Tektronix

Technical Brief

Installing, Commissioning, and Provisioning SONET Rings using the CTS 710 SONET Test Set

The CTS 710 SONET Test Set is the ideal tool for installing, commissioning, and provisioning SONET rings.

SONET Ring Networks are being installed more frequently to handle the growing volume of telecom traffic brought on by an increase in access lines and the growth of Intranet/Internet traffic.

Installing a new SONET Ring Network requires a new set of test tools to verify performance and ensure continued reliability. In the field or in the central office, the Tektronix CTS 710 SONET Test set is a cost-effective, easy-to-use tool to get the job done with confidence.

What is a SONET Ring?

Figure 1 illustrates a simple SONET ring. Basically, it's a network in where the input/output of each Add Drop Multiplexer (ADM) is connected to the next device in the network in a serial fashion.

Multiple ADMs can be put into a ring configuration for either bi-directional or uni-directional traffic. The main advantage of the ring architecture is its survivability; if a fiber cable is cut, the multiplexers have the intelligence to send the services affected via an alternate path through the ring without interruption.

The Processes

Installing refers to the process of physically building the network and testing it for operational capability.

Provisioning is the adaptation of the available system components to the requirements of your network. This may include hardware settings such as switches as well as software setup.

Commissioning, or acceptance testing, involves a series of steps to prove that the system meets certain requirements. It can be a series of specifications from the manufacturer of the system, or standards established by a government agency.

Making the Tests

Following are overviews of some of the tests required in installing, commissioning, and provisioning a SONET network. Also described are the test capabilities that the CTS 710 provides for the network engineer.

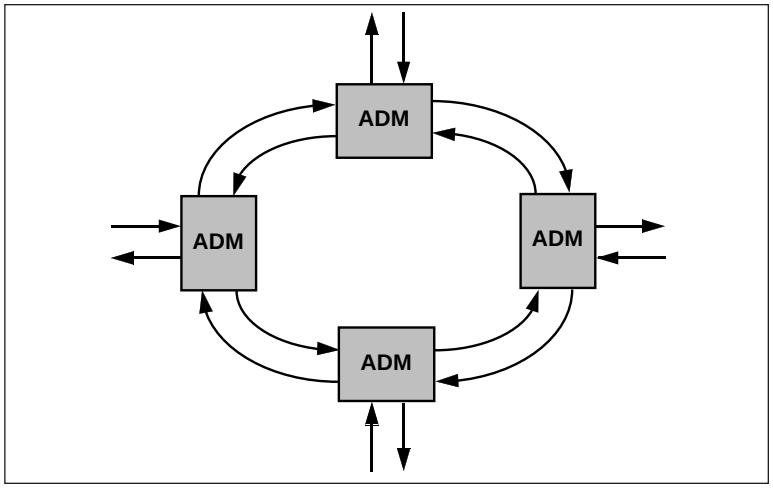
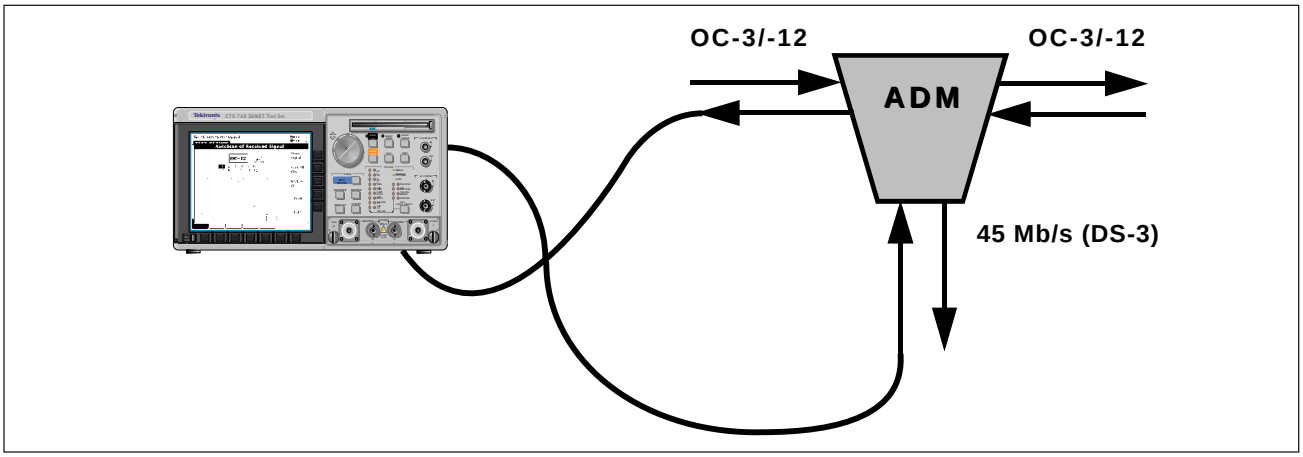


