Real Time Bit Error Rate Analysis at Parallel Interfaces (UTOPIA) with HP E4829B

How to use the HP E4829B custom / UTOPIA level 1 implementation for Real Time Bit Error Rate (BER) Measurements

Product Note

Product Number
HP E482xA/B, E4889A

Figure 1: HP E4829B integrated into BSTS System

Introduction

One requirement to achieve Quality of Service in an ATM System is reasonable robustness against data interference. When data interference occurs, the quality of data, video and audio sent to a user decreases. The designer's goal is to make the complex ATM system robust enough against the large number of interference mechanisms. That starts at the component level (Physical Layer Device), is true for sub-modules and finally a complete system has to be characterized.

To make BER Measurements in a communication system dealing with ATM cells, the HP E4829B test system is able to map and extract Pseudo Random Data (PRBS) into and from the payload of ATM cells and it adapts at parallel interfaces. Standalone it is able to measure from parallel to parallel (UTOPIA) ports. Together with a HP BSTS system it is possible to measure from serial to parallel port and vice versa (Figures 2 .. 4).

So for Hardware and Software engineers in the communication industry, designing ICs, Modules or working in System Integration, the HP E4829B 'Parallel Cell & Traffic Generator and Analyzer offering real-time Bit Error Rate Analysis, is the basic tool for Debug and Characterization at parallel interfaces (UTOPIA). When already using a BSTS System, the HP E4829B is the complementary product to the protocol test equipment in use. Figure 1 shows the HP E4829B as an integral part of a BSTS system.

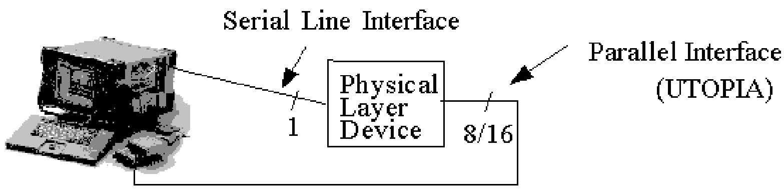

Figure 2: Test Setup for Physical Layer Test with HP E4829B and BSTS

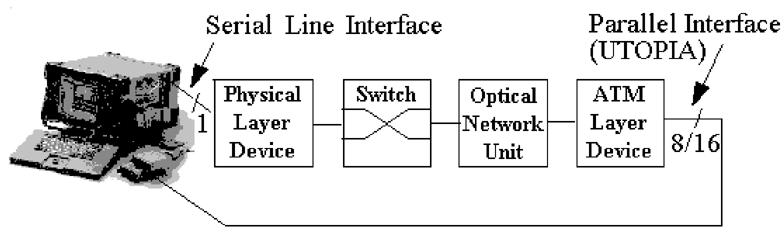

Figure 3: Test Setup for ATM System Test with HP E4829B and BSTS

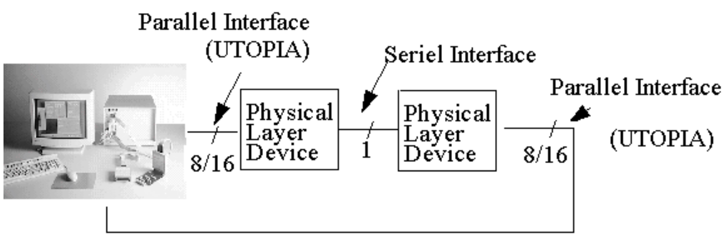

Figure 4: Test Setup for Physical Layer Test with HP E4829B from parallel to parallel interface

Application:

Component Test:

Typical Devices are ICs designed for use at the Physical Layer. These ICs provide one or more connections for serial ports on one side and a parallel port (UTOPIA) on the other side.

Problem areas are the high speed of the serial ports and analog design parts like PLL's.

Both, the designer of the IC, as well as the module designer using this IC on his PC-board, use the BER Test (see figure 2) as the primary tool for characterization and verification of the design.

Module Test:

Figure 4 shows an example test setup for a transmission system together with the active components as transmitter and receiver.

Problem areas are interference for electrical systems, power loss in optical systems.

The advantage of measuring the BER from parallel to parallel port is to characterize performance as a whole. There is no longer a need for a substitution method.

System Test:

The setup shown in Figure 3 is taken from the 'Residential Broadband' application, or better known as 'Video on Demand'. The serial port is where the central video server connects to, the parallel port is in the settop box of an end user. The system integrator's responsibility is to guarantee a BER to be below a certain level to achieve the desired Quality of Service. So the measurement on the overall system is very similar to the one on a Physical Layer IC.

