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User Manual

Tektronix

CTS 850
Test Set
SDH/PDH, Jitter & Wander

070-9988-01

This document supports firmware version 2.8 and above.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

CTS 850 SDH/PDH Test Set

Injury Precautions

Use Proper Power Cord

To avoid fire hazard, use only the power cord specified for this product.

Avoid Electric Overload

To avoid electric shock or fire hazard, do not apply a voltage to a terminal that is outside the range specified for that terminal.

Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Do Not Operate Without Covers

To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

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Use Proper Fuse

To avoid fire hazard, use only the fuse type and rating specified for this product.

Do Not Operate in Wet/Damp Conditions

To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in Explosive Atmosphere

To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Wear Eye Protection

To avoid eye injury, wear eye protection if there is a possibility of exposure to high-intensity rays.

Product Damage Precautions

Use Proper Power Source

Do not operate this product from a power source that applies more than the voltage specified.

Provide Proper Ventilation

To prevent product overheating, provide proper ventilation.

Do Not Operate With Suspected Failures

If you suspect there is damage to this product, have it inspected by qualified service personnel.

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Safety Terms and Symbols

Terms in This Manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product

These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product

The following symbols may appear on the product:



DANGER
High Voltage



Protective Ground
(Earth) Terminal



ATTENTION
Refer to
Manual



Double
Insulated

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Certifications and Compliances

CSA Certified Power Cords

CSA Certification includes the products and power cords appropriate for use in the North America power network. All other power cords supplied are approved for the country of use.

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Preface

This manual describes how to use the Tektronix CTS850 SDH/PDH Test Set. This paper based manual, along with an accompanying user manual on CD ROM, is your primary source of information about how the CTS850 SDH/PDH Test Set functions.

How This Manual is Organized

The CTS850 information is divided into four sections: *Getting Started*, *Operating Basics*, *Reference*, and *Appendices*.

Getting Started provides an overview of the CTS850 and describes first time operation. Both the paper based user manual and the reference manual on CD contain this information.

Operating Basics explains the basic principles of operating the CTS850. The *Operating Basics* section also includes a tutorial which introduces you to most of the capabilities of the CTS850 test set. Both the paper based user manual and the reference manual on CD contain this information.

Reference provides explanations of how to perform detailed tasks. The paper based manual includes information on Basic Test Procedures and a detailed look at Jitter/Wander Testing. All other *Reference* information is contained in the reference manual on CD.

The *Appendices* provide a listing of specifications, default factory settings, an incoming inspection test, a section on telecommunications technology, a listing of relevant ITU T standards, and other useful information. All *Appendices* information is contained on the reference manual on CD only.

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Conventions

This manual uses the following conventions:

The names of front-panel controls and menus appear in all upper case letters, for example, TRANSMIT and HELP.

Names appear in the same case in this manual as they appear on the display of the CTS850, for example, Test Duration and USER DEFINED.

Within a procedure, a specific button to be pressed or a parameter to be selected appears in boldface print. For example, press the **AUTOSCAN** button or select **Continuous**.

The *Tutorial* and the *Reference* sections frequently present procedures in tables. Perform the procedure by 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 with Step 1	Step 2	Step 3	Step 4
		Step 5	Step 6
		Step 7	Step 8, CTS850 instruction is complete

Some procedures require several iterations of highlighting parameters and selecting choices. Some procedures may require more than one menu button or menu page selection as well.

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Related Manuals

The following documents are also available for CTS850 SDH/PDH Test Set:

The CTS850 SDH/PDH *Reference Manual on CD* (Tektronix part number 063 3013 01) contains all the user manual information, in a portable electronic document format.

The CTS850 SDH/PDH Test Set *Programmer Manual* (Tektronix part number 070-9990 XX) describes how to control the CTS850 using an instrument controller.

Wander Analyst User Manual (Tektronix part number 071 0518 XX) and Wander Analyst 6.0 PC software (Tektronix part number 063 3196 XX) for TDEV/MTIE analyis. This PC application software is bundled with Option 14 Jitter/Wander.

The *CTS850 SDH/PDH Test Set Service Manual* (Tektronix part number 070-9991-XX) provides information on maintaining and servicing your instrument to the module level.

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Contacting Tektronix

Product Support	For application-oriented questions about a Tektronix measurement product, call toll free in North America: 1-800-TEK-WIDE (1-800-835-9433 ext. 2400) 6:00 a.m. 5:00 p.m. Pacific time Or contact us by e-mail: tm_app_supp@tek.com For product support outside of North America, contact your local Tektronix distributor or sales office.
Service Support	Contact your local Tektronix distributor or sales office. Or visit our web site for a listing of worldwide service locations. http://www.tek.com
For other information	In North America: 1-800-TEK-WIDE (1-800-835-9433) An operator will direct your call.
To write us	Tektronix, Inc. P.O. Box 1000 Wilsonville, OR 97070-1000

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Getting Started

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Getting Started

This section provides a description of the CTS850, a list of standard and optional accessories, and explains how to operate the CTS850 for the first time.

Product Description

The Tektronix CTS850 SDH/PDH Test Set is a rugged, portable test set designed for installing and maintaining telecommunications networks. The CTS850 is an SDH analyzer that combines bit error rate test capabilities with overhead testing, payload mapping, and demapping in one unit. The CTS850 features the following capabilities:

- STM-0E, STM-0, STM-1E, STM-1, STM-4, 2 Mb/s, 8 Mb/s, 34 Mb/s, and 140 Mb/s transmit and receive
- Optical interface available at 1310 nm and 1550 nm
- Bit Error Rate testing
- BER test of VC4 4c concatenated payloads at 622 Mbit/s
- 45 Mbit/s mapping and demapping into SDH (optional)
- BIP error monitoring and analysis
- 2, 8, 34 and 140 Mbit/s PDH multiplexing/demultiplexing (MUX/DEMUX) with N/Mx64 kbit/s testing
- Payload mapping and demapping
- Jitter generation and analysis
- Wander generation and measurement (Real Time Wander Analyst PC application software for TDEV/MTIE)
- Unique timing quality measurement
- Pointer generation, including sequences and analysis
- Alarm generation and analysis

