

# Basic Test Procedures

This section gives examples of how to set up and use the CTS850 SDH/PDH Test Set for several common telecommunication network applications:

- H Network continuity checking
- H Transmission signal quality testing
- H Fault tolerance testing
- H Performance monitoring
- H Jitter and wander testing
- H Video timing quality testing

## Setting Up the CTS850

This section presents setup instructions for the CTS850 in tables. Perform the steps reading from left to right in the table (see example below). The word *none* in a cell indicates that no action is required.

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
Begin here with Step 1	Step 2	Step 3	Step 4
		Step 5	Step 6
		Step 7	Step 8, CTS850 Setup is complete

Menu buttons are located on the instrument front panel. Select menu pages with the buttons below the display. Use the knob to highlight a parameter; then use the buttons at the right to select a choice. Many setups require several iterations of highlighting parameters and selecting choices. Some setups may require more than one menu button or menu page selection as well.

The first step in each application setup initializes the CTS850 to a known state.

## Network Continuity Checking

With the AUTOSCAN feature of the CTS850, it is easy to make a quick continuity check. The continuity check verifies that a SDH network element (NE), or portion of the network, is correctly set up and provisioned and that the signal passes through intact. In this example, the CTS850 transmits an STM-1E signal into an NE. Then the CTS850 receives the output from the NE and verifies that the AU-4, including its payload patterns, is intact.

1. Connect the CTS850 to the NE as shown in Figure 3 1.

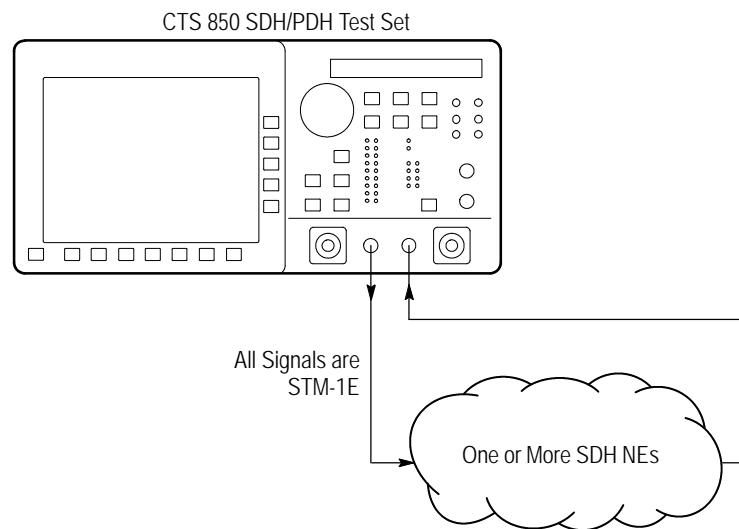


Figure 3 1: Setup to Check Network Continuity

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-1E

3. Press the **AUTOSCAN** button. The receiver locks onto the output from the NE, displays the signal structure, and shows information about the content of AU #1.
4. To analyze the payload pattern, select **Show Payload**. The CTS850 detects a PRBS of length  $2^{23} - 1$ .
5. Check the J1 Path Trace for any message.
6. Check the front-panel status lights to verify that there are no errors, alarms, or failures.
7. Select **EXIT** to leave the AUTOSCAN dialog box.

## Transmission Signal Quality Testing

### Measuring Bit Error Rate

The bit error rate (BER) test is one of the best ways to measure the quality of an SDH transmission link. You can use the CTS850 to make a BER test on a two-way link that is connected in a loop-back configuration. If this is a test you perform often, save it as a pass/fail test for easy recall.