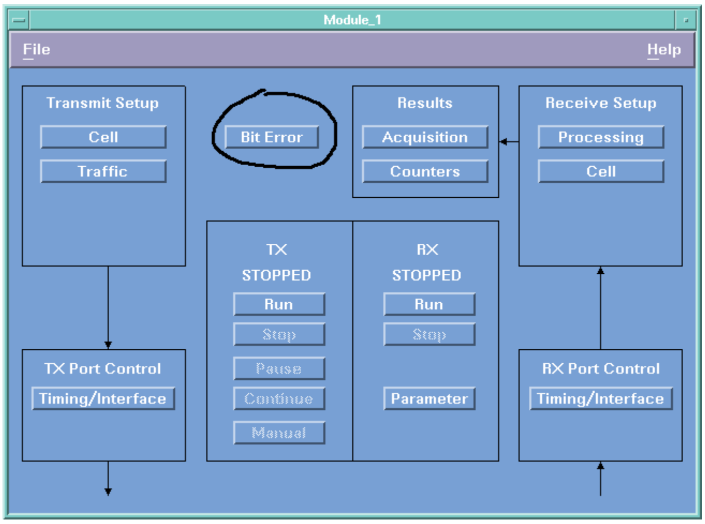

Figure 5: Main Menue of HP E4829B with Bit Error rate Measurement Capability

How to Use

Cell Definition

PRBS is a segment to be selected when the cell structure is defined. Segment length can be from 1 byte/word up to full length of cell. There could also be more than one PRBS segment per cell.

In an ATM cell the payload will be defined to be PRBS as indicated in Figure 6. It is possible to select from 3 different polynomials.

The definition of cells on Transmitter and Receiver is identical. On the Transmitter the definition is used for the PRBS generator to fill the bytes/words with PRBS bits. On the Receiver it defines the bytes/words, which will be used for comparison and calculation of the BER figure. The trigger cell can be used to specify other parameters too, to make the BER only on certain cells (e.g. matching for a dedicated VPI/VCI) within the incoming cell stream.

Analysis

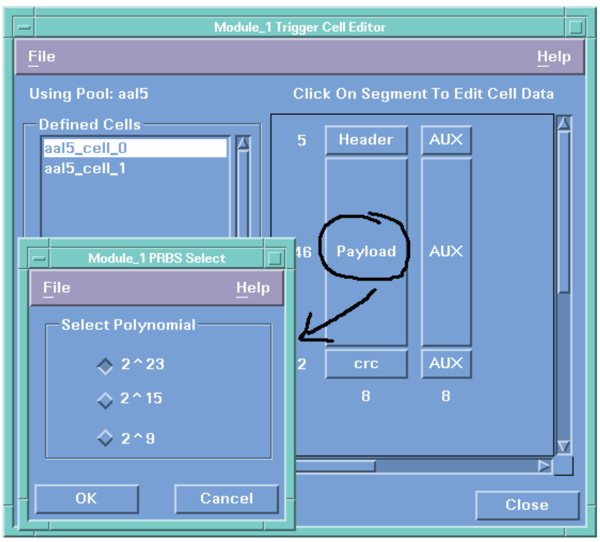

Figure 6: Cell Editor of HP E4829B with PRBS selection

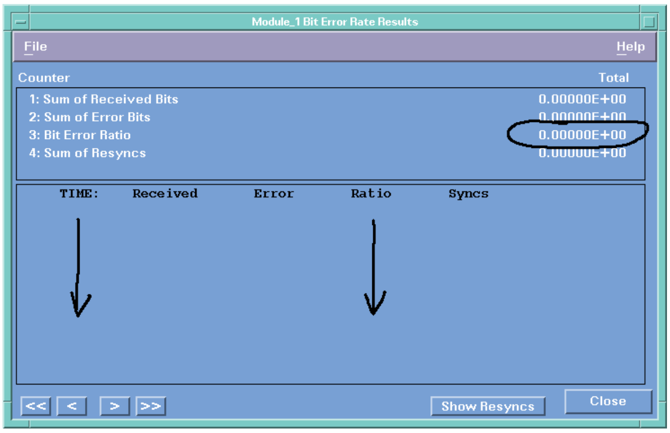

Figure 7: BER Result Window

To perform a BER measurement, the processing capabilities of the HP E4829B provide a new action called' Detect Bit Errors', which has to be selected.

Results

With the BER measurement capability a dedicated Result window is available. This is opened using the 'Bit Error Rate' button in the Main Menu (see figure 5). When clicking to this button, the BER result window (figure 7) will appear. This window is similar to the existing real time counter display window, and the 4 additional counters are already assigned for the BER results. This Result window is updated in user defined measurement intervals after the Receiver is started.

There is an additional more condensed window available, which is appropriate for long time measurements: as long as the BER figure is below the user defined threshold, cumulated figures for time since last synchronization and the BER are shown. So the user gets the information on success of his long-time measurement at a glance.

Background

The industry has established a measuring unit for characterizing the quality of data transmission: it's called Bit Error Rate (BER). This figure gives a ratio of errored bits versus all bits transferred.

Bit Error Rate measurements have been used for a long time in industry. But so far this measurement has been performed by injecting a continuous sequence of Pseudo Random Data (PRBS) into one serial port and analyzing it at a second serial port.

The requirements for the characteristics of bit-error ratio measurements must be adhered to in order to ensure compatibility between equipment produced by different manufacturers. The bit-error ratio of digital transmission systems must be evaluated by direct comparison of a pseudo-random test pattern with an identical locally generated test pattern. Also the capability to measure faulty time intervals is needed. The technical background and requirements are documented in ITU-T recommendation [1] and [2].

