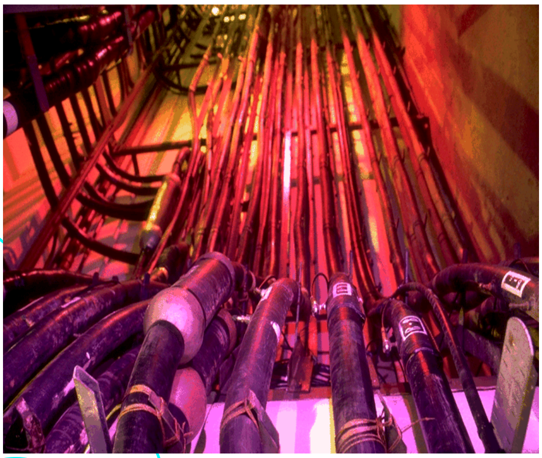
BER tests with Victoria

Quantifying the bit error rate (BER) forms the basis of out-of-service measurements. This document describes how this test can be applied to PDH and SDH networks working from patterns and test structures.



Application Note NAVASDHBER22e

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Measuring the Bit Error Rate (BER) consists of determining the relation between the errored bits and the total number of bits in the digital signal being analyzed. This test requires an instrument for measuring the BER, which usually incorporates a generator section and an analyzer section. The instrument must generate a test signal in its generator section. This signal is a Pseudo-random Binary Sequence (PRBS) that is in line with the rate of the interface under test, as defined in ITU-T recommendations O.150 to O.153 and O.181. This sequence is sent through the entity (network element or system) under test (EUT). The analyzer section receives the signal that has been sent and, once it has been synchronized with the clock that it extracts from this signal, generates the PRBS locally. These locally generated and received sequences are compared bit by bit, thus determining the number of errored bits received. Since the length of the sequence is known, the total number of bits is also known, and as a result the bit error rate can be established.

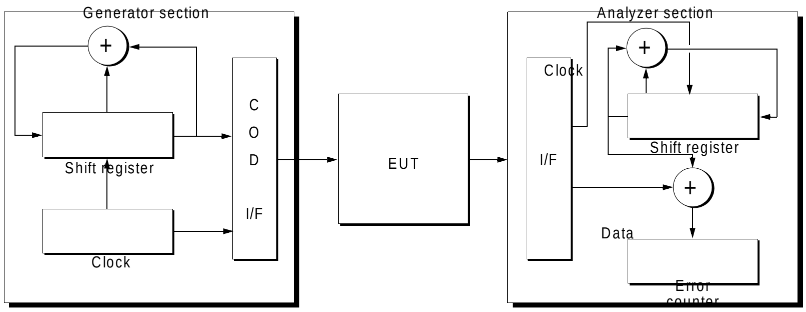

Figure 1 BER test: Set-up for general measurement.

Victoria can generate a variety of test patterns for BER tests, in line with ITU-T recommendations. Likewise, it can also generate bit errors to compare the response with the EUT.

BER TESTS IN PDH

ITU-T recommendations O.150 to O.153 establish a correspondence between PRBS test signals and PDH hierarchies. Each PDH hierarchy is characterized by its transmission rate. The recommendations assign longer sequences (see Table 1) to the higher hierarchy signals. There are two reasons for this:

1. In order to maintain a long repetition period at a high rate, a long test sequence is required. Otherwise the traffic would be simulated badly,

since the sequence would be repeated too frequently and it would therefore lose randomness.

2. In a BER measurement it is necessary to synchronize the test signal received by the analyzer and the signal that the analyzer generates locally as a prior step to comparing both signals. To carry out this synchronization several test sequences must be received. If the hierarchical signal that carries the test sequence was at a low rate and the sequence long, the synchronization period would be unacceptably high.

