RSC-11-9

DSN RADIO SCIENCE SYSTEM INTERFACE

ORIGINAL DATA RECORD

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

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Approved by: _____(430)

_____(368)

_____(441)

A. PURPOSE

This module defines and controls the format of the Radio Science Original Data Record (ODR). This record is 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 DSP-R.

NOTE

Implementation of the DSCC Spectrum Processing Subsystem will occur during more than one stage. This interface will indicate which features will not be available in the first delivered version of the software (DMO-52-5-OP-A).

B. REVISION AND CONTROL

Revision or changes to the information herein presented may be initiated according to the procedures in Section 1 of this document.

C. GENERAL INFORMATION

The DSP is a computer controlled subsystem that digitally samples and records on tape a received spacecraft signal along with the monitor data necessary to reconstruct the signal. 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 occulted by the spacecraft.

The Radio Science ODR is delivered via mail to the Network Data Control (NDC) for delivery to the appropriate project Radio Science team, or it may be played back via wideband data lines (see module RSC-11-4) to the Ground Communications Facility (GCF), where it can be processed in order to produce an Intermediate Data Record (IDR) (reference module IDR-12-1 of this document).

D. DATA RECORDS AND CONTENT

The DSP-R digitally samples the received spacecraft signal with 8-bit resolution and writes tape records with one of three lengths, depending on the sample rate. Table RSC-11-9-1 lists the record length for each sample rate. Each tape record is composed of (1) a header containing information on system configuration, time receiver local oscillator values, etc., (2) a block of digital data from the four A-D converters, (3) data from the Precision Power Monitor, and (4) frequency and time offsets entered by the station operator.

The DSP-R records data on a 9-track tape at 75 inches per second, with either (1) a tape density of 6250 bytes per inch (bpi) using the Group-Coded Recording (GCR) format with an 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.

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., DMD-5205-OP-A v 2.5). The remaining six words are nulls.

Table RSC-11-9-1. 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(4) (Words/Record)
8-bit Resolution				
50,000(5)	1000	50	2000	2195
20,000(5)	1000	20	2000	2195(6)
10,000(5)	1000	10	2000	2195(6)
5,000	1000	5	2000	2195
2,000	1000	2	2000	2195
1,000	500	2	1000	1195
200	100	2	200	395

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

(2) The total number of samples per record is four times that per individual A-D converter.

(3) A word contains 16 bits; see NOTE following Word 43.

(4) Includes 40-word header, N words of data, 150 words of PPM data, and 5 words of predict offset values (6) (see Figures RSC-11-9-1 through -4).

(5) Only available when recording at 6250 bpi density.

(6) In the OP-A version of the software, the five words of the operator-entered time and frequency offsets will not be recorded; thus, the number of words/record will be 2190.

E. DETAIL RECORD DESCRIPTION

1. Header* - 40 Words (See Figure RSC-11-9-1)

WORD 1

BIT

1 Origin of Narrow Band Occultation Converter (NBOC) time tag (Words 7 and 8) and configuration information (Words 38 thru 40).

0 if time tag (Words 7 and 8) was generated by DSP-R software counting from last FTS 1-second pulse

or

if configuration information (Words 38 thru 40) was generated by software and not read directly from NBOC buffer.

1 if time tag is from FTS and Words 38 thru 40 came directly from NBOC buffer.

NOTES

If BIT 1 is set to "1" the following additional validity checks may be made:

(a) Word 38 should be "A55A"

(b) Word 40, 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 column 3 of Table RSC-11-9-1.