1. Connect the CTS850 to a network as shown in Figure 3 2.

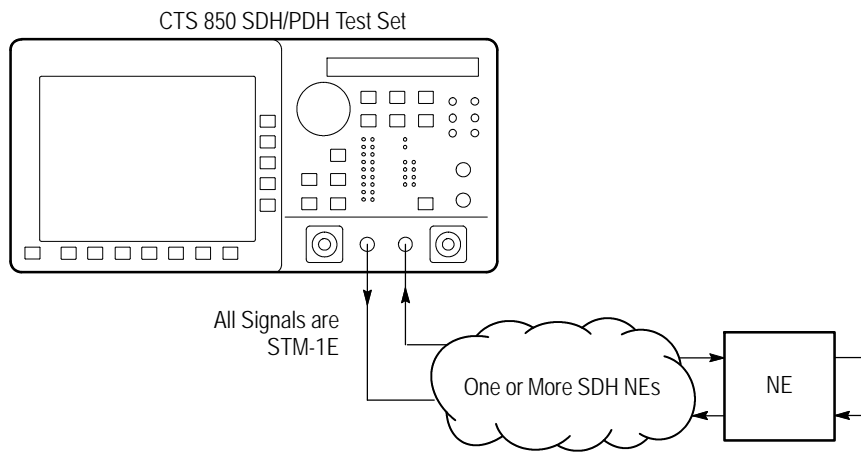


Figure 3 2: Setup to Check a Transmission Link

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-1E
		Payload	Bulk Fill (Equipped)
		Tx/Rx Setup	Coupled
TEST SETUPS	TEST CONTROL	Test Duration	15 Minutes
RESULTS	SDH RESULTS	<i>none</i>	SDh Anomalies

3. Press the **START/STOP** button.
4. While the test is running, the CTS850 counts errors and errored seconds and then calculates the error ratio for each error type or errored seconds.
5. After 15 minutes have elapsed, the test stops automatically and the measured results are held on the SDH RESULTS page until another test is started.
6. When the test is complete, you can store the test results to disk or print out a hardcopy. To save the test results to disk, you must enter a name for the disk file as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SAVE RESULTS	Name	EDIT NAME

7. Enter an eight-character name for the file.

8. If you wish, you can also enter a description of the test results by highlighting **Description** and selecting **EDIT TEXT**.
9. Save the test results to disk as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Save to Disk	Save Current

#### Testing Mapping and Demapping (All PDH rates)

The following map/demap procedure applies to all PDH rates in the CTS 850 test set: 2 Mb/s, 8 Mb/s, 34 Mb/s 45 Mb/s and 140 Mb/s. The example is written in terms of a 2 Mb/s signal, but the basic test procedure would be the same in all other PDH rates.

To test that a 2 Mb/s signal is correctly mapped into an SDH signal, you would use a Bit Error Rate test. However, testing mapping/demapping requires a different test setup than that described on page 3 3.

In this example, the Transmitter is generating a 2 Mb/s test signal which is mapped into a STM 1 signal by the Add/Drop Mux. The Receiver monitors the STM 1 signal received from the Add/Drop Mux, demaps the 2 Mb/s test signal and verifies the test pattern received.

1. Connect the CTS850 to an Add/Drop Multiplexer (ADM) as shown in Figure 3 3.

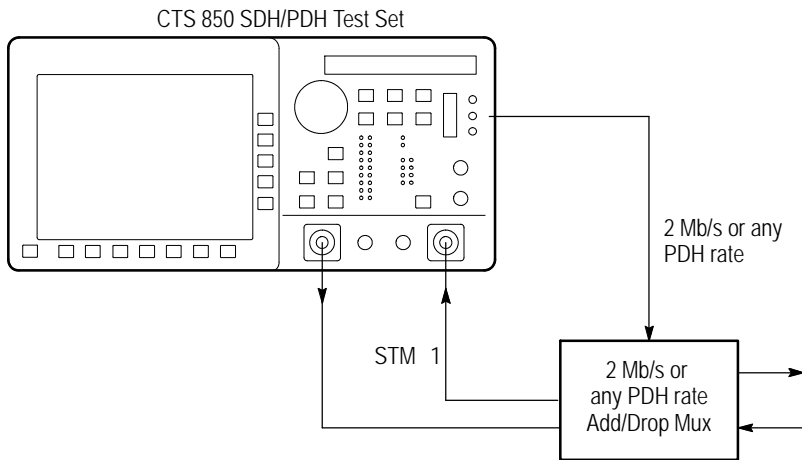


Figure 3 3: Setup to Test Mapping and Demapping

**2.** Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	2 Mb/s or any PDH rate
RECEIVE	RECEIVE SETTINGS	Receive Rate	STM-1
		Structure	TU 12Async or applicable TU x
		TU Under Test	<i>Set to match how the NE is provisioned</i>
		Payload	2 Mb/s Unframed or any PDH rate
TEST SETUPS	TEST CONTROL	Test Duration	15 Minutes
RESULTS	SDH RESULTS	<i>none</i>	Defects

**3.** Press the **START/STOP** button.

While the test is running, the CTS850 counts errors and errored seconds and then calculates the error ratio for each error type.

