Response time testing using output triggers

Application note

OmniBER OTN communications performance analyzer

Agilent Technologies

Introduction

Today's SONET/SDH optical transmission networks provide hi-bandwidth, hi-performance data transmission over robust, readily manageable transmission paths.

The huge success of SONET/SDH is due, in part, to the rich performance monitoring and management capability that has been developed within the relevant SONET and SDH standards. Network equipment automatically responds to fault conditions, and will degrade its performance accordingly, thereby minimizing disruption to revenue earning traffic.

The SONET, SDH, and recently developed Optical Transport Network (OTN) standards define error (anomaly) and alarm (defect) conditions. The standards also define how they should be detected in the network, and what response should be made by network equipment.

In order that network equipment from numerous vendors can successfully co-exist in the network, it is vital that each network element complies with the relevant standard. Thus ensuring appropriate responses are made to defined fault conditions.

Response time testing

A key element in the design and verification of network equipment is to ensure that appropriate responses are made to distinct fault conditions within a specified time. This is known as response time testing. This product note explains how the OmniBER OTN can be used to measure the response times for a wide range of fault conditions when testing SONET, SDH and ITU-T G.709/G.798 network equipment.

OmniBER OTN triggers

The OmniBER OTN has two trigger outputs. One of the triggers signal error/alarm events detected by the instrument's receiver. The other trigger signals when an error/alarm event has been sent by the instrument's transmitter. By connecting both trigger outputs to a measuring device, such as an oscilloscope or counter/timer, it is possible to accurately measure the response time of a device under test (DUT) to a stimulus event.

AIS-L example

This product note looks in detail at measuring the response time of a DUT to an AIS-L stimulus, using the OmniBER OTN. (AIS-L is the SONET equivalent of the SDH alarm MS-AIS)

Figure 1 shows the test configuration for this example. The OmniBER OTN is configured to transmit the AIS-L alarm. The OTN transmit interface is connected to the DUT receive port. And the DUT downstream port is connected to the OmniBER OTN receiver interface.

The OmniBER OTN trigger outputs are connected to the timer and configured as follows:

- The transmit trigger output will set a voltage level on its output when the AIS-L alarm is transmitted.
- The receive trigger output will set a voltage level on its output when the AIS-P alarm is detected by the instrument receiver.

Alarm generation and detection criteria

Alarm events are generated by setting byte values in the SONET/SDH overhead and detected by monitoring for defined values in specific overhead bytes.

The generation and detection criteria for the events given in this example are as follows:

AIS-L

- Generation – Valid section overhead with all 1s pattern in all other parts of the SONET frame.
- Detection – K2 bits 6, 7 and 8 are set to 111 for 5 consecutive frames.

AIS-P

- Generation – All 1s pattern transmitted in H1, H2 and H3 bytes and entire SPE.
- Detection – All 1s pattern detected in H1 and H2 bytes for 3 consecutive frames.

Performing the measurement

Figure 2 illustrates the measurement sequence of events, frame by frame. At frame labeled A.1, the OmniBER OTN starts transmitting the AIS-L alarm. At the same time, frame A.2, the voltage output level on the transmit trigger output port is set. This signal level initiates the timer to begin counting. The device under test will see the AIS-L condition at its input,