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- TU error monitoring and analysis
- Performance monitoring per G.821, G.826, M.2100 and M.2101.1 on all layers simultaneously
- Automatic Protection Switching (APS) testing
- DCC and user channel access
- Programmable via IEEE 488.2 and RS-232

The CTS850 meets the needs of the craftsperson and the network engineer. The CTS850 meets the requirements of those working in network installation and maintenance by providing the capability to perform:

- Network integrity testing
- In-service performance monitoring
- Stimulus and response testing
- Stress testing
- Overhead testing
- Automated jitter conformance testing
- G.821, G.826, M.2100 and M.2101.1 performance measurement

Accessories

Some accessories are included with the CTS850 SDH/PDH Test Set. If you wish to purchase optional accessories or additional standard accessories, see a Tektronix products catalog or contact your local Tektronix field representative.

Standard Accessories

- CTS850 SDH/PDH Test Set *User Manual*, Tektronix part number 070-9988-XX
- CTS850 SDH/PDH Test Set *Reference Manual on CD ROM,* Tektronix part number 063 3013 XX

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- CTS 850 SDH/PDH Test Set *Programmer Manual*, Tektronix part number 070-9990-XX
- Instrument Front Cover, Tektronix part number 200-3232-XX
- 75 loopback BNC cable, Tektronix part number 012-1338-XX
- Pouch (to hold printer, user manual, etc.) Tektronix part number 016-1266-XX

Optional Accessories

- *CTS 850 SDH Test Set Service Manual* (Tektronix part number 070-9991-XX)
- Electrical STS 0E/1E and STM 1 Plug in (Standard)
- FC, SC or ST Optical Connectors
- 1.6/1.5 connectors for all 75 Ohm BNC front panel connectors
- 2,8,34, 140 Mbit/s, VC 12, TU 3 Add/Drop Test
- Universal European: 220 V, 50 Hz power cord
- UK: 240 V, 50 Hz power cord
- Australian: 240 V, 50 Hz power cord
- North American: 240 V, 60 Hz power cord
- Switzerland: 220 V, 50 Hz
- Hard Transit Case, Tektronix part number 016-1157-XX
- Soft Carrying Bag, Tektronix part number 016-1158-XX
- Optical Connector Kit, Tektronix part number 020-1885-XX

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Navigation CTS 850 Paper based Manual & CD ROM

The following table shows you where to quickly find the section that answers your particular test & measurement questions.

In order to get you going as fast as possible with the CTS 850 test set, the paper based user manual focuses solely on Getting Started information.

Everything else appears in the reference manual on CD ROM, including all information contained in the paper based user manual.

Table 1 1: Where to Find Information in this User Manual

If you want to know how to:	Look in this part of the manual:
Use the basic functions of the test set, including Controls, indicators, connectors; Elements of front panel display; Menu structure; Online help; Connecting signals; Selection and editing of choices; Disk drive operation	*Functional Overview,* Chapter 2 (paper based and reference manual on CD)
Tutorial	*Tutorial,* Chapter 2
Setup and use the test set for network and equipment test applications, including * Network continuity checking * Transmission signal quality testing * Fault tolerance testing * Performance monitoring * Jitter and wander testing * Video timing quality testing	*Basic Test Procedures,* Chapter 3 (paper based and reference manual on CD)
Set TX (SDH, PDH) (reference manual on CDonly)	
Set transmit rate; specify the AU under test; set the payload mapping and content; and set the overhead bytes for SDH signals	*Setting SDH Transmit Parameters,* Chapter 3
Set transmit rate, transmit clock, line clock offset, payload, framing, test pattern, active channel and background pattern for PDH signals	*Setting PDH Transmit Parameters,* Chapter 3

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Table 1 1: Where to Find Information in this User Manual (Cont.)

If you want to know how to:	Look in this part of the manual:
Set RX (SDH, PDH) (reference manual on CDonly)	
Set receive line rate; specify the AU under test; set payload mapping and content; check received optical signal power; view overhead bytes for SDH	*Setting SDH Receive Parameters,* Chapter 3
Set the receive rate, receive level, framing and test pattern for PDH signals	*Setting PDH Receive Parameters,* Chapter 3
Jitter/Wander Set TX/RX, Work with Test Setups, Calibrate (paper based and reference manual on CD)	*Setting Jitter/Wander Parameters,* Chapter 3
Set & Test Alarms, Errors, Pointers, Timing, APS (reference manual on CDonly)	
Generate error conditions, set alarms, and simulate network failures	*Setting Alarms and Inserting Errors,* Chapter 3
Generate Automatic Protection Switching (APS) commands and view the network response	*Testing Automatic Protection Switching,* Chapter 3
Set the duration for a test, the resolution of test history, start and stop a test	*Setting Test Control Parameters,* Chapter 3
Save and recall instrument setups; Create and run pass/fail tests	*Working with Test Setups*, Chapter 3
Change date and time settings, printer settings, GPIB, RS 232 parameters. Run a self test	*Changing Instrument Settings*, Chapter 3
View, Print, Save & Recall Measurements (reference manual on CDonly)	
Monitor input signal for alarms, errors and failures, indicating current signal status, history of signal status	*Checking Signal Status*, Chapter 3
View, save, recall, and print test results	*Viewing Results*, Chapter 3

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Table 1 1: Where to Find Information in this User Manual (Cont.)

