Alarm stress testing

Application note

OmniBER OTN communications performance analyzer

G.709

Agilent Technologies

Introduction

Standardization has played a major part in the successful evolution of the modern telecom network. The introduction of SONET and SDH standards in the 1980s opened the door to increased competition between network equipment manufacturers, leading to the reduced cost of network equipment. Standardization also provides the path towards seamless integration of equipment from different vendors in the network. However, realizing this goal requires vendors to interpret and implement the standards in the same way.

Ensuring that network equipment designs faithfully follow the specifications laid down in OTN, SONET and SDH standards requires highly specialized test equipment. The test equipment must be capable of fully stressing the designers' implementation. Failure to verify designs at this stage can lead to expensive interoperability issues later on.

This product note will show how the OmniBER OTN's powerful and flexible test capability can be used to ensure design compliance to the latest standards.

The OmniBER OTN alarm stress test capability covers SONET, SDH and the more recent ITU-T G.709 Interface for the Optical Transport Network (OTN).

Network management

Current optical transport networks allocate a portion of the bandwidth to management functions. This allows real-time monitoring of network performance, including automatic recovery and restoration of some faults that can occur during normal day to day operation.

The network management system gains awareness of adverse conditions in the network through alarm (defect) and error (anomaly) events. These are detected by network equipment and flagged to the management system under defined conditions.

Alarms are only raised when a significant event, such as a broken optical fiber, occurs which may require some operator intervention. Verifying that alarms are detected and cleared as defined in the appropriate standards is vital. Compliance to standards must be made at the design stage to ensure and to reduce the risk of interoperability issues with other vendors' equipment.

Alarm stress testing with OmniBER OTN

The OmniBER OTN has powerful alarm stress testing capability that allows frame by frame control of alarm generation. This paper will take you through an example of out-of-frame (OOF) and loss-of-frame (LOF) stress testing, for ITU-T G.709 frame synchronization.

Frame synchronization

Let's look at the frame alignment process. The framing bytes (OA1/OA2) of an ITU-T G.709 signal are found in columns 1 to 6 of the first row of the optical channel frame (see Figure 1). These bytes are unscrambled.

During the out-of-frame state, a framing device will constantly search for a 4-byte subset of the six OA1/OA2 framing bytes. (It's worth noting that G.709 does not specify which 4 byte subset of the six framing bytes should be used).

In-frame takes place if this subset is found and confirmed in the same location, one frame later. (Two consecutive frames with good framing bytes are required for in-frame conditions).

During in-frame, the signal is continually monitored for correct frame alignment using the OA1 OA2 OA2 pattern found in columns 3, 4 and 5 of the optical channel frame. The out-of-frame state occurs if this subset is not found in the correct location for five consecutive frames (See Figure 2). An out-of-frame condition that persists for 3 ms becomes loss-of-frame (LOF).