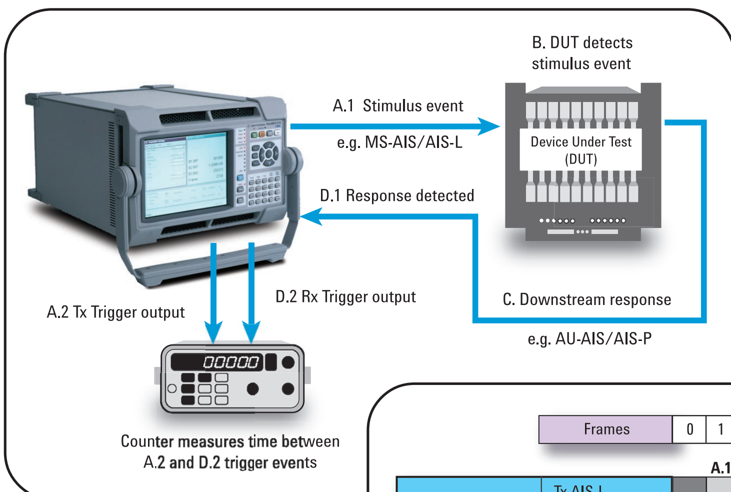

Figure 1
Response time testing

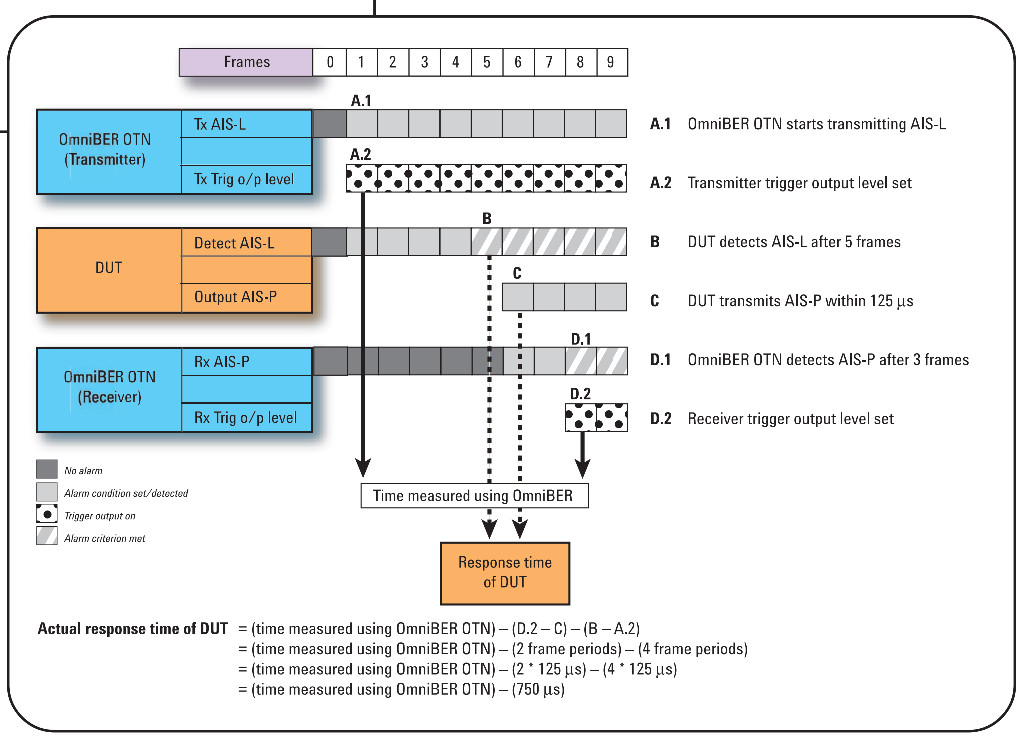

Figure 2
Response time of device under test (DUT)

however no action should be taken until the condition has been present for 5 consecutive frames – label B in the diagram.

Once the criterion for AIS-L is detected by the DUT, it should transmit the AIS-P alarm downstream within 125 µs, approximately 1 frame later, at label C in Figure 2.

The OmniBER OTN receiver detects the AIS-P condition. When the alarm criterion is met at point D.1, the receive trigger output level at D.2 is set, thereby stopping the timer.

Determining the actual response time of the DUT requires a simple calculation to allow for the detection time of the received and transmitted alarm events.

The actual response time of the DUT, C-B in Figure 2 is calculated as follows.

The time measured by the timer includes the detection time for the two alarms of interest i.e. B-A.2 and D.2-C.

The number of frames to detect an alarm is known. The frame period for a line signal with no frequency offset is 125 µs. It is therefore a simple calculation to determine the actual response time of the DUT by removing the detection time from the value measured by the timer.

Following this procedure, it is possible, using the OmniBER OTN, to test the upstream and downstream responses of a DUT for a large number of SONET, SDH and OTN fault conditions.

Trigger outputs

Alarm events

For transmitted and detected alarm events, a voltage level is set on the trigger output port.