If you want to know how to:	Look in this part of the manual:
Appendices (reference manual on CDonly)	
Review available menu choices; Navigate menus	*Menu Maps*, Appendix A
Interpret Status & Error Messages	*Status & Error Messages*, Appendix B
Review Default Factory Settings	*Default Factory Settings*, Appendix C
Check all Specifications	*Specifications*, Appendix D
Verify the test set functions properly	*Incoming Inspection Test*, Appendix E
Check examples of instrument setups, test results and pass/fail tests that can be loaded into the test set	*Example Disk Contents*, Appendix F
Explain Rear Panel Connectors	*Rear Panel Connectors*, Appendix G
Change Optical Port Connectors	*Changing Optical Port Connectors*, Appendix H
Pack for Shipment	*Packing for Shipment*, Appendix I
Review telecommunications technology used by the test set	*Telecommunications Technology*, Appendix J
Look up word meanings in Glossary; review ITU T standards used by the test set	*Glossary and ITU T Standards*

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First Time Operation

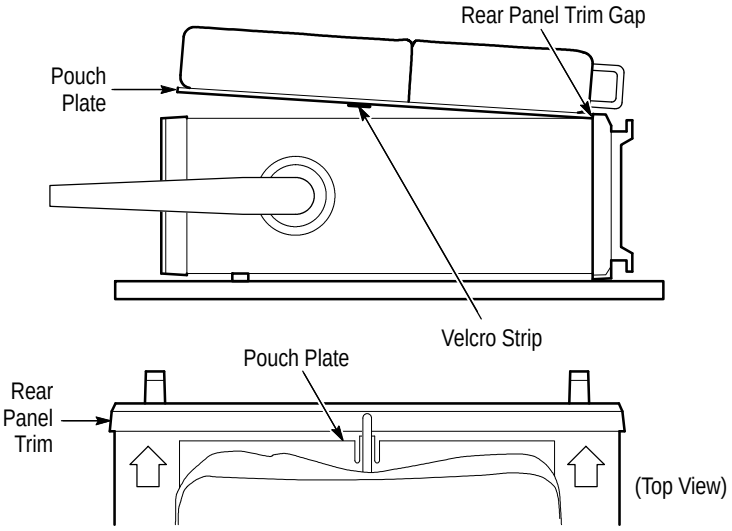
This section describes how to set up the CTS850 for the first time.

Installing the Accessory Pouch

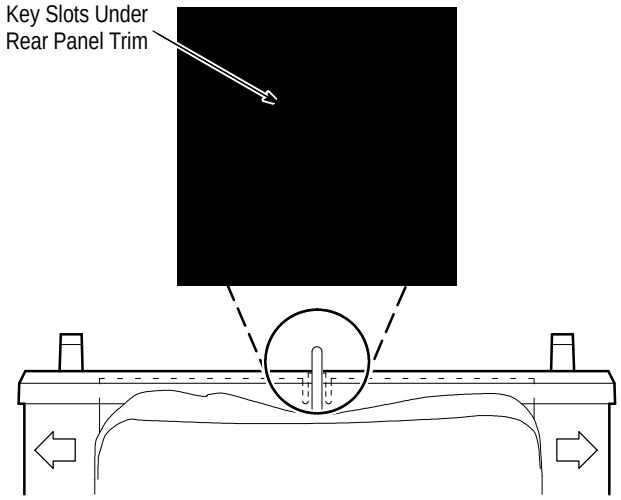
The CTS850 ships with an accessory pouch that mounts on top of the instrument. The pouch is not installed at the factory. To install the accessory pouch:

1. Place the CTS850 on a table or work bench with the front facing toward you.
2. Center the pouch plate and insert the rear edge of the plate in the space between the cabinet top and the rear panel trim (see part A of Figure 1 1).
3. Move the pouch sideways as necessary to line up the key slots in the pouch plate with the keys on the rear panel (the plate is centered when it is aligned) and push the plate all the way in (see part B of Figure 1 1).
4. While keeping the pouch plate pushed under the rear panel trim, reach under the pouch plate and carefully remove the backing from the Velcro strip to expose the adhesive on the Velcro strip. The Velcro should remain attached to the pouch plate.
5. Grasp the pouch plate assembly with both hands near the front of the assembly.

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A. Push the pouch plate into the rear panel trim gap.



B. Center the pouch plate to align with key slot under the rear panel trim.

Figure 1 1: Installing the Accessory Pouch

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CAUTION. *In the next step, use only enough force to clear the front panel trim with the plate front edge. Excessive force will cause a permanent bow in the plate.*

6. Push back on the pouch plate and press down with the heels of your hands to bow the plate enough to slide the front of the plate into the space between the cabinet top and the front panel trim (see Figure 1 2).
7. Move the front of the pouch as needed to line up the slots in the plate with the keys on the front panel.
8. Release the pressure on the plate to allow it to return to its normal flat shape.
9. Press down firmly to secure the Velcro strip to the top of the cabinet top.

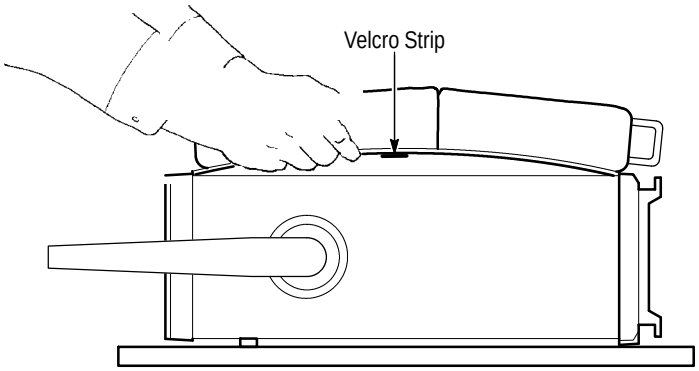


Figure 1 2: Inserting the Pouch Under the Front Panel Trim

CAUTION. *Do not use the D-ring (see Figure 1 3) on the pouch plate to lift the* CTS850. *Using the D-ring to lift the* CTS850 *can pull the accessory pouch off the* CTS850, *resulting in damage to the* CTS850.*The purpose of the D ring is to provide extra support when the test set is placed in an upright position.*