2 Start of recording session flag:

0 if other than first record of recording session

1 if this is the first record of recording session

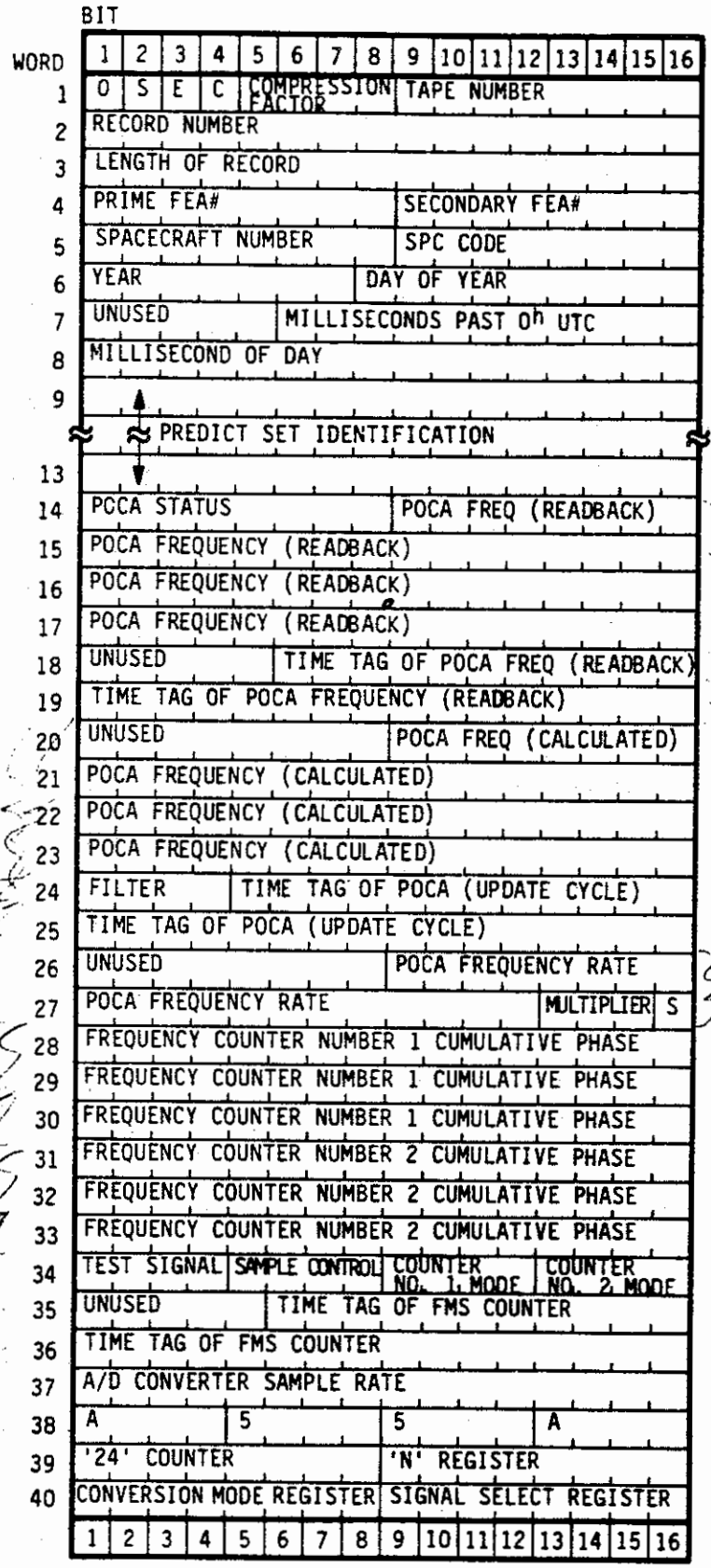


Figure RSC-11-9-1. Record Header

NOTE

Each time the program mode is changed from IDLE to RUN, this bit is set to 1 in the first record.

WORD 1 (Contd)

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: 0 indicates 8-bit resolution (No other resolution level is currently implemented.)
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. Therefore, cycling between these two models 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.

WORD 2

BIT	
1 thru 16	Record Number (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 RSC-11-9-1, column 5.

WORD 4

BIT	
1 thru 8	Prime Front End Area (FEA) number (e.g., 14, 43) (Binary)
9 thru 16	Secondary FEA number (Recording of Secondary FEA number is not implemented in OP-A.)

WORD 5

BIT	
1 thru 8	Spacecraft Number (Binary) from predicts (See Document 820-13; module OPS-6-8)
9 thru 16	Signal Processing Center (SPC) designator (i.e., 10, 40, 60, or 21) (Binary) (See Document 820-13; module OPS-6-8)

WORD 6

BIT	
1 thru 7	Last two digits of year from predicts (Binary)
8 thru 16	Day of Year (Binary representation of decimal 1 through 366)

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 through 86,399,999). See Word 1, bit 1, for origin of time tag.

