Digital Television Measurement

Why Transmitter Measurement?

Transmission quality losses mean lost coverage area for the DVB-T broadcaster. Fortunately, these can be detected with the right type of signal monitoring.

For Analog Transmission systems, such as those used for PAL television broadcasts, loss of transmission quality will generally result in degraded picture quality. Typically, this degraded picture quality appears as added noise, with the program still viewable, until the noise level gets very high and the television loses synchronization. A Digital Television (DTV) System behaves quite differently as transmission quality degrades. The received program signal will be unaffected until noise and other impairments cause the digital receiver system to reach a threshold point. Then, very small changes in transmission quality will cause the received program to suddenly go from error-free operation to no picture at all. This very steep threshold behavior, sometimes called the "cliff effect", makes DTV system performance insensitive to minor changes in transmission quality as long as you stay away from the "cliff". This desirable characteristic has one down side: simply watching the received picture gives you no warning that the "cliff" is near. To ensure reliable coverage, it is necessary to know how far the transmission system is operating from "the cliff".

The BER Approach

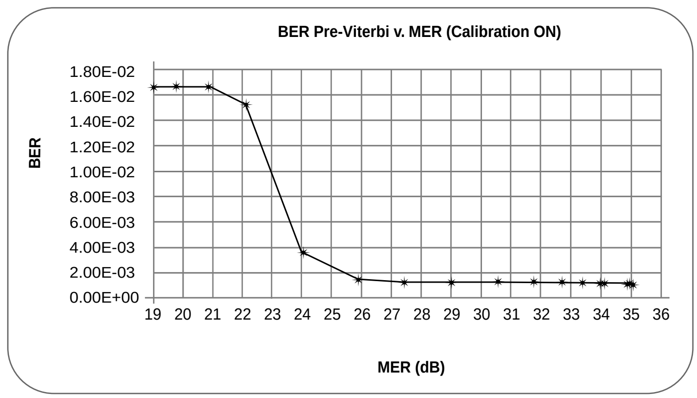
The first DTV monitoring receivers provided a readout of Bit Error Rate (BER). This is simple to implement since the data is provided by the COFDM demodulator chip and is easily processed. For example, pre-Viterbi BER can be calculated from the number of bits corrected by the Viterbi decoder (part of the DVB-T Forward Error Correction (FEC) system) in each second. When the transmission system is operating far from the "cliff", few data errors occur and the pre-Viterbi BER will be near zero. As the system approaches the "cliff" the pre-Viterbi BER rises sharply, giving some warning before the post-Viterbi BER increases and picture errors suddenly occur. The weakness with this approach is that pre-Viterbi BER increases only occur when the "cliff" is very near. This happens because the bulk of the "cliff effect" results from the COFDM modulation method, not the FEC. The FEC simply sharpens the "cliff". So, BER alone does give us warning, but when it is really too late.

The BER plus noise Approach

Since the "cliff" is principally caused by the COFDM modulation method, we could establish our distance from the "cliff" by adding an impairment to the received signal until the BER starts to increase. Often this is done by adding White Noise. For example, if an operating system could tolerate 13dB of additive noise before BER increased we would have 13dB of margin from threshold. Effectively we have had to "break" the monitoring receiver system to find the "cliff" point. The drawback of this approach is that the monitoring receiver is continually going into threshold (BER changing) with minor changes in the transmission system performance. If the monitoring receiver is providing an ASI Transport Stream (TS) to an MPEG decoder or monitor, errors will occur in the TS whenever the monitoring receiver enters threshold. So, while our additive noise method allows us to see if our 13dB margin has decreased, we have in the process created an unreliable ASI feed. What we really need is a way to monitor system margin without having to "break" it.

The MER Approach

A method for determining system margin is described in the European Telecommunications Standards Institute (ETSI) Technical Report (TR) 101 290, formerly known as ETR290. TR 101 290 describes measurement guidelines for DVB systems. One measurement, Modulation Error Ratio (MER), is designed to provide "a single ‘figure of merit’ analysis of the received signal". MER "is computed to include the total signal degradation likely to be present at the input of a commercial receiver’s decision circuits and so give an indication of the ability of that receiver to correctly decode the signal". The MER computation compares the actual location of a received symbol (a "symbol" represents a digital value in the COFDM modulation process) to its ideal location, giving a figure of merit for system performance. As degradation occurs, and the received symbols land further from their proper locations, the MER value will decrease. Ultimately when the symbols start being incorrectly interpreted, the BER will rise; this is the threshold or "cliff" point. The graph below shows this relationship for a receiver with MER measurement capability. The graph was obtained by connecting the MER receiver to a test modulator. Noise was then introduced in gradually increasing quantity, and the MER and pre-Viterbi BER values recorded. With no additive noise, the MER starts as 35 dB with the BER near zero. Note that as noise is added the MER gradually decreases, while the BER stays constant. When the MER reaches 24 dB the BER starts to climb rapidly indicating threshold. MER has allowed us to see progressive system degradation long before reaching the "cliff".



