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**Test Method for
Downstream Bit Error Rate**

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1.0 SCOPE

The purpose of this test is to measure Bit Error Rate (BER) of downstream (forward path) broadband telecommunications QAM signals. This procedure will address mainly pre-Forward Error Correction BER results for 64 and 256 QAM.

It is important to rely upon both the pre-FEC and post-FEC BER results. In North America, most 64 and 256QAM signals incorporate Annex B, FEC encoding. It is therefore important to reference the post-FEC result, but extremely dangerous to rely solely upon it. BER suffers from what is commonly known as a “cliff effect” in which the post-FEC BER remains error free up to a point and then begins to rapidly decline. Referring to the pre-FEC BER result can yield insight as to how much margin is available prior to reaching the cliff.

Although ITU J.83 Annex B is the standard of choice for forward error correction in North America, it can lead to an overoptimistic pre-FEC BER result. When utilizing ITU J.83 Annex B, the pre-FEC measurement is after the Trellis decoder, but before the Reed Solomon decoder. Therefore, the Annex B pre-FEC test results will include the improvements of the Trellis coding.

ITU J.83 Annex C is similar to Annex B in that it relies on Reed Solomon Error Correction and occupies a 6MHz channel; however, Annex C does not incorporate Trellis coding. Since Annex C does not contain Trellis coding, it allows the test to yield a result closer to the true pre-FEC performance. Annex C is however, not likely to be the FEC encoding used in the field in North America.

This test is a static measurement at a single, specified DUT (Device Under Test) input level. It does not provide performance over an input operating range. Also, the user will have the option of either testing with Annex B or Annex C. The final test results must clearly indicate which standard was utilized.

In addition to a Bit Error Rate measurement, Appendix B refers to the parameters, Errored and Error-Free Seconds, which can be a useful tool in determining the impairments resulting in the bit errors.

Appendix A: TEST INTEGRATION TIME

Appendix B: ERRORED AND ERROR-FREE SECONDS

2.0 DEFINITIONS AND ACRONYMS

- 2.1 **Adaptive Equalizer** – Real-time signal compensation for the linear distortion created by the components of a cable system, such as frequency response and group delay.
- 2.2 **Bit Error Ratio (BER)** - The number of erroneous bits divided by the total number of bits transmitted, received, or processed over some stipulated period.
- 2.3 **Errored Second** – A one second period with one or more Errored blocks.
- 2.4 **Forward Error Correction (FEC)** - A system of error control for data transmission wherein the receiving device has the capability to detect and correct any character or code block that contains less than a predetermined number of symbols in error. ITU J.83 Annex B (North America standard) FEC is composed of four processing layers
- 2.5 **Interleaving** – Evenly disperses the symbols, protecting against a burst of symbol errors being sent to the RS decoder.
- 2.6 **International Telecommunications Union** – An international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services.
- 2.7 **ITU-T J.83** – T refers to the Telecommunications Standardization sector of the ITU. Series J applies to the transmission of television, sound programme and other multimedia signals. Recommendation J.83 is specific to digital multi-programme systems for television, sound and data services for cable distribution.
- 2.8 **Quadrature Amplitude Modulation (QAM)** - Method of combining two amplitude-modulated signals into a single channel, thereby doubling the effective bandwidth. In a QAM signal, there are two carriers, each having the same frequency but differing in phase by 90 degrees (one quarter of a cycle, from which the term quadrature arises). One signal is called the I (in phase) signal, and the other is called the Q (quadrature) signal. Mathematically, one of the signals can be represented by a sine wave, and the other by a cosine wave. The two modulated carriers are combined at the source for transmission. At the destination, the carriers are separated, the data is extracted from each, and then the data is combined to recreate the original modulating information.
- 2.9 **Randomization** – Randomizes the data on the channel to allow effective QAM demodulator synchronization.
- 2.10 **Reed-Solomon Coding** – Provides block encoding and decoding to correct one symbol for each pair of R-S symbols within an R-S block (correction of up to 3 symbols in J-83 Annex B and up to 8 symbols in Annex C).
- 2.11 **Symbol Rate** – The number of symbols transmitted over a give time.