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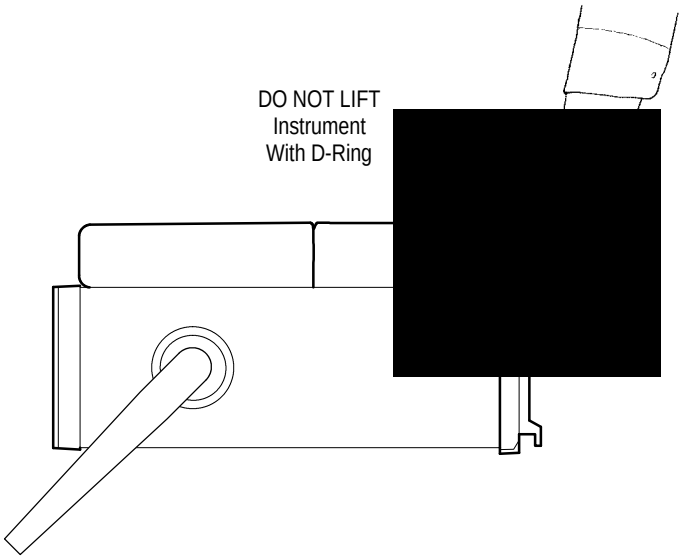


Figure 1 3: Location of the D-Ring on the Accessory Pouch

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Setting Up the CTS850

Before you use the CTS850, ensure that it is properly set up and powered on.

To properly set up the CTS850, do the following:

1. Be sure that the environment in which you will operate the CTS850 is within instrument specifications. Specifications for temperature, relative humidity, altitude, vibrations, and emissions are included in the Appendix.
2. Leave space around the CTS850 for cooling. Verify that the air intake and exhaust holes on the sides of the cabinet (where the fan operates) are free of any airflow obstructions. Leave at least 5 cm (2 in) free on each side.



WARNING. *To avoid electrical shock, be sure that the power cord is disconnected before checking the fuse.*

3. Check the fuse to be sure it is the proper type and rating (see Figure 1 4). The CTS850 works with one of two fuses, depending on the AC supply. Each fuse requires its own cap (see Table 1 2). The CTS850 is shipped with the UL-approved fuse installed.

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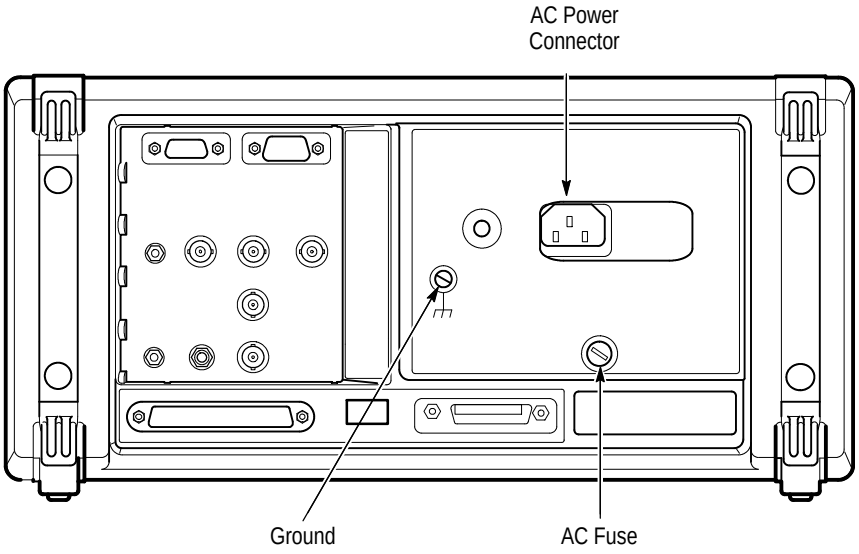


Figure 1 4: Rear-Panel Controls and Connectors Used in Setup

See page 2 4 in the next chapter for a labeling of what each rear panel connector is. See the appendix on Rear Panel Connections for a more comprehensive explanation of the rear panel connectors.

Table 1 2: Fuse and Fuse Cap Part Numbers

Fuse	Fuse Tektronix Part Number	Fuse Cap Tektronix Part Number
0.25 in 1.25 in (UL 198.6, 3AG): 8 A FAST, 250 V	159-0046-XX	200-2264-XX
5 mm 20 mm * (IEC 127): 6.3 A, 250 V	159-0381-XX	200-2265-XX

* If it is necessary to use the extra 5 mm x 20 mm fuse included in the fuseholder, the fuse cap must be removed.

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4. Check that you have the proper electrical connections. The CTS850 power requirements are listed in Table 1 3.

Table 1 3: Power Requirements

Voltage Range	Frequency Range
90 132V	50/60 Hz
180 250V	50/60 Hz
100 132V	400 Hz

5. Connect the proper power cord from the rear-panel power connector (see Figure 1 4) to the power system.

Turning On the CTS850

To properly turn on the CTS850:

1. Press the front panel **ON/STBY** button (see figure 1 5).

   The ON/STBY button controls power to all instrument circuits.

   The CTS 850 performs an internal self test each time it is turned on. When turned on, it displays a screen that states whether or not it passed the self test. (If the self test passes, the status display screen is removed after a few seconds.)

2. Check the self test results.

   If the self test fails, contact your local Tektronix Service Center for assistance.

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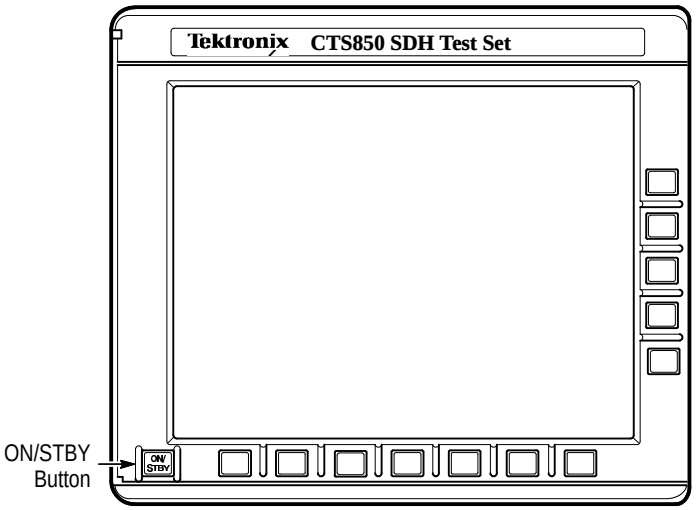


Figure 1 5: ON/STBY Button

Turning Off the CTS850

Press the **ON/STBY** button to turn off the CTS850.