After 15 minutes have elapsed, the test stops automatically and the measured results are held on the SDH RESULTS page until another test is started.



4. When the test is complete, you can store the test results to disk or print out a hardcopy. To save the test results to disk, you must enter a name for the disk file as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SAVE RESULTS	Name	EDIT NAME

5. Enter an eight-character name for the file.
6. If you wish, you can also enter a description of the test results by highlighting **Description** and selecting **EDIT TEXT**.
7. Save the test results to disk as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Save to Disk	Save Current

## Fault Tolerance Checking

Fault tolerance testing (sometimes called stimulus/response testing or stress testing) is used to ensure that a network responds correctly to various fault conditions. Though there are many additional fault conditions you can test with the CTS850, this section covers three common examples:

- H Response to errors and alarms
- H Response to pointer movements
- H Response to line frequency offset

### Response to Errors and Alarms

This example uses two CTS850 testers to simultaneously check the upstream and downstream responses to an error or alarm condition. You can use a single CTS850 to do the same thing by alternately

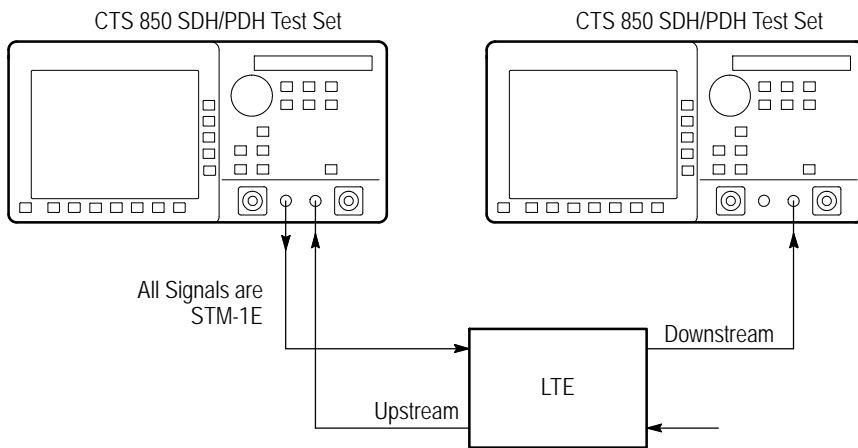
connecting the upstream and downstream signals to the RECEIVE input.

Table 3 1 shows the responses expected from Line Terminating Equipment (LTE), such as an STM-4/STM-1 multiplex section terminating element, when presented with three possible error and alarm conditions.

**Table 3 1: LTE Responses to Errors and Alarms**

Transmitted Error or Alarm	Expected Upstream Response	Expected Downstream Response
RS B1 Error	MS REI	<i>none</i>
MS AIS	MS RDI	AU AIS
HP RDI	<i>none</i>	HP RDI
LOS	MS RDI	AU AIS

1. Connect two CTS850s to an LTE as shown in Figure 3 4.



**Figure 3 4: Setup to Check Error and Alarm Response**

2. To check the LTE response to an RS B1 error, set up the upstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-1E
		Tx/Rx Setup	Coupled
TRANSMIT	Defects & Anomalies	Error Type	RS B1
		Error Rate set to	1.0E 5
RESULTS	SDH RESULTS	<i>none</i>	SDH Anomalies

**3.** Set up the downstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
RECEIVE	RECEIVE SETTINGS	Receive Rate	STM-1E
RESULTS	SDH RESULTS	<i>none</i>	Defects

