CORRELATION OF TAPE DROPOUTS WITH DATA QUALITY

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ABSTRACT

When recording and reproducing telemetry data, signal dropouts are a prime concern to most tape users. The effect of particular depths and lengths of dropouts on data quality must be known before the acceptability of a tape for a specific application can be determined. This paper discusses the correlation of tape dropouts with data quality when recording predetection and post-detection telemetry data and IRIG timing on wideband instrumentation tape, as well as methods of reducing dropouts.

INTRODUCTION

Tape dropouts are reductions in signal amplitude of the magnetic tape reproducer output. The effect of a dropout on data quality is dependent on the length and depth of the dropout. The other major factors are the way the data is recorded (1) and the type of data being recorded. (2) This study was initiated to determine the best tape dropout criteria to use in evaluating SAMTEC wideband telemetry tapes and explore methods of reducing dropouts.

CAUSES OF TAPE DROPOUTS

Dropouts are caused by contaminants on the tape surface (oxide particles, dust, etc), coating non-uniformity and tape damage. Dropouts due to the first two causes may be on the tape as received from the manufacturer. The third type is usually a result of improper human or recorder handling. The signal reduction or dropout is an effect caused by the record and/or playback head being spaced away from the nominal surface of the tape. The amount of this loss is given by the formula (3):

$$La = 20 \log_{10} \exp (2 \pi a / \lambda$$
$$= 54.6 a/\lambda$$

where:
La = spacing loss in db
a = head to tape spacing
λ = recorded wavelength = $\frac{\text{tape speed}}{\text{recorded frequency}}$

This formula says that for every wavelength separation of the tape to the head, there is a 54.6 db loss in signal amplitude. For an upper bandedge signal, the wavelength is only 0.06 mils, so a very small contaminant can result in a large reduction in signal amplitude.

DROPOUT MEASUREMENT

Tape procured by the General Services Administration (GSA) for Government use is presently specified to have from 10 to 40 dropouts per 100 feet or less, depending on the class of tape and the track being tested (4). A new tape category is being added specifying five dropouts or less on center tracks and 10 or less on edge tracks. GSA defines a dropout as a 50% reduction in output of a 1 MHz sinewave for 10 microseconds. An additional dropout is counted for each additional 10 microseconds that the signal stays below 50%.

APPROACH

Since the Space and Missile Test Center (SAMTEC) has been experiencing problems with both data and timing quality due to dropouts on new tape, we wanted to determine how the GSA dropout specification related to our actual data requirements and what dropout criteria was best suited to our specific recording applications. Our most critical data was recorded and both dropouts and data quality were evaluated simultaneously. The data selected for these tests was as follows:

Pre-detection PCM, 500 KBPS Bi-Ø

Post-detection PCM, 1000 KBPS Bi-Ø

IRIG A Timing, 10 KHz carrier frequency

Equipment setup was as shown in Figures 1, 2 and 3. The bit error probability (BEP) tests were basically as specified in IRIG Document 118-73 (revised July 1975), Appendix C. Noise was added to the PCM signal until a BEP of 1×10^{-6} was obtained when dropouts were not present. Timing was recorded per IRIG specification.

Upon playback, bit/timing errors and dropouts were displayed on a stripchart recorder and the length and depth settings of the dropout detector varied until the best correlation was obtained. Our dropout detector has variable depth from 0-100% and variable length of 5, 10, 20 and 40 microseconds, AGC amplifiers are used to keep the nominal recorder output constant. Results are given in TABLE I.

TABLE I - Dropout Correlation Results

Test	Dropout Depth (%)	Dropout Length (usec)
Predetection	50	5
Post-detection	72	5
Timing	60	10

EFFECT OF RECORDER TYPE ON DROPOUTS

SAMTEC uses several types of wideband magnetic tape recorders, which can generally be categorized as those using vacuum chambers to isolate the tape in the head area from reel disturbances and those using pinch rollers. On SAMTEC recorders, it has been found that a major factor effecting dropouts is the type of recorder used. TABLE II shows the average number of dropouts per 100 feet of tape when tested using various vacuum chamber (VC) and pinch roller (PR) recorders. The results are an average of 8500 feet of tape on a total of 31 tracks of five (5) different recorders. It should be noted that the dropout correlation tests discussed previously were conducted using pinch roller type recorders.