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Operating Basics

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Functional Overview

This section describes how to use and navigate through the basic functions of the CTS850, including:

- Controls, indicators, and connectors
- Elements of the display
- Menu structure
- On-line help
- Connecting signals
- Parameter selection and editing
- Disk drive operation

This section also details conceptual information important to the use of the CTS 850, in particular:

- Difference between Synchronous, Plesiochronous, and Asynchronous
- PDH Hierarchy
- Definitions Anomaly, Defect, Failure and Alarm
- SDH Multiplexing Principles
- Difference between Add/Drop, Map/Demap and Multplex/ Demultiplex
- 45 Mb/s Map/Demap Implementation

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Front-Panel Controls, Indicators, and Connectors

Figures 2 1 and 2 2 identify the controls, indicators, and connectors located on the front panel of the CTS850 SDH/PDH Test Set.

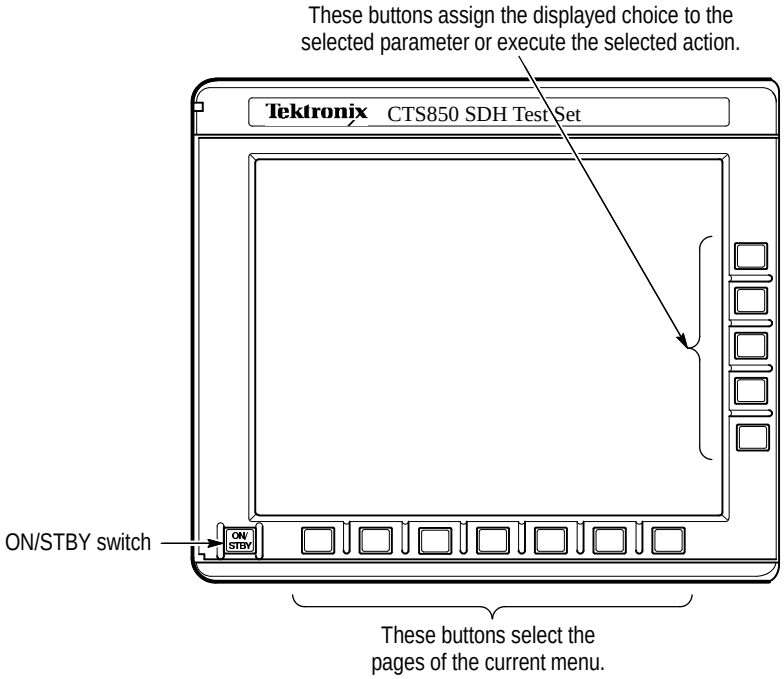


Figure 2 1: Controls Located Around the Display

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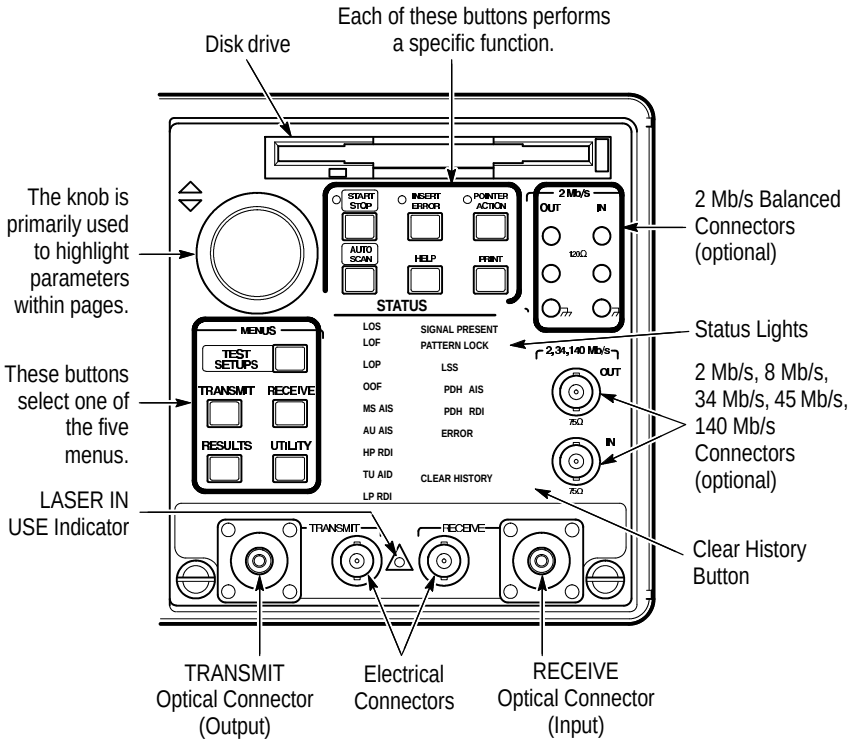


Figure 2 2: Front-Panel Controls, Indicators, and Connectors

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Rear-Panel Controls and Connectors

See the appendix on Rear Panel Connections for a more comprehensive explanation of the rear panel connectors.