Figure 1. A simple SONET Ring. The input/output of each ADM is connected to the next device in the ring in a serial fashion.

Installation – Commissioning and Provisioning



Test Requirement	Areas Tested/Test Challenges	CTS-710 Features/Test Procedures
Physical Path Continuity	Problems in identifying correct fiber cable.	Use built-in Optical Power meter.
SONET Signal Identification	Problems in identifying correct STS channel.	Use AutoScan and show STS structure to find STS channel with correct payload pattern to test (see Figure 2). Also shows if other channels are Equipped or Unequipped and whether any alarms are present.
Equipment – Multiplexing and Demultiplexing	Test the mapping, demapping, multiplexing, and demultiplexing capability of a network element.	Use AutoScan to find test pattern at output of ADM (see FIgure 2). Check for correct location of VT1.5 inside the SONET signal; insert PRBS pattern. Check for correct location of 45 Mb/s signal at ADM output.
Network – SONET Section Continuity	SONET line continuity verification recommends an OC-N signal with a J1 path trace message. Verification is performed by viewing the J1 message from the SONET demultiplexer.	Insert unique path trace message in J1 and use AutoScan to find the path trace (see Figure 2). Check for correct location of the STS inside the SONET network.
Network – SONET Path Continuity	SONET path continuity verification recommends a STS-N signal with a J1 path trace message (e.g., low-order path). Verification is performed by viewing the J1 message from the SONET demultiplexer.	Insert unique path trace message in J1 and use AutoScan to find the path trace (see Figure 2). Check for correct location of the STS-N inside the SONET network.
Network – DS3/DS1 Service Path Continuity	DS3/DS1 path verification is verified using a known pattern in a DS3/DS1 signal. The test requires one test set with a loopback at the far-end, or a generator and receiver at each end of the DS3/DS1 path.	Insert PRBS test pattern and inject single errors or set an error rate; view results after selecting the correct VT or STS.
COMPANION PRODUCTS: Physical layer tests may be required – Extinction ratio, etc. To support OC-48, use the Tektronix ST2400 SDH/SONET 2.4 GB/Sec Test Set.		

NOTE

All of the following example screen shots were captured from a CTS 710 under actual test conditions.

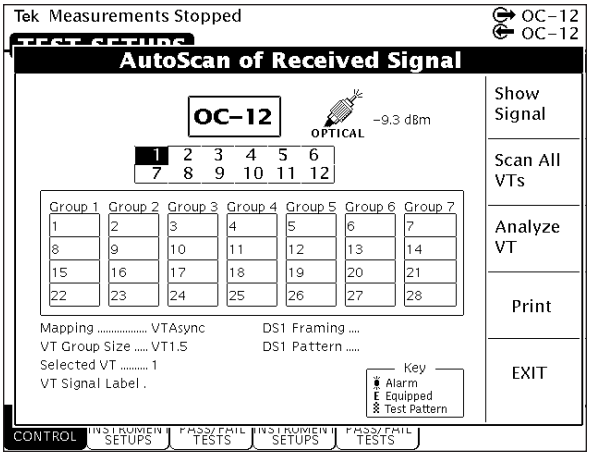


Figure 2. AutoScan – Pressing one button will automatically configure the receiver to the incoming signal and display what the signal looks like.