Length of PRBS	Consecutive Os	Data signals and PDH (kbit/s)	Application
$2^{15}-1$ inverted	15	2048 8448	Measurement of errors and jitter
$2^{23}-1$ inverted	23	34368 139264	Measurement of errors and jitter

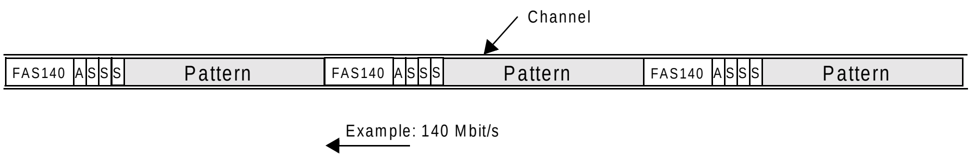

Table 1 *Correspondence between test patterns and PDH signals. Inverted logic: The exponent n in the length of the sequence (2^n-1) indicates the maximum number of consecutive 0s. If the logic is normal, it indicates the maximum number of consecutive 1s.*

The test signal as PDH frame only keeps the FAS signal as long as the rest of the frame is completely taken up by the test pattern (*framed* pattern). In more general cases, unframed patterns can be used, when the structure of the signal does not simulate traffic in PDH frames but rather generic traffic at PDH rates.

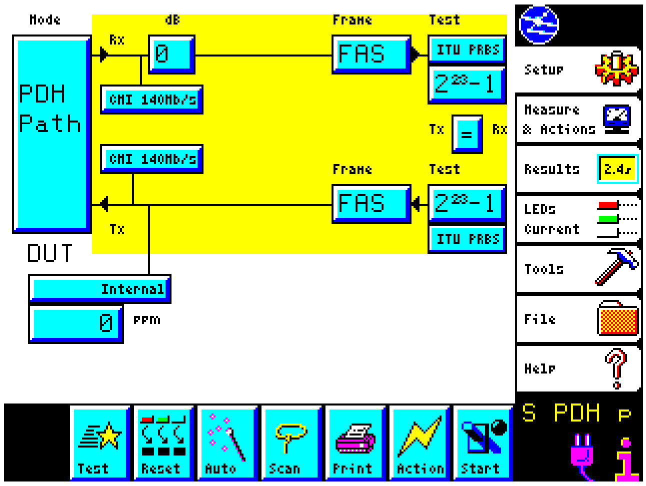

Figure 2 *Configuration screen of Victoria for PDH measurements with framed pattern*

BER TEST ON VIRTUAL CONTAINERS

To verify that the traffic does not deteriorate in an SDH EUT, it is necessary to check the integrity of the information carried by the virtual containers (VC) of the synchronous frames. This is done by means of a BER test. The generator section of the measuring device introduces a PRBS in the container carried by the VC whose integrity is to be checked. The EUT receives this signal and processes it. When it leaves the EUT, another measuring device recovers the test signal of the VC received, measuring the BER to check whether bit errors have been produced as the signal passes through the EUT.

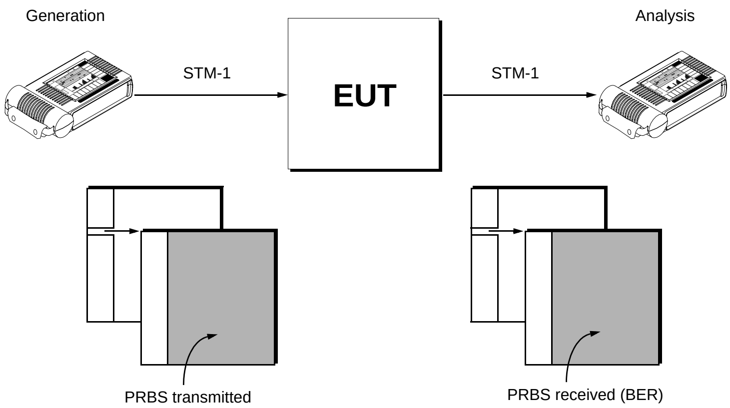

Figure 3 *BER test on VC.*

The pattern and the virtual container generated for the test receive the name of *test signal structure* or TSS. These are defined in the ITU-T recommendation O.181.