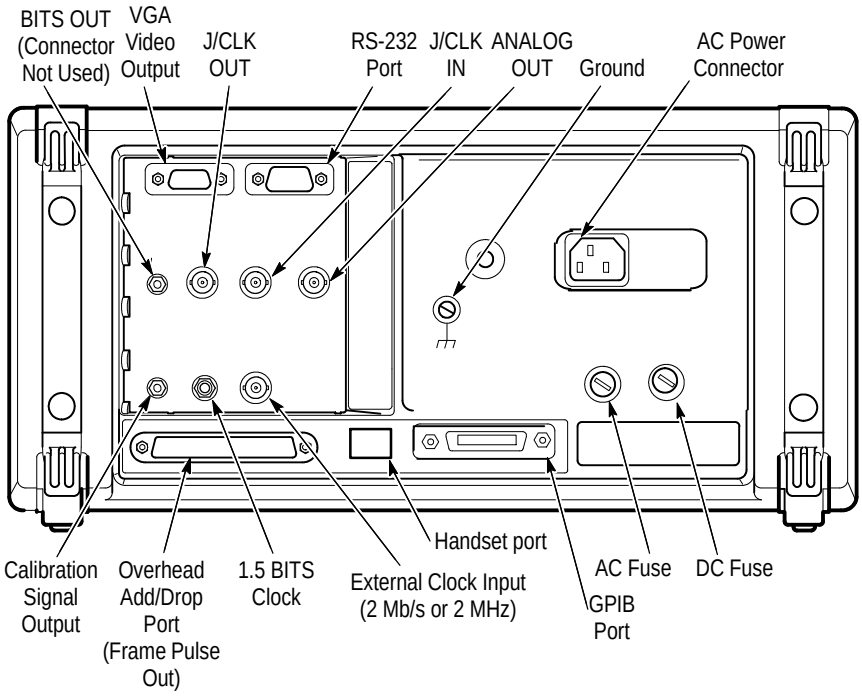


Figure 2 3: Rear-Panel Controls and Connectors

Front-Panel Status Lights

The status lights make it easy to quickly determine the condition of the received signal. There are three types of front-panel status lights.

H Green status lights. Green lights indicate whether a signal is present and whether the CTS850 has locked onto the signal.

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- **H** Red status lights. When a red status light is on, it means that the indicated event is occurring. When the red light is off, no event is occurring.
- **H** Yellow history lights. Once an event has been detected, a yellow history light is turned on. The yellow history light shows that the associated event occurred at some time in the past. Yellow history lights remain on until you reset the event history by pressing the CLEAR HISTORY button, starting a new test, or changing the Receive Configuration settings (Receive Rate, Receive Pattern, etc.).

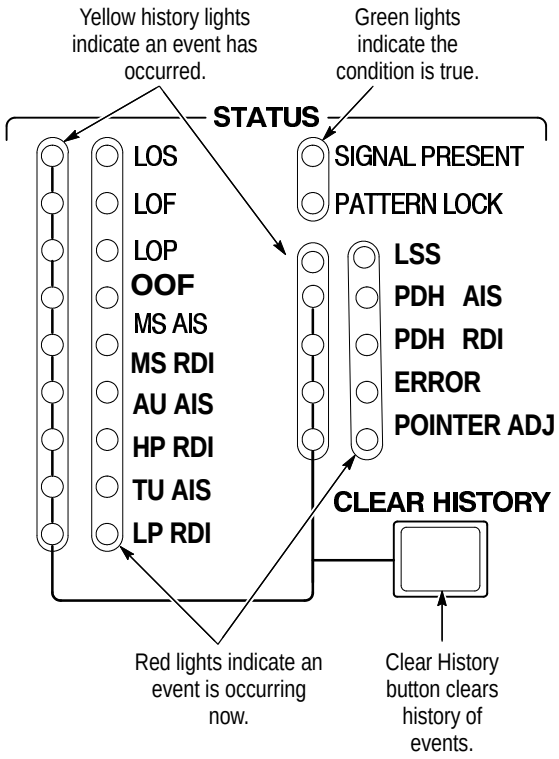


Figure 2 4: Status Lights

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Reading the Display

There are several major areas that make up the CTS850 display (see Figure 2 5).

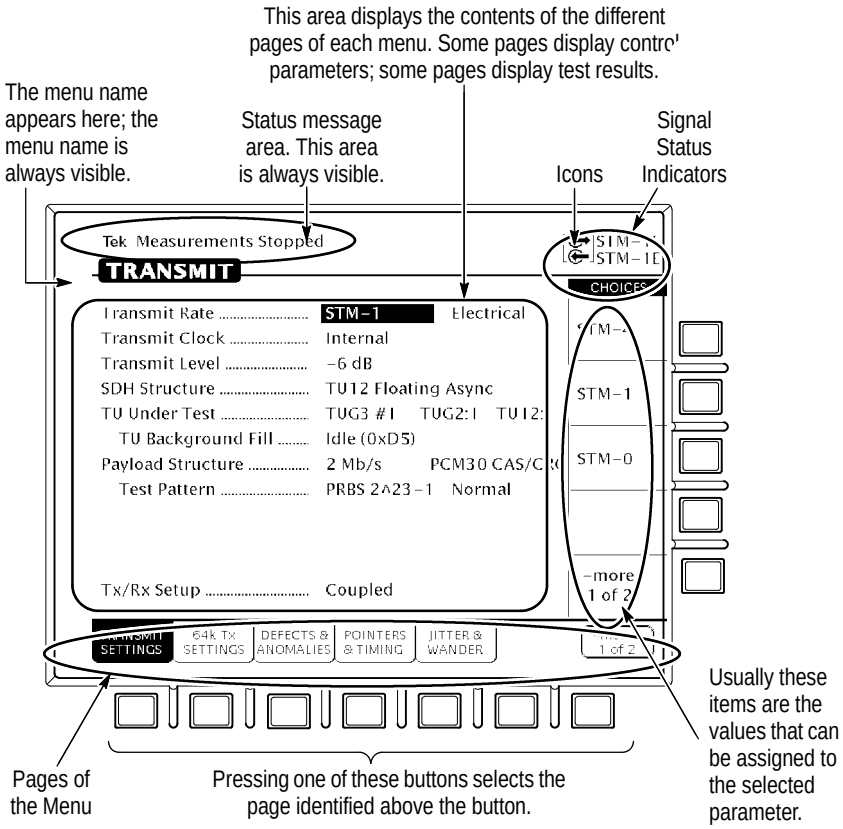


Figure 2 5: Major Areas of the Display

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Figure 2 6 provides a guide to specific areas of the display.