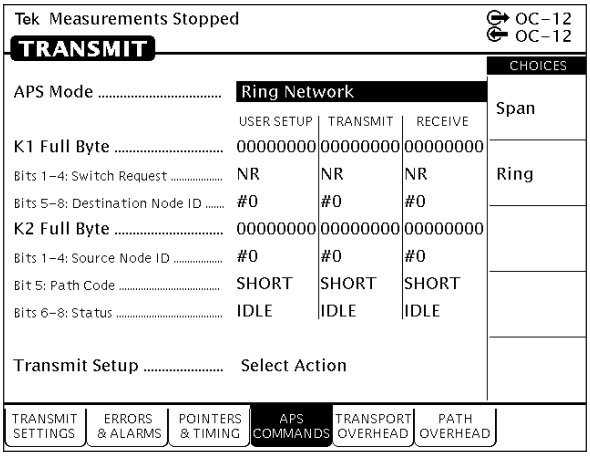
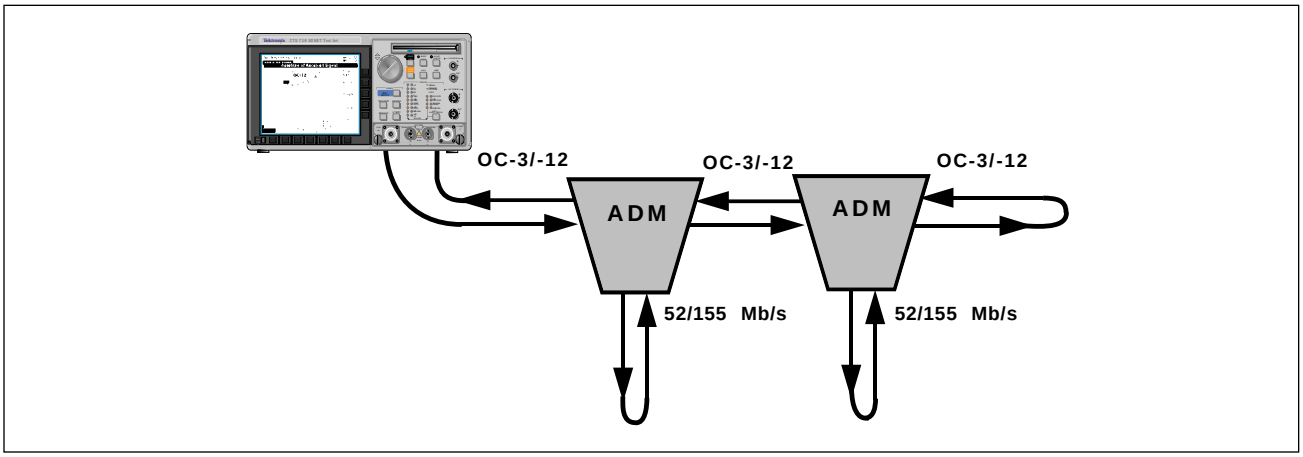


Figure 3. Faults – Transmit an APS message and see the resulting messages from the Network Element you are testing.

Installation – Transmission Quality Tests



Test Requirement	Areas Tested/Test Challenges	CTS-710 Features/Test Procedure
Error Rate Analysis – General	Tests quality of the SONET and DS3/DS1 paths. Performed out-of-service.	Uses a pattern generator to generate a PRBS test pattern; run a 15-minute pass/fail test on the network testing for zero errors. A Pass/Fail test can be created to automate testing for a specified period of time and verify that a specific threshold is met (see Figure 4). ANSI T1.05 and Bellcore GR253 specify short intervals for zero errors and longer intervals if one or more errors are found. Simultaneous comprehensive error analysis is performed at all layers. Variety of SONET and DS3/DS1 histories with storage up to 45 days. Several modes of viewing (1 min, 15 min, …). Layered presentation of information helps in quick identification of performance requirements (see Figure 5).
Equipment – Mapping and Demapping Process	Tests the mapping, demapping, multiplexing, and demultiplexing of a Network Element in a SONET network.	Quick Check: Daisy-chain all DS3/DS1 lines of Terminal Multiplexer; Loopback OC-3; send DS3/DS1 signal to Terminal Multiplexer; receive DS3/DS1 signal from end of daisy-chain; check for errors. Check each DS3/DS1 channel; send known DS3/DS1 pattern to channel 1 of Terminal Multiplexer; verify channel exists inside OC-3; use AutoScan to view where the pattern exists, and whether it exists in the correct location. Repeat this for all 63 DS3/DS1 channels. SONET – Similar setup and test as in DS3/DS1; for example, verify each OC-3 is multiplexed into correct OC-12 channel.
Network – SONET Path Quality, Error Testing	Test flexibility of the SONET Network to run error-free over a period of time. Also known as a "Soak Test."	Insert PRBS pattern and measure error rate over time; compare real error rate with B1, B2, B3 results (see FIgure 5). Perform all measurements and performance analysis on all layers of the network simultaneously.
Network – DS3/DS1 Service Path Quality, Error Testing	Tests the ability of the DS3/DS1 service to run error-free over a period of time. Also known as a "Soak Test."	Insert PRBS pattern and measure error rate over time; compare real error rate with CRC results (see Figure 5). Perform measurements and performance analysis on all layers of the network simultaneously. Also perform M.2100 analysis on payload.