- 4.** Press the **START/STOP** buttons on both the upstream and downstream CTS 850 units so that the START/STOP lights are on.
- 5.** Verify that RS B1 BIP errors are counted in the SDH RESULTS display of the upstream CTS850.
- 6.** Verify there are no errors counted in the SDH RESULTS display of the downstream CTS850.
- 7.** Press the **START/STOP** buttons on both the upstream and downstream CTS850s so that the START/STOP lights are off.
- 8.** To check the LTE response to an MS AIS alarm, change the upstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies	Error Rate set to	None
		Transmit Alarm set to	MS AIS
RESULTS	SDH RESULTS	<i>none</i>	SDH Defects

9. Change the downstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
Results	Main Results	SDH Defects	<i>none</i>

10. Press the **START/STOP** buttons on both the upstream and downstream CTS850 units so that the START/STOP lights are on.

11. Verify that MS AIS alarm seconds are counted in the SDH RESULTS display of the upstream CTS850.

12. With the downstream CTS850, verify that the displayed K1 or K2 bytes are not all zeros.

13. Press the **START/STOP** buttons on both the upstream and downstream CTS850s so that the START/STOP lights are off.

14. To check the LTE response to a HP RDI alarm, change the upstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies	Error Rate set to	None
		Transmit Alarm set to	HP RDI
RESULTS	SDH RESULTS	<i>none</i>	Defects

15. Change the downstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SDH RESULTS	<i>none</i>	Anomalies

16. Press the **START/STOP** buttons on both the upstream and downstream CTS850 units so that the START/STOP lights are on.

17. Verify that the HP RDI light is on, on the downstream CTS850.

#### Response to Pointer Movements

Pointers allow the SDH network to multiplex signals from independent sources, even if the signal clock rates differ slightly from each other. Within the allowed range, pointer movements should have no adverse affect on the performance of the network.

This example transmits a signal with frequent pointer movements to an NE and checks that the downstream signal is error free.

1. Connect the CTS850 to an NE as shown in Figure 3 5.

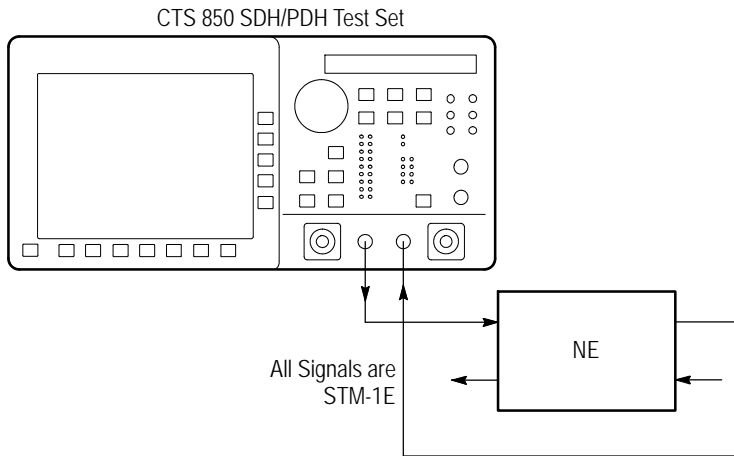


Figure 3 5: Setup to Check Pointer Movements

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-1E
		Tx/Rx Setup	Coupled
TRANSMIT	POINTERS & TIMING	Pointer Control	Continuous
RESULTS	SDH RESULTS	<i>none</i>	Defects

3. Press the **START/STOP** button on the CTS850 so that the START/STOP light is on.
4. Verify that there are no errors in the SDH RESULTS display. When the front-panel ERROR light is not on, it also indicates there are no errors in the received signal.
5. To check for received pointer movements, change the CTS850 setup as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SDH RESULTS	<i>none</i>	Pointers

6. Verify that the CTS850 is counting positive pointer justifications. Depending on the clock rate of the NE, some negative pointer justifications are also possible.



### Response to Line Frequency Offset

Pointers also accommodate differences in line frequency from one NE to another. In this example, the CTS850 transmits a signal at an offset line frequency to an NE and measures the response.

