RSC-11-6
DSN INTERFACES RADIO SCIENCE
MEDIUM BAND COMPUTER COMPATIBLE IDR

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

EFFECTIVE DATE: 1 July 1981

Initial Release Date: 1 September 1980	Approved by: _BJ Buckles_	(DSN S/E)
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A. PURPOSE.

This document defines and controls the format for the Radio Science System
Medium Bandwidth Computer compatible Intermediate Data Record (IDR)*.

B. REVISION AND CONTROL.

Revisions or changes to the information herein may be initiated according
to the procedure in Section I of this document.

C. GENERAL INFORMATION.

Radio Science Medium Band Computer compatible IDRs may be produced by the
Network Radio Science Subsystem (WRS) or by the DSS Radio Science Subsystem
(DRS) from Digital Recording Assembly (DRA) Original Data Recordings (ODRs)
recorded by the DRS. These IDRs are digital tapes. Each tape will contain
data for one spacecraft for one DSS for one pass.

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*Radio Science IDRs should not be confused with the IDRs which are generated
at the GCF and may contain Radio Science data (See 820-13; Rev. A; RSC-11-4).

D.   MEDIUM BANDWIDTH RADIO SCIENCE IDR TAPE FORMAT.

The Medium Bandwidth Radio Science IDR tape format is shown in Figure RSC-11-6-1. This format conforms to the American National Standards Institute (ANSI) Standards for Phase Encoded (PE) tape, using wire tracks with a density of 1600 b/in.

The data portion of the tape format is as described below and shown in Figure RSC-11-6-2.

WORD 1

.BIT

1
Time-Tag Validity Indicator*
Indicates that time-tag data in Words 6 through 9 are valid for this record
    0 = Invalid
    1 = Valid

2
Record Continuity Indicator
Indicates that this record is the first record of a playback run
    0 = Continuation
    1 = First Record

3
Copy Source Error Indicator
Applies to IDR tape copies only; indicates that this record was copied from an original record containing a parity error
    0 = No Source Error
    1 = Source Error