These recommendations define an error-ratio measurement range 10 ^-3 up to 10^-10, anyway customer inputs extend this range up to 10 ^-13. It also requires the measurement of faulty seconds and other faulty or error-free time intervals, which should be observed in a selectable period ranging from 1 minute up to 24 hours or continuous.

Manufacturers providing customer premise equipment for ATM network therefore have to specify their equipment according to international standards, where bit-error ratio is one of these pseudo standards.

Implementation

Bit error rate testing can be performed on the 8 and the 16 bit solution of the HP E 4829B.

To achieve the BER application, the HP E4829B includes the following features with Software Revision A.1.3.0:

Enhanced PRBS Segment

One of the following polynomials can be selected:

- 2 ^9 -1 (ITU-T O.153)
- 2 ^15 -1, inverse (ITU-T O.151)
- 2 ^23 -1, inverse (ITU-T O.151)

This provides full compatibility to the BSTS system.

Bit Error Rate Analysis

The receiver is able to generate the same polynomial for comparison with the incoming data stream. It further provides synchronization to the incoming data, before the measurement starts, this is called 'Sync' Phase (for more details see Theory of Operation). The advantage is that the receiver can perform a measurement starting at any point in the PRBS sequence, there is no need to start the transmitter from the beginning for every measurement.

Results

- number of received bits
- number of errored bits
- calculated BER from both
- all in a selectable time interval or cumulative.

- These results are gathered by additional counters. So all other functionality is fully maintained.

  If for any reason the device under test loses synchronization or the data gets corrupted, the error rate will increase beyond a customer programmable threshold. This forces the system to redo Synchronization. The information on Synchronization status is displayed in the Result window.

Parameters

- Polynomial
- selectable for transmitter and receiver independently, selection at receiver must match with polynomial of incoming data.
- Measurement Interval: multiple of 10 ms. This defines the update time for the Result display. Internally the results will still be polled every 10 ms and put to a queue.

- Sync Threshold if BER figure exceeds the user defined threshold within a measurement interval, system will automatically perform a new synchronization. The calculation of the BER figure will start from the beginning.

Results per Measurement Interval

√ indication of sync status: sync or out of sync/re-sync
√ # of received bits / measurement interval, polled and displayed ongoing like counter display
√ # of errored bits / measurement interval, polled and displayed ongoing like counter display
√ bit error ratio / measurement interval, calculated: # of errored bits divided by # of received bits

Cumulated Results

√ total # of received bits,
√ total # of errored bits,
√ actual bit error ratio, all three results since last re-synchronization cycle
√ # of necessary re-synchronizations since measurement was started

Theory of Operation

Transmitter

PRBS segments are filled with bits from the PRBS Generator according to the selected polynomial. Whenever the bit stream of PRBS segments of consecutive cells is reassembled, a true PRBS sequence is obtained. The PRBS is looped infinitely as long as PRBS segments have to be filled and the transmitter is not stopped. From each start of the transmitter, the PRBS sequence is the same as long as the same polynomial is used. The segmentation of PRBS is fixed to byte/word boundaries.

When cells with PRBS segment are generated with different VPI/VCI settings or different ports in a UTOPIA Level 2 environment, the reassembled bits gathered at a certain port are no longer a true PRBS sequence. The reason is that if only pieces of the original PRBS stream are reassembled, this is not a true PRBS sequence by nature. The segments sent to other ports are missing in that reassembly. Therefore it is recommended to use the PRBS segment only in cells dedicated for the port at which the BER measurement is wanted.

Receiver / Analyzer:

The definition of the PRBS segment in the Trigger cell indicates to the Receiver which bits to extract from the incoming cells for BER analysis. Before a measurement starts, the analyzer will synchronize on the extracted PRBS bit stream, see figure 8:

For synchronization, the receiver will need 16 bytes/words. After the synchronization, the receiver generates the bits according to the PRBS sequence for comparing with the further bits extracted from the incoming cells. In each time interval (10 ms) the number of extracted incoming bits and errored bits is counted and the figure for the BER is calculated and compared with the user defined threshold. If the BER exceeds the defined threshold, the system again synchronizes in the next interval, otherwise measurement starts/continues. So a minimum bit error rate of the device under test must be achieved to perform a measurement. This figure is in the range of 10 ^-2 to 10 ^-3.

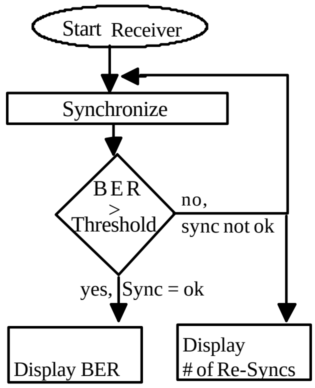

Figure 8: Synchronization Process

References

[1] ITU-T Recommendation O.151, Specification for Instruments to measure error performance on digital systems, Red Book Volume IV

[2] ITU-T Recommendation O.153, Basic parameters for the measurement of error performance at bit rates below the primary rate