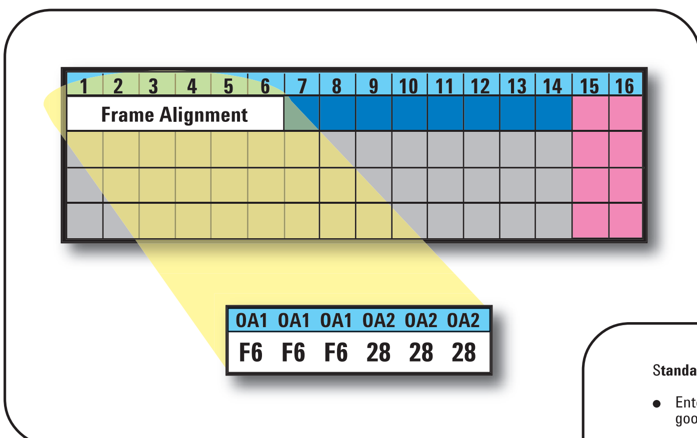


Figure 1
Framing bytes

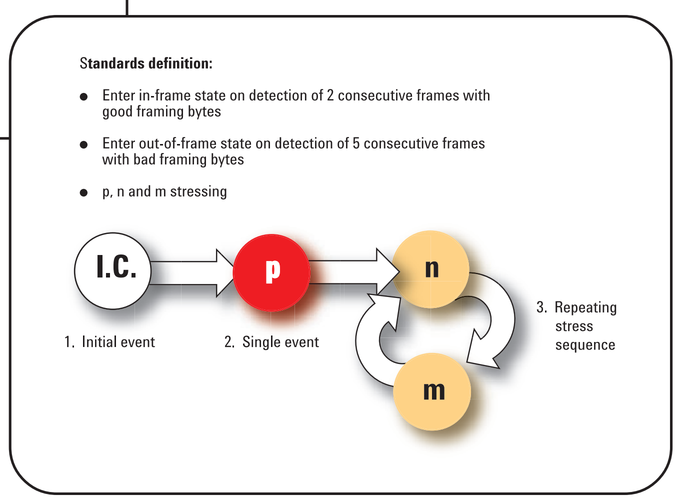


Figure 2
Example of OTN OOF stress test

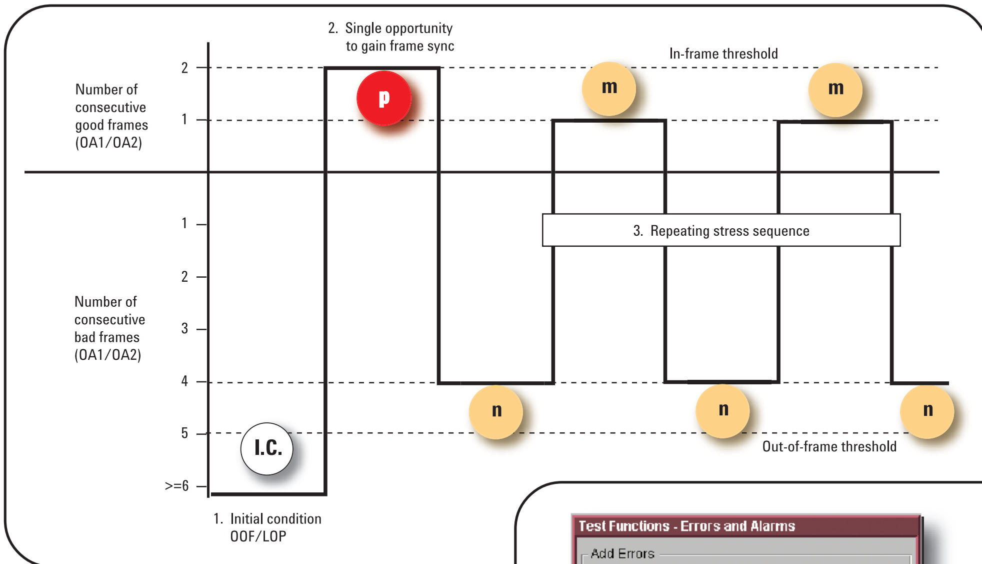
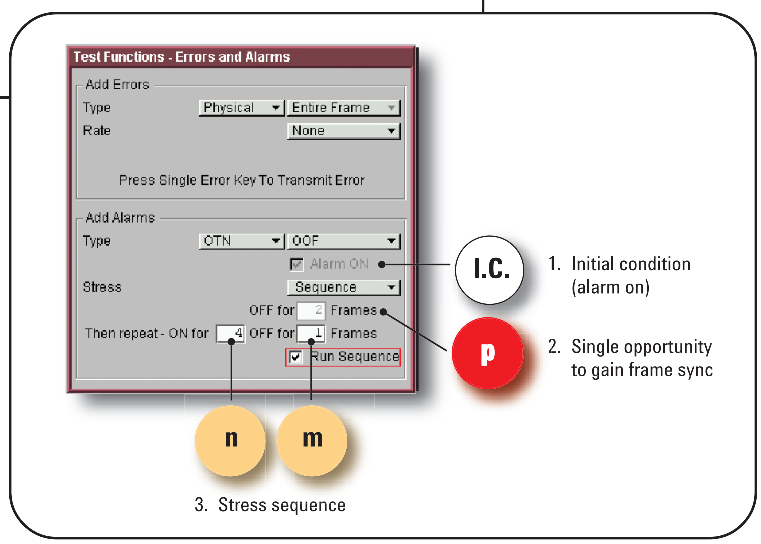


Figure 3
OTN frame sync stress test

Figure 4



p, n and m stress testing

The p, n and m alarm stress-testing feature of the OmniBER OTN is used to verify entry and exit criteria for a wide range of alarms.

Testing OOF

Figure 3 graphically shows how the OmniBER OTN can be used to stress test the framing algorithm of a network element.

With the OmniBER OTN transmit interface connected to the input of the device under test (DUT), the alarm stress test feature is selected (see Figure 4). OOF is now turned on, as this is the starting point for the test.

The stress test feature allows the user to transmit either a single pulse of the alarm on/off condition (number of frames defined by the user).

Alternatively a single pulse (‘p’) followed by a repeating sequence of frames with the alarm switching between the on (‘n’) and off (‘m’) states.

A powerful feature of the OmniBER OTN stress test is the ability to dynamically and seamlessly change the number of frames in the ‘n’ and ‘m’stress sequence while the test is running.

Figure 4 shows the OmniBER OTN settings required to generate the stress sequence in Figure 3.