TABLE II - Dropouts per 100' of Tape by Recorder Type

Recorded on PR Recorder		Recorded on VC Recorder	
Reproduced PR	Reproduced VC	Reproduced VC	Reproduced PR
23	6	9	27

It can be seen from this table that pinch roller recorders exhibited more dropouts than vacuum chamber recorders in both the record and reproduce process.

EFFECT OF TAPE TENSION ON DROPOUTS

Dropouts were tested on two 7-track pinch roller recorders at a tension of 8 ounces. When the tension was reduced to 5 1/2 ounces, dropouts increased significantly. Results are shown in TABLE III.

TABLE III - Tension vs Dropouts per 100 Feet of Tape

Recorder	Track	Tension (oz) 8	Tension (oz) 5-1/2
1	1	92	141
1	4	9	13
1	7	12	19
2	1	25	82
2	4	22	39
2	7	54	78

EFFECT OF TAPE CLEANING ON DROPOUTS

In an effort to improve tape quality, tape cleaner/winders are in operation at SAMTEC. Both new and used tapes are cleaned prior to use. New tapes averaged 31 dropouts per 100 feet. Degaussing and re-recording the once used tapes reduced dropouts to 25 per 100 feet, a reduction of 19%. Cleaning new tape reduced dropouts to 12 per 100 feet or 61%. These results are an average of 8500 feet of tape on 7-tracks of 7 recorders.

METHOD OF REDUCING TIMING DROPOUTS

G. R. McKelvey has shown that data quality can be improved by optimizing the recorder for the type of data being recorded (1). SAMTEC has been able to significantly reduce the effect of dropouts on timing by optimizing the record electronics for the timing signal. This was made practical by dedicating certain tracks to timing. Record bias is set for 2 db overbias at 50 KHz, rather than at upper bandedge (2 MHz at 120 ips). Record level is then set just below saturation (clipping). Normal IRIG reproduce equalization is satisfactory so that playback is compatible with any reproduce electronics. We have notfound it practical to optimize the data recording because of the variety of formats required on a day-to-day basis.

CONCLUSIONS

A more effective use of magnetic tape can be obtained by tailoring the certification criteria to the data requirements of your particular facility. A criteria should be established that will insure that data is not significantly degraded, but not so stringent that useable tapes are discarded.

Although dropouts are caused by contaminants on the tape surface, coating non-uniformity and tape damage, the way the recorder reacts to the dropout depends on several factors. The type of equipment being used to record and reproduce the data has a major effect on the total number of dropouts. On SAMTEC recorders, pinch roller recorders exhibited 3 to 4 times as many dropouts as vacuum chamber recorders. Tape certification should be done on or correlated with the "worst case" recorders. Also, dropouts can be minimized by insuring that tension is not set below manufacturer's specifications. An increase above that value should not be made without first consulting with the manufacturer on the effects on tape handling and head wear.

At a minimum, tape should be run across the recorder heads once prior to use. Dropouts can be reduced further by cleaning the tapes prior to use.

REFERENCES

1. McKelvey, G.R., "Recorder Parameters Affecting Bit Error Rate," Proceedings International Telemetry Conference, 1972.
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3. Mee, C.D., "The Physics of Magnetic Recording," John Wiley & Sons, Inc., New York, 1964.
4. Interim Federal Specification W-T-001553 (GSA-FSS), Tape , Recording, Instrumentation, Magnetic Oxide-Coated; December 21, 1979.

