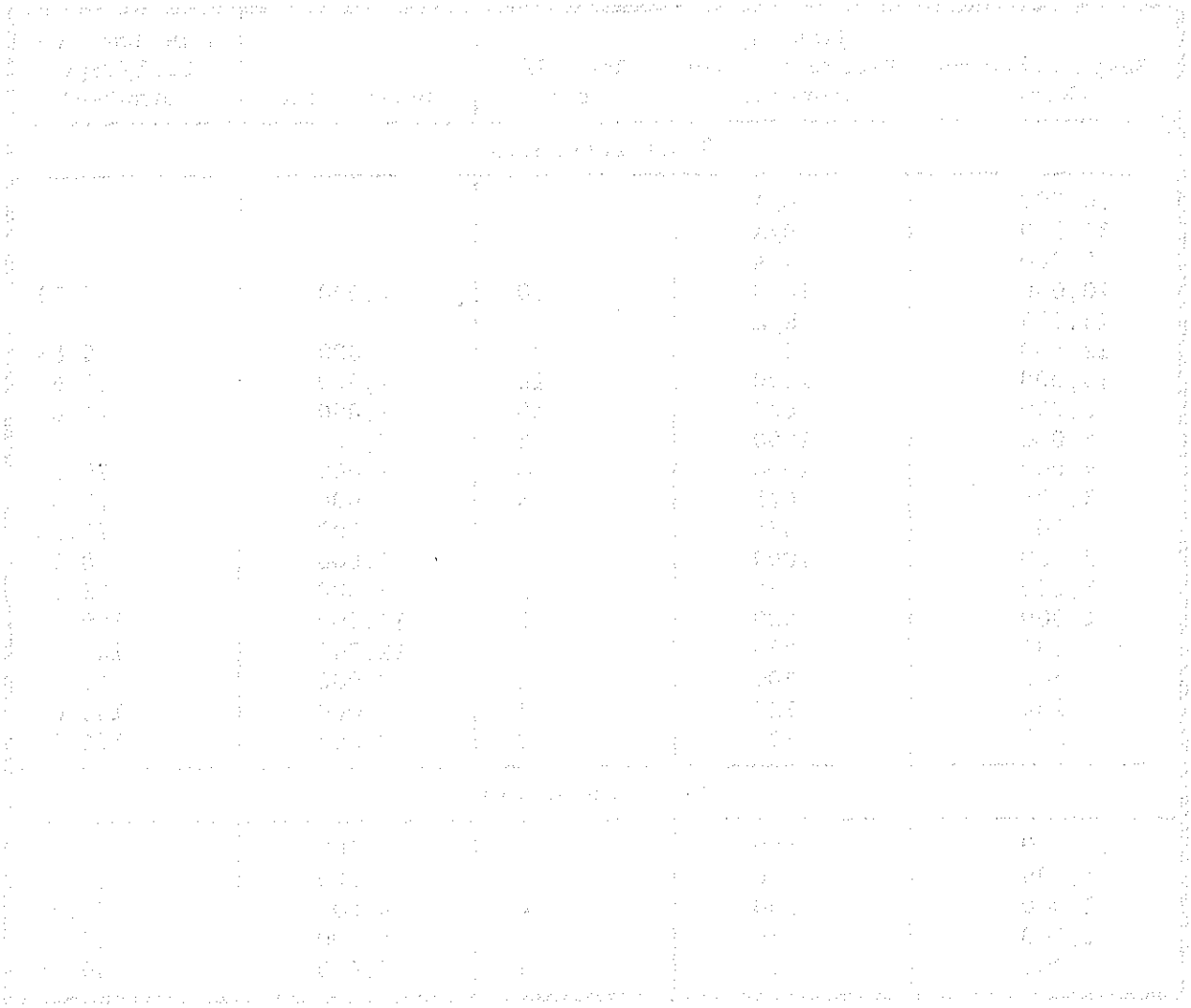
3. Printed Tape Label Format

The following description refers to the information in Figure 1.

DRIVE = x
DSP tape drive number (1-6) on which the tape was generated

YEAR = xxxx
Year in which tape was generated, such as "1988"

SCN xxx
Spacecraft number



PASS xxxx
Pass number

SPC xx
SPC number

P xx S xx
Primary and secondary antenna numbers as received from CMC in setting up the link in which the DSP resides. If only one antenna is used, the secondary antenna number will be 0.

START TIME xxx:xx:xx:xx.xxx
Time tag of first record on the tape in DOY:HH:MM:SS.SSS format. An example is 325:12:02:00.000, which would indicate the first data on the tape corresponds to a time of DOY 325 at 12:02:00.

END TIME xxx:xx:xx:xx.xxx
Time tag of last record on the tape

ERRORS = xxxxx
Number of write errors detected while recording on this tape

TAPE# = xxx
The number of this tape in this recording session. The first tape of a recording session is numbered 1.

VERSION xxxxxxxxxxxxxxxxxxxx
The ID of the SPA-R software version which generated the tape, such as "DMO-5205-OP-E v 8.04".

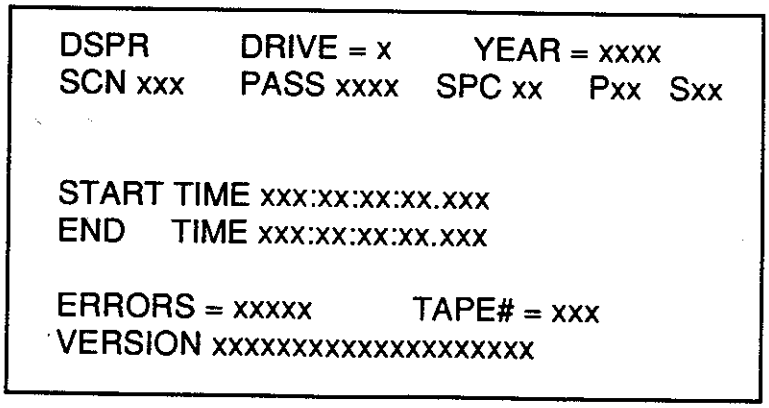


Figure 1. Table Label Format

E. DETAIL RECORD DESCRIPTION

1. Header* - (See Figure 2)

WORD 1

BIT

1 Origin of Narrow Band Occultation Converter (NBOC) time tag (Words 7 and 8) and configuration information (Words 81 thru 83).
= 0 if time tag (Words 7 and 8) was generated by DSP-R software counting from last Frequency and Timing Subsystem (FTS) 1-second pulse and configuration information (Words 81 thru 83) was copied forward by software and not read directly from NBOC buffer.
= 1 if time tag is from FTS and Words 81 thru 83 came directly from NBOC buffer.