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*If time tag is invalid, the remaining header information may be erroneous. Valid header information (Words 1 through 27) occur on integer seconds, as indicated by Time-Tag Validity.
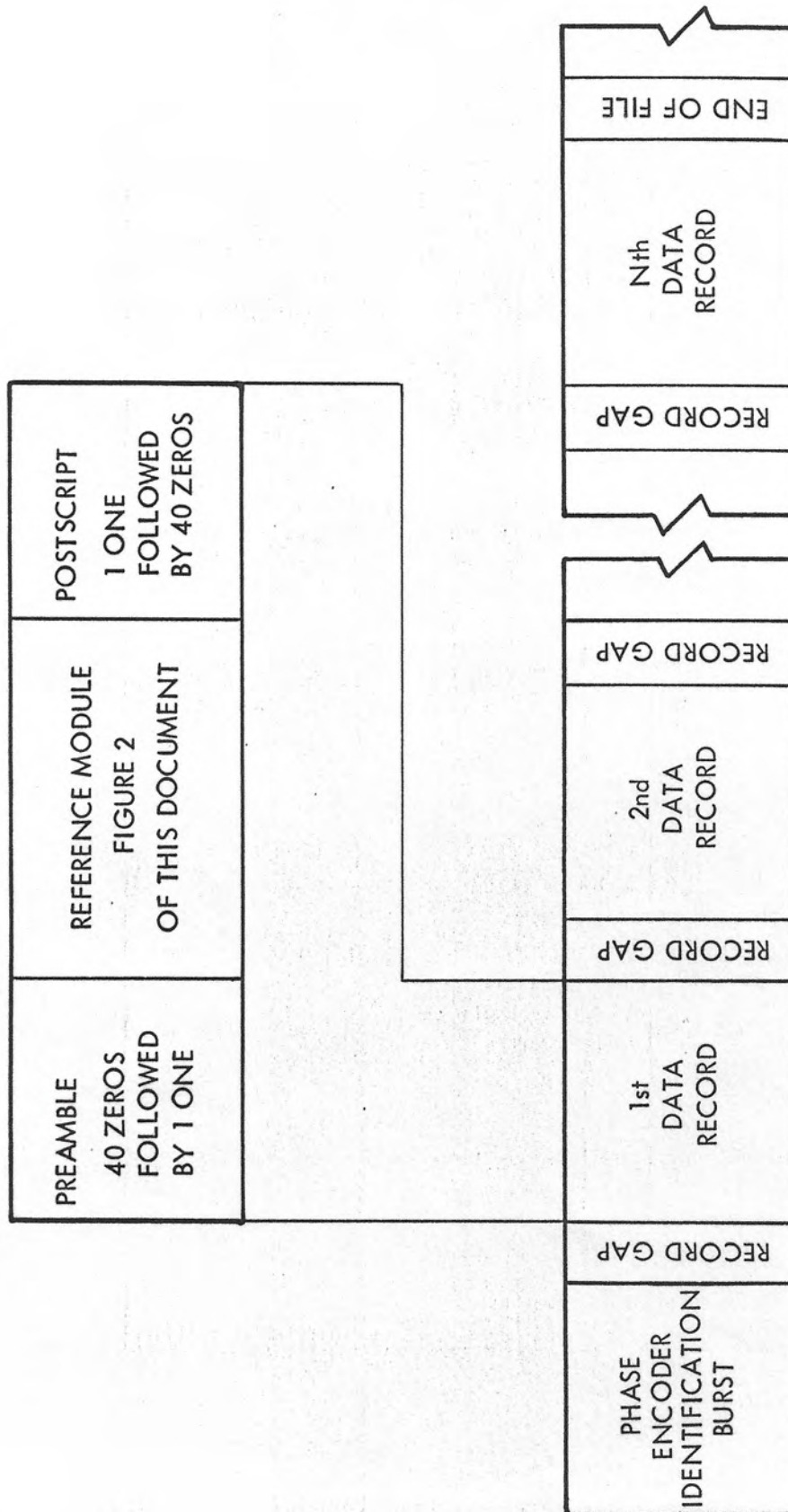
Figure RSC-11-6-1. Medium Bandwidth Radio Science Computer Compatible Tape
Format Conforming to ANSI Standards

BIT															
WORD 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16															

```
BIT
WORD   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
   1   V  C  E  S  0  0  0  0  TAPE NO.
   2   RECORD NO.
   3   RECORD LENGTH
   4   SPACECRAFT ID          SOURCE STATION
   5   DRA TAPE NO.
   6   DAY (100's)  DAY (10's)  DAY (UNITS)  HR (10's)
   7   HR (UNITS)  MIN (10's)  MIN (UNITS)  SEC (10's)
   8   SEC (UNITS) MICROSECONDS
   9   MICROSECONDS (contd)  CONFIGURATION
  10   UNDEFINED                 REDUCT RATE
  11   UNDEFINED                 SAMPLE RATE
  12   REDUCTION SOURCE      INPUT BLK SIZE REG
  13   INPUT BLOCK SIZE REGISTER (Cont.)
  14   UNDEFINED
  15
  16
  17
  18
  19
  20
  21   UNDEFINED
  22   REPLACEMENT RECORD FLAG
  23   REDUCTION DAY            UNDEFINED
  24   REDUCTION TIME OF DAY
  25   UNDEFINED
  26   UNDEFINED            STATUS
  27   SAMPLE COUNT
  28   SAMPLE COUNT (Cont.)
  29   DATA SAMPLES
        ~
2528   DATA SAMPLES
       1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
```

Figure RSC-11-6-2. Medium (Bandwidth) Record Format

Sample Count Validity Indicator

4   Indicates that the sample count in Words 27 and 28 is valid for this record

     0 = Invalid

     1 = Valid

ODA Tape Type Indicator

5 thru 8   Always set to 0000 to indicate medium band reduction tape.