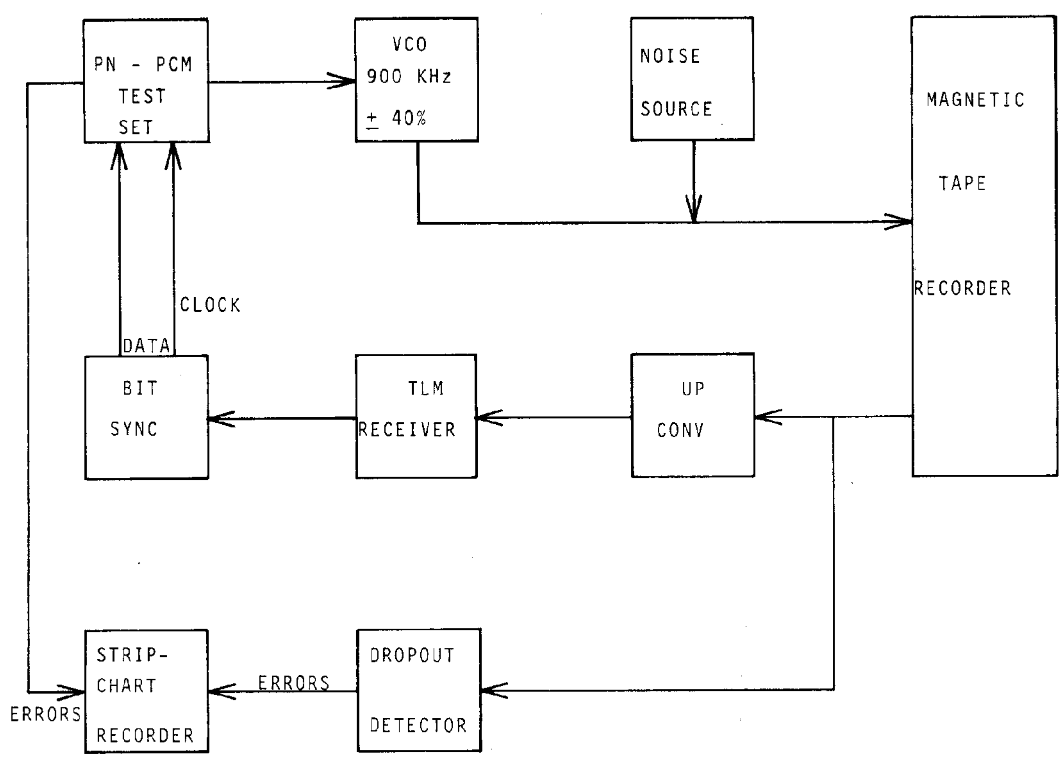

Figure 1 - Predetection Test Configuration

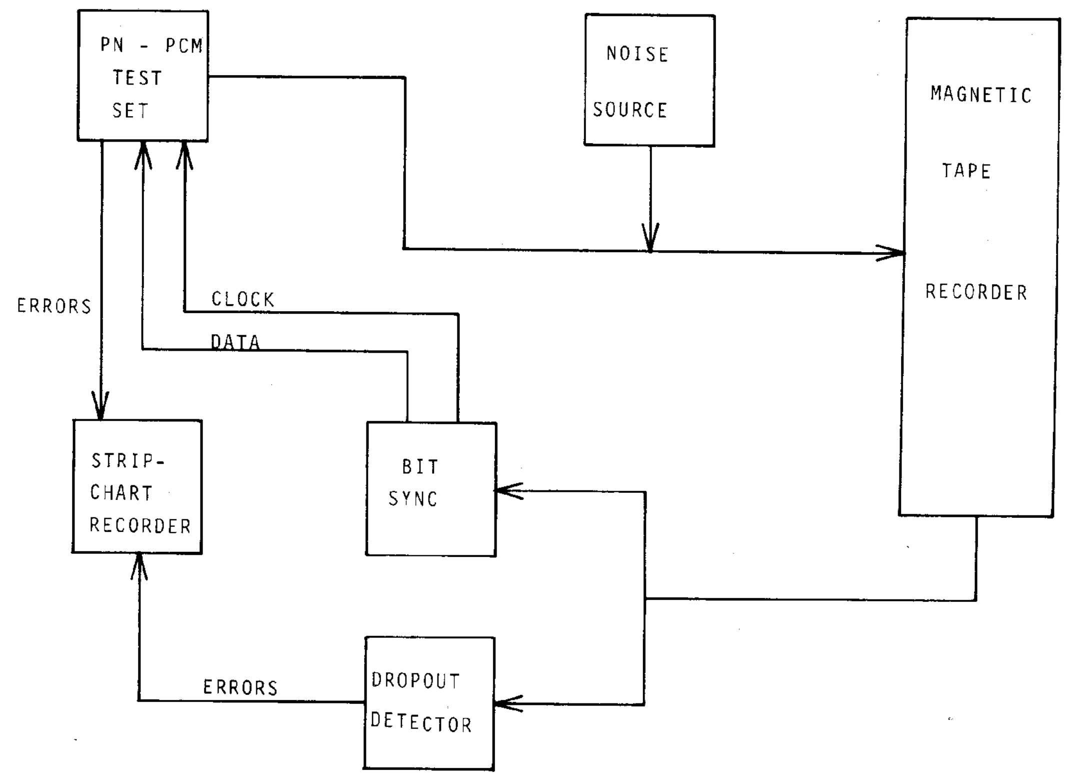