NOTES

If bit 1 is set to "1" the following additional validity checks may be made:
(a) Word 81 should be "A55A"
(b) Word 83, bits 1 thru 8 should indicate correct configuration from the Conversion Mode Register.

After bit 1 is set to "1" it will read "0" for the next L-1 Records, where L is the number of "Records Per Second" (shown in the third column) in Table 1 of this module.

BIT

2 Start of recording session flag:
0 if other than first record on recording session.
1 if this is the first record of recording session.

NOTES

Each time the program mode is changed from IDLE to RUN, this bit is set to 1 in the first record. When the SPA-R software is in its auto-start/stop operating mode, this bit is set to 1 in the first record after a BEGIN RECORDING directive is processed from the active predict set.

BIT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WORD 1	O	S	E	C	COMPRESSION FACTOR				TAPE NUMBER							
2	RECORD NUMBER															
3	LENGTH OF RECORD															
4	PRIME FEA								SECONDARY FEA							
5	SPACECRAFT NUMBER								SPC CODE							
6	YEAR								DAY OF YEAR							
7	UNUSED								MILLISECONDS PAST O UTC							
8	MILLISECONDS OF DAY															
9	PREDICT SET IDENTIFICATION															
10																
11																
12																
13	PREDICT SET IDENTIFICATION															
14	POCA STATUS								POCA FREQ (RDBK)							
15	POCA FREQUENCY (READBACK)															
16	POCA FREQUENCY (READBACK)															
17	POCA FREQUENCY (READBACK)															
18	UNUSED								TIME TAG OF POCA FREQ (RDBK)							
19	TIME TAG OF POCA FREQUENCY (READBACK)															
20	UNUSED								POCA FREQ (CALCULATED)							
21	POCA FREQUENCY (CALCULATED)															
22	POCA FREQUENCY (CALCULATED)															
23	POCA FREQUENCY (CALCULATED)															
24	UNUSED								TIME TAG OF POCA FREQ (UPDATE CYCLE)							
25	TIME TAG OF POCA FREQUENCY (UPDATE CYCLE)															
26	RFCNF	RFIF	UNUSED						POCA FREQUENCY RATE							
27	POCA FREQUENCY RATE													MULTIPLIER: S		
28	FREQUENCY COUNTER NO. 1 CUMULATIVE PHASE															
29	FREQUENCY COUNTER NO. 1 CUMULATIVE PHASE															
30	FREQUENCY COUNTER NO. 1 CUMULATIVE PHASE															
31	FREQUENCY COUNTER NO. 2 CUMULATIVE PHASE															
32	FREQUENCY COUNTER NO. 2 CUMULATIVE PHASE															
33	FREQUENCY COUNTER NO. 2 CUMULATIVE PHASE															
34	TEST SIGNAL			SAMPLE CONTROL					CNTR #1 MODE				CNTR #2 MODE			
35	UNUSED								TIME TAG OF FMS MEASUREMENT							
36	TIME TAG OF FMS MEASUREMENT															
37	PREDICT TIME OFFSET (DAYS)								UNUSED						SGN	MSB
38	TIME OFFSET (SECONDS)															LSB
39	PREDICT FREQUENCY OFFSET															
40	PREDICT FREQUENCY OFFSET															
41	PREDICT FREQUENCY OFFSET															
42	FILTER OFFSET															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

BIT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WORD 43	FILTER OFFSET															
44	RIC CH 1 F OPR				RIC CH 2 F OPR				RIC CH 3 F OPR				RIC CH 4 F OPR			
45	RIC CH 1 FLTR				RIC CH 2 FLTR				RIC CH 3 FLTR				RIC CH 4 FLTR			
46	CH 1 ATTENUATOR								CH 2 ATTENUATOR							
47	CH 3 ATTENUATOR								CH 4 ATTENUATOR							
48	FUTURE ATTENUATOR								FUTURE ATTENUATOR							
49	FUTURE ATTENUATOR								FUTURE ATTENUATOR							
50	UNUSED								TIME TAG OF RIV ATTENUATOR READING							
51	TIME TAG OF RIC RMS VOLTAGE READING															
52	RIV CHANNEL 1 RMS VOLTAGE															
53	RIV CHANNEL 2 RMS VOLTAGE															
54	RIV CHANNEL 3 RMS VOLTAGE															
55	RIV CHANNEL 4 RMS VOLTAGE															
56	FUTURE								RMS VOLTAGE							
57	FUTURE								RMS VOLTAGE							
58	FUTURE								RMS VOLTAGE							
59	FUTURE								RMS VOLTAGE							
60	UNUSED								TIME TAG OF RIC RMS VOLTAGE READING							
61	TIME TAG OF RIC RMS VOLTAGE READING															
62	A-D "1" RMS MEASUREMENT(SOFTWARE CALCULATED)															
63	A-D "2" RMS MEASUREMENT															
64	A-D "3" RMS MEASUREMENT															
65	A-D "4" RMS MEASUREMENT															
66	A-D "1" MAX VALUE								A-D "1" MAX VALUE							
67	A-D "1" NUMBER OF OCCURENCES OF MAX.															
68	A-D "1" NUMBER OF OCCURENCES OF MIN.															
69	A-D "2" MAX VALUE								A-D "2" MIN. VALUE							
70	A-D "2" NUMBER OF OCCURENCES OF MAX.															
71	A-D "2" NUMBER OF OCCURENCES OF MIN.															
72	A-D "3" MAX VALUE								A-D "3" MIN. VALUE							
73	A-D "3" NUMBER OF OCCURENCES OF MAX.															
74	A-D "3" NUMBER OF OCCURENCES OF MIN.															
75	A-D "4" MAX VALUE								A-D "4" MIN. VALUE							
76	A-D "4" NUMBER OF OCCURENCES OF MAX.															
77	A-D "4" NUMBER OF OCCURENCES OF MIN.															
78					TIME TAG OF RMS MEASUREMENT											
79	TIME TAG OF RMS MEASUREMENT															
80	A-D CONVERTER SAMPLE RATE															
81	A				5				5				A			
82	"24" COUNTER								"N" REGISTER							
83	CONVERSION MODE REGISTER								SIGNAL SELECT REGISTER							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Figure 2. Record Header Information

