

DATE 11 January 1982

ICA No. 152

DEEP SPACE NETWORK  
INTERFACE CHANGE AUTHORIZATION

~~MARK III ODA~~ DSN RADIO SCIENCE SUBSYSTEM INTERFACE  
820-13 MODULE No. RSC-11-9 TITLE ORIGINAL DATA RECORD

INITIAL RESPONSE DATE \_\_\_\_\_

REVISION DATE \_\_\_\_\_

ABSTRACT:

DESCRIPTION OF CHANGE:

- 1) New document

REASON FOR CHANGE:

- 1) Responds to new requirements

PARKES  
ODR  
FORMA

NOT DCP

CONCURRENCES:

DSN MANAGER

MCCC MANAGER

FLIGHT PROJECT  
RMOC REPRESENTATIVE

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DISPOSITION:

CHANGE REJECTED. REASONS:

CHANGE RELEASED FOR PUBLICATION

DSN SYSTEM ENGINEER *B. Buckler* DATE 11 January 1982

5 14



DOCUMENT 820-13; REV. A  
DSN SYSTEM REQUIREMENTS  
DETAILED INTERFACE DESIGN

RSC-11-9  
DSN RADIO SCIENCE SUBSYSTEM INTERFACE  
ORIGINAL DATA RECORD

(Insert this modular document in 820-13; Rev. A)

EFFECTIVE DATE: 1 March 1982

Initial Release Date: 1 March 1982

Approved by:

BQ Buckles 2/11/82 (DSN)

G M Jamieson 2/11/82 (CDE)

Spiller Luster 2/2/82 (COE)

A. PURPOSE

This module defines and controls the format of the Original Data Record (ODR) generated by the DSS Radio Science Subsystem (DRS) Occultation Data Assembly (ODA).

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 DRS ODR is delivered via mail to the Network Data Control (NDC) or played back via wideband data lines 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. BLOCK FORMATS AND CONTENT

There are two type of blocks which have three record lengths each. Table RSC-11-9-1 contains a tabulation of the different block lengths based on the type and the Programmed Oscillator Control Assembly (POCA) converter sample rate.

Table RSC-11-9-1. Block Length Tabulation

| Conversion Type | Converter Sample Rate Per Second | Number of Samples Per ODR Record | Number of Words Per ODR Record* |
|-----------------|----------------------------------|----------------------------------|---------------------------------|
| 8-Bit Sample    | 20 k                             |                                  |                                 |
|                 | 10 k                             |                                  |                                 |
|                 | 5 k                              |                                  |                                 |
|                 | 2 k                              | 1000                             | 2045 (Y)+                       |
|                 | 1 k**                            | 500                              | 1045 (Y)+                       |
| 12-Bit          | 200**                            | 100                              | 245 (Y)+                        |
|                 | 10 k                             |                                  |                                 |
|                 | 5 k                              | 500                              | 1545 (Z)+                       |
|                 | 2 k                              |                                  |                                 |
|                 | 1 k**                            | 250                              | 795 (Z)+                        |
|                 | 200**                            | 50                               | 195 (Z)+                        |

\*\*Effective

\*Includes 28-Word header and 17-Word PPM trailer (see Figures RSC-11-9-1 and -2)

+Last word of data samples

1. Eight-Bit Analog-to-Digital Converter (A-D) Block Format (See Figure RSC-11-9-1.)

WORD 1

BIT

|           |   |   |
|-----------|---|---|
| 1         | Time and Status Validity:                             |   |
|           | Valid   | 1 |
|           | Not Valid   | 0 |
| 2         | Sequence:   |   |
|           | Start of sequence block                               | 1 |
|           | Continuation of sequence block                        | 0 |
| 3         | Error:  |   |
|           | Master Tape contains no error                         | 0 |
|           | Master Tape contains an error                         | 1 |
| 4         | Conversion:   |   |
|           | 12-bit conversion                                     | 1 |
|           | 8-bit conversion                                      | 0 |
| 5 thru 8  | Compression Factor Type Indicator (Valid Values Only) |   |
|           | 0001 = Narrow band, no compression                    |   |
|           | 0010 = Narrow band 2                                  |   |
|           | 1010 = Narrow band 10                                 |   |
| 9 thru 16 | Tape Number (Binary)                                  |   |