1. OOF begins the sequence in the on state.

2. A single two-frame opportunity for the DUT to gain frame alignment.

3. Followed by a repeating stress cycle of the alarm on for four frames then off for one frame.

The OmniBER OTN never generates five bad frames in a row in this setup. Therefore the DUT should never enter the out-of-frame state. However, it will show frame errors. The OmniBER OTN can also be configured to test the OOF/LOF requirements as illustrated in Figure 5.

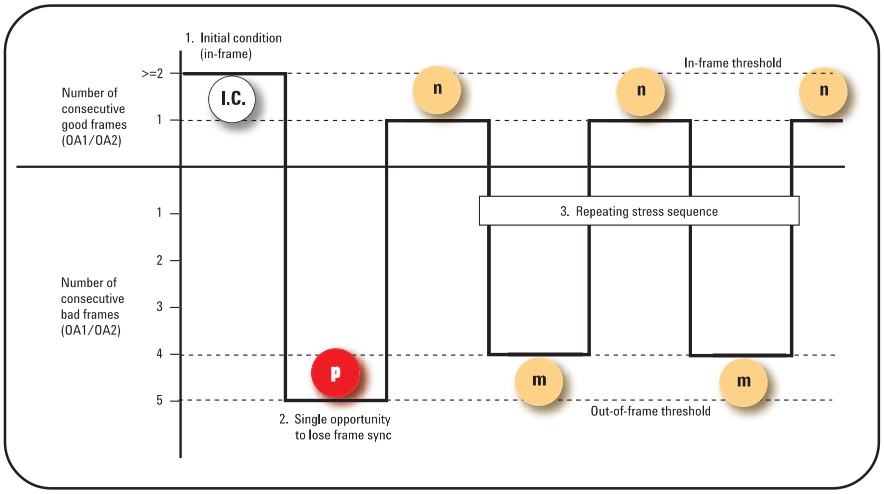


Figure 5
OTN out of frame (OOF) stress test

OTN, SONET and SDH alarm stress test

This paper gives one example of an alarm stress test on an ITU-T G.709 compliant network element or sub-assembly. Other alarms that can be tested in this manner by the OmniBER OTN are as shown in the following table:

OTN alarms	SONET alarms	SDH alarms
LOS (10.7 Gb/s)	LOS (10.7 Gb/s)	LOS (10 Gb/s)
LOF	LOF	LOF
OOF	SEF	OOF
LOM	AIS-L	MS-AIS
OOM	RDI-L	MS-RDI
OTU-AIS	AIS-P	AU-AIS
OTU-IAE	LOP-P	AU-LOP
OTU-BDI	UNEQ-P	HP-UNEQ
ODU-AIS	RDI-P	HP-RDI
ODU-OCI		
ODU-LCK		
ODU-BDI		

LOS stress test

In the SONET and SDH standards, there are two types of anomalies that can be used to detect a loss of signal (LOS).

These are:

- A period of time with no transitions.
- Optionally, optical power below some threshold level[1] may also be used.

The OmniBER OTN has the unique capability to stress network equipment to correctly detect LOS at 10 Gb/s. It does this by transmitting runs of zeros (no transitions) for a user defined time period.

The SONET and SDH standards differ slightly when defining the detection criterion for LOS. The definitions from the standards are shown in Figure 6. Put simply, for optical signals, an LOS defect is defined as a period of time with no transitions (light pulses).

SONET definition from GR-253

An LOS defect shall be detected when an all-zeros pattern on the incoming SONET signal lasts 100 µs or longer. If an all-zeros pattern lasts 2.3 µs or less, an LOS defect shall not be detected.

Figure 6

SDH example from G.783

An LOS defect occurs upon detection of no transitions on the incoming signal (before descrambling) from time T, where $2.3 \leq T \leq 100$ µs.

[1] *This method of LOS detection is implemented in the OmniBER OTN receiver*

LOS in SONET

In the SONET standard, a LOS defect should be declared if there are no transitions on an incoming signal for 100 µs or longer. A LOS should NOT be declared if the period with no transitions lasts for 2.3 µs or less. If the LOS defect persists for more than 2.5 seconds, then a LOS alarm will be raised

What happens for periods of no transitions lasting greater than 2.3 µs and less than 100 µs is not defined in the SONET standards and is left to the choice of the equipment designer.

LOS in SDH

For SDH, no timing is specified. Rather it states that “ The timing requirements for detection of the LOS defect (is) in the province of regional standards”. The example in Figure 6 shows where a LOS would be declared if no transitions were detected for a period T greater than 2.3 µs.

Testing LOS detection

Using the OmniBER OTN, it is a simple matter to verify that a network device complies with the relevant standard for LOS detection. This is achieved by sending pulses of no transitions into the device under test (DUT). The test setup is shown in Figure 7. The OmniBER OTN output is connected to the input of the DUT and the response of the DUT is monitored via the network management system or craft port.