WORD 1 (Continued)

BIT	
3	Error flag (can only occur during tape copy process): 0 if Master Tape contains no error, 1 if error occurred while reading record on Master Tape
4	A-D Conversion: 1 indicates 8-bit resolution 0 indicates 12-bit resolution
5 thru 8	0001 = Narrow Band, no compression (for compatibility with Mk III ODR)
9 thru 16	Tape Number (binary) in this recording session; first tape is No. 1.

NOTE

A new recording session is indicated each time the program mode is changed from IDLE to RUN. Cycling between these two modes will cause each tape to be labeled No. 1. The recording time listed on the tape label must be used to properly verify the tape sequence. During auto-start/stop operating mode, the BEGIN RECORDING and END RECORDING directives do not alter the Tape Number.

WORD 2

BIT	
1 thru 6	Record Number (unsigned binary, reset to 1 at beginning of each tape)

WORD 3

BIT	
1 thru 16	Record Length (binary unsigned integer), number of total words per record: See Table 1, column titled "Total Words per Record."

WORD 4

BIT	
1 thru 8	Prime Front End Area (FEA) Number (e.g., 14, 43) (binary)
9 thru 16	Secondary FEA Number

WORD 5

BIT	
1 thru 8	Spacecraft Number (binary) from predicts (see Module OPS-6-8 of this document)
9 thru 16	Signal Processing Center (SPC) Designator (i.e., 10, 40, 60, or 21); (binary) (see Module OPS-6-8)

WORD 6

BIT	
1 thru 7	Last two digits of year from Monitor and Control Subsystem (DMC) monitor data (binary)
8 thru 16	Day of Year (binary representation if decimal 1 through 366, from FTS system)

WORD 7

BIT	
1 thru 5	Unused
6 thru 16	Time of first sample in record, in milliseconds past 0 h Universal Time Coordinated (UTC) (Binary representation in milliseconds of decimal 0 thru 86,399,999.) See Word 1, bit 1, for origin of time tag. (See paragraph D.2 for time tag offset information.)

WORD 8

BIT	
1 thru 16	Time tag (continued)

WORD 9 THRU 13

BIT	
1 thru 16	Predict Set ID; Identification of predicts set used to tune the receiver frequency (ten 8-bit ASCII characters)

WORD 14

BIT	POCA Status Function	Status When Bit = 1	Status When Bit = 0
1	Control	Manual	Computer*
2	Control	Ready*	Not Ready
3	Synthesizer Power	On*	Off
4	Synthesizer In-Lock	In-Lock*	Out-of-Lock
5	Limit Enable	On	Off*

WORD 14

BIT	POCA Status Function	Status When Bit = 1	Status When Bit = 0
6	Track	On*	Off
7	Acquisition	On	Off*
8	Sweep	On*	Off
9 thru 16	Frequency value back from the Programmed Oscillator - Control Assembly (POCA) frequency registers - binary coded decimal (BCD) representation in microhertz.		

WORDS 15 THRU 17

BIT	
1 thru 16	Value from POCA Frequency registers (continued)

NOTE

Examples of POCA frequency values:

Word 14, bits 9 thru 16 (hex)	=	41
Word 15 (hex)	=	5624
Word 16	=	2167
Word 17	=	3152

Indicates a POCA frequency of 41,562,421.673152

WORD 18

BIT	
1 thru 5	Unused
6 thru 16	Actual FTS time read from the POCA register in milliseconds past 0 h UTC. This is the time value that should be used for reconstructing POCA frequency values.

WORD 19

BIT	
1 thru 16	Time tag (continued)

WORD 20

BIT	
1 thru 8	Unused
9 thru 16	POCA frequency (calculated) - BCD representation in microhertz. Value of the predicted frequency (plus filter offset and operator-entered offset) interpolated by the DSP-R for the time recorded in Words 18 and 19. The predicted frequency is supplied by the NSS Radio Science prediction software.

WORDS 21 THRU 23

BIT	
1 thru 16	POCA frequency (calculated) (continued)

WORD 24

BIT	
1 thru 5	Unused
6 thru 16	Time tag of POCA frequency update cycle in milliseconds past 0 h UTC. This time value is for diagnostic purposes only, and should not be used for data reconstruction.

WORD 25

BIT	
1 thru 16	Time tag for POCA frequency (update cycle) (continued)

*Denotes Normal Radio Science Use

WORD 26

BIT

1 thru 2	Antenna RF configuration code which reflects configuration of IF-video switch selection. (Operator input selection) Modes used are: 01 = PRIME mode (70 m) 10 = CROSS mode (34 m HEF) 11 = FAROT mode (Faraday rotation)
3 thru 4	Antenna RF configuration as reported by the IF switch assembly. Same value codes in bits 1-2.
5 thru 8	Unused
9 thru 16	POCA frequency rate from POCA rate registers - in Hertz per second (5 BCD digits following the decimal point; i.e., 0.12345)

WORD 27

BIT

1 thru 12	POCA Frequency Rate (continued)
12 thru 15	Power of 10 multiplier for POCA frequency rate (binary)
16	Sign for POCA Frequency Rate: if 0, rate is negative if 1, rate is positive

NOTE

The following are examples of POCA rates:

Word 26 (hex, bits 9-16)	Word 27 (hex)	Decimal Rate Conversion
12	3452	-1.2345 Hz/sec
12	3457	123.45 Hz/sec
12	3451	.12345 Hz/sec

WORDS 28 THRU 30

BIT

1 thru 16	One-second accumulated phase from frequency counter No. 1. Scaled to 2^{-20} cycles. Last 20 (8) bits are fractional part of one cycle. This is a "running count," not the difference count from the previous second.

