Society of Cable Telecommunications Engineers

ENGINEERING COMMITTEE
Interface Practices Subcommittee

AMERICAN NATIONAL STANDARD

ANSI/SCTE 132 2007

Test Method For Reverse Path (Upstream) Bit Error Rate

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140 Philips Road
Exton, PA 19341

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1.0 SCOPE AND DEFINITIONS

1.1 Scope

This procedure defines a method of measurement for Bit Error Rate (BER) in the return path of active Cable Telecommunications equipment. It is intended for measurement of 75-ohm devices having type "F" or 5/8-24 KS connectors. See the Cable Telecommunications Testing Guidelines document, ANSI/SCTE 96 2003, for a discussion of proper testing techniques.

For Bit Error Rate measurements in the forward path see ANSI/SCTE 121 2006.

1.2 Definitions

Bit Error Rate: (BER) The ratio of error bits to the total number of bits transmitted. BER is normally expressed as the negative exponent of a number. E.g. 1×10^{-7} meaning that 1 out 10,000,000 bits is in error.

1.3 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 fewer than a predetermined number of symbols in error.

1.4 Symbol Rate: The number of symbols transmitted over a given time.

2.0 INFORMATIVE REFERENCES

The following document may provide valuable information to the reader but is not required when complying with this standard.

ANSI/SCTE 121 2006: Test Method for Downstream Bit Error Rate

3.0 NORMATIVE REFERENCES

The following documents contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

ANSI/SCTE 96 2003: Cable Telecommunications Testing Guidelines

4.0 EQUIPMENT

4.1 Only equipment specific to this procedure is described in detail here. ANSI/SCTE 96 2003: Cable Telecommunications Testing Guidelines, should be consulted for further information on all other equipment

4.2 Equipment

4.2.1 Digital Loading

Digital loading can consist of individual QAM channels or broadband simulated digital noise loading (SDNL)

A. **Equipment if using Simulated Digital Noise Loading (SDNL)**

- Broadband Noise Generator
  - Bandwidth equal to or wider than specified channel plan
  - Variable output power or incorporates an external variable attenuator.
- Appropriate bandpass (high/low pass) filter to shape the noise loading in accordance with the specified channel plan
  - 16dB minimum return loss, 75ohm
  - +/- 10MHz from edge frequency, >40dB rejection
  - +/- 0.25dB flatness
  - < 1.5dB insertion loss
- Notch filters (channel deletion filters)
  - Center frequency = Center frequency of test channel
  - 16dB minimum return loss, 75ohm
  - Bandwidth sufficient for the modulation under test, >50dB rejection
  - +/- 2MHz from band edge, <3.0dB insertion loss
  - +/- 0.25dB flatness in the passband
  - < 1.5dB insertion loss

B. Equipment if using individual QAM channels for loading

- QAM generators, equal in bandwidth to channel under test (Quantity = digital bandwith/QAM bandwidth -1)
- RF combiner, used to combine QAM generators

4.2.2 Common Equipment

- Transmitter for conversion of data to a RF modulated signal in the range of return path frequency.

- Receiver for conversion of RF signals in the range of return path signals to data.

- Bit Error Rate Transmitter and Receiver. This equipment generates and analyzes the data stream for errors. This equipment can be either a complete test set or stand alone instruments. This equipment should be capable of both pre-FEC and post-FEC results as well as BER without FEC.

- Amplifier to obtain sufficient level at the System under test input

- QAM generator, frequency = test channel

- Optional Receiver/demodulator filter.
    - This filter may be required if the input of the receiver/demodulator is driven into overload by the full power loading of the test system.
    - This filter should have a 3 dB bandwidth of slightly greater than the symbol rate of the modulation method under test. For example, a 64 QAM signal with a symbol rate of 5.056941 Msps would normally use a 6 MHz wide filter.
    - This filter should have 25 dB of rejection at ± 10 MHz from the center frequency.
    - This filter should have an input/output impedance of 75 ohms and a return loss of 18 dB.