WORD 2

BIT

1 thru 16      Record Number (Binary)

WORD 3

BIT

1 thru 16      Record Length : See Table RSC-11-9-1

| 1        | 2   | 3          | 4                            | 5           | 6 | 7 | 8      | 9 | 10             | 11 | 12 | 13 | 14 | 15 | 16          |
|----------|---|------------|------------------------------|-------------|---|---|--------|---|----------------|----|----|----|----|----|-------------|
| VALIDITY | SEQUENCE ERROR                                  | CONVERSION | COMPRESSION FACTOR / TYPE ID | TAPE NUMBER |   |   |        |   |                |    |    |    |    |    |             |
| 47       |   |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
| 34       | RECORD NUMBER                                   |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
| 38       | RECORD LENGTH                                   |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
| 43       | SPACECRAFT NUMBER                               |            |                              |             |   |   | SOURCE |   |                |    |    |    |    |    |             |
| 41       | DAY OF YEAR                                     |            |                              |             |   |   |        | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0           |
|          | TIME OF DAY contd                               |            |                              |             |   |   |        |   |                |    |    |    |    |    | TIME OF DAY |
|          | PREDICT SET IDENTIFICATION                      |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | PREDICT SET ID contd                            |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
| 45       | PROGRAMMABLE OSCILLATOR CONTROL ASSEMBLY STATUS |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | POCA FREQUENCY contd                            |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | POCA FREQUENCY contd                            |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | POCA FREQUENCY contd                            |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
| 49       | 0   | 0          | 0                            | 0           | 0 | 0 | 0      | 0 | POCA FREQ RATE |    |    |    |    |    |             |
|          | POCA FREQ RATE contd                            |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | CONVERTER SAMPLE RATE                           |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | SIGNAL SFLCT                                    |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | FREQ COUNTER NO. 1 CUMULATIVE PHASE             |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | FREQ COUNTER NO. 1 CUMULATIVE PHASE contd       |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | FREQ COUNTER NO. 1 CUMULATIVE PHASE contd       |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | FREQ COUNTER NO. 2 CUMULATIVE PHASE             |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | FREQ COUNTER NO. 2 CUMULATIVE PHASE contd       |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | FREQ COUNTER NO. 2 CUMULATIVE PHASE contd       |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | TEST SIGNAL                                     |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | SPARES  |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | 0   | 0          | 0                            | 0           | 0 | 0 | 0      | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0           |
|          | '24' COUNTER                                    |            |                              |             |   |   |        |   |                |    |    |    |    |    |             |
|          | 0   | 0          | 0                            | 0           | 0 | 0 | 0      | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0           |

▲ FIXED POINT

Figure RSC-11-9-1. Eight-Bit Conversion Block Format for ODA Temporary ODR (Sheet 1 of 2)