All that is required is to set the OmniBER OTN to transmit a correctly structured SONET, SDH or OTN signal. Then select Menu → Test Functions → Errors and Alarms. This provides access to the LOS stress test shown in Figure 8. Enter any value from 0.1 to 2.3 µs and select the ‘Transmit’ button on the display. The DUT should NOT declare LOS. Next, enter any value from 100 to 110 µs, select the ‘Transmit’ button on the instrument display and the DUT SHOULD declare LOS.

Note: There is no specification in any of the standards that sets out a requirement for a number of consecutive zeros that a network device should receive without errors.

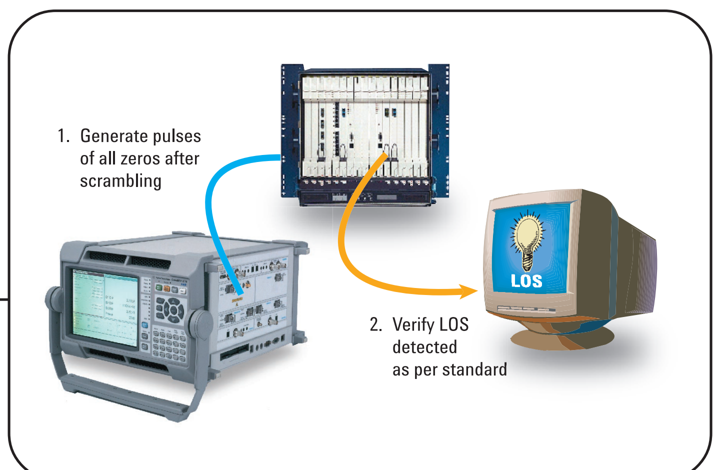


Figure 7
LOS test setup

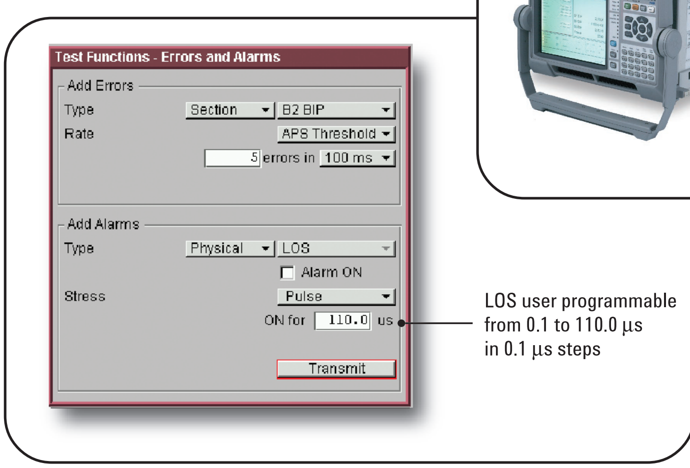


Figure 8
OmniBER OTN setup

Conclusions

This application note has shown how the OmniBER OTN powerful alarm stress test feature can easily be used to verify equipment conformance to SONET, SDH and ITU-T G.709 (OTN) standards.

Precise sequences of alarm on/off conditions can be readily configured by the user to test entry and exit criteria for major alarms. This precise control offers equipment designers the ideal tool for verifying and debugging new equipment designs using an independent test source.

The unique LOS (loss of signal) stress test also provides a simple, independent method for verifying compliance to the requirements for this critical alarm.

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).

UNIVERSAL INSTRUMENT DRIVERS

Agilent Technologies' Test and Measurement Support, Services, and Assistance
Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise
Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage
Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

Agilent Email Updates

www.agilent.com/find/emailupdates

Get the latest information on the products and applications you select.

By internet, phone, or fax, get assistance with all your test & measurement needs

Online assistance:
www.agilent.com/find/assist

Phone or Fax
United States:
(tel) 1 800 452 4844

Canada:
(tel) 1 877 894 4414
(fax) (905) 282 6495

China:
(tel) 800 810 0189
(fax) 1 0800 650 0121

Europe:
(tel) (31 20) 547 2323
(fax) (31 20) 547 2390

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (82 2) 2004 5004
(fax) (82 2) 2004 5115

Latin America:
(tel) (305) 269 7500
(fax) (305) 269 7599

Taiwan:
(tel) 080 004 7866
(fax) (886 2) 2545 6723

Other Asia Pacific Countries:
(tel) (65) 375 8100
(fax) (65) 836 0252
Email: tm_asia@agilent.com

Product specifications and descriptions in this document subject to change without notice.

Printed in USA, September 20, 2002
5988-6633EN

Agilent Technologies