- (2) Variable attenuators (0.5 or 1 dB step capable)

- (2) 2 way signal splitter/combiner

- RF Power meter

- RF spectrum analyzer (optional)

- Adaptors, connectors and cables

5.0 SETUP

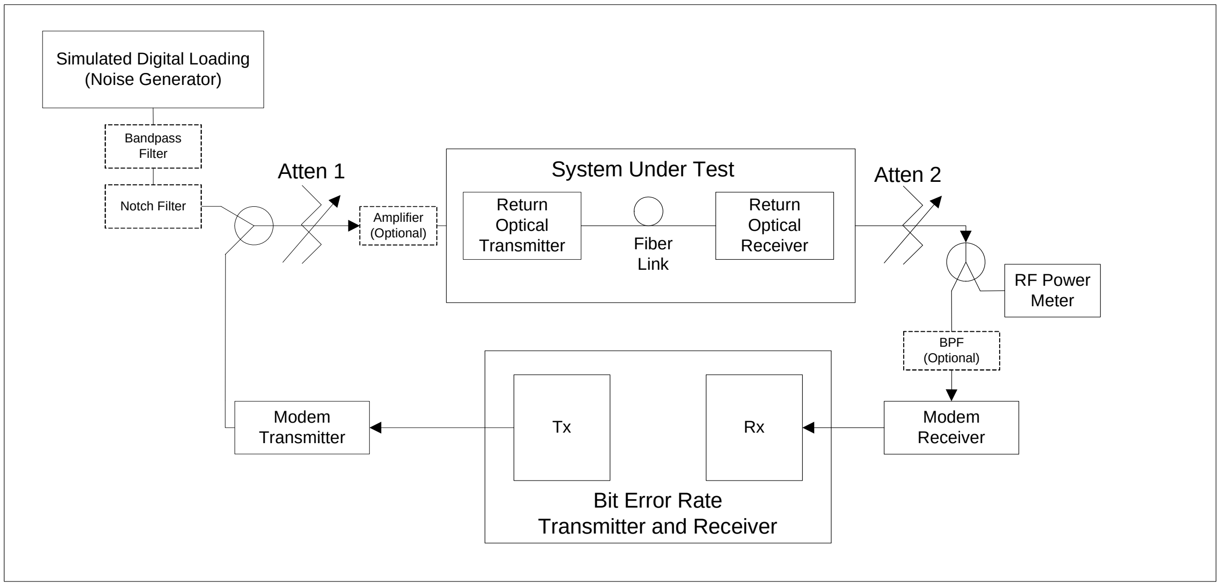

Figure 1 BER Setup (Simulated Digital Noise Loading)