Tape Number

9 thru 16   Binary integer number; increments each time a tape is completed for a given playback run

WORD 2
BIT

Record Number

1 thru 16   16-bit binary integer

WORD 3
BIT

Record Length

1 thru 16   16-bit binary integer; indicates number of words in this record; set to 2528_{10}

WORD 4
BIT

Spacecraft Number

1 thru 8   Binary representation of spacecraft number (Refer to module OPS-6-6, Tables OPS-6-6-9 and -10 of this document)

Source Station

9 thru 16   Binary representation of DSS station number

WORD 5

BIT

DRA Tape Number

1 thru 16   16-bit binary number; tape number of DRA tape which is the source for this reduction record

WORD 6

BIT

Data Time Tag

1 thru 4   Hundreds of Days; the data time tag is valid only when Word 1, bit 1 is set to 1; the time tag in general will not correspond to an exact integral second, but the first data sample in the record will correspond to the exact integral second which is closest to the time tag

Data Time Tag (Continued)

5 thru 8   Tens of Days

Data Time Tag (Continued)

9 thru 12   Units of Days

Data Time Tag (Continued)

13 thru 16   Tens of Hours

WORD 7

BIT

Data Time Tag (Continued)

1 thru 4   Units of Hours

Data Time Tag (Continued)

5 thru 8   Tens of Minutes

Data Time Tag (Continued)

9 thru 12   Units of Minutes

6

Data Time Tag (Continued)

13 thru 16   Tens of Seconds

WORD 8
  BIT

Data Time Tag (Continued)

1 thru 4   Units of Seconds

Data Time Tag (Continued)

5 thru 16   First 12 bits of 20-bit binary number indicating
number of microseconds since start of second (MSB is
bit 5)

WORD 9
  BIT

Data Time Tag (Continued)

1 thru 8   Last 8 bits of 20-bit binary number indicating number
of microseconds since start of second (LSB is bit 8)

DRA Configuration/Status (DRA Input Selection)

9 thru 11   Should always be set to 001 for medium-band data
  000 = Input #1
  001 = Input #2
  010 = Input #3
  011 = Input #4
  100 = Test Input

12   DRA Configuration/Status (DRA 1-PPS Status)
  0 = Present
  1 = Absent

13   DRA Configuration/Status (DRA Clock Sync Status)
  0 = In-Sync (Normal)
  1 = Out-of-Sync

14   DRA Configuration/Status (Real-Time Recording Monitor Source)

    0 = Recorder A

    1 = Recorder B

15   DRA Configuration/Status (DRA Microsecond Time Status)

    0 = Normal

    1 = Abnormal

16   DRA Configuration/Status (DRA Time-Track Sync)

    0 = Out-of-Sync

    1 = In-Sync (Normal)

WORD 10
BIT

Unused (Reserved) Bits

1 thru 11   Undefined

Reduction Rate

12 thru 16   Rate at which data samples are transferred from DRA tape to computer-compatible tape; the following are the only codes valid for playback operations:

	Playback Rate (samples/sec)	DRA Tape Speed (ips)
10000	50K	7.5
01000	62.5K	7.5
00000	75K	7.5

WORD 11
BIT

Unused (Reserved) Bits

1 thru 11   Undefined

Channel Sampling Rate

12 thru 16   Sampling rate at which data were originally recorded on the DRA tape; rate is the same for all four data channels

	Sampling Rate (samples/sec)	DRA Tape Speed (ips)
10000	50K	7.5
01000	62.5K	7.5
00000	75K	7.5
10001	100K	15
01001	125K	15
00001	150K	15
10010	200K	30
01010	250K	30
00010	300K	30
10011	400K	60
01011	500K	60
00011	600K	60
10100	800K	120
01100	1.0M	120
00100	1.2M	120

WORD 12

BIT

Reduction Data Source

1   Indicates data flow path for reduction data

   0 = DRA Tape (Normal)

   1 = DRA Bypass (Short-loop test only)

Change 128: 1 July 81

Reduction Decimation Ratio

2 thru 4   Factor by which data samples on the DRA tape are
decimated during playback/transfer to this tape record

      111 = 1 (no decimation)
      110 = 2
      101 = 3
      100 = 4
      011 = 5
      010 = 6
      001 = 7
      000 = 8

1 PPS Track Selection

5   Indicates which track on the DRA tape is used for the
start-of-second reference
      0 = Track 16
      1 = Track 21

Time Track Selection

6   Indicates which track on DRA tape is used for
time-of-day reference
      0 = Track 22
      1 = Track 23

Reduction Channel Selection

7 and 8   Indicates which originally recorded medium-bandwidth
input channel is selected for playback
      00 = Channel 1
      01 = Channel 2
      10 = Channel 3
      11 = Channel 4

Input Block Size Register

9 thru 16   Number of samples in 1 second or reduced data expressed
as a negative two's complement binary number.