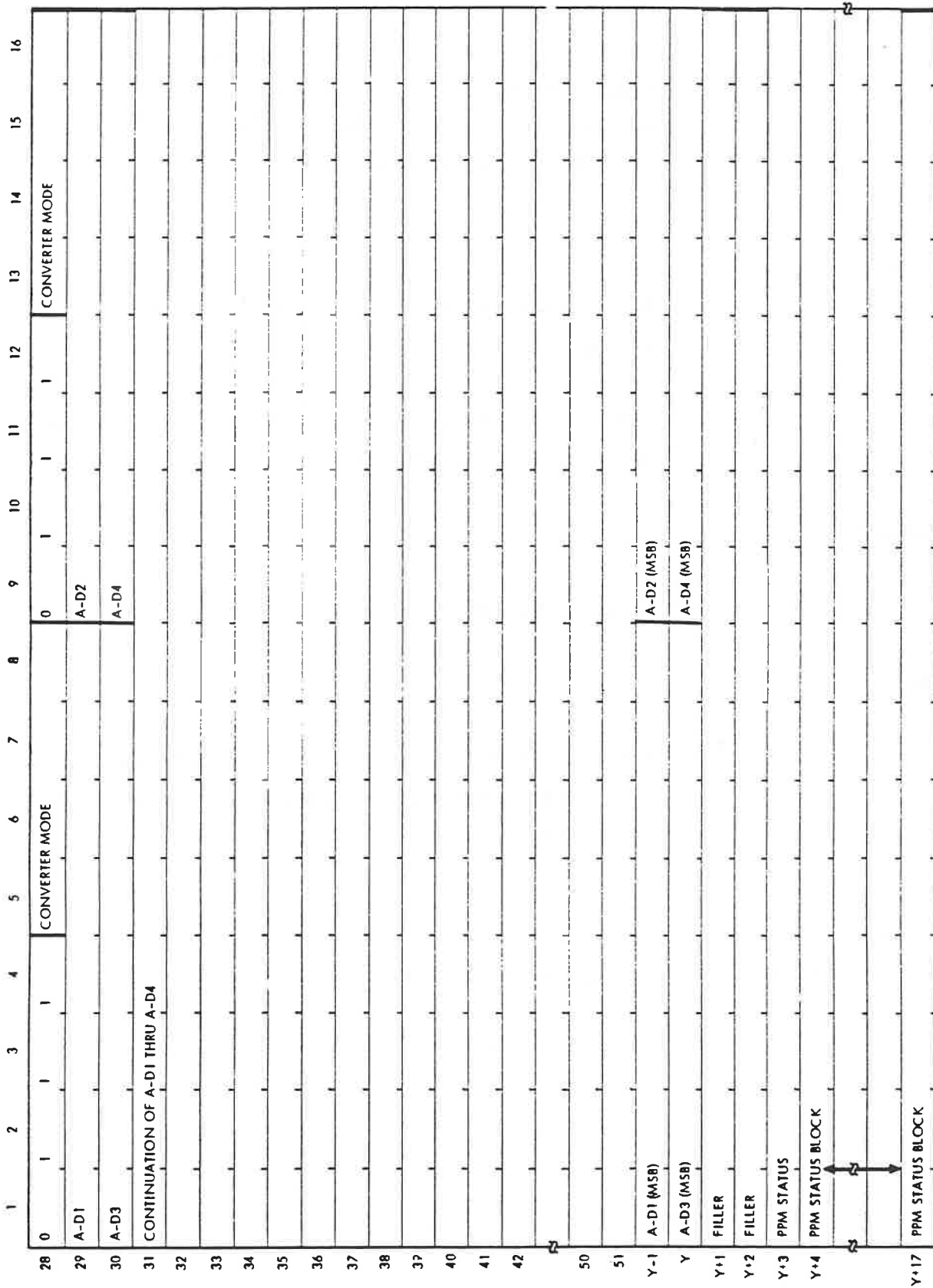


Figure RSC-11-9-1. Eight-Bit Conversion Block Format for ODA Temporary ODR (Sheet 2 of 2)

WORD 4

BIT

1 thru 8           Spacecraft Number: Binary (See 820-13; Rev. A,  
                  module OPS-6-6 for assignments)  
9 thru 16          Source Code: Binary (See 820-13; Rev. A, module  
                  OPS-6-6 for assignments)

WORD 5

BIT

1 thru 9           Day of Year (Binary representation of decimal 1  
                  through 366)  
10 thru 15         Zeros  
16                  Time of Day (Binary representation of seconds of  
                  decimal 0 through 86,399).

WORD 6

BIT

1 thru 16         Time of Day (continued)

WORD 7

BIT

1 thru 16         Predict Set ID; identification of predicts used to  
                  obtain data (see 820-14, module 5-011, Table 1)  
                  using four 8-bit ASCII characters

WORD 8

BIT

1 thru 16         Predict Set ID (continued)



WORD 9 POCA Status:

BIT

|           | <u>Function</u>   | <u>1<sub>2</sub></u> | <u>0<sub>2</sub></u> |
|-----------|---|----------------------|----------------------|
| 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 | POCA Frequency (BCD representation of approximately 46 MHz in microhertz) |                      |                      |

WORD 10 THRU WORD 12

BIT

1 thru 16 POCA Frequency (continued)

WORD 13

BIT

1 thru 8 Zeros  
9 thru 16 POCA Frequency Rate in Hertz per second (5 BCD digits with fixed point before first digit)

WORD 14

BIT

1 thru 12 POCA Frequency Rate in Hertz per second (5 BCD digits with fixed point before first digit)