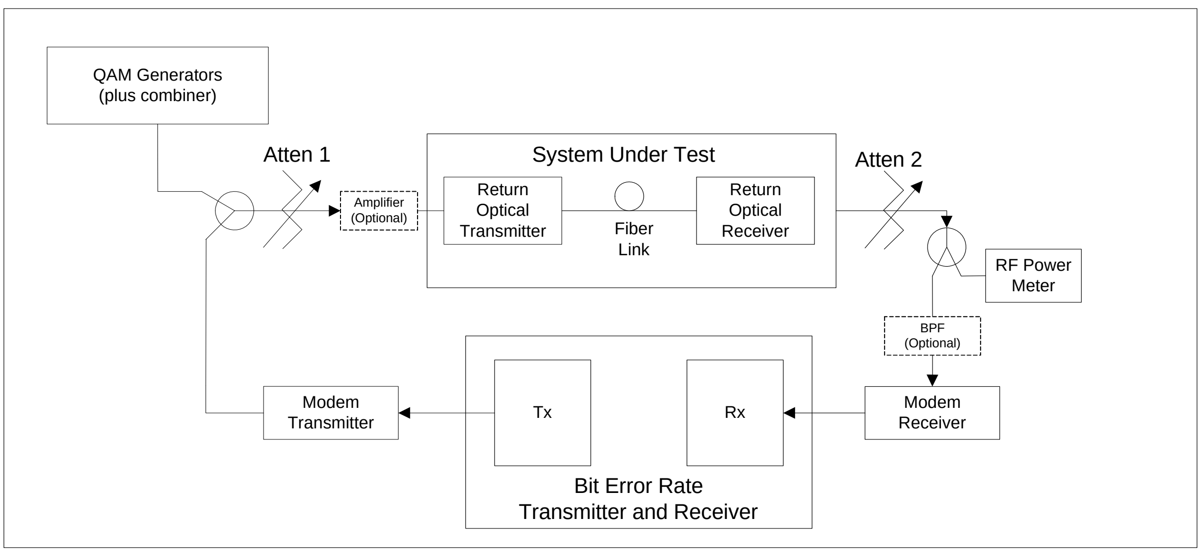

Figure 2 BER Setup (QAM Generators)

6.0 TEST SETUP

6.1 Following the equipment manufacturer's recommendations, perform the appropriate warm-up and calibration procedures.

6.2 Connect the equipment as shown in Figure 1 or 2 but bypassing the system under test.

6.3 Source Level Setting

Refer to ANSI/SCTE 96 2003: Section 4.3.4.1 for Digital Power Measurements.

Using individual QAM carriers

- Set the RF center frequency as required per the channel plan
- The RF output level should be adjusted such that all digital channels are at an equal level as indicated in Figure 3.

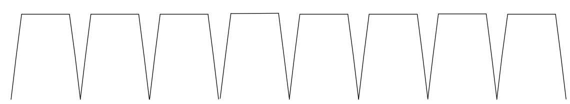

Figure 3 – QAM only Display

Simulated Digital Noise Loading

- When using a combination of Simulated Digital Noise Loading (SDNL) and a digitally modulated test channel, the actual digital channel will appear to be higher in level than the SDNL when viewed on a spectrum analyzer. The level of the digitally modulated channel should be set to the same level as the SDNL. This may be accomplished by setting the spectrum analyzer to measure power channel bandwidth or measuring in power/Hz.

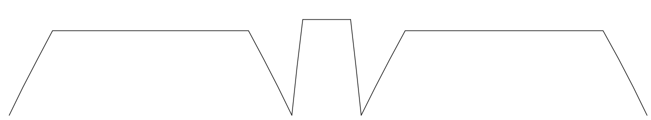

Figure 4 – QAM & SDNL Display

6.4 Set the BER Transmitter to generate the specified data pattern and format. Be sure any forward error correction is turned OFF. Set the BER receiver to receive the desired data pattern and format. Note that no interleaving is used in return path testing.

6.5 Set the BER test set for a 1 minute test interval and begin the test. Record the result.

6.6 Set the BER Transmitter to generate the specified data pattern and format. Set forward error correction ON. Set the BER receiver to receive the desired data pattern and format. Note that no interleaving is used in return path testing.

Set the BER test set for a 1 minute test interval and begin the test. Record the result of both pre FEC and post FEC BER.

If either test case fails to meet error free performance, verify the test setup connections, levels, modulator/demodulator settings and BERT settings.

7.0 PROCEDURE

7.1 Connect the System under Test into the test setup shown in Figure 1 or 2. Note that the System under test can be an optical link, RF amplifier or other device.

7.2 Set the system under test to the specified input and output levels.

7.3 Measure the input level to the data Modem Receiver and use ATTN 2 to set the input level to the center of the receiver operating range.

7.4 Set the BER test integration time as required and begin the test.

7.5 Wait for the test integration time to complete and record the BER from the BER test set in a test spreadsheet.

7.6 Reduce the input level to the system under test by 1 dB with ATTN 1 and restart from 7.3.

7.7 When the BER measurements reach the limit from noise, return to the beginning level and increase the level to the system under test. Continue until the BER is limited by distortion.

7.8 When the BER reaches the limit of the test setup, typically 10^{-9}, the data can be taken in 5 dB steps until the lower level limit is approached. At this point switch back to 1 dB steps.