WORD 8

BIT	
1 thru 16	Time tag (Continued)

WORDS 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*
6	Track	On*	Off
7	Acquisition	On	Off*
8	Sweep	On*	Off
9 thru 16	Frequency value read 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)

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.

*Denotes Normal Radio Science Usage

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 offsets) 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 (PREDIK).

WORDS 21 THRU 23

BIT	
1 thru 16	POCA frequency (calculated) - (Continued)

WORD 24

BIT	
1 thru 4	Multimission Receiver Filter number (i.e., 1 to 8) from the Operator-Controlled Input (OCI) - binary
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 of POCA frequency (update recycle) (Continued)

WORD 26

BIT	
1 thru 8	Unused

WORD 26 (Contd)

BIT	
9 thru 16	POCA Frequency Rate from POCA rate registers - in Hertz per second (5 BCD digits following the decimal point i.e., .12345)

WORD 27

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

WORDS 28 THRU 30

BIT	
1 thru 16	One-second accumulated phase from frequency counter No. 1. Scaled to 2^{-8} cycles. Last 8 bits are fractional part of 1 cycle. (Bits 1 thru 16 will not be implemented in OP-A.)

WORDS 31 THRU 33

BIT	
1 thru 16	One-second accumulated phase from frequency counter No. 2. Scaled to 2^{-8} cycles. Last 8 bits are fractional part of 1 cycle.

WORD 34

BIT	
1 thru 4	Test Signal Selection: 0001 = Live input of Counter 1 (POCA) 0010 = Live input of Counter 2 1000 = 1 MHz

WORD 34 (Contd)

BIT	
5 thru 8	Sample Control Register 1011 = Enable live sample; internal 10 MHz to resolvers and test facility
9 thru 12	Frequency Counter Number 1 Mode Register 0000 = Test frequency to counter 0001 = Live frequency to counter (POCA)
13 thru 16	Frequency Counter Number 2 Mode Register 0000 = Test frequency to counter 0001 = Live frequency to counter (not presently connected)

WORD 35

BIT	
1 thru 5	Unused
6 thru 16	Time tag of Frequency Monitoring Subassembly (FMS) counter readings (Words 28-33) in milliseconds past 0^h UTC. This is the FTS time at which the program calculated the FMS phases described in Words 28 thru 33. (This time tag is for diagnostic purposes only, and will not be implemented in OP-A.)

WORD 36

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

WORD 37

BIT	
1 thru 16	Single A-D Converter Sample Rate (16-bit unsigned binary integer).

WORD 38	First two bytes of the six bytes of sync data received from the NBOC at the beginning of each second

WORD 38 (Contd)

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 39

BIT

1 thru 16 Reserved for diagnostic use.

WORD 40 (Bytes 4 & 5 of NBOC Synch Data)

BIT

1 thru 8 Conversion Mode Register

Where:

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

Bits 2-3: Not used

Bit 4: = 1 for 50-, 20-, 10-, 5- & 2-kilo samples/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
= No other resolution level is currently implemented.

Bits 7-8: 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 by 1 A-D converter, and 1 signal sampled sequentially by 3 A-D converters

WORD 40 (Bytes 4 & 5 of NBOC Synch Data) (Contd)

BIT

9 thru 16 Signal Select Register

Where:

Bits:

9-10: A-D 1
11-12: A-D 2
13-14: A-D 3
15-16: A-D 4

where

00 = Input Signal Channel 1
01 = Input Signal Channel 2
10 = Input Signal Channel 3
11 = Input Signal Channel 4

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

NOTE

Five additional words containing operator-entered offsets to predict time and frequency are appended to record at the end of the Precision Power Monitor (PPM) data; however, this feature is not implemented in OP-A. (See paragraph E.4. of this module.)