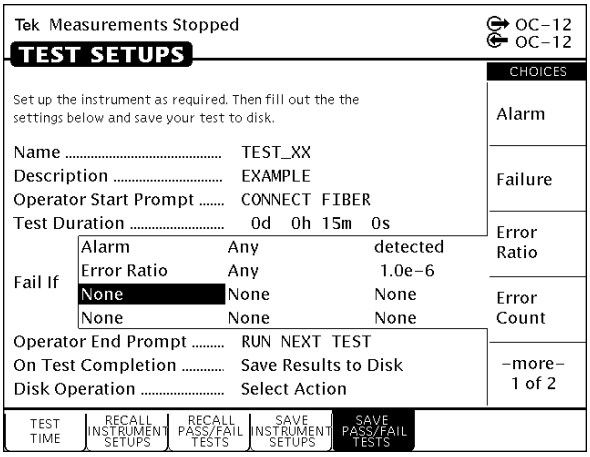


Figure 4. Pass/Fail Testing – If you have trouble obtaining consistent, repeatable results, create your own test once and store the test/test set-up configuration on a floppy diskette.

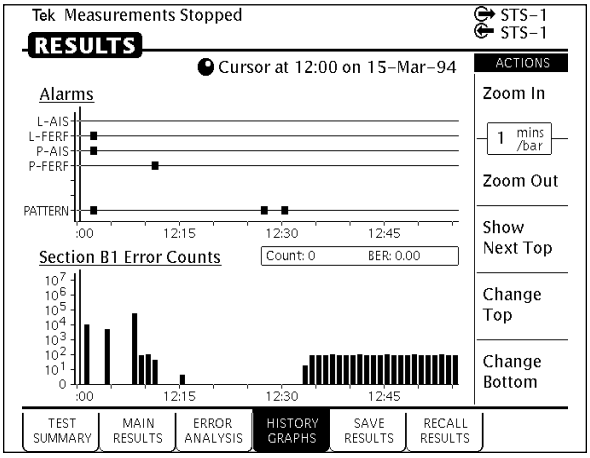
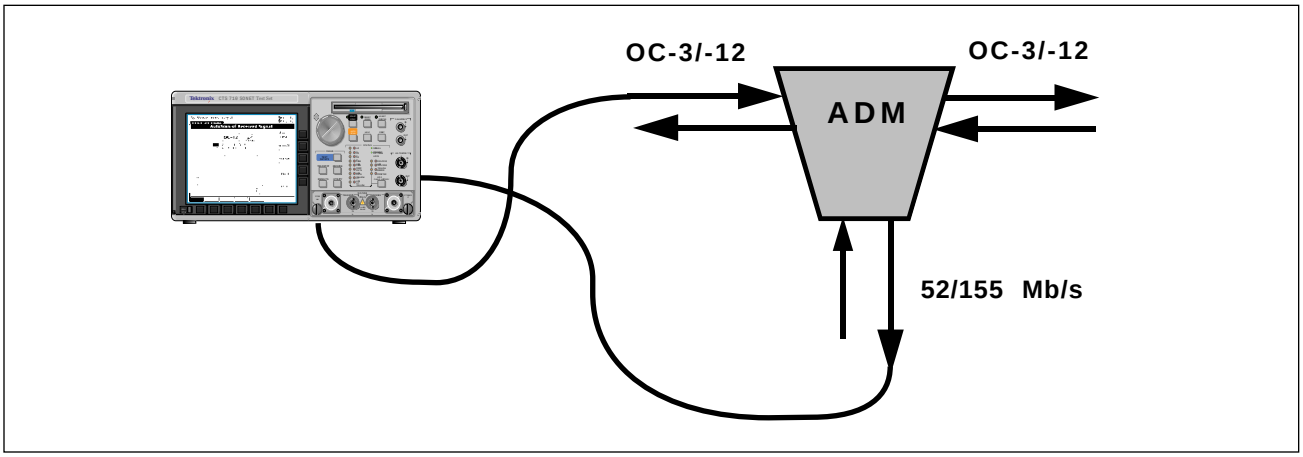


Figure 5. Graphical Display – Visually see the results of your testing! For example, these graphs allow you to quickly and easily compare two types of errors and alarms to see if a correlation exists.