Figure 2 - Post-detection Test Configuration

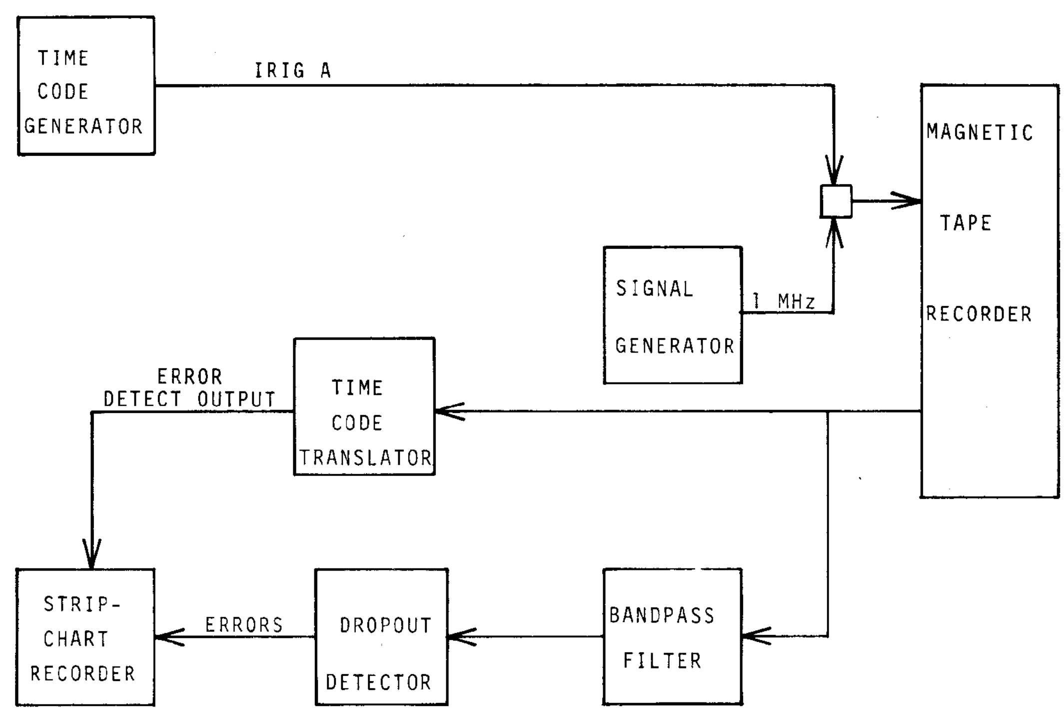

Figure 3 - IRIG Timing Test Configuration