7.9 Once the data is complete a graphical presentation can be made as shown in figure 5.

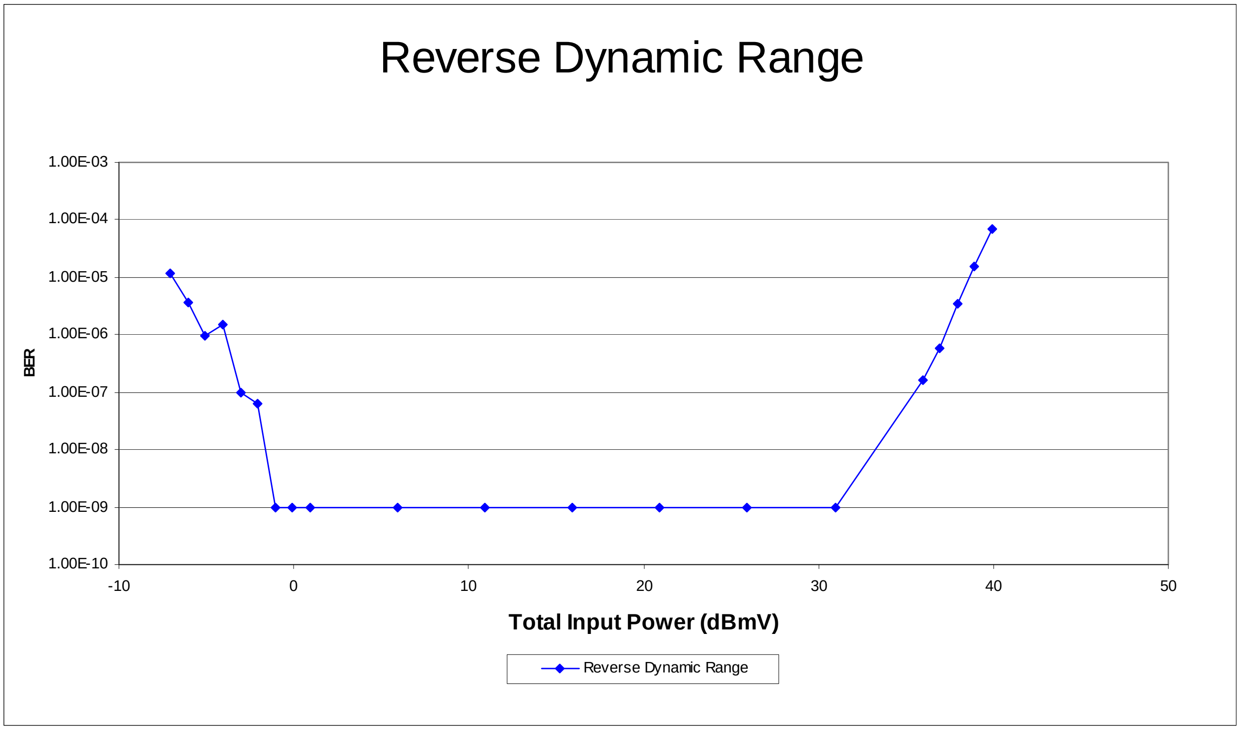

Figure 5 - BER Graphical Dynamic Range Results

Reverse Dynamic Range
SampleTime (S) = 120

DATA #	ATTN 1 VALUE	TOTAL POWER dBmV	AVERAGE BER	BIT ERRORS
1	9	39.94	6.90E-05	13018
2	10	38.94	1.57E-05	2971
3	11	37.94	3.52E-06	662
4	12	36.94	5.68E-07	107
5	13	35.94	1.60E-07	30
6	18	30.94	1.00E-09	0
7	23	25.94	1.00E-09	0
8	28	20.94	1.00E-09	0
9	33	15.94	1.00E-09	0
10	38	10.94	1.00E-09	0
11	43	5.94	1.00E-09	0
12	48	0.94	1.00E-09	0
14	49	-0.06	1.00E-09	0
15	50	-1.06	1.00E-09	0
16	51	-2.06	6.40E-08	12
17	52	-3.06	9.60E-08	18
13	53	-4.06	1.51E-06	285
18	54	-5.06	9.82E-07	191
19	55	-6.06	3.71E-06	699
20	56	-7.06	1.20E-05	2266

Figure 6 - BER Tabular Dynamic Range Results