WORDS 31 THRU 33

BIT

1 thru 16	One-second accumulated phase from counter No. 2. Scaled to 2^{-20} cycles. Last 20 bits are fractional part of one cycle.

WORD 34

BIT	
1 thru 4	FMS Test Facility Input Signal Selection: 0001 = Live input of Counter 1 (POCA "J1")* 0010 = Live input of Counter 2 ("J2", not used)
5 thru 8	FMS Sample Control Register Bit 5 =1 Enable live sample to counter* =0 Disable live sample Bit 6 =1 Enable test sample to counter* =0 Disable test sample Bit 7 =1 Enable internal 10 MHz to resolvers* =0 Enable reference 10 MHz to resolvers Bit 8 =1 Enable internal 10 MHz to test facilities* =0 Enable reference 10 MHz to test facilities
9 thru 12	Frequency Counter Number 1 Mode Register 0000 = Test facility output frequency to counter 0001 = Live frequency to counter (POCA)*
13 thru 16	Frequency Counter Number 2 Mode Register 0000 = Test facility output frequency to counter* 0001 = Live frequency to counter (not presently connected)

WORD 35

BIT	
1 thru 5	Unused
6 thru 16	Time tag Frequency Monitoring Subassembly (FMS) counter readings (Words 28-33) in millisecond past 0 h UTC. This is the FTS time at which the program stored the FMS phases described in Words 28 thru 33. (This time tag is for diagnostic purposes only.)

WORD 36

BIT	
1 thru 16	Time tag of FMS counter (continued)

WORD 37 AND 38

BIT	
1 thru 9	Predict Time Offset (Days) (binary, positive value)
10 thru 14	Unused
15	Sign of Predict Time Offset: this sign is applied to the days and seconds portion 1 = Negative 0 = Positive

*Denotes Normal Radio Science Use

WORD 37 AND 38 (Continued)

BIT	
16	Predict Time Offset in seconds (17-bit integer); MSB is Word 37, bit 16; LSB is Word 38, bit 16. This time offset is input by the operator in real time as a last-minute correction to the time domain of the predict set. This value is added to the predict set times, and the results are tracked relative to real (current FTS). Therefore, positive time offsets will cause the original predict times to occur later, and negative values cause the times to occur earlier.

WORD 38

BIT	
1 thru 16	Predict Time Offset in seconds (continued)

WORD 39 THRU 41

BIT	
1 thru 16	The S-band Frequency Offset to the predict set; formatted as a 48-bit binary number with LSB (Word 41, bit 16) equal to 2-20 Hz. Value may be positive or negative (2's complement format). Maximum value is 2 MHz. This value is entered by the operator in real time as a last-minute correction to the frequency domain of the predict set.

WORD 42 AND 43

BIT	
1 thru 16	Filter Offset; value used by software to tune carrier signal to center of filter. This offset compensates for the unique characteristics and placement of the filter in the RF spectrum. Value is 32-bit signed binary, scaled in hertz, applied to the predict set frequencies to obtain the final frequency result for the POCA.

NOTE

The following station-dependent formulas are used to determine POCA settings

$$POCA = \left(\frac{(S\text{-}Band\ Value) - (300Mhz) - (Filter\ Offset\ value)}{3} - 600Mhz\right) * \frac{2}{3}$$

DSS 7 and 42

$$POCA = \left(\frac{(S\text{-}Band\ Value) - (300Mhz) - (Filter\ Offset\ value)}{48} \right)$$

DSS 12 and 61

$$POCA = \frac{(S\text{-}Band\ Value) - (Filter\ Offset\ value)}{3} - \left(721 + \frac{9}{11}\right) Mhz$$

all other stations

All values are in MHz, and filter offset is the value found in Words 42 and 43. The offsets found in Words 37 through 41 are applied to the S-band values before this formula is used.

WORD 44

BIT	
1 thru 4	IF-VF Downconverter Controller (RIC) Operator filter selection for Channel 1. Value is binary representation with a range from 1 to 6.
5 thru 8	RIC Operator filter selection for Channel 2.
9 thru 12	RIC Operator filter selection for Channel 3.
13 thru 16	RIC Operator filter selection for Channel 4.

WORD 45

BIT	
1 thru 4	IF-VF RIC reported filter selection for Channel 1. Value is binary representation with a range from 1 to 6.
5 thru 8	RIC reported filter selection for Channel 2.
9 thru 12	RIC reported filter selection for Channel 3.
13 thru 16	RIC reported filter selection for Channel 4.

WORD 46

BIT	
1 thru 8	RIV Attenuator setting for Channel 1. Value is positive, binary representation. Range of values from 0 to 119 db.
9 thru 16	RIV Attenuator setting for Channel 2.

WORD 47

BIT	
1 thru 8	RIV Attenuator "A" setting for Channel 3.
9 thru 16	RIV Attenuator "A" setting for Channel 4.

WORD 48

BIT	
1 thru 8	RIV Attenuator "B" setting for future use. Value is positive, binary representation. Range of values from 0 to 119 db.
9 thru 16	RIV Attenuator "B" setting for future use.

WORD 49

BIT	
1 thru 16	RIV Attenuator "B" setting for future use.

WORD 50

BIT	
1 thru 5	Unused; set to zeros
6 thru 16	Time tag of RIV Attenuator readings (Words 46-47) in millisecond past 0 h UTC.

WORD 51

BIT	
1 thru 16	Time tag of RIV Attenuator readings (continued)

WORD 52

BIT	
1 thru 16	Receiver Channel 1 RMS voltage as reported by RIC. Positive binary representation of voltage scaled in millivolts.

WORD 53

BIT	
1 thru 16	Re ceiver Channel 2 RMS voltage as reported by RIC.

WORD 54

BIT	
1 thru 16	Receiver Channel 3 RMS voltage as reported by RIC.

WORD 55

BIT	
1 thru 16	Receiver Channel 4 RMS voltage as reported by RIC.