\*Normal Radio Science Usage

WORD 14, continued

BIT

13 thru 15 Power of ten multiplier for POCA Frequency Rate  
16 Sign for POCA Frequency Rate where 0 = - and 1 = +

WORD 15

BIT

1 thru 16 Converter Sample Rate (Binary)

WORD 16

BIT

1 thru 8 Signal Select (Binary)  
SIG1 (J1) 00 Bits 1 and 2 = A-D1  
SIG2 (J2) 01 where Bits 3 and 4 = A-D2  
SIG3 (J3) 10 Bits 5 and 6 = A-D3  
SIG4 (J4) 11 Bits 7 and 8 = A-D4  
9 thru 16 'N' Counter (Value determined from the following  
formula):

$$\text{Converter Sample Rate} = \frac{1 \times 10^7}{20 M}$$

where M = 257-N

and N = Contents of bits 9 thru 16

NOTE: Allowable values for M are 250, 125, 100,  
50, or 25.

WORD 17 THRU WORD 19

BIT

1 thru 16 Frequency Counter Number 1 Cumulative Phase; scaled  
at  $2^{-8}$  Hz (last 8 bits fractional part of 1 Hz)



WORD 27

BIT

1 thru 16      Zeros

WORD 28

BIT

1      Overflow Indicator:  
             No Overflow              0  
             Overflow                  1

2 thru 4      Ones

5 thru 8      Analog-to-Digital Converter (A-D) Mode as follows:  
 5      Test Mode:  
             Test                      1  
             Normal                    0

6      Short Conversions (A/O):  
             8-bit                      1  
             12-bit                     0

7 and 8      Mode:  
             00 = 4 signals at 1 times bandwidth (BW)  
             01 = 1 signal at 4 times BW  
             10 = 2 signals at 2 times BW  
             11 = 1 signal at 1 times BW (S-Band) and  
                     3 signals at 3 times BW (X-Band)\*

9 thru 16      Repeat of bits 1 thru 8

WORD 29

BIT

1 thru 8      A-D1 Most Significant Bits (MSB) Data Sample  
 9 thru 16      A-D2 MSB Data Sample

---

\*S-band A-D1  
X-band A-D1 through A-D4

WORD 30

BIT

|           |                      |
|-----------|----------------------|
| 1 Thru 8  | A-D3 MSB Data Sample |
| 9 thru 16 | A-D4 MSB Data Sample |

WORD 31 THRU WORD 227, 693, or 2027 (Y)

BIT

|           |   |
|-----------|---|
| 1 thru 16 | Data Samples of MSB for A-D1, A-D2, A-D3, and A-D4<br>in the same sequence as Words 29 and 30 |
|-----------|---|

WORD (Y) THRU (Y+17)

BIT

|           |               |   |
|-----------|---------------|---|
| 1 thru 16 | Y+1 thru Y+2  | Filler Data   |
|           | Y+3           | ODA PPM Status  |
|           | Y+4 thru Y+17 | PPM Status Block (See document<br>820-14, module 2-049) |

2. 12-Bit Analog-to-Digital Converter (A-D) Block Format (Reference Figure RSC-11-9-2).

WORD 1 THRU WORD 28

BIT

|           |  |
|-----------|--|
| 1 thru 16 | Same as Word 1 thru Word 28 of 8-bit block |
|-----------|--|

WORD 29 THRU WORD 177, 525, or 1527 (Z)

BIT

|           |   |
|-----------|---|
| 1 thru 16 | Data samples of LSB and MSB for A-D1, A-D2, A-D3,<br>and A-D4 |
|-----------|---|

WORD (Z) THRU (Z+17)