- Alarm on: 2.3 V typical output voltage, 1.85 V min
- Alarm off: 0.8 V typical voltage, 1.05 V max

Error events

For transmitted and detected error events, a voltage pulse is applied to the trigger output port.

- Pulse width: 10 µs nominal

For BIP and FEC block errors, a single pulse is transmitted for every errored block.

Trigger position

The trigger level/pulse outputs as soon as the alarm/error condition is set/detected. This happens when the relevant byte is transmitted/received and not at the start/end of the frame.

Trigger output delay

Transmitter: The trigger output pulse/level will always be transmitted before the data on the output.
Maximum lead time: 25 µs.

Receiver: The trigger output pulse/level will always be sent after the data on the receiver input has been processed.
Maximum delay time: 25 µs.

Available OTN triggers

Trigger source	Tx & Rx
Start of frame	Y
Entire frame error	Tx only

OTN error	Tx & Rx
Bit error	Y
Frame (OA1,OA2)	Y
Multiframe (MFAS)	Y
OTUk-BIP8	Y
ODUk-BIP8	Y
OTUk-BEI	Y
ODU-BEI	Y
FEC block	Y

OTN alarm	Tx & Rx	Detection criterion
LOS	10.71 Gb Tx	>= 100 μs
LOF	Y	OOF for 3 ms
OOF	Y	5 consecutive frames
LOM	Y	OOM for 3 ms
OOM	Y	5 consecutive frames
OTUk-AIS	Y	As per G.798
OTUk-IAE	Y	5 consecutive frames
OTUk-BDI	Y	5 consecutive frames
ODUk-AIS	Y	3 consecutive frames
ODUk-OCI	Y	3 consecutive frames
ODUk-LCK	Y	3 consecutive frames
ODUk-BDI	Y	5 consecutive frames

Available SONET/SDH triggers

Trigger source	Tx & Rx
Start of frame	Y
Entire frame error added	Tx only
Pointer adjust	Y
K1/K2 change – change must persist for three consecutive frames. Pulse output on third frame containing new value.	Rx only

Error		
SDH	**SONET**	**Tx & Rx**
Frame (A1,A2)		Y
B1 BIP	CV-S	Y
B2 BIP	CV-L	Y
MS REI	REI-L	Y
B3 BIP	CV-P	Y
HP REI	REI-P	Y
TC-IEC (VC-4-Xc/VC-4/VC-3)	Not applicable	Y
TC-REI (VC-4-Xc/VC-4/VC-3)	Not applicable	Y
TC-OEI (VC-4-Xc/VC-4/VC-3)	Not applicable	Y
Bit error		Y

Alarm			
SDH	**SONET**	**Tx & Rx**	**Detection Criterion**
LOS		10 Gb Tx	>= 100 μs
LOF	Y	OOF for 3ms	4 consecutive frames
OOF	SEF	Y	4 consecutive frames
MS-AIS	AIS-L	Y	5 consecutive frames
MS-RDI	RDI-L	Y	5 consecutive frames
AU-AIS	AIS-P	Y	3 consecutive frames
HP-RDI	RDI-P	Y	10 consecutive frames
AU-LOP	LOP-P	Y	8 consecutive frames
HP-UNEQ	UNEQ-P	Y	5 consecutive frames
Not applicable	PDI-P	Y	5 consecutive frames
VC-AIS	Not applicable	Y	5 consecutive frames
TC-RDI (VC-4-Xc/VC-4/VC-3)	Not applicable	Y	5 consecutive frames
TC-ODI (VC-4-Xc/VC-4/VC-3)	Not applicable	Y	5 consecutive frames
TC-UNEQ (VC-4-Xc/VC-4/VC-3)	Not applicable	Y	5 consecutive frame alignment words in error (N1 b7 & b8)
TC-OOM (VC-4-Xc/VC-4/VC-3)	Not applicable	Y	2 consecutive frames
TC-IAIS (VC-4-Xc/VC-4/VC-3)	Not applicable	Y	5 consecutive frames

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Agilent Technologies manufactures the OmniBER OTN family under a quality system approved to the international standard ISO 9001 plus TickIT (BSI Registration Certificate No FM 10987).

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