WORDS 56 THRU 59

BIT	
1 thru 16	Reserved; for future RMS voltage readings.

WORD 60

BIT	
1 thru 5	Unused
6 thru 16	Time tag of RIC RMS voltage readings (Words 52 thru 55) in milliseconds past 0 h UTC. This is the FTS time that the DSP received the monitor data from the RIC reporting the voltmeter readings on the receiver channels.

WORD 61

BIT	
1 thru 16	Time tag of RIC RMS voltage readings (continued)

WORD 62

BIT	
1 thru 16	Software-calculated RMS voltage for A-D channel "1". Signed two's-complement representation, scaled in millivolts.

WORD 63

BIT	
1 thru 16	Software-calculated RMS voltage for A-D channel "2".

WORD 64

BIT	
1 thru 16	Software-calculated RMS voltage for A-D channel "3".

WORD 65

BIT	
1 thru 16	Software-calculated RMS voltage for A-D channel "4".

WORD 66

BIT	
1 thru 8	Maximum A-D value found in A-D "1" data during RMS sample. Value is same format as A-D data found starting in Word 84 and following. (In 12-bit recordings, this is the MSB 8 bits of the 12-bit sample.)
9 thru 16	Minimum A-D value found in A-D "1" data during RMS sample.

WORD 67

BIT	
1 thru 16	Number of occurrences of maximum value found in A-D "1". Two's complement binary format, range 0-1000.

WORD 68

BIT	
1 thru 16	Number of occurrences of minimum value found in A-D "1". Two's complement binary format, range 0-1000.

WORD 69

BIT	
1 thru 8	Maximum A-D value found in A-D "2" data during RMS sample.
9 thru 16	Minimum A-D value found in A-D "2" data during RMS sample.

WORD 70

BIT	
1 thru 16	Number of occurrences of maximum value found in A-D "2".

WORD 71

BIT	
1 thru 16	Number of occurrences of minimum value found in A-D "2".

WORD 72

BIT	
1 thru 8	Maximum A-D value found in A-D "3" data during RMS sample.
9 thru 16	Minimum A-D value found in A-D "3" data during RMS sample.

WORD 73

BIT	
1 thru 16	Number of occurrences of maximum value found in A-D "3".

WORD 74

BIT	
1 thru 16	Number of occurrences of minimum value found in A-D "3".

WORD 75

BIT	
1 thru 8	Maximum A-D value found in A-D "4" data during RMS sample.
9 thru 16	Minimum A-D value found in A-D "4" data during RMS sample.

WORD 76

BIT	
1 thru 16	Number of occurrences of maximum value found in A-D "4".

WORD 77

BIT

1 thru 16 Number of occurrences of maximum value found in A-D "4".

WORD 78

BIT

1 thru 5 Unused

6 thru 16 Time tag of NBOC buffer sample used to calculate RMS voltages and obtain maximum and minimum values in Words 66 thru 77 in milliseconds past 0 h UTC. This time tag corresponds to the time tag found in Words 7 and 8 of an earlier tape record. The A-D data from this earlier record was saved to run the calculations found in Words 63 through 66 of this (current) record.

WORD 79

BIT

1 thru 16 Time tag of RIC RMS Voltage readings (continued)

WORD 80

BIT

1 thru 16 Single A-D Converter Sample Rate (16-bit unsigned binary integer, see Table 2).

WORD 81 First two bytes of the six bytes of sync data received from the NBOC at the beginning of each second.

BIT

1 thru 4 Hex 'A' (binary '1010')

5 thru 8 Hex '5' (binary '0101')

9 thru 12 Hex '5' (binary '0101')

13 thru 16 Hex 'A' (binary '1010')

WORD 82

BIT

1 thru 16 Reserved for diagnostic use.

WORD 83

BIT

1 thru 8 Conversion Mode Register (Bytes 4 and 5 of NBOC Sync Data)

Where:

Bit 1: = 1 if an NBOC converter overflow occurred
= 0 if nominal

Bit 2: Not used

Bit 3: = 1 NBOC PLL in lock
= 0 NBOC PLL out of lock

Bit 4: = 1 for 50-, 20-, 10-, 5-, and 2-kilosamples/second rates
= 0 for 1000- and 200 samples/second rates
Bit 5: = 1 for test mode
= 0 for normal operational mode
Bit 6: = 1 for 8-bit resolution
= 0 for 12-bit resolution
Bits 7 thru 8: = Mode:
00 = 4 input signals, each sampled by a separate converter
01 = 1 input signal sampled sequentially by 4 A-D converters
10 = 2 input signals, each sampled sequentially by 2 A-D converters
11 = 1 signal sampled sequentially by 3 A-D converters

9 thru 16 Signal Select Register
Where:
Bits:
9 and 10: A-D 1 — 00 = Input Signal Channel 1 (J1)
11 and 12: A-D 2 — 01 = Input Signal Channel 2 (J2)
Where
13 and 14: A-D 3 — 10 = Input Signal Channel 3 (J3)
15 and 16: A-D 4 — 11 = Input Signal Channel 4 (J4)

(Example: If bits 9 thru 16 = 10101010, then all 4 A-D converters will sample input Signal Channel 3.)

WORD 83 (Continued)
BIT

2. Data Portion of Tape Record

a. 8-bit Quantization Type (See Figure 3).