BIT

|           |               |   |
|-----------|---------------|---|
| 1 thru 16 | Z+1 thru Z+2  | Filler Data   |
|           | Z+3           | PPM Status  |
|           | Z+4 thru Z+17 | PPM Status Block (See document<br>820-14, module 2-049) |

| 1  | 2                   | 3          | 4                          | 5           | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|--|---------------------|------------|----------------------------|-------------|---|---|---|---|----|----|----|----|----|----|----|
| VALIDITY                                   | SEQUENCE ERROR      | CONVERSION | COMPRESSION FACTOR/TYPE ID | TAPE NUMBER |   |   |   |   |    |    |    |    |    |    |    |
| RECORD NUMBER                              |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| RECORD LENGTH                              |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| SPACECRAFT NUMBER                          | SOURCE              |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| DAY OF YEAR                                | 0                   | 0          | 0                          | 0           | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| TIME OF DAY cont'd                         | TIME OF DAY         |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| PREDICT SET IDENTIFICATION                 |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| PREDICT SET ID cont'd                      |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| PROGRAMMABLE OSCILLATOR ASSEMBLY STATUS    |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| POCA FREQUENCY cont'd                      | POCA FREQUENCY      |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| POCA FREQUENCY cont'd                      |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| POCA FREQUENCY cont'd                      |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| POCA FREQUENCY cont'd                      | 0                   | 0          | 0                          | 0           | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| POCA FREQ RATE cont'd                      | POCA FREQ RATE      |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| CONVERTER SAMPLE RATE                      |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| SIGNAL SELECT                              |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| FREQ COUNTER NO. 1 CUMULATIVE PHASE        |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| FREQ COUNTER NO. 1 CUMULATIVE PHASE cont'd |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| FREQ COUNTER NO. 1 CUMULATIVE PHASE cont'd |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| FREQ COUNTER NO. 2 CUMULATIVE PHASE        |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| FREQ COUNTER NO. 2 CUMULATIVE PHASE cont'd |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| FREQ COUNTER NO. 2 CUMULATIVE PHASE cont'd |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| TEST SIGNAL                                | SAMPLE CONTROL      |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| SPARES                                     | COUNTER NO. 1 MODIF |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| 0  | 0                   | 0          | 0                          | 0           | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| '24' COUNTER                               | COUNTER NO. 2 MODE  |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |
| 0  | 0                   | 0          | 0                          | 0           | 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| ▲ FIXED POINT                              |                     |            |                            |             |   |   |   |   |    |    |    |    |    |    |    |

Figure RSC-11-9-2. Twelve-Bit Conversion Block Format for ODA Temporary ODR (Sheet 1 of 2)