2. Data portion of Tape Record (See Figure RSC-11-9-2)

WORD 41

BIT

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

WORD 42

BIT

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

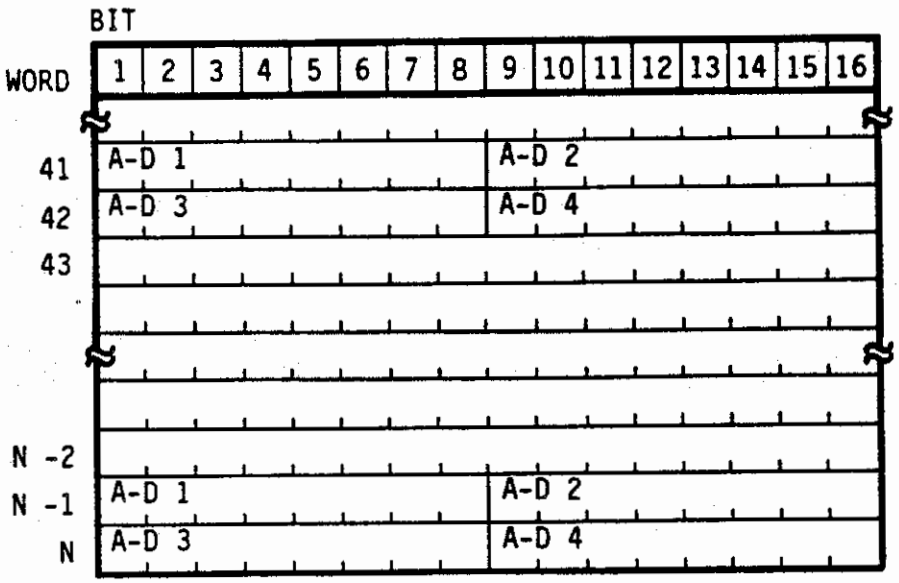


Figure RSC-11-9-2. Format of the 8-bit Quantized Data From the Four A-D Converters

WORDS 43 THRU N

BIT

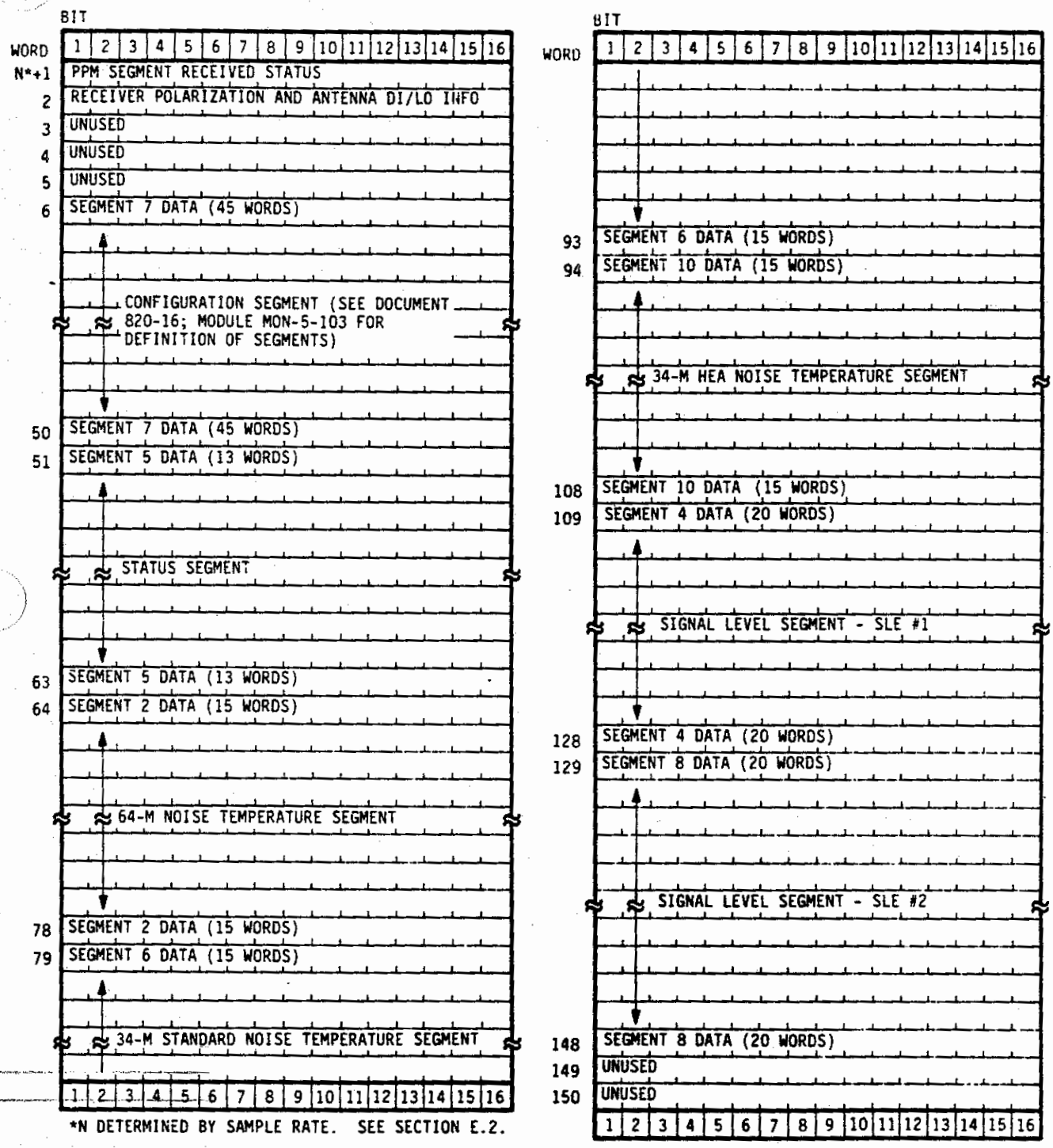
1 thru 16 Data Samples of A-D 1, A-D 2, A-D 3, and A-D 4 in the same sequence as that in Words 41 and 42