WORD 13
   BIT

            Input Block Size Register (Cont.)

    1 thru 16
WORD 14 THRU 21
   BIT

            Unused (Reserved) Bits
    1 thru 16   Undefined
WORD 22
   BIT

            Replacement Record Flag
            257 = Record replaced during migration
            0   = Original record

WORD 23
   BIT

            Reduction Day or Year
    1 thru 9   Contains binary value of reduction day (GMT)

            Unused (Reserved) Bits
    10 thru 15   Undefined

            Reduction Time of Day
    16   First bit (MSB) of 17-bit number representing number
          of seconds since beginning of day

WORD 24
   BIT

            Reduction Time of Day (Cont.)
    1 thru 16   Last 16 bits of 17-bit number representing number of
                 seconds since beginning of day

WORD 25
   BIT

            Unused (Reserved) Bits
    1 thru 16   Undefined

WORD 26

BIT

Unused (Reserved) Bits

1 thru 8   Undefined

9   Status

1 = Input buffer overflow

0 = No overflow

10   Status (Cont.)

1 = 1 pps Out-of-Sync

0 = Not Out-of-Sync

11   Status (Cont.)

1 = Bit Slip

0 = No Out-of-Sync

12-13   Status (Cont.)

Spares

14 thru 16   Decimation Counter Value

111 = 1 (No decimation)

110 = 2

101 = 3

100 = 4

011 = 5

010 = 6

001 = 7

000 = 8

WORDS 27 and 28

BIT

Sample Count

1 thru 16   A 32-bit binary number which relates the first data

sample in this block to an integral second; valid only

when Word 1, bit 4 is set to 1; a number "n" stored in

this field indicates that the first sample in this
block was the nth sample after the start of the second
(at a decimation ratio of one -- see Word 12, bits 2
through 4); MSB is Word 27, bit 1 and LSB is Word 28,
bit 16.

NOTE

Refer to appendix for cases involving other decimation
ratios.

WORDS 29 THRU 2528
BIT

1 thru 16   Data Samples
Each word contains two 8-bit data samples. MSBs of
samples are in bit 1 and bit 9; the "earlier" sample
is in bits 1 through 8

APPENDIX A

MEDIUM BAND IDR RECORDS

The medium band converter hardware inputs data to the computer through two channels, a control/monitor channel, and a data channel. The control/monitor channel input contains time of day and status. It appears in the record in Words 6 through 13. The data channel input contains A/D converter values and a header. It appears in the record in Words 25 through 28. The header on the data channel contains 8 bytes of auxiliary information that are inserted into the data stream when the number of data samples indicated by the block size register has been input to the computer. The ODA software sets the block size register to equal the sample rate of the recorder at playback speed. If the record sample rate was 300K samples/second, the playback rate is 75K samples/second. Validity flags are set when an input occurs on either the control/monitor channel or the data channel. The data header validity flag is set when an input occurs on the data channel (every 75K samples of input data) and the time validity flag is set every 300K samples of input data. A control/monitor channel input sets bit 1 of Word 1 of the medium bandwidth record. The data channel header input sets bit 4 or Word 1.

The decimation ratio is the factor by which the data samples on the DRA tape are decimated during IDR production. A decimation ratio of one indicates that every recorded sample is input to the computer. A decimation ratio of 3 indicates that every third sample is input to the computer.

The sample count in the ODA medium band IDR is the count of the number of data samples (on the DRA tape) that have occured since the last tape 1 pps. It indicates the data sample that is to be associated with the time of the record.