Structure	Name	Application
2^{23}-1 in all the bytes of a C4	TSS1	Test on NE that provide HPC and use an AU-4 structure
2^{15}-1 in all the bytes of a C3 of HO	TSS2	Test on NE that provide HPC and use an AU-3 structure
2^{23}-1 in all the bytes of a C3 of LO	TSS3	Test on NE that provide HPC and LPC
2^{15}-1 in all the bytes of a lower order container (C-2, C-11 or C-12)	TSS4	Test on NE that provide HPC and LPC
2^{23}-1 in all the PDH tributary bits with mapping in C-4	TSS5	Test on NE that only provide LPA-4 functions and use an AU-4 structure
2^{15}-1 in all the PDH tributary bits with mapping in C-3 of HO	TSS6	Test on NE that only provide LPA-3 functions and use an AU-3 structure
2^{23}-1 in all the PDH tributary bits with mapping in C-3 of LO	TSS7	Test on NE that only provide LPA-3 functions and use an AU-4 structure
2^{15}-1 in all the PDH tributary bits with mapping in a lower order container (C-2, C-11 or C-12)	TSS8	Test on NE that provide LPA-m functions (m=11, 12, 2)

Table 2 Test structures for SDH according to O.181.

Victoria has an operating mode that lets the whole of the bandwidth of a container be taken up by one test pattern. In this operating mode, the BER test on VC can be performed.

BER TEST ON SDH OVERHEADS

The test is designed to check the integrity of the information sent via the overhead channels in the SDH frames. For example, the integrity of the data communications channels (DCC) defined by the D bytes of the section overheads can be checked. These channels carry management information exchanged between the different network elements. For this test, the DCC channels of the synchronous frames generated are occupied by a PRBS signal. After this signal has passed through the EUT, a BER measurement will be carried out on these channels to check that there are no errors in the signal sent. The same type of test can be performed on other overhead channels.

In general, problems occur when large networks are connected together for the first time because of the different programming of overhead bytes in network elements from different manufacturers. In such cases, the simulation and analysis of SDH overheads is especially

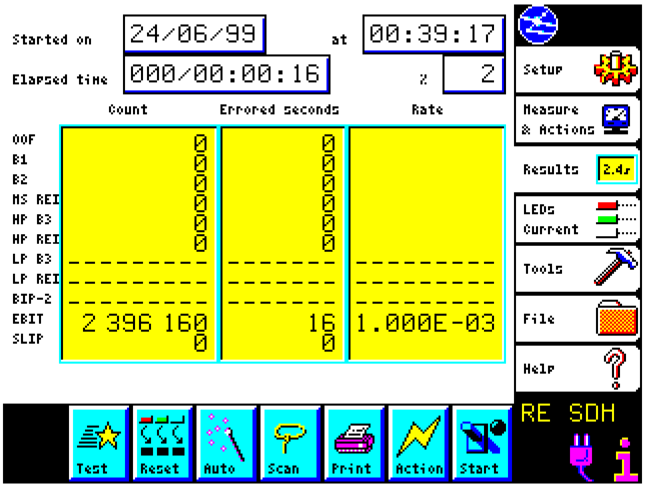

Figure 4 *Victoria results screen showing bit errors.*

useful, since it allows specific tests relative to the reaction of the system to different events (variation in value in the overhead bytes).

In line with the above, it is advantageous to have instruments at our disposal that simultaneously present on the same screen both the overhead bytes transmitted and those received during the simulation. This simplifies problem-solving during the simulation and makes it easier to follow up how the system reacts.

Victoria lets us perform BER tests on overheads using the associated function incorporated in the device. This test is performed on a PRBS pattern in DCC, E1, E2, F1, N1 and N2 channels, including a counter of seconds with alarm for loss of sequence synchronization (LSS), and the number, rate and errored seconds for bit errors in the test pattern.

