iTR notes

INSTRUMENTATION TAPE RECORDER NOTES NUMBER 1

DROPOUTS

Dropouts are a loss of signal in either the record or reproduce mode caused by imperfections or foreign particles separating the tape from the head.

IRIG Document 106-73 defines a dropout for a tape speed of 15 ips as a 50% (6 dB) or greater decrease in output voltage for 80 μs or longer. Dropouts with a duration in excess of 80 μs are counted as one dropout for each 80 μs duration; 160 μs constitutes two dropouts; 240 μs, three dropouts, etc.

Two conditions must be satisfied in order for a dropout to exist. The magnitude of the voltage drop (50% or greater), and the duration of the voltage drop (80 μs). A 90% drop for anything less than 80 μs does not constitute a dropout nor does a 40% voltage drop for lengths of time greater than 80 μs.

Because dropouts result from factors external to the recorder, they are not specified by tape recorder manufacturers, and little data exists as to comparative recorder performance in the presence of dropout producing factors. The only published specifications on dropouts are those of instrumentation tape manufacturers in which the number of dropouts per 100 feet of tape per track are specified as a measure of quality.

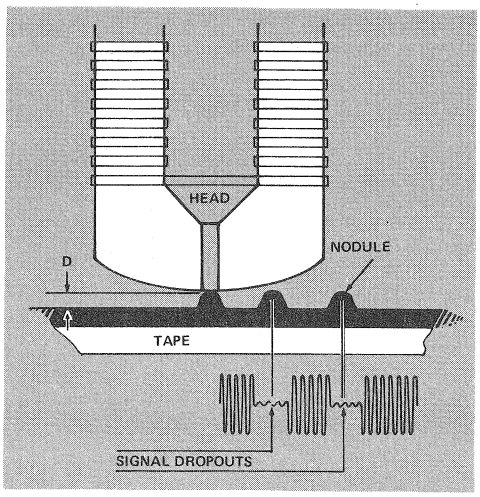

FIGURE 1

TYPES AND CAUSES OF DROPOUTS

Dropouts can be classified as either permanent, temporary, or temporary/permanent. Permanent dropouts result from tape imperfections. Small clusters of improperly dispersed oxide particles, called nodules, (see Figure 1) form on the tape surface during the manufacturing process. Also, oxide that sheds from the tape during manufacturing or recording operations and are redeposited on the tape as clumps. Good tapes are specified at less than 15 dropouts per 100 feet of tape/track, and some exceptional quality tapes now appearing are specified at less than two dropouts per 100 feet of tape/track. Less expensive tapes, e.g., audio tapes, do not specify dropouts and can have 10 to 100 times more dropouts than instrumentation tapes.

Temporary dropouts are a controllable condition caused by foreign particles such as dust, dirt, and cigarette smoke coming between the tape and the recorder head.

Temporary/permanent dropouts are caused by foreign particles such as dust or dirt becoming imbedded in the tape.

The significance of a dropout varies with: (1) The size of the imperfection or the foreign particle producing the dropout; (2) the frequency being recorded and/or reproduced, and; (3) the recording mode being used – FM vs. Direct.

When a particle size is small compared to the wavelength of the recorded signal, its interruptions will be insufficient to impair the integrity of the data. But as the particle size approaches an appreciable portion of the wavelength, the signal loss increases dramatically.

The relationship of the loss in signal, wavelength, and tape-to-head separation is expressed by the equation:

$$\text{dB Loss} = \frac{55D}{\lambda}$$

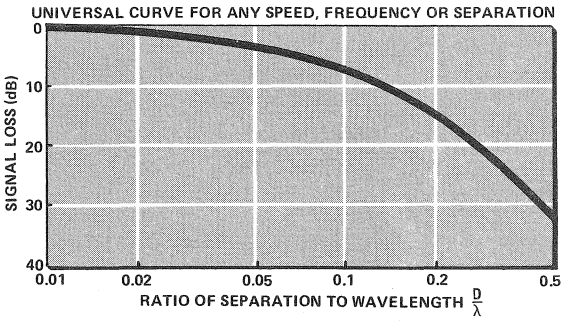

FIGURE 2

Where D = tape-to-head separation, and

$$\lambda = \text{wavelength on tape} = \frac{\text{Tape Speed}}{\text{Frequency}}$$

If, for example, a frequency of 50 kHz is being recorded at a tape speed of 15 ips, λ = .30 mils. A tape-to-head separation of 50 microinches will give:

$$\text{Signal Loss dB} = \frac{55\,(50 \times 10^{-6})}{.3 \times 10^{-3}} = 9.16 \text{ dB}$$

Figure 2 is a universal curve that shows signal attenuation for any separation and frequency.

Since a 6 dB or 50% signal loss defines a dropout, the 50 microinch separation for a frequency of 50 kHz is sufficient to produce a serious gap in the recorded data. To appreciate the sensitivity of instrumentation tape recorders to foreign particles, consider that the average cigarette smoke particle with a diameter of 25 microinches is capable of producing a 4.58 dB or 41% signal attenuation while recording a 50 kHz signal.

FM RECORDING AND DROPOUTS

Recording in the FM mode minimizes the effect of dropouts since this method employs a carrier which is frequency modulated by the signal to be recorded. The information is preserved in the frequency domain and amplitude variations will have little or no effect on the data. So long as complete cycles are not lost, the FM signal will reproduce the data. This is not the case in the Direct recording process in which information is carried in the amplitude of the recorded signal. Direct recording is always more sensitive to dropout producing factors which cause amplitude instability and loss of data.

MINIMIZING DROPOUTS

Use good quality tapes. An instrumentation tape recorder's performance is very dependent upon the tape used. Therefore, the first step toward minimizing dropouts is the use of a good quality instrumentation tape. The use of old or damaged tapes should be avoided.

Maintain a clean recording environment and a clean recorder. The tape path should be cleaned following each pass of the tape. Smoking, eating, and drinking should be avoided in the vicinity of a working recorder. The recorder reel cover should be closed while recording and reproducing.

Exercise care in storing and handling of tapes. Minimize handling and store tapes in recommended containers in areas free of dust and contaminants.