1. Connect the CTS850 to an NE as shown in Figure 3 6.

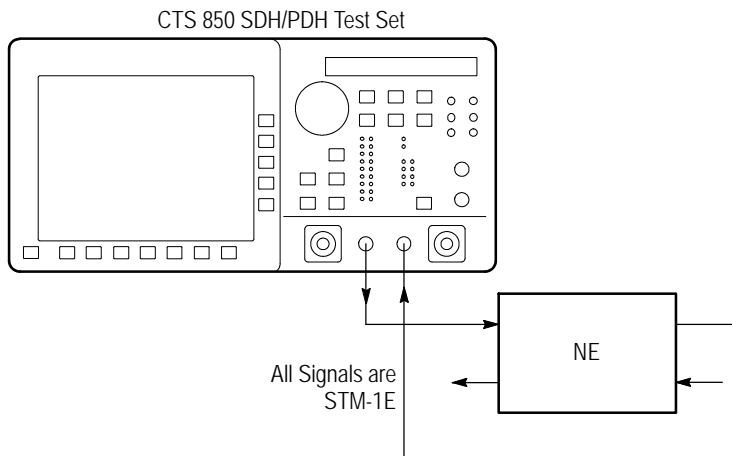


Figure 3 6: Setup to Check Line Frequency Offset Response

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-1E
		Tx/Rx Setup	Coupled
TRANSMIT	POINTERS & TIMING	Pointer/Timing Mode	Frequency Offset
		Offset Mode	Line
		Frequency Offset	Stress +4.6 ppm
RESULTS	SDH RESULTS	<i>none</i>	Network Defects Section Defects Path Defects

3. Press the **START/STOP** button on the CTS850 so that the START/STOP light is on.
4. Verify that there are no errors in the SDH RESULTS displays. When the front-panel ERROR light is not on, it also indicates there are no errors in the received signal.
5. To check that the NE is generating pointer movements, change the CTS850 setup as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SDH RESULTS	<i>none</i>	Pointers

6. Verify that negative pointer justifications are being counted.

## Performance Monitoring

When a new line is installed you may want to monitor performance for a day or so to be sure it is operating correctly. Or, if problems are suspected on a line, you may want to run a long test to determine the cause of the problem. In either case, the CTS850 makes it easy to monitor an electrical or optical line without the need for splitters.

During a test, the CTS850 simultaneously takes all performance measurements, analyzes the results according to the G.821 standard, and displays the measurements and analysis in your choice of three formats:

- H In a brief summary
- H In detail by type (defect, anomaly, alarm, failure)
- H In detail by layer (regenerator section, multiplexer section, path)

In this example, the CTS850 is placed directly in line with a live optical signal to monitor performance in an unintrusive mode (Through Mode).

1. Connect the CTS850 in line with an optical signal as shown in Figure 3 7.

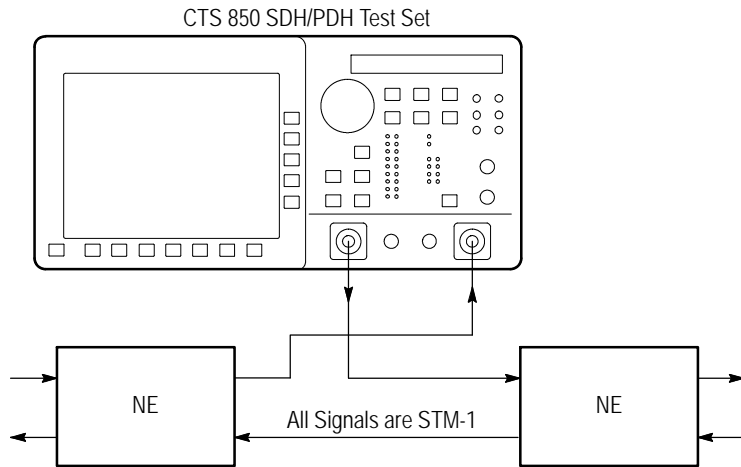


Figure 3 7: Setup to Monitor Performance

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
RECEIVE	RECEIVE SETTINGS	Receive Rate	STM-1
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Through Mode
RESULTS	ERROR ANALYSIS	<i>none</i>	SDH G.821 Analysis

3. Press the **START/STOP** button on the CTS850 so that the START/STOP light is on.
4. As the test is running, the analysis of Regenerator Section errors continually updates. You can also look at the analysis of

Multiplexer Section, Path, or Payload errors by pressing the buttons corresponding to those choices.