NOTE

N = 240 for 200 samples/second per channel
N = 1040 for 1000 samples/second per channel
N = 2040 for ≥2000 samples/second per channel

3. Precision Power Monitor Data (150 Words)

The PPM data, the next 150 words of each record, are appended to the data portion. (See Figure RSC-11-9-3.)



*N DETERMINED BY SAMPLE RATE. SEE SECTION E.2.

Figure RSC-11-9-3. Format of PPM Data in 150 Words That Follow Data Portion of Record

a. PPM Segment Received Status (See Figure RSC-11-9-3).

WORD 1

BIT	
1	Segment 7 1 = New data 0 = Old data
2	Segment 5 1 = New data 0 = Old data
3	Segment 2 1 = New data 0 = Old data
4	Segment 6 1 = New data 0 = Old data
5	Segment 10 1 = New data 0 = Old data
6	Segment 4 1 = New data 0 = Old data
7	Segment 8 1 = New data 0 = Old data
8 thru 16	Unused

b. Receiver Polarization and Antenna DI/LO Information.*

WORD 2

BIT	
1 and 2	Rcvr 1 Polarization; from POL/DI OCI 0 = LCP 1 = RCP 2 = Linear
3	Rcvr 1 Diplex/Listen Only, from POL/DI OCI 0 = Diplex 1 = Listen Only

*Reserved for future implementation.

WORD 2 (Contd)

BIT	
4 and 5	Rcvr 2 Polarization; from POL/DI OCI 0 = LCP 1 = RCP 2 = Linear
6	Rcvr 2 Diplex/Listen Only, from POL/DI OCI 0 = Diplex 1 = Listen Only
7 and 8	Rcvr 3 Polarization; from OCI 0 = LCP 1 = RCP 2 = Linear
9	Rcvr 3 Diplex/Listen Only, from OCI 0 = Diplex 1 = Listen Only
10 and 11	Rcvr 4 Polarization; from OCI 0 = LCP 1 = RCP 2 = Linear
12	Rcvr 4 Diplex/Listen Only, from OCI 0= LCP 1 = Listen Only
13 and 14	Rcvr 5 Polarization; from OCI 0 = LCP 1 = RCP 2 = Linear
15	Rcvr 5 Diplex/Listen Only, from OCI 0 = LCP 1 = Listen Only
16	Validity of previous 15 bits 0 = Invalid 1 = Valid

NOTE

Bits 1-16 of Word 2 will not be implemented in OP-A.