Figure 1 shows the monitor/control and data channel inputs for a decimation ratio 1. The DRS recorder is operated at 1/4 the rate at which the data were recorded. The block size register is set to 75,000. This causes a data

channel header input once per second. Note that the 1 pps that was recorded on the DRA tape when it was running at 300K samples, occurs every 4 seconds when the data is played back at 1/4 rate.

Figure 2 shows the two input channels when the decimation ratio is 3. The data channel header is still input every 75,000 samples, but since every third sample is being input, 225K recorded samples must pass before 75K are input to the computer. Data channel header inputs now occur every 3 seconds. The data channel validity flag is set every 3 seconds, which is 3/4 of a tape second. The control/monitor validity flag is set every 12 seconds, which is every 3 tape seconds.

Figure 3 shows the actual sample count for a decimation ratio of 3. Every third sample is input in the computer, and causes the block size counter increment. When the counter reaches 75,000, a data channel header is input. The raw sample counter value input at the start of a tape 1 pps period is 299997. Samples 299998 and 299999 were not yet counted when the header was input. The ODA software adjusts the sample count to compensate for the decimation ratio and to tag the first sample in the record as 1 rather than 0. It also subtracts the record sample rate from the compensated sample count when a control/monitor input occurs. The records with valid time in the header, therefore, have sample counts of 1, indicating that the first sample corresponds to the time in the record. An illustration of this appears below.

DECIMATION RATIO = 1		DECIMATION RATIO = 3	
Record No.	Sample Count	Record No.	Sample Count
1	1	1	3
16	75001	16	225001
31	150001	31	150001
46	225001	46	75001
61	1	61	1
76	75001	76	225001
91	150001	91	150001
106	225001	106	75001
121	1	121	1

Figure 1. Time and Data Channel Inputs Showing Sample Count
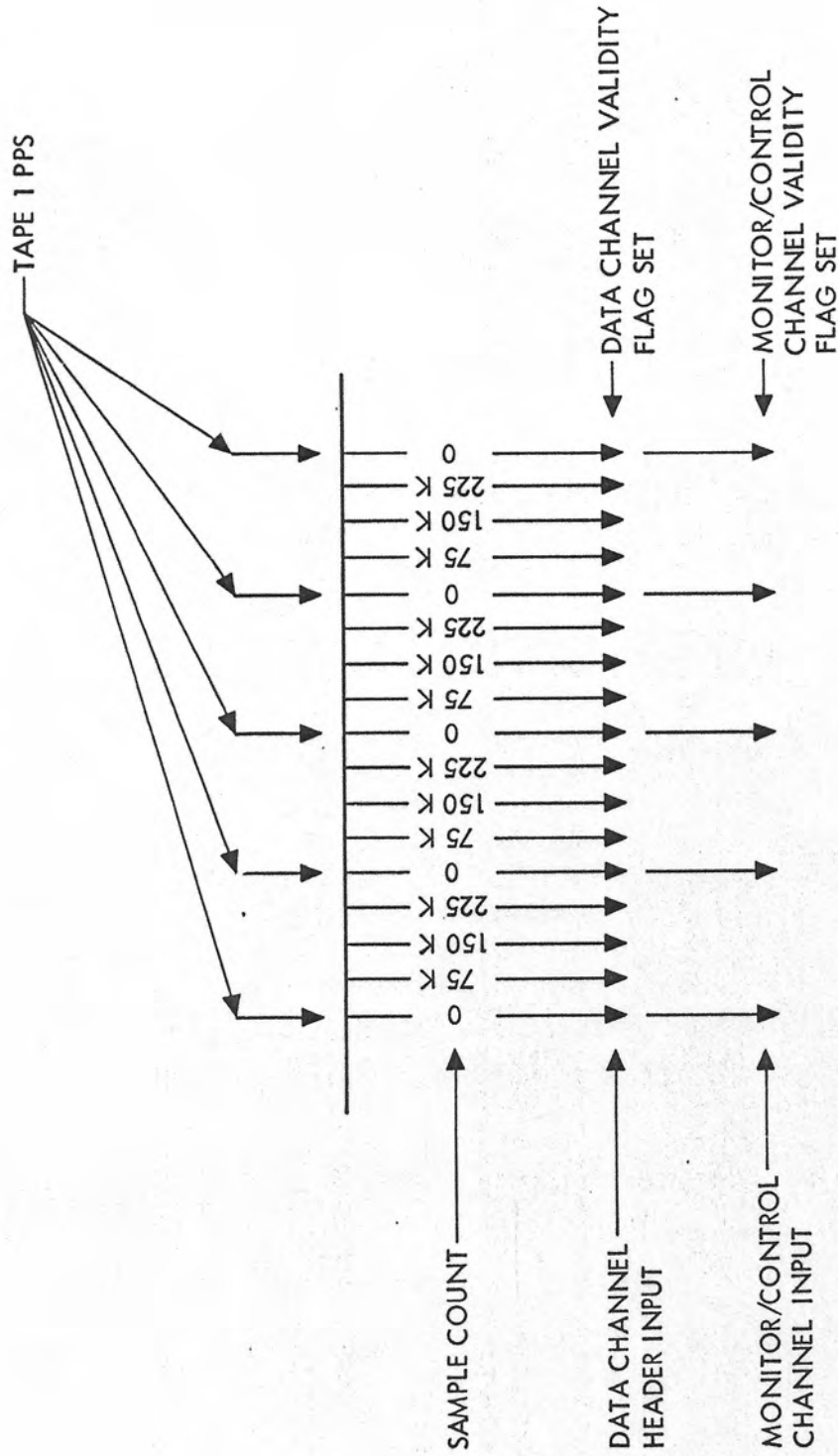
DECIMATION RATIO = 1
RECORD SAMPLE RATE = 300 K
PLAYBACK SAMPLE RATE = 75 K
DATA CHANNEL HEADER INPUT EACH 75 K RECORDED SAMPLES
SAMPLE COUNT RESET BY TAPE IPPS