WORD 84
BIT
1 thru 8 A-D 1 data sample
9 thru 16 A-D 2 data sample

WORD 85
BIT
1 thru 8 A-D 3 data sample
9 thru 16 A-D 4 data sample

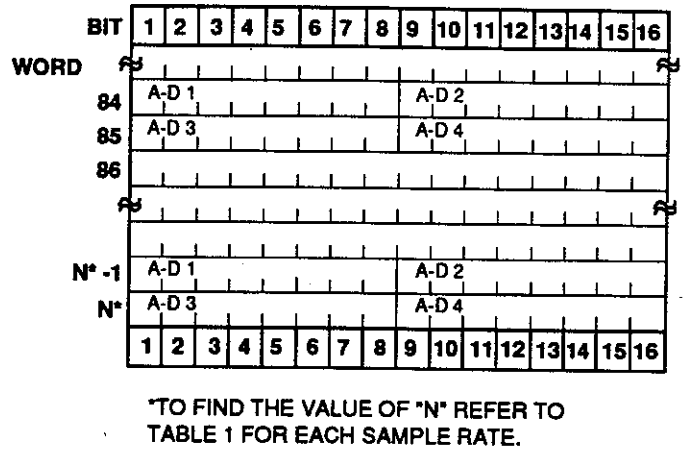


Figure 3. 8-bit Quantization Format

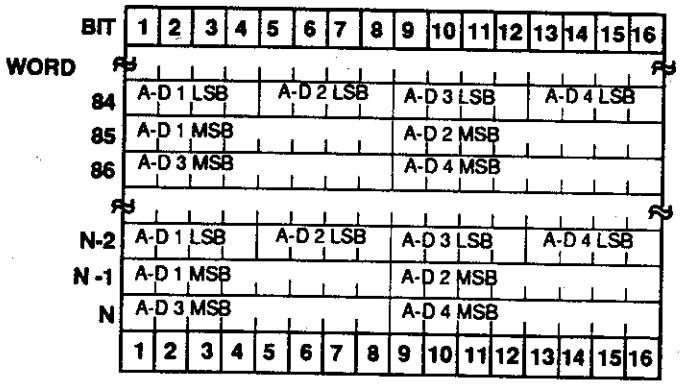


Figure 4. 12-bit Quantization Format

WORDS 86 THRU N

BIT	
1 thru 16	Data Samples of A-D 1, A-D 2, A-D 3, and A-D 4 in the same sequence as that in Words 84 and 85

b. 12-bit Quantization Type (See Figure 4).

WORD 84

BIT	
1 thru 4	A-D 1 data sample LSB
5 thru 8	A-D 2 data sample LSB
9 thru 12	A-D 3 data sample LSB