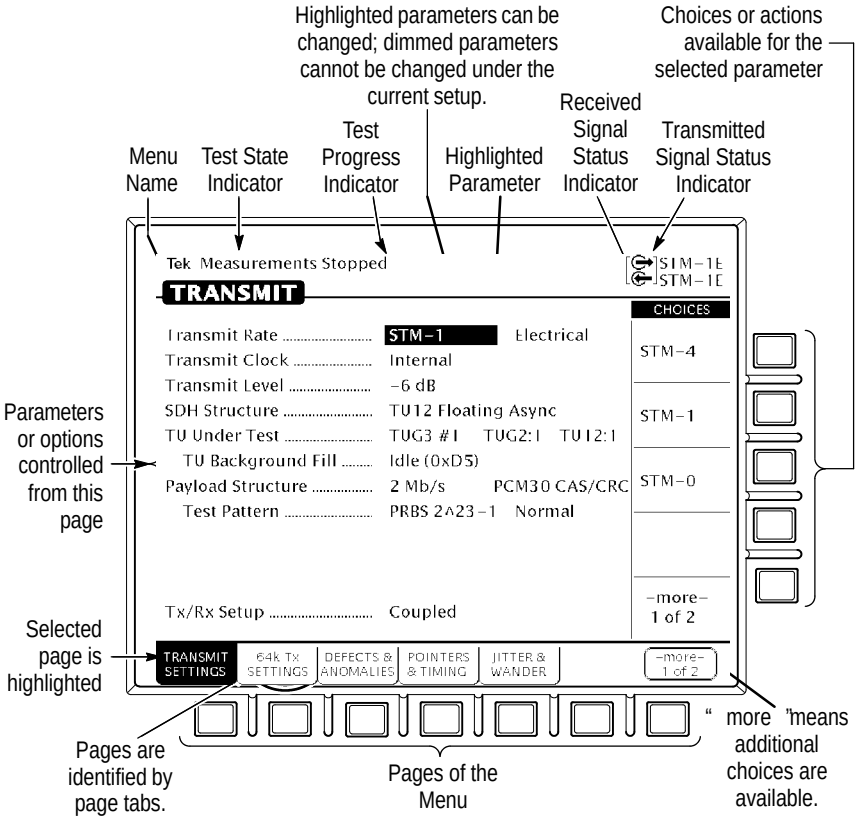


Figure 2 6: Specific Elements of the Display

Table 2 1 provides a list of icons that appear on the display. Icons are used to identify information, indicate instrument status, and clarify available actions.

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Table 2 1: Icons that Appear in the Display

Icon	Meaning
	Transmitted signal
	Received signal
	CTS850 is in through mode
	CTS850 is in coupled mode
	Use the knob
	Not allowed
	File stored on disk
	File stored in memory
	Message or warning identifier
	Press the button to perform the indicated action
	The CTS850 is busy

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The Basic Menu Structure

The CTS850 is controlled primarily through its menu system. Though several controls are located on the front panel, such as INSERT ERROR, most functions are controlled from one of the five menus. Figure 2 7 shows the five menus.

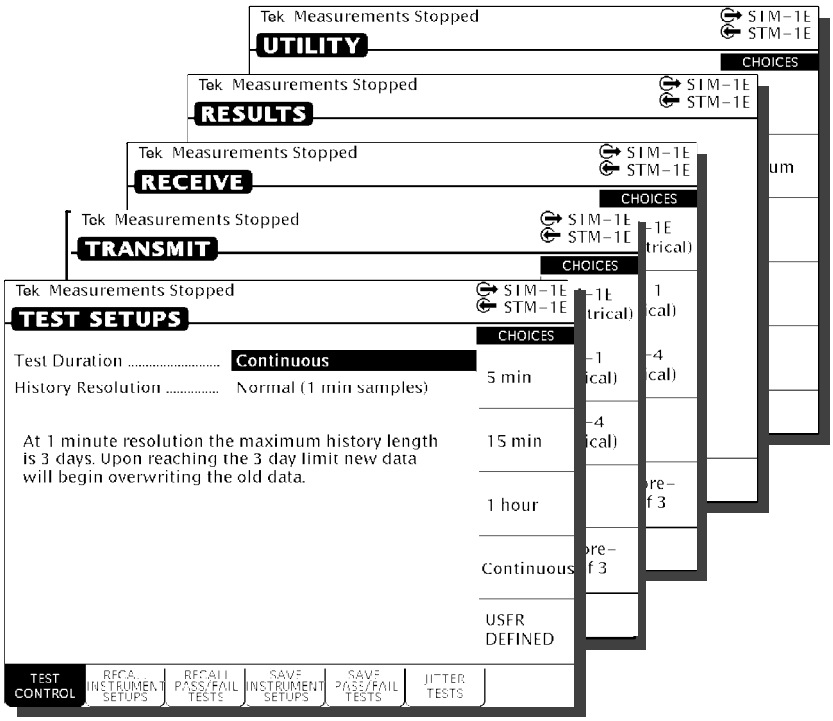


Figure 2 7: The Five Menus

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What is a Menu?

A menu groups related functions together. For example, all settings that affect the signal transmitted by the CTS850 are located in the TRANSMIT menu. Each menu is made up of pages. A page is identified by a page tab located at the bottom of the display (see Figure 2 8).

If the choice is not available, it is not displayed or it is not highlighted.

The CTS850 always displays a menu. The name of the current menu is shown near the top of the display. To change to another menu, press a menu button on the front panel.