Figure 2. Time and Data Channel Inputs Showing Sample Count
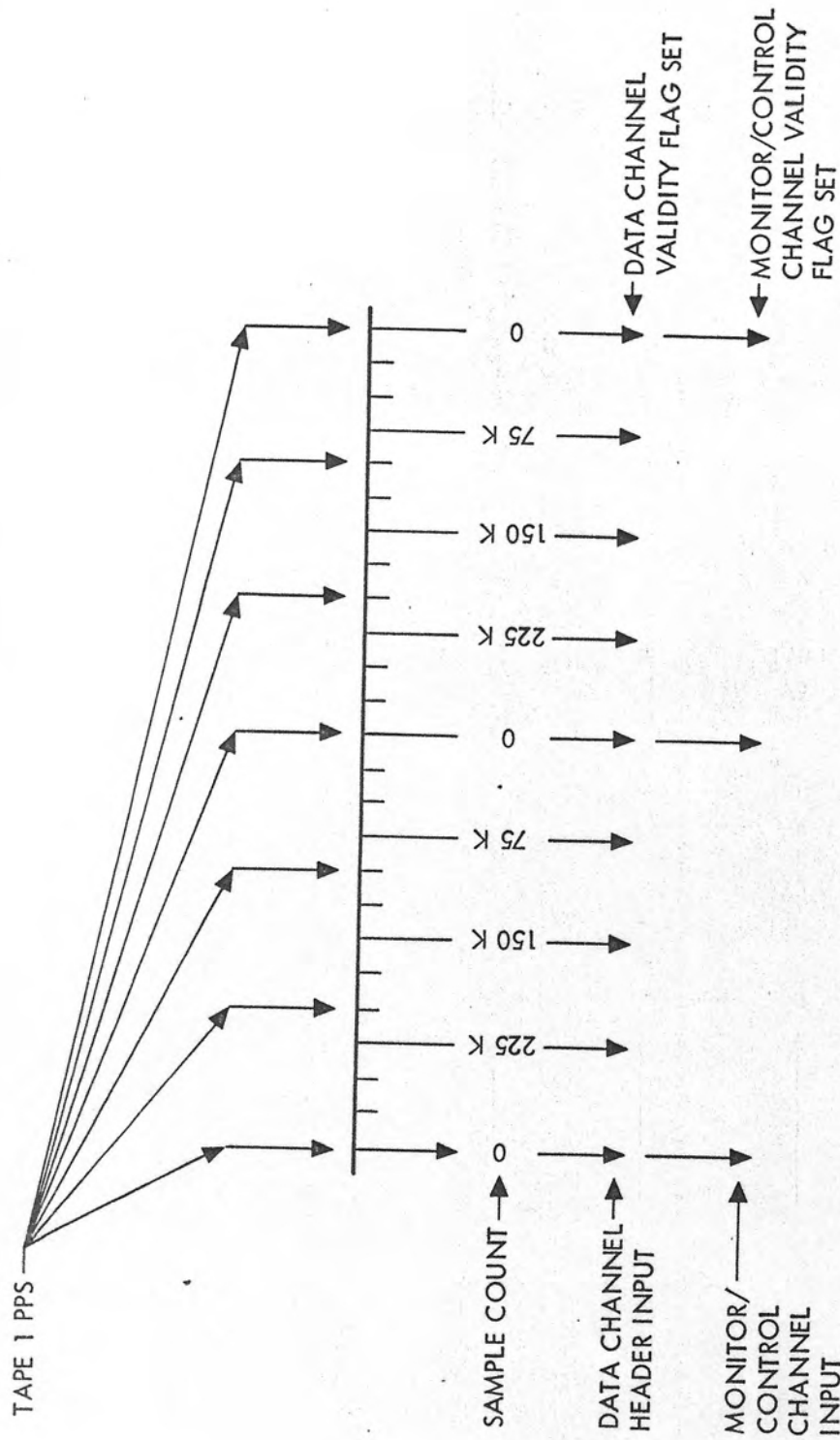
DECIMATION RATIO = 3