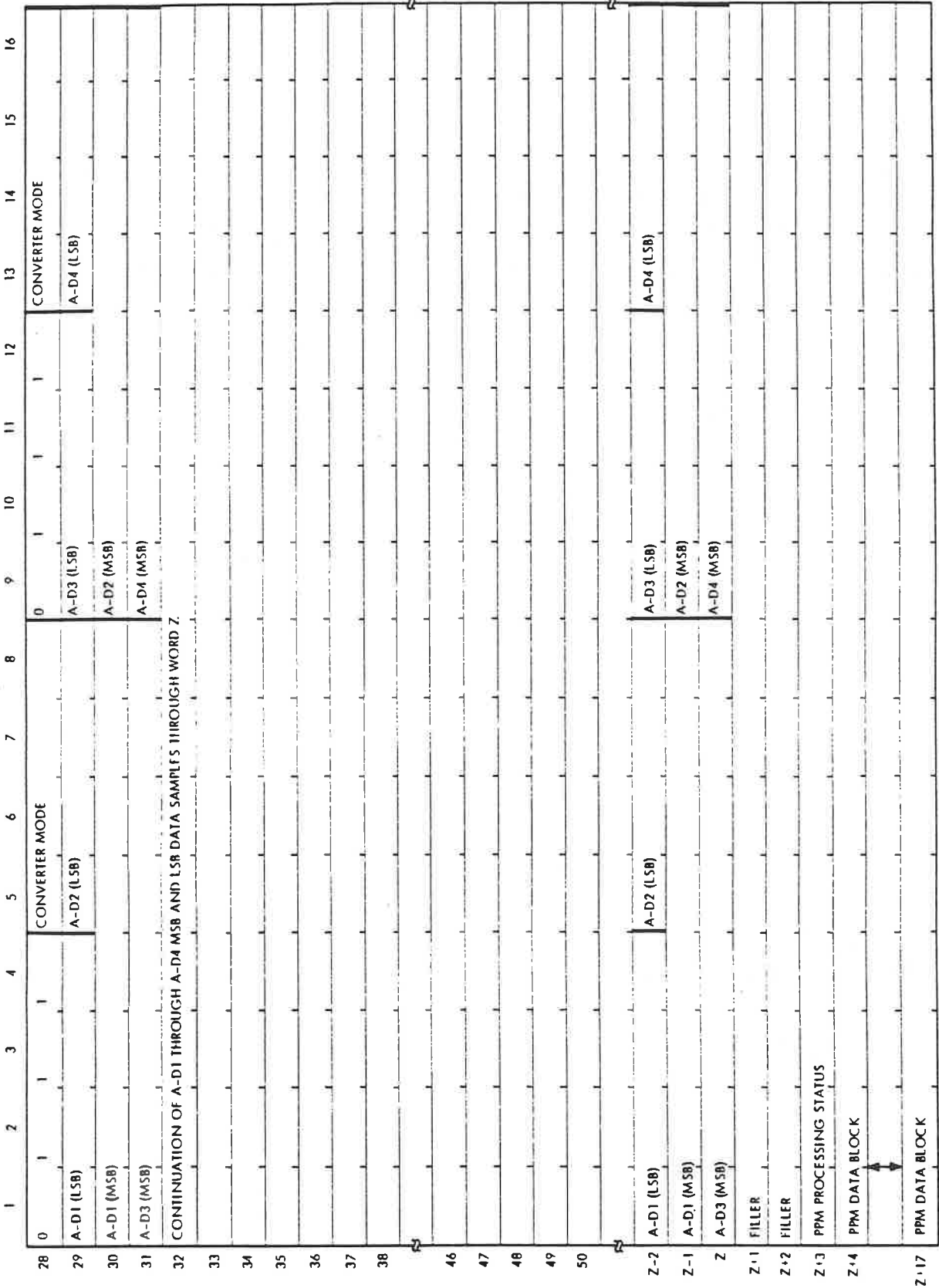


Figure RSC-11-9-2. Twelve-Bit Conversion Block Format for ODA Temporary ODR (Sheet 2 of 2)

JET PROPULSION LABORATORY

INTEROFFICE MEMORANDUM  
JRS:368-88-006

11/22/88

TO: R. Kursinski

FROM: J. R. Smith

SUBJECT: RSC 11-9 Appendix

The latest version of the subject appendix is attached. This version should contain all of the suggested changes and additions discussed at our meeting last week. This version is adequate for submission to the experimenter for his comments. I plan start this into the formal publication process about December 5, so I would appreciate any additional comments you may have before that date.

JRS:tbh

Distribution

S. Asmar

K. Kimball

H. Cox

Applies to:  
Parker ODA's  
Usuda ODA



Appendix  
RSC-11-9

This appendix to RSC-11-9 provides supplementary information for use in interpreting ODR tapes produced at Parkes and Usuda in support of the Voyager Neptune encounter. Only the modes planned to be used in this support are described, and this appendix is not to be considered to apply to any other operational mode of the ODA.

## ODA Modes:

This appendix applies only when the ODA sample rate = 20K samples/second and ODA recording mode 2 (1 signal sampled at 4 times the sample rate of an individual A/D converter.) In this mode, the ODA measures one signal at 80K values/second with 8 bits per value.

For the purposes of this interface specification, the word "Sample" is used to refer to a collection of four readings, one each from each of four A/D converters. When the readings are properly staggered, as in Mode 2, the 20K samples/second represents 80K values/second. In this Appendix, "Sample" is used for this collection of four readings, and the term "Value" is used to mean one reading.

The data is written onto magnetic tape in records containing 1000 samples, each sample consisting of one value from each of four A/D converters. Including Header and Trailer, each record requires 2045 words. 20 records are recorded per second at the rate of interest here.

## Interpretation of the ODA tape format:

The following interpretive information is supplemental to the format description in section D.1. of RSC-11-9

WORD 1

## BIT

1

This bit is set in the block in which a valid POCA frequency and ramp rate appear. This will occur in the first block written after the start of a second. The POCA parameters that appear in this block are the values that applied at the beginning of the prior second. The POCA frequency was saved by the POCA in response to the 1 pps pulse, and is read out by the ODA computer about 8 msec later. The computer saves the value until 0.8 seconds into the second, when it writes it into the header. Thus, the new frequency and ramp rate will first appear in the first block written after 0.8 seconds into the second, which is the seventeenth record at the 20K sample rate. This bit (the Time and Status Validity bit) is not set, however, until the start of the second when the time field is updated.