Installation – Fault Tolerance Tests



Test Requirement	Areas Tested/Test Challenges	CTS-710 Features/Test Procedure
Error Injection and Response	Tests correct response to parity errors by inserting errors in BIPs and monitoring network response. Parity tests are: Section (B1), Line (B2), Path (B3).	Loopback SONET demux side; connect OC-12 Tx/Rx; evaluate correct FEBE upstream and B1, B2, B3 downstream response after inserting errors.
Alarm Simulation and Response	Tests correct response to alarms.	For example, send AIS-L on an OC-3 down-stream channel and look for an ROI-L (FERF) indication to be returned on the upstream channel.
Failure Simulation and Response	Tests correct response to failures.	Loopback SONET demux side; connect OC-12 Tx/Rx and check upstream and downstream responses. For example, generate LOS, LOF, or AIS-L; verify RDI-L (FERF) of return path.
Frequency Offset	Tests the clock recovery circuitry of a SONET network element.	Insert frequency offset into the SONET line and monitor for errors on the output (see Figure 6). Insert frequency offset into the tributary and monitor for errors on the mapped tributary.
Pointer Justifications and Sequences	Tests correct de-mapper synchronization and filtering.	Force pointer movement sequences (see Figure 7) into STS and VT at the SONET side of the ADM, including 87-3 and 16-1 pointer sequences. Measure tributary output for errors and jitter.
Automatic Protection Switching	Test APS response to errors by inserting errors at APS threshold and/or excessive rates and monitoring the network response.	Monitor K1 and K2 both upstream and downstream. For example, send OC-12 signal with increasing error rate until APS threshold is crossed. APS screen clearly displays K1/K2 messages.

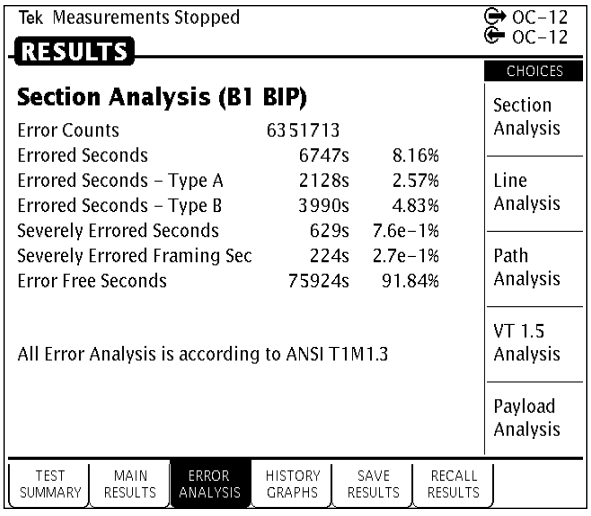


Figure 6. Results – Test results are readily available with the press of a few buttons. Results are listed in a fashion that allows you to compare the results for compliance to existing standards.