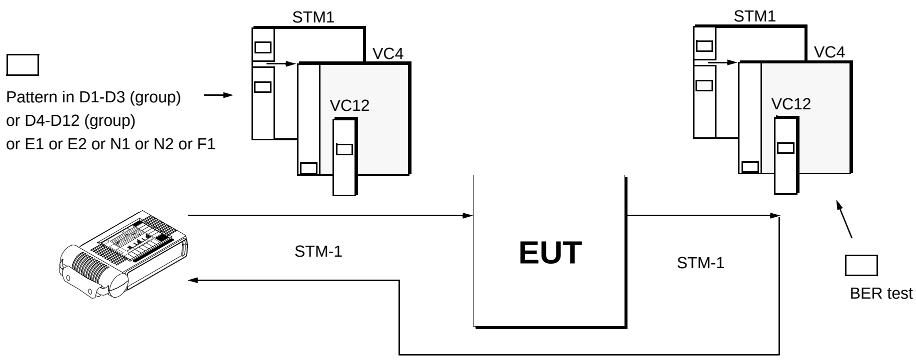

Figure 5 *BER test on overheads.*

The overhead viewing screen also lets you see both the values transmitted and those received for these octets at the same time. The measurement is designed to check that no bit errors appear in the overhead channels being looked at. The test also lets us check for possible loss of sequence synchronization (LSS alarm) at the same time.

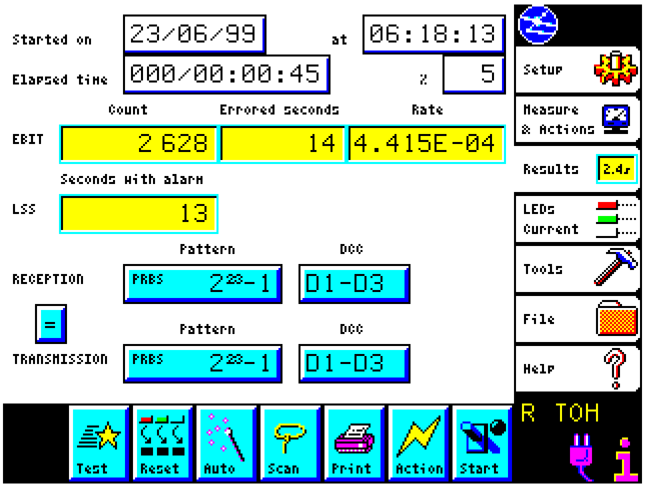

Figure 6 *Screen showing BER test on overheads.*

Victoria lets us perform two simultaneous overhead transparency tests on different overhead bytes in the transmission and reception paths. For this test two instruments are required, one at each end of the EUT. A button at the bottom of the screen lets us couple or uncouple the programming of the analyzer and generator sections, in order to perform two different tests simultaneously. ❒

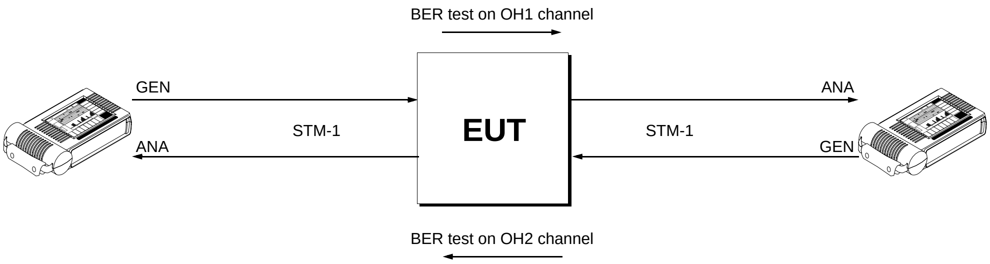

Figure 7 *Double BER test on different overhead (OH) channels.*

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