USE OF PSEUDO-RANDOM PCM TAPE SIGNATURES FOR TELEMETRY GROUND STATION VALIDATION

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Summary. This paper describes an improved tape recorder signature using pseudo-random PCM data. The use of the signature for telemetry ground station validation is discussed. Advantages over other techniques in common use are shown.

Introduction. There have been several ITC papers presented which describe the difficulties experienced in recording telemetry data at one facility and processing the data at another facility [Ref. 1, 2, 3, 4].

As discussed in these papers, degradation can be reduced by aligning the head azimuth and reproduce electronics of the playback machine to match the acquisition site recorder. To facilitate the alignment, it has become standard practice to record signatures on each data tape. Signatures in common use include low frequency sine waves for azimuth adjustment (the lissajous presentation method) and white noise or stepping oscillator signals for equalization adjustment [Ref. 5].

Use of these signatures in the SAMTEC processing environment has not, however, proven satisfactory for the following reasons:

a. Alignment of the playback machine is time consuming. It requires special test setups and auxiliary equipment such as spectrum analyzers, oscilloscopes, etc.

b. On several recorder models, trim pots are not readily accessible and are not designed for repetitive adjustment.

c. Many of the problems previously attributed to the recorder are caused by other equipment in the system. Ideally, the signature should certify not only the recorder, but the playback receiver, demodulator, data distribution amplifiers and cables, and bit synchronizer as well.

Consequently, SAMTEC has developed an improved signature which overcomes these limitations on PCM formats.

Station Certification. As a part of the system reliability improvement program instituted at SAMTEC [Ref. 6], telemetry acquisition sites are required to perform a bit-error-rate test during pre-operational checks. As shown in Figure 1, a pseudo-random PCM pattern is used to simulate an operational data link. The signal to noise ratio required to provide 1×10^{-6} data is determined and compared to established criteria. This is a useful test which verifies that the receiving equipment and recorders are performing to an expected norm.

During the acquisition site test, a 20 second segment of data is placed on the operational tape. Also, a voice annotation of the individual error counts as observed by the operator is provided. This leader is then used to certify the processing station prior to a data run as shown in Figure 2. A properly operating system will provide at least 1×10^{-4} data which equates to a signal to noise degradation of about 2 db. If the bit synchronizer and error rate monitor do not indicate a solid lock, then an effective degradation exceeding 3 db is indicated and system alignment or maintenance is required.

The advantages of this certification technique are obvious. First, the signature is made with the acquisition station in the operational configuration. No special setup is required. Next, the entire processing station front end is tested including the recorder, playback receiver, demodulator, bit synchronizer, and distribution network. Again, no special setup is required as the error rate monitor can be permanently connected to unused outputs of the bit synchronizer. Finally, a permanent record of the error rate count is provided on a strip chart as evidence of station quality at the time of the data run.

The philosophy associated with the station certification results should also be considered. Note than an effective “go/no go” test has been provided which is simple to interpret. Either the error rate monitor reads better than 1×10^{-4} or it doesn’t. If so, there is no need to perform time consuming alignments. If not achieved, the data run cannot commence until the problem is resolved.

Recorder Alignment. If a station fails the certification test, recorder alignment is suspect and should be checked. For predetect and high bit rate postdetect PCM formats, it has been found that all required alignments can be accomplished using only the bit error rate leader. No other tape signatures are required [Ref 7].

For head azimuth alignment, it is only necessary to rock the playback head until the output level meter is peaked and a minimum error rate is verified. Not only is this method easy to perform, but it provides an extremely accurate alignment as shown in Figure 3.

Adjustment of playback equalization on PCM formats has been found to be unnecessary. However, this conclusion is qualified as follows:

a. SAMTEC playback facilities use only 2 MHz recorders.

b. For predetect recording, the effective bandwidth is limited to 1.5 MHz by the down/up translation equipment. Consequently, postdetect recording is used whenever the data spectrum exceeds 1.5 MHz when centered at 900 kHz.

c. No postdetect data formats are presently in use at SAMTEC which require a bandwidth in excess of 1.5 MHz.

Consequently, it is only necessary for the playback recorders to be "flat" to 1.5 MHz. Test results [Ref 6] show that the entire bandedge adjustment of ±10 db causes only a small change in the error rate. Consequently, the desired approach is to simply follow manufacturer's recommendations regarding equalization adjustment. Special adjustment to provide a "flat" response for each tape played is not required.

Field Tests. Using the configuration of Figure 2, a bit error rate leader was played into several SAMTEC processing stations. Operators were allowed to adjust head azimuth by peaking the output meter as previously discussed. If the error rate monitor failed to achieve lock, a failure was recorded. The test was then stopped and maintenance performed to correct the system problem. The technique effectively identified numerous problems in a minimum of time. Results are tabulated below.

Number of test runs	48
Number of failures	35

Receiver Main Frame Failures	4
Demodulator/Distribution Failures	21
Recorder Failures	10
Bit Synchronizer Failures	0

Conclusions. The bit error rate leader provides a means of rapidly certifying telemetry equipment. The leader can also be used to simply and accurately align recorder head azimuth. No special alignment for equalization is required for PCM formats if 2 MHz machines are used for playback.

References.