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TEST SETUPS						
Test Control	Recall Instrument Settings	Recall Pass/Fail Tests	Save Instrument Setups	Save Pass/Fail Tests	Jitter Tests	
TRANSMIT						
Transmit Settings	64k Tx Settings	Defects & Anomalies	Pointers & Timing	Jitter & Wander	APS Commands	More 1 of 2
Transmit Settings	Section Overhead	Path Overhead	Trace Settings	Signal Labels	Overhead PRBS Test	More 2 of 2
RECEIVE						
Receive Settings	64k Rx Settings	Signal Status	Analysis Config	Jitter & Wander		More 1 of 2
Receive Settings	64k Rx Settings	Section Overhead	Path Overhead	RX CAS & Voice		More 2 of 2
RESULTS						
Test Summary	SDH Results	PDH Results	Jitter & Wander	Error Analysis	Perf Analysis	More 1 of 2
Test Summary	SDH Results	PDH Results	History Graphs	Save Results	Recall Results	More 2 of 2
UTILITY						
Misc. Settings	Printer Setup	Remote Control	Instr Config	Self Test	Jitter Cal	

Figure 2 8: Menus and Pages

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***NOTE**. The only time pressing a menu button does not change menus is when a dialog box is displayed or when you are entering a value for a parameter. You must first exit the dialog box or finish entering the value before you can change menus.*

A page usually provides control over a related group of instrument functions or parameters. For example, the TRANSMIT SETTINGS page in the TRANSMIT menu controls the rate, format, and active channels of the signal transmitted by the CTS850. However, some pages display information rather than provide control over settings; for example, the pages of the RESULTS menu display various test results.

Selecting Menus

To display a menu, press the button with the same on the front panel with the same name (see Figure 2 9).

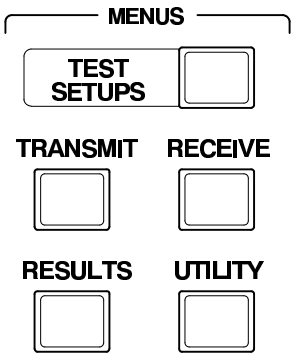


Figure 2 9: Menu Select Buttons

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Selecting Pages

To select a page within a menu, press the button beneath the page tab located at the bottom of the display (see Figure 2 10).

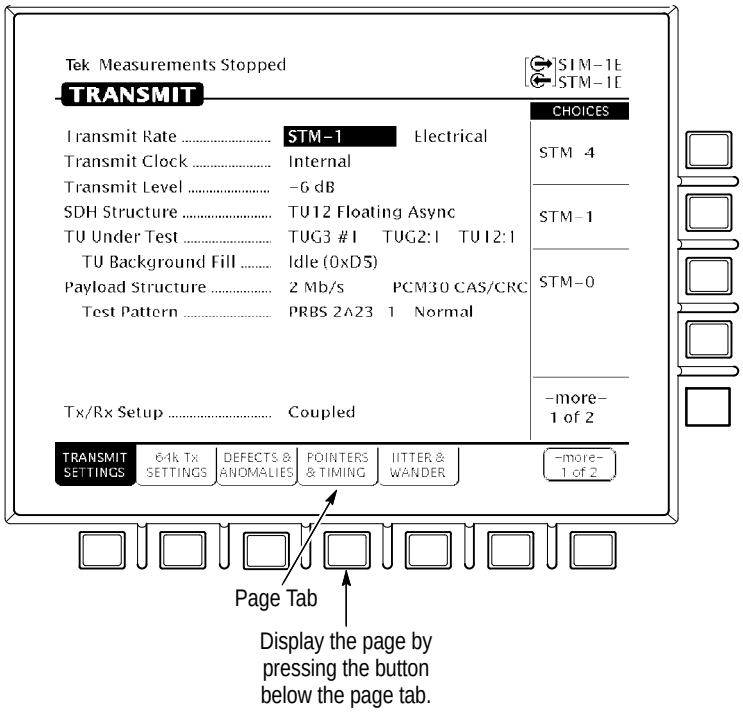


Figure 2 10: How to Display a Page

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Displaying Help

To display help, press the **HELP** front-panel button.

When the HELP dialog box appears, use the knob to select the topic you wish to view (see Figure 2 11). After you select the topic to view, select **View Help** to see the help screen.

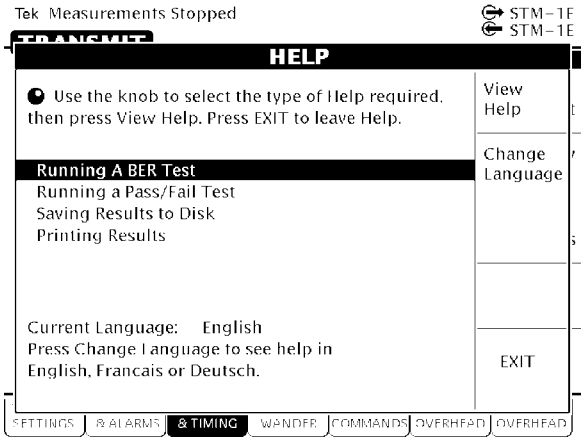


Figure 2 11: Help Dialog Box

Once you press View Help, the help screen for that topic is displayed. If a help topic covers more than one page, you can display the next page by selecting **Page Down**. To display the previous page, select **Page Up**.

To display help in a different language, select **Change Language**. Then, to display help in French, select **Francais**. To display help in German, select **Deutsch**. To display help in Spanish, select **Espanol**. To display help in Portuguese, select **Portugues.**

When you finish reading the help text, you can exit the help dialog box by selecting **EXIT**. If you wish to read additional help topics, select **Help Menu** to return to the main help screen.

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Connecting Signals

To connect signals to the CTS850, use the electrical and optical connectors located at the bottom and right side of the front panel.

For optical connections, the CTS850 accepts both single mode and multimode fiber. For electrical connections, the CTS850 accepts 75 coaxial cable with BNC connectors for SDH rates and 2 Mb/s Unbalanced, 8 Mb/s, 