WORDS 3 THRU 5

BIT	
1 thru 16	Unused

WORDS 6 THRU 50

BIT	
1 thru 16	Segment 7 data (45 words) as defined in Document 820-16, Module MON-5-103 (configuration segment)

WORDS 51 THRU 63

BIT	
1 thru 16	Segment 5 data (13 words) as defined in Document 820-16, Module MON-5-103 (status segment)

WORDS 64 THRU 78

BIT	
1 thru 16	Segment 2 data (15 words) as defined in Document 820-16, Module MON-5-103 (noise temperature segment, 64-m)

WORDS 79 THRU 93

BIT	
1 thru 16	Segment 6 data (15 words) as defined in Document 820-16, Module MON-5-103 (noise temperature segment, 34-m Std.)

WORDS 94 THRU 108

BIT	
1 thru 16	Segment 10 data (15 words) as defined in Document 820-16, Module MON-5-103 (noise temperature segment, 34-m HEF)

WORDS 109 THRU 128

BIT	
1 thru 16	Segment 4 data (20 words) as defined in Document 820-16, Module MON-5-103 (signal level segment, SLE #1)

WORDS 129 THRU 148

BIT	
1 thru 16	Segment 8 data (20 words) as defined in Document 820-16, Module MON-5-103 (signal level segment, SLE #2)

WORDS 149 THRU 150

BIT	
1 thru 16	Unused

4. Operator-Entered Offsets (5 Words)

This information is appended following the PPM data. (See Figure RSC-11-9-4.)

NOTE

The following five words are not written in the tape records generated by OP-A of the DSP-R software.

WORD N*+151 and N+152

BIT	
1 thru 9	Predict Time Offset (days), (Binary)
10 thru 14	Unused
15	Sign of Predict Time Offset 1 = Negative 0 = Positive
16 thru Word N+152, bit 16	Predict Time Offset in seconds (17-bit integer); MSB is Word N+151, bit 16; LSB is Word N+152, bit 16.

WORD N+153 thru N+155

BIT	
1 thru 16	The S-band frequency offset to the predict set; formatted as a 48-bit binary number with LSB (Word N+155, bit 16) equal to 2^{-20} Hz. Value may be positive or negative (2's complement format). Maximum value is 1.5 MHz.

*Determined by sample rate (see Section E.2).

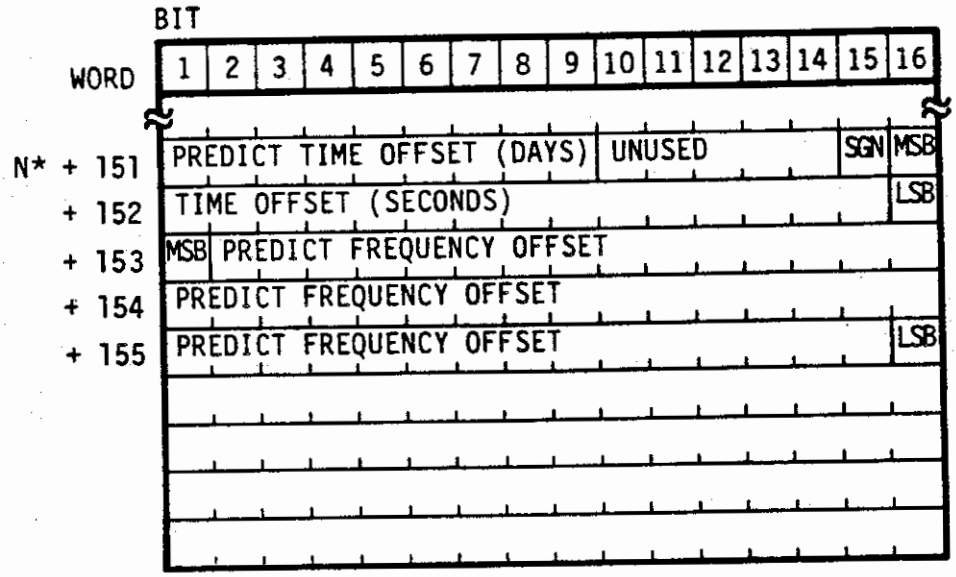


Figure RSC-11-9-4. Operator-Entered Offsets to Predict Time and Frequency (Not implemented in OP-A.)