13 thru 16	A-D 4 data sample LSB

WORD 85

BIT	
1 thru 8	A-D 1 data sample MSB
9 thru 16	A-D 2 data sample MSB

WORD 86

BIT	
1 thru 8	A-D 3 data sample MSB
9 thru 16	A-D 4 data sample MSB

WORDS 87 THRU N

BIT	
1 thru 16	Data samples of A-D 1, A-D 2, A-D 3, and A-D 4 in the same sequence as that in Words 84 thru 86.

F. SFDU HEADER

Figure 5 details the SFDU header structure, which is pre-pended to each ODS record for transmission to SFOC.

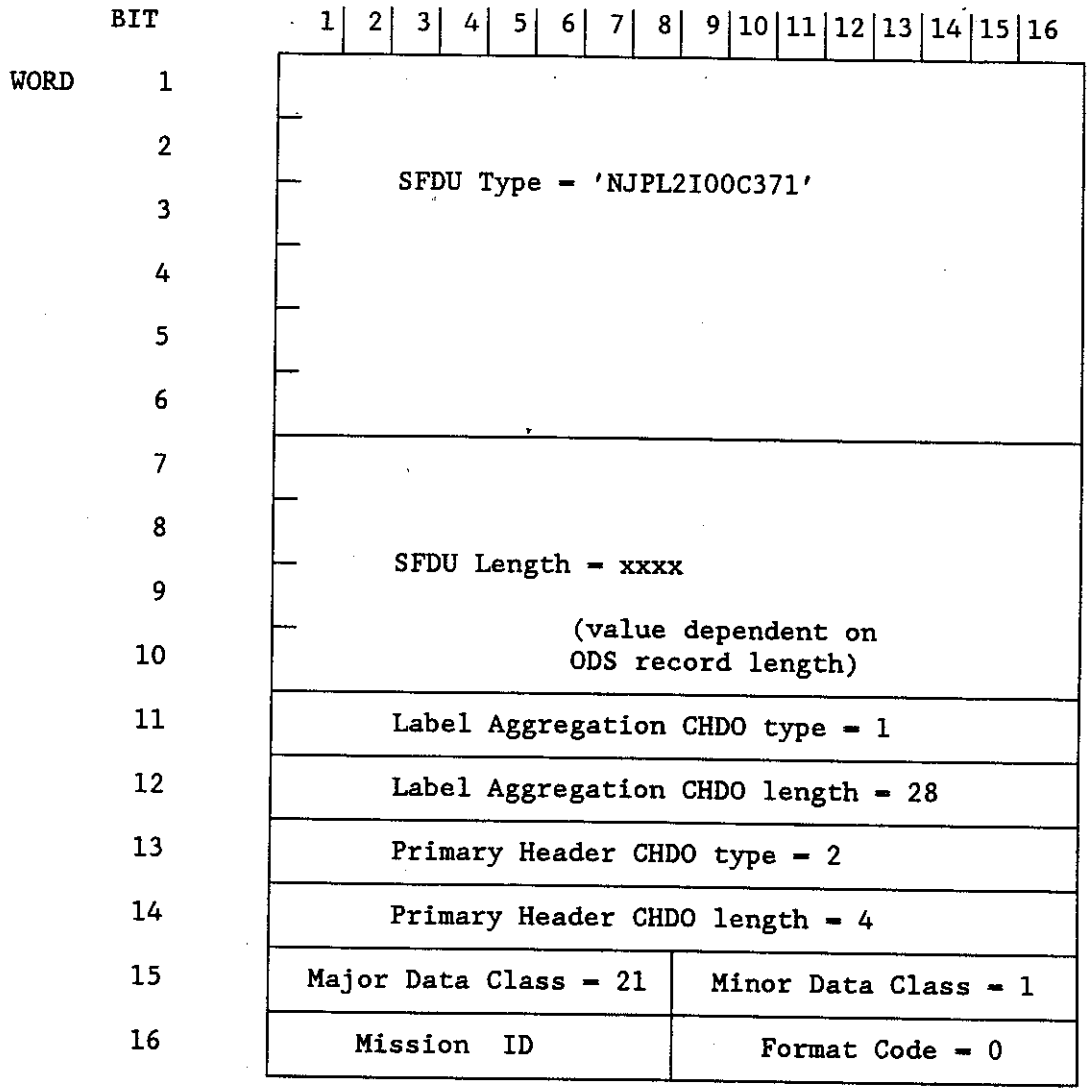
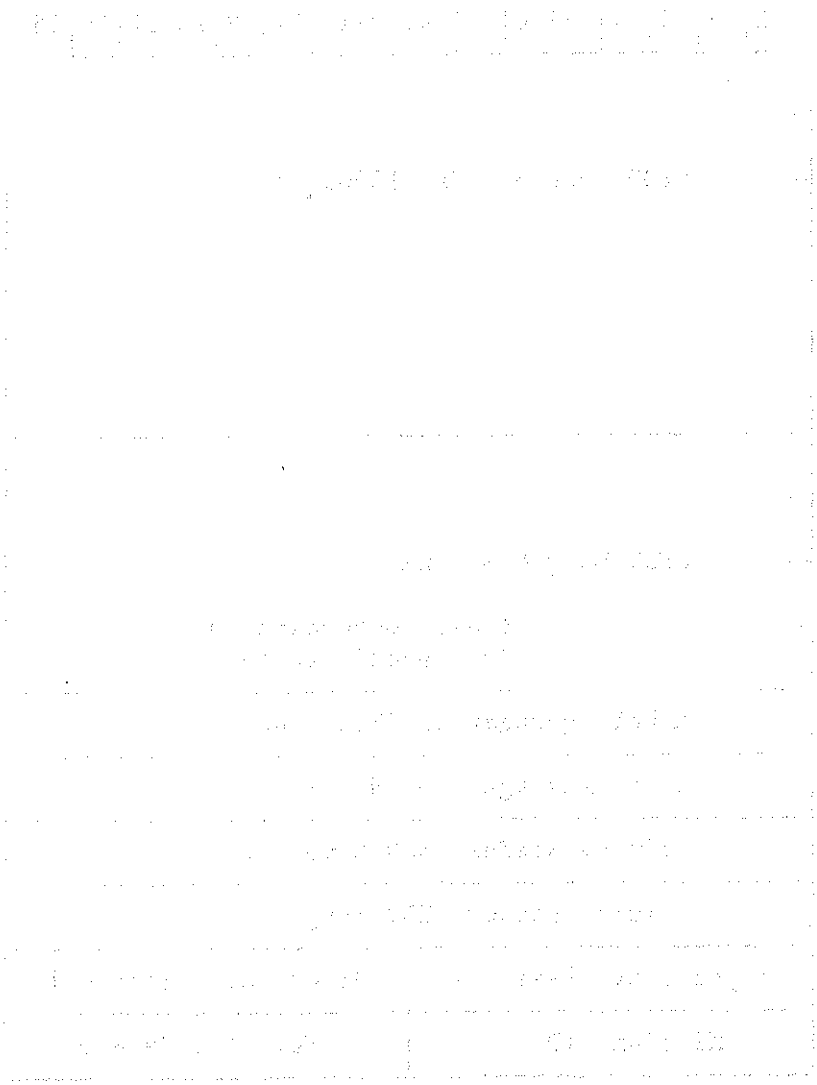
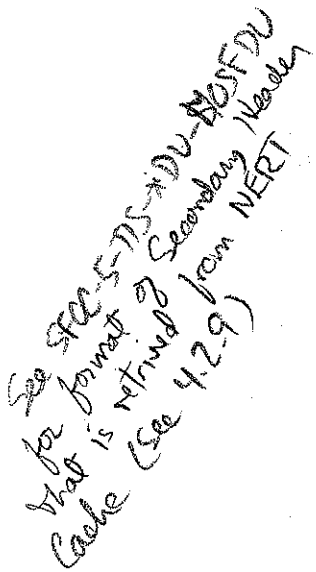