Uses for an MER Transmission Monitor

Since MER provides a sensitive indication of transmission system performance changes, an MER monitor receiver like the Tektronix RFM210 is an ideal way to watch for system degradation arising from High-Power Amplifier (HPA) aging or tuning drift, antenna and feedline degradation, or modulator drift. See figure 1. Since MER is influenced by any parameter that causes symbol target error, it will flag conditions such as noise, carrier leakage, IQ level errors, and quadrature imbalance. By observing MER upon system commissioning, including adding noise to determine the MER for threshold, the transmission system can be continuously monitored while in operation for MER changes. Alarm thresholds can be set to notify over SNMP if MER is moving outside desired limits.

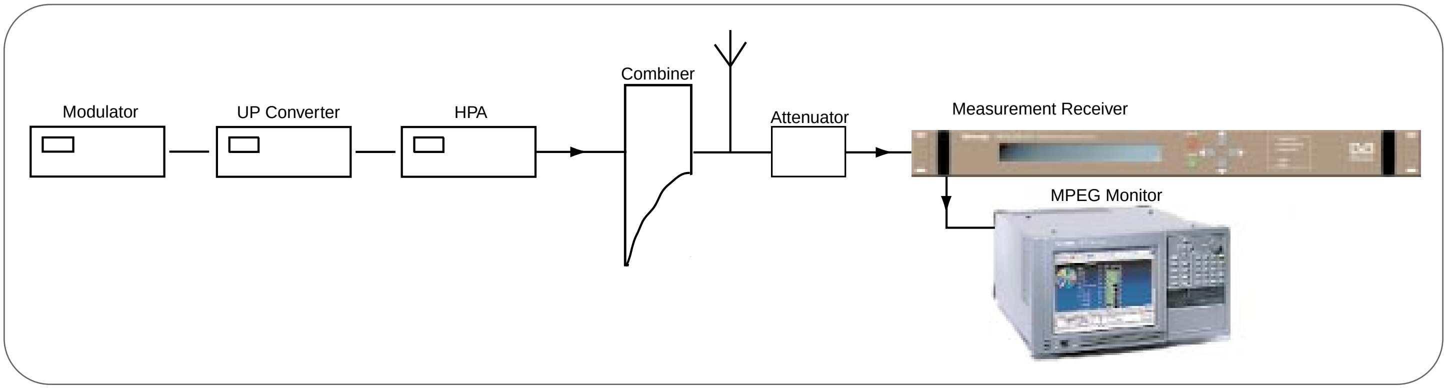
Another application for the RFM210 is in transmission systems with dual redundant circuitry. Here an RFM210 can monitor a DTV transmitter and, if MER and other selected parameters fall outside of selected limits, initiate a changeover to the back-up transmitter. Since MER looks at the ideal figure of merit – symbol target error – it is a good way to detect failures with a minimum of false alarming.

A Real World Example

An early DTV network broadcaster installed DTV receivers that monitored using the "BER plus noise" approach. This was the only receiver available at the launch of this network. Operations were plagued by unreliable RF performance monitoring, including false alarms, and an inconsistent ASI TS feed for the MPEG monitor. Ultimately these receivers were withdrawn from service and replaced with an MER monitor similar to the RFM210. The BER receivers were effectively scrapped, for an estimated cost of $2.4M, plus the cost of the replacement MER receivers.

Conclusion

The MER technique is able to measure small changes in transmitter performance, without compromising a receiver's ability to provide a reliable ASI stream. Because MER is sensitive to any error that causes symbol target error, it is one of the best figures-of-merit for a DVB transmission system. Using a transmission monitor with MER, like the Tektronix RFM210, helps assure reliable DVB-T transmission coverage.



▶ ***Figure 1:*** *Simplified DTV transmission system.*

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RFM210 DVB-T Measurement Receiver

- Comprehensive RF measuring and monitoring capabiltiy.
- High-performance tuner/demodulator.
- Alarm reporting via SNMP.

MTM300 and SV970 MPEG Transport Monitors

- Simultaneous 24x7 monitoring of multiple transport streams.
- Extensive data rate and timing analysis.
- Analysis of system information tables.

PQM300 Program QoS Monitor

- Modular main frame for multi-channel monitoring.
- Intuitive, icon-based alarm display.

For Further Information

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology.

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