5. To see network performance data since the start of the test presented in graphical form, change the CTS850 setup as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	HISTORY GRAPHS	<i>none</i>	<i>none</i>

6. The CTS850 history coverage is based on storage interval which is determined by TEST SETUP. You can choose history graphs of the measured performance indicators in the following categories:
  - H Error count (any error you choose)
  - H Errored seconds (any error you choose)
  - H Pointer justifications
  - H Pointer value
  - H All failures
  - H All alarms

7. For example, to change the bottom graph to display the history of Path B3 Errored Seconds, change the CTS850 setup as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	HISTORY GRAPHS	<i>none</i>	Change Bottom
		<i>turn the knob to select the desired graph</i>	Path B3 Errored Secs
			Select Graph

8. Turning the knob moves the cursor from one bar to the next. The specific measurement values at the cursor location are shown in the display.
9. Once the graph fills the width of the display, you can pan through the entire test using the knob.
10. You can compress or expand the time scale with the Zoom Out or Zoom In action buttons. Press the button next to Zoom Out to change the time scale to 5 minutes per bar.

## Jitter/Wander Testing

With the CTS850 jitter generation and analysis capability, it is easy to run the following automated ITU jitter conformance tests:

- H Jitter Tolerance
- H Jitter Transfer
- H Output Jitter (Jitter Generation)
- H Pointer Jitter

This section shows examples of the jitter tolerance, jitter transfer and video timing quality tests.

### Testing Jitter Tolerance

The CTS850 generates a signal that contains jitter at various frequencies and feeds it to the network element. Simultaneously, the CTS850 receives the output from the network element and analyzes its performance.

You can specify several parameters for the test:

- H Mask type for jitter analysis
- H Start frequency
- H End frequency
- H Number of frequency samples
- H Tolerance criteria

The results are displayed in numerical and graphical form.

The CTS850 provides two methods to measure the tolerance of a network element to jitter applied at its input:

- H Onset-of-errors method
- H 1 dB power penalty (BER) method

These methods are fully specified and described in the ITU-T Recommendation O.171 test set standard.

**Onset-of-Errors Method.** The onset-of-errors method measures the error output of a network element when jitter is applied to its input. If there are two or more Errored Seconds in a 30-second time interval, then the CTS850 plots the jitter frequency and amplitude on a graph and compares it to a mask you can choose.

1. Connect the CTS850 to the network element as shown in Figure 3 8.

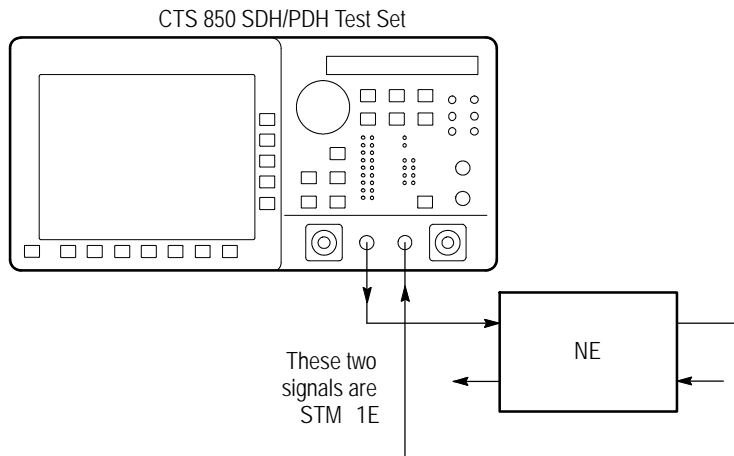


Figure 3 8: Setup to Check Onset-of-Errors Jitter Tolerance

2. Set the transmit and receive signals to STM-1E.



3. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Output Jitter	Line
TEST SETUPS	JITTER TESTS	Test Type	Jitter Tolerance
		Test Control	Edit Setup
		Mask Type	<i>as appropriate</i>
		Start Frequency	<i>as appropriate</i>
		End Frequency	<i>as appropriate</i>
		Number Freq Samples	<i>as appropriate</i>
		Tolerance Criteria	Onset of Errors

4. Press the **START/STOP** button on the CTS850 so that the START/STOP light is on.

As the test is running, the jitter tolerance graph is displayed on the screen. The results of each frequency point will also be displayed. The test stops automatically after it has completed. The CTS 850 will also display whether the test passed or failed.