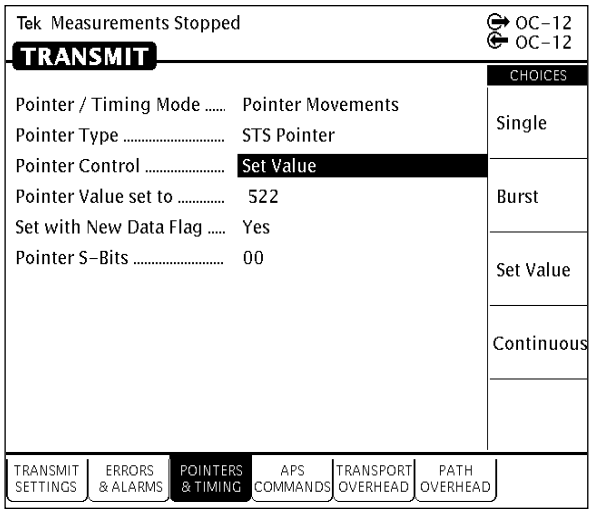
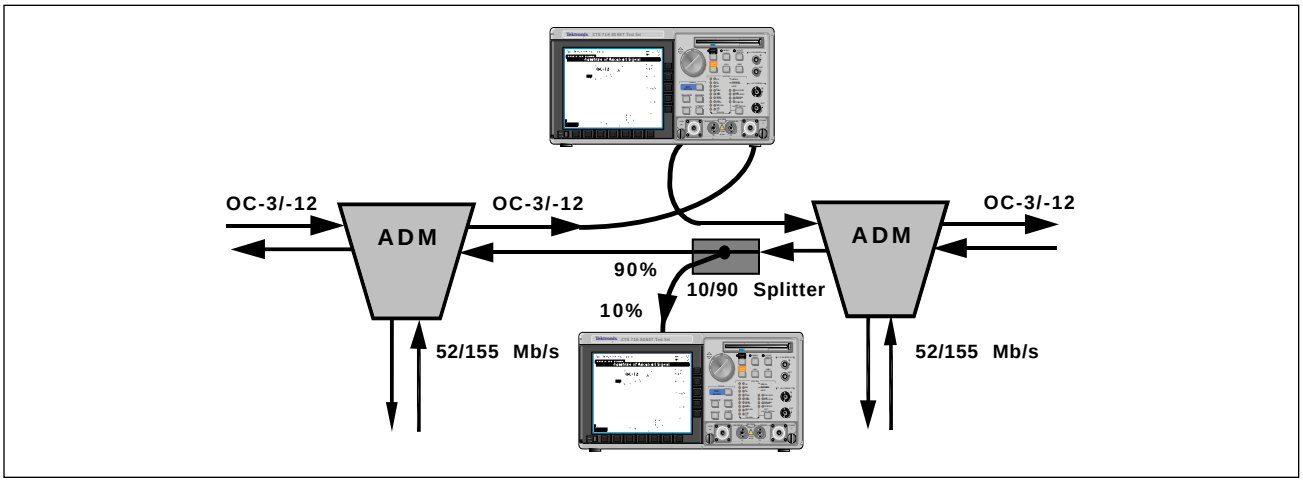


Figure 7. Pointer Movements – Let the CTS 710 generate the many different pointers listed in the standards and measure the performance of your Network Element.

Maintenance – In-Service Monitoring



Test Requirement	Areas Tested/Test Challenges	CTS-710 Features/Test Procedure
Trouble Isolation	Quickly identify and resolve issues that can cause service affecting problems.	Identify problem using AutoScan. Use TroubleScan to quickly see primary alarm, error, and failure conditions and monitor overhead byte (see FIgure 8).
Performance Monitoring	Monitor the Network Element to gather data that provides an early warning of possible service-affecting problems.	During in-service monitoring only, CRC-6 errors and frame errors can be verified to M.2100. Use Through Mode for non-intrusive performance monitoring – receives, analyzes, and regenerates with no changes to the signal such as pointer justifications or overhead changes. Use AutoScan to set up Through Mode; then monitor overhead byte, alarm, error, and failure activity. TroubleScan measurement results and history graphs show minute-by-minute performance. Access to the signal can be obtained by also using 10/90 optical splitters; preferably at the PMP (Passive Monitoring Point).
Restoration Verification	Verify restoration was performed properly by the Network Element.	During restoration, similar testing may be performed as those completed originally during commissioning; e.g.: • Provisioning (see Figure 9) • Transmission quality
COMPANION PRODUCTS: If needed, a separate test set can be used for detailed analysis of 64 K channels within a DS1 (dropped from the CTS 710).		

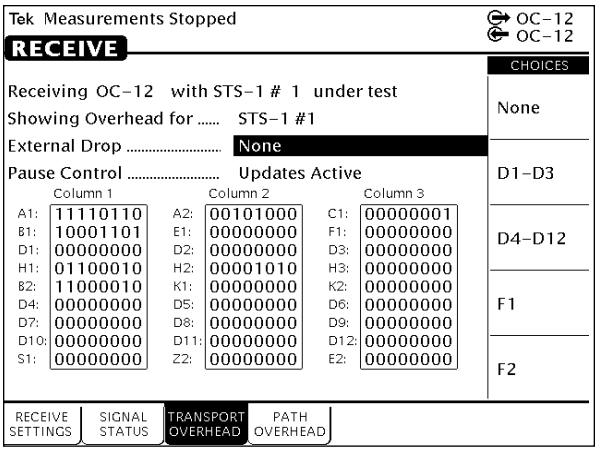


Figure 8. Overhead – Look at all the transport overhead on one screen.