WORD 1BIT

- 2 This bit indicates the start of a sequence of blocks. It is set in the first block written after a "Run" command and is reset in all subsequent blocks until recording is stopped.
- 9 thru 16 The tape number will normally start at 1 and will increment for each subsequent tape written.
- 1 thru 16 The record number will normally start at 1, but under some abnormal starting conditions, it may start at -1. Since the tape is deemed full when the record number reaches a particular value (8000 in the mode of interest here), there will be two extra records on the tape in this abnormal situation which will cause the second and all subsequent tape to start with the third record after the start of a second. All data will have been recorded, however. The first tape will have 8002 records numbered from -1 to 8000, and all subsequent tapes will have 8000 records numbered from 1 to 8000. When the recording process is started normally at the 20 K sample/second rate, the first block of each second will be numbered 1, 21, 41, .... but if this abnormal start is used, the first block of each second will be numbered -1, 19, 39, ....

WORD 9 THRU WORD 12BIT

- 1 thru 16 The POCA Status and Frequency are updated as described above. They should be taken only from the block in which the validity bit is set (word 1 bit 1) which will be the first block of a second, and the values that appear there apply to the beginning of the previous second.

WORD 13 THRU WORD 14BIT

- 1 thru 16 The POCA rate is also updated in the block in which the POCA frequency is updated. It should be taken only from the block in which the validity bit is set (word 1 bit 1). The new POCA rate will always appear in the block with a time tag one second after a predict point, but will represent the commanded rate during the prior second only if the "Brownlee Offset" in ODA Software Global Common location 2200 is set to 3. Other values of this offset will cause the new rate to take affect in the POCA at other times causing ramping errors in the POCA. While the rate will appear in the header at the time that is one second after the predict point, the POCA will actually start to use the new ramp rate "3 - offset" seconds earlier

than the predict point time (ie. one second early when the offset is 2). (For earlier systems that operated with the Mark III era Frequency and Timing Subsystem, the correct value was 2.)

WORD 29 THRU WORD 30

BIT

1 thru 16 These two words contain the first sample, which consists of four A/D converter values taken one each from converters A-D1 thru A-D4. The A/D converter values are packed into consecutive bytes. The values are encoded in a complementary offset binary format as follows:

| <u>D/A value (binary)</u> | <u>input voltage</u> |
|---------------------------|----------------------|
| 00000000                  | +5.00                |
| 00000001                  | +4.96                |
| .                         | .                    |
| .                         | .                    |
| 01111110                  | +0.06                |
| 01111111                  | +0.02                |
| 10000000                  | -0.02                |
| 10000001                  | -0.06                |
| .                         | .                    |
| .                         | .                    |
| 11111110                  | -4.96                |
| 11111111                  | -5.00                |

In each word, bit 1 is the most significant bit of one value, bit 8 is the least significant bit of that value, bit 9 is the most significant bit of the next A/D converter value, and bit 16 is the least significant bit of that next value.

The design of the NBOC determines the relationship of the time tag that appears in words 5 and 6 to the data. There is an internal delay of about 4.5 microseconds between the on time edge of the station 1 pps pulse that defines the beginning of a second for the DSN station, and the first a/d converter sample command. In addition, there is a one sample buffer in the NBOC through which the data must pass before being read into the computer. These characteristics of the

hardware can be incorporated into an equation for computing the time tag for the first value in word 29 as follows:

$$T_1 = TT - 1/Sr + 4.5*10^{-6}$$

where:

$T_1$  is the actual time tag in seconds of the first value in a record in which Bit 1 of Word 1 is set to 1.

TT is the time tag (in seconds) that appears in words 5 and 6 in that block.

Sr is the sample rate ( $20 * 10^3$  samples/second in this case.)

$4.5*10^{-6}$  represents an internal 4.5 microsecond delay in the NBOC.

WORD 31 THRU WORD 2028

BIT

1 thru 16 Additional data samples in the same format as Words 29 and 30.