**1 dB Power Penalty Method.** The 1 dB power penalty method uses the BER to measure the amount of jitter that is equivalent to a 1 dB loss of signal power at the optical input of a network element.

1. Connect the CTS850 to the network element as shown in Figure 3 9.

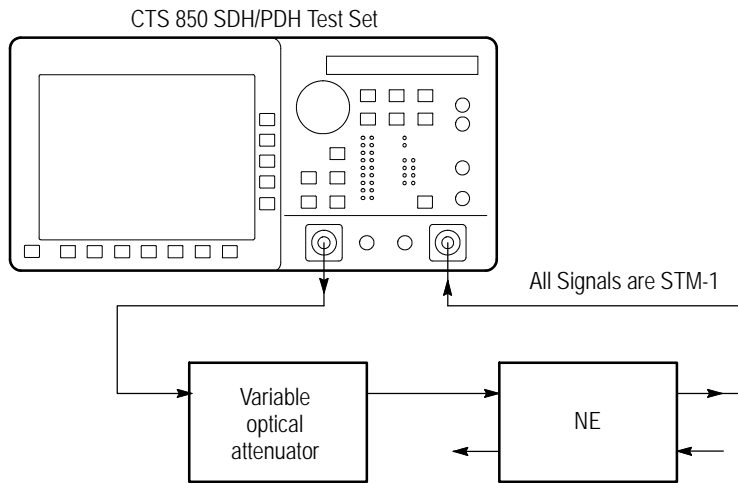


Figure 3 9: Setup to Check 1 dB Power Penalty Jitter Tolerance

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter Output	Line
TEST SETUPS	JITTER TESTS	Test Type	Jitter Tolerance
		Test Control	Edit Setup
		Mask Type	<i>as appropriate</i>
		Start Frequency	<i>as appropriate</i>
		End Frequency	<i>as appropriate</i>
		Number Freq Samples	<i>as appropriate</i>
		Tolerance Criteria	BER
		Record Error Threshold	Measure BER

3. Observe the Current BER and Recommended BER values in the display. Increase the optical attenuation until the Current BER reaches or exceeds the Recommended BER.
4. When the Current BER exceeds the Recommended BER:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Record Error Threshold	Record BER

5. Reduce the optical attenuation by 1 dB.
6. Press the **START/STOP** button on the CTS850 so that the START/STOP light is on.

The CTS850 applies progressively increasing jitter to the input until the Current BER reaches the threshold you set. At that time, the test stops automatically and the results are displayed.

#### Testing Clock-to-Line Jitter Transfer

This test measures the transfer function for jitter in the output of a network element relative to jitter in its clock. The CTS850 generates a 2 MHz G.703 clock signal containing jitter that is connected to the network element. The CTS850 also generates a jitter-free test pattern connected to the input of the network element. Then, the CTS850 receives the output from the network element and analyzes its performance.

You can specify several parameters for the test:

- H Mask type for jitter analysis
- H Start frequency
- H End frequency
- H Number of frequency samples

The results are displayed in numerical and graphical form.