Figure 5. SFDU Header (Sheet 1 of 2)





17	Secondary Header CHDO type = 76	
18	Secondary Header CHDO length = 16	
19	RS-BSN	
20	SPA-R ID	
21	Prime FEA	Secondary FEA
22	Spacecraft Number	SPC Number
23	Originator ID = 48 (DSN)	Year (hundreds)
24	Year (tens and units)	Day of Year
25	Milliseconds of Day	
26		
27	General Data CHDO type = 10	
28	General Data CHDO length = xxxx (ODS dependent)	

Figure 5. SFDU Header (Sheet 2 of 2)

WORD 1 THRU 6 — Radio Science Real Time Data Delivery SFDU label; ASCII value = 'NJPL2I00C371'.

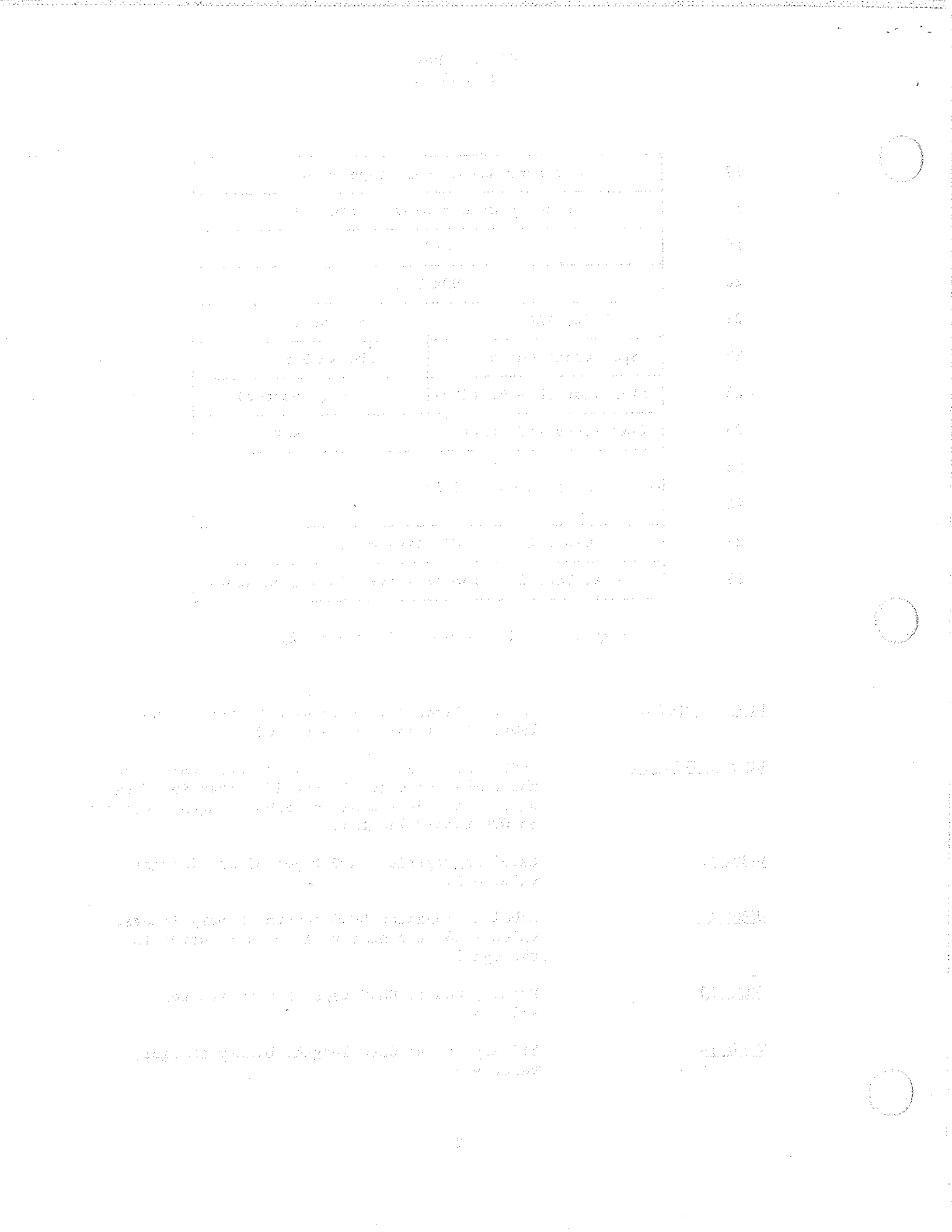
WORD 7 THRU 10 — SFDU length; 64-bit binary integer, value equals the number of bytes in the SFDU starting from word 11 to the end of the SFDU (length dependent on ODS record length).

WORD 11 — Label Aggregation CHDO type; binary integer, value = 1.

WORD 12 — Label Aggregation CHDO length; binary integer, value = 28, the number of bytes in words 13 through 26.

WORD 13 — Primary Header CHDO type; binary integer, value = 2.

WORD 14 — Primary Header CHDO length; binary integer, value = 4.



WORD 15

BIT	
1 thru 8	Major Data Class; binary integer, value = 21.
9 thru 16	Minor Data Class; binary integer, value = 1.

WORD 16

BIT	
1 thru 8	Mission ID; binary integer; (see SFOC-5-SYS-*D-NJPL for values).
9 thru 16	Format code; binary integer; value = 0.

WORD 17 — Secondary Header CHDO type; binary integer, value = 76.

WORD 18 — Secondary Header CHDO length; binary integer, value = 16, the number of bytes in words 19 through 26.

WORD 19 — RS-BSN, Radio Science Block Serial Number; incrementing integer value used for SFOC processing.

WORD 20 — SPA-R ID, identifier of Radio Science Spectrum Processing Assembly generating this data stream; hexadecimal binary integer 0E30 = SPA-R 1, 0E31 = SPA-R 2.

WORD 21

BIT	
1 thru 8	Prime Front End Area (FEA) Number (e.g., 14, 43) (binary)
9 thru 16	Secondary FEA Number

WORD 22

BIT	
1 thru 8	Spacecraft Number (binary) from predicts (see module OPS-6-8 of this document)
9 thru 16	Signal Processing Center (SPC) Designator (i.e., 10, 40, 60, or 21); (binary) (see module OPS-6-8)

WORD 23

BIT	
1 thru 8	Originator ID; binary integer; value = 48, representing the DSN as the originator of this data.
9 thru 16	First two digits of year from Monitor and Control Subsystem (DMC) monitor data (binary).

WORD 24

BIT	
1 thru 7	Last two digits of year from Monitor and Control Subsystem (DMC) monitor data (binary)
8 thru 16	Day of Year (binary representation if decimal 1 through 366, from FTS system)

WORD 25

BIT	
1 thru 5	Unused; set to zeros.
6 thru 16	Time of first sample in record, in milliseconds past 0 h Universal Time Coordinated (UTC) (Binary representation in milliseconds of decimal 0 thru 86,399,999.) See Word 1, bit 1, for origin of time tag. (See Paragraph D.2 for time tag offset information.)

WORD 26

BIT	
1 thru 16	Time tag (continued)

WORD 27 — General Data CHDO type; binary integer, value = 10.

WORD 28 — General Data CHDO length; binary integer, value = xxxx, (length dependent on, and equal to, the ODS record length in bytes).

GLOSSARY

A-D	Analog To Digital
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
BCD	Binary Coded Decimal
bpi	Bits Per Inch
CHDO	Compressed Header Data Object
DMC	DSCC Monitor and Control Subsystem
DSN	Deep Space Network
DSCC	Deep Space Communications Complex
DSP-R	Radio Science DSCC Spectrum Processor
FAROT	Faraday Rotation
FEA	Front End Area
FMS	Frequency Monitor Subassembly
FTS	Frequency and Timing Subsystem
GCF	Ground Communication Facility
GCR	Group Coded Recording
IDR	Intermediate Data Record
LSB	Least Significant Bit
MSB	Most Significant Bit
NBOC	Narrow Band Occultation Converter
NDC	Network Data Control
ODR	Original Data Record
ODS	Original Data Stream
PE	Phase Encoding
POCA	Programmed Oscillator Control Assembly
RIC	Receiver-Exciter Subsystem IF-Video Downconverter Controller
RIV	Receiver-Exciter Subsystem IF-Video Downconverter
RMS	Root Mean Square
SFDU	Standard Formatted Data Unit
SFOC	Space Flight Operations Center
SPA-R	Radio Science Spectrum Processor Assembly
SPC	Signal Processing Center
UTC	Universal Time Coordinated