RECORD SAMPLE RATE = 300 K

PLAYBACK SAMPLE RATE = 75 K

DATA CHANNEL HEADER INPUT EACH 3 × 75 K RECORDED SAMPLES

SAMPLE COUNT RESET BY TAPE 1 PPS

TAPE SECOND N ⟶ TAPE SECOND N + 1

DECIMATION COUNT   1 2 3 1 2 3 1 2 3 1 2 3 . 1 2 3 1 2
                                                     0 1 2 3 4

SAMPLE COUNTER   299991 299992 299993 299994 299995 299996 299997 299998 299999
                                                                              1 2

BLOCK SIZE COUNTER   74998   74999   75000

DATA CHANNEL HEADER
INPUT TO COMPUTER

RAW SAMPLE COUNT   =   299997
ODA S/W ADDS   +4
ODA S/W SUBTRACTS   -300000
                   ──────────
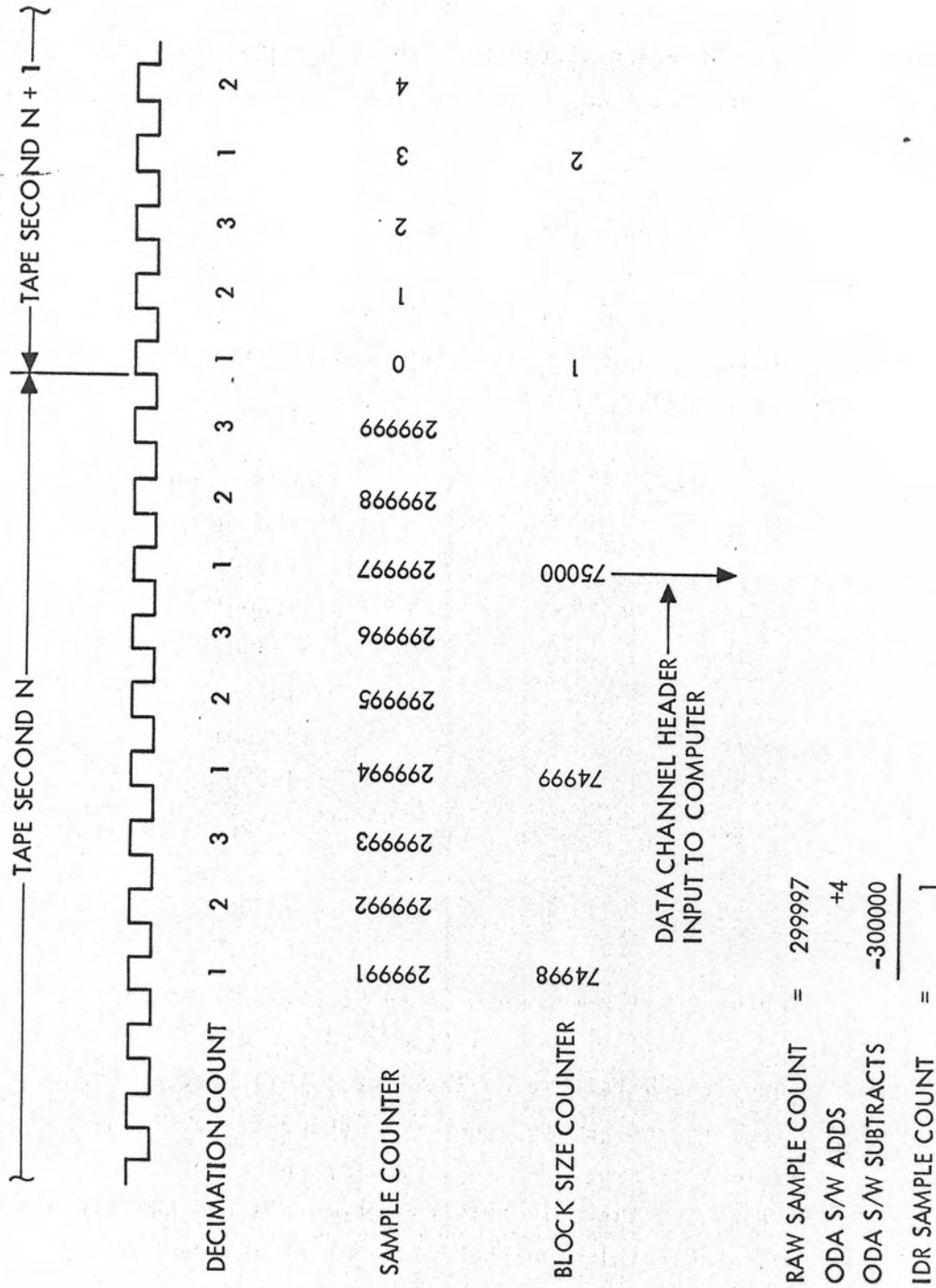IDR SAMPLE COUNT   =   1

Figure 3.   IDR Sample Count—Decimation Ratio = 3

The sequence repeats throughout the entire IDR tape for records that do not have missing or additional samples. Note that the first record on the decimated tape has a sample count of 3 rather than 1. This occurs because the first input occurs at the start of second rather than when the block size count is exhausted, causing the raw sample count to be input as 299999 rather than 299997.

A DRA tape can contain data errors. These errors usually occur as parity errors in the data samples. If an error occurs on the 1 pps track that causes a spurious tape 1 pps, the sample counter will not contain the correct count. The sample count returns to normal during the next second. This situation is illustrated below record 181.

Record No.	Sample Count
121	1
136	225001
151	150001
166	75001
181	164196
196	225001
211	150001
226	75001
241	1
256	225001

A DRA tape of poor quality may have "loss of sync" errors in addition to the sample count reset errors. The data clock and the data lose synchronization when this occurs, the data samples are lost. This type of error is indicated by an offset in the sample count. In the example below, records 451 through 481 illustrate this type of error. During the interval, the sample count changed from 1 to 4. The data between record 451 and 481 are not useable because the time tag associated with the data samples is unknown.

Record No.	Sample Count	Record No.	Sample Count
361	1	466	29791
376	225001	481	4
391	150001	496	225004
406	48288	511	150004
421	273288	526	75004
436	225001	541	4
451	150001		

When the sample count shifted from 1 to 4, it indicated that the time tag of the first sample in the record shifted by 3 sample periods at the record ratio, and is now 3 sample periods later in time than before. Another way to consider it is that the first sample in the block would have been the fourth sample had the sync loss not occured.