1. Connect the CTS850 to the network element as shown in Figure 3 10.

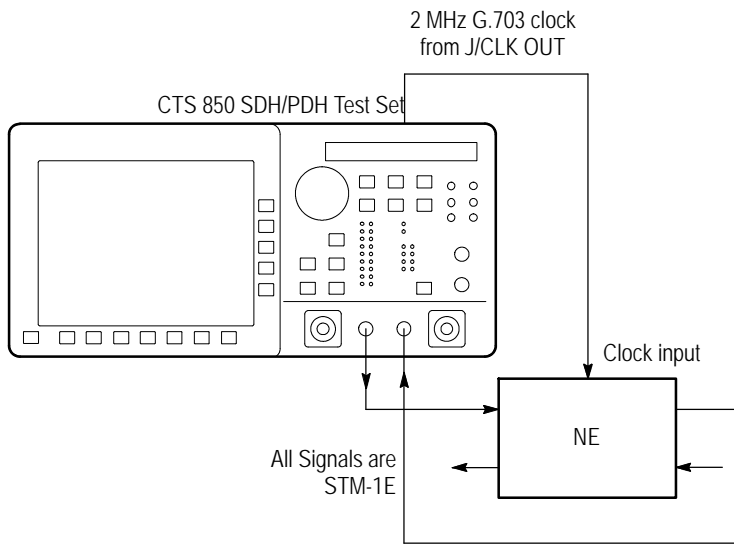


Figure 3 10: Setup to Check Clock-to-Line Jitter Transfer

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter Output	MHz G.703
RECEIVE	JITTER & WANDER	Jitter Input Source	Line
TEST SETUPS	JITTER TESTS	Test Type	Jitter Transfer
		Test Control	Edit Setup
		Mask Type	<i>as appropriate</i>
		Start Frequency	<i>as appropriate</i>
		End Frequency	<i>as appropriate</i>
		Number Freq Samples	<i>as appropriate</i>

3. Press the **START/STOP** button on the CTS850 so that the START/STOP light is on.

As the test is running, the jitter transfer graph is displayed on the screen. The test stops automatically after it has completed.

## Video Timing Quality Testing

Compressed digital video signals transmitted over a network can be impaired by low-frequency jitter or frequency drift that may be acceptable in other applications. One source of this jitter is pointer movement used to synchronize SDH payloads across a network. You can use the CTS850 to analyze jitter in a PDH signal due to pointer movement in the SDH signal. Two new measurements, Frequency Drift Rate and Pointer Hit Seconds, help show this effect.

The CTS850 generates a SDH signal containing a sequence of pointer movements. The CTS850 analyzes the timing of the dropped 34 Mb/s signal.

1. Connect the CTS850 to the network element as shown in Figure 3 11.

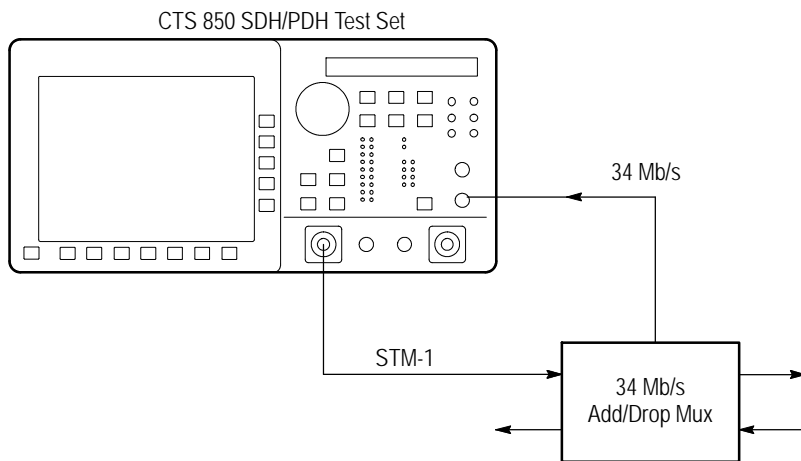


Figure 3 11: Setup to Check Video Timing Quality

2. Set up the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-1E
		Structure	TU3 Async
TRANSMIT	JITTER & WANDER	Jitter Output	Line
TRANSMIT	POINTERS & TIMING	Pointer/Timing Mode	Pointer Sequences
		Pointer Type	AU Pointer
		Sequence Type	Periodic 87 3
RECEIVE	RECEIVE SETTINGS	Receive Rate	34 Mb/s
RESULTS	SDH RESULTS	<i>none</i>	Jitter

3. Press the **POINTER ACTION** button to start the pointer sequence.

4. Press the **START/STOP** button on the CTS850 so that the START/STOP light is on.

As the test is running, results are displayed on the screen. The test stops automatically after it has completed.