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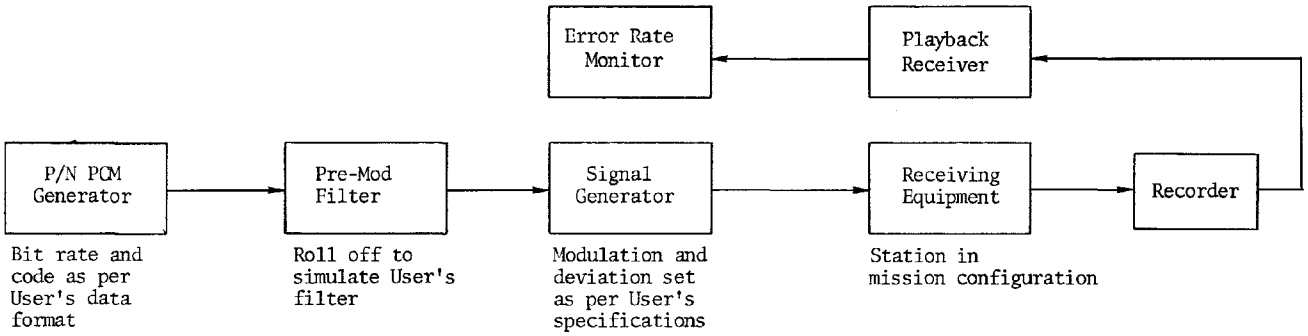


Figure 1 Pseudo-Random PCM Test Setup for Acquisition Site Certification

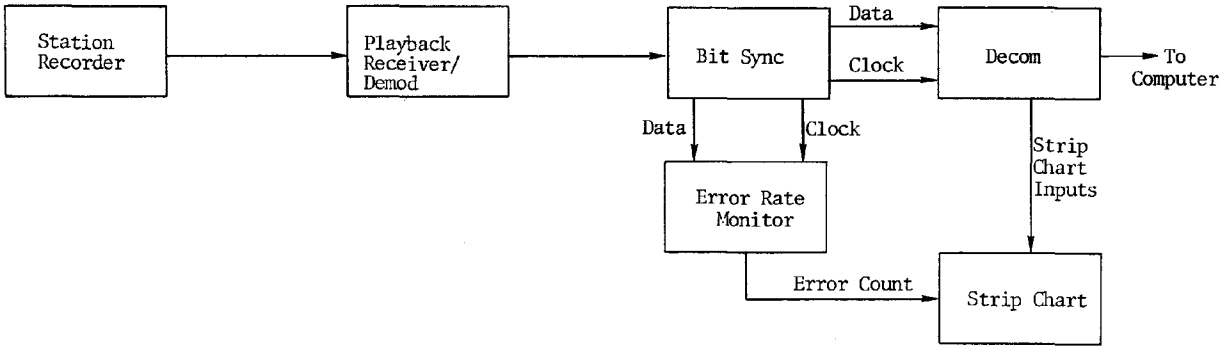
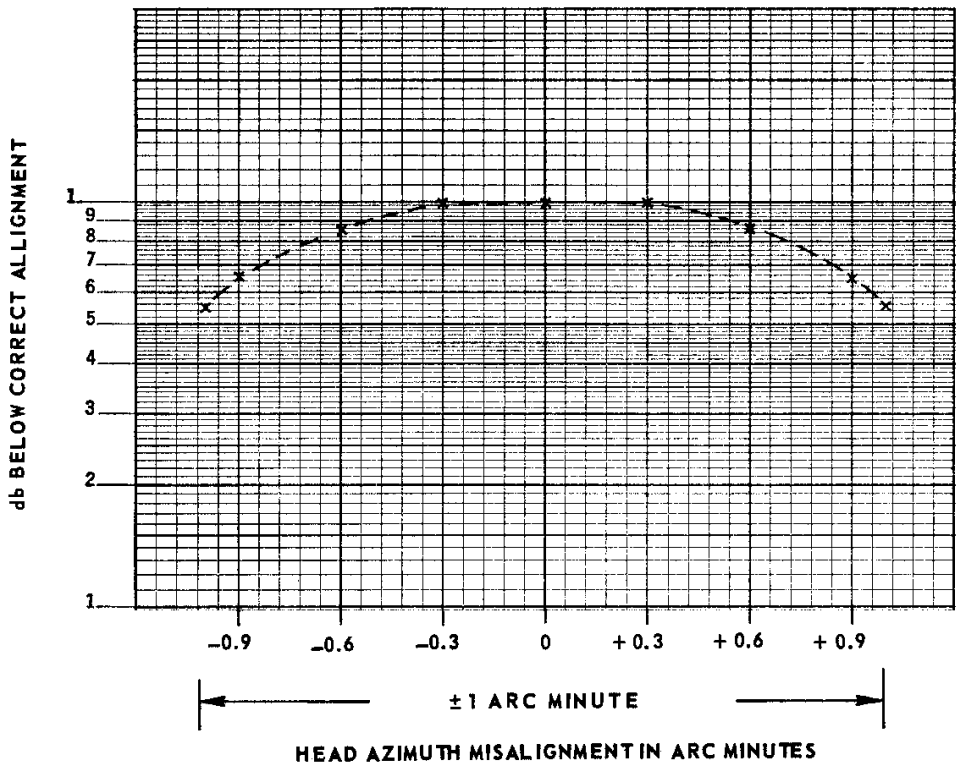


Figure 2 Processing Configuration for Certification with the PCM Tape Leader



Note: 1 arc minute misalignment results in approximately 4.5 db change in reproduce level, yet there is negligible change in bit error rate up to 1 Mbit. These measurements were compiled from many tests made on twelve of the operational 1/2 inch Model VR3700B analog tape recorder/reproducers at the SAMTEC.

Figure 3 Reproduce Output Level versus Head Azimuth Alignment