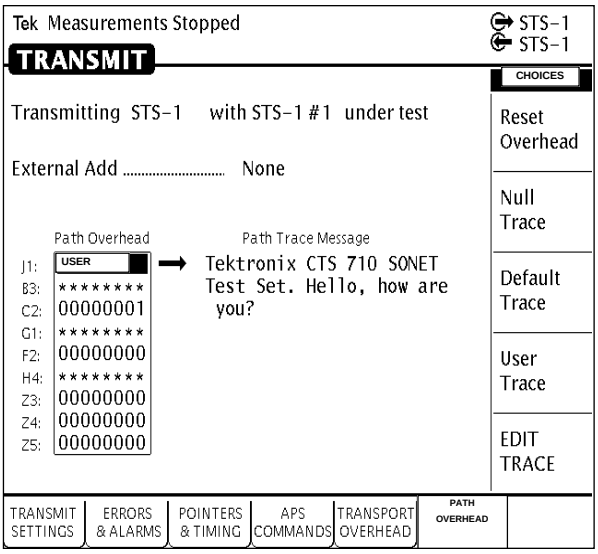


Figure 9. Path Trace – Validate that your cross-connects are provisioned properly by setting a path trace message.

The CTS 710 SONET Test Set – The Ideal Tool For The Job

The Tektronix CTS 710 SONET Test Set is the ideal tool for the job of installing, commissioning, and provisioning a SONET network. Primary on the list of qualifications is its ease-of use.

Ease-Of-Use

The one-button AutoScan feature allows you to quickly configure the receiver to an incoming signal. This not only saves time on the job, it makes the training task for new technicians easier and helps reduce human error.

Here's some of the measurements the CTS 710 can make quickly and efficiently:

- **ID a Circuit/Path Tracing –** track DS-3s through ADMs.
- **Fault Transmission –** Introduce a specific fault condition and verify the alarm results.
- **Pointer Adjustments –** Choose from standard pointer sequences.
- **Transport Overhead –** View a great amount of overhead information on one screen.
- **Pass/Fail Testing –** You can create personalized Pass/Fail tests to match the needs of your system. The CTS 710's configuration setup is also stored on floppy disk to allow a technician to quickly configure the CTS 710 to run a test. Results are compared to your Pass/Fail criteria and the word PASS or FAIL is clearly displayed on-screen so the technician immediately knows the results of the test.

Remote Control

With a built-in RS-232 interface, the CTS 710 can monitor a test from a remote location via a modem. You can even run tests overnight and monitor the results from home, office, or any remote site. This makes it easy to set up long duration tests without tying up valuable time on-site.

Store/Recall Files

You can store test types and test results on the built-in floppy disk drive. Recall the stored files to quickly run tests, to show your customer the results of system tests right on your PC or Laptop using conventional PC software programs, or archive results for long-term records of network performance. Stored test results are also helpful when troubleshooting a network if problems arise.

Cost Effective

The CTS 710 is the most cost-effective solution to network testing. Not only is it less expensive than many network test sets or even the cost of major upgrades to bring installed systems up to current standards, it continues to save money in the ease-of-use and the ease-of-training for new technicians and infrequent users.

Want More Information?

This is only a summary of the capabilities of the CTS 710 Test Set. For detailed information or a demonstration, contact your Tektronix Account Manager.

Reference Information

The following publications and product data sheets provide additional information on SONET testing:

SONET Telecommunications Standard Primer, Tektronix literature number 2RW-11407-0.

CTS 710 Data Sheet, Tektronix literature number 2GW-10004-4.

ST2400 Data Sheet, Tektronix literature number 2RW-11122-1.

CTS 710 Demo Video Tape, Tektronix literature number 2GW-10022-1.

Broadband Transmission Test Solutions Brochure, Tektronix literature number 2GW-10703-0.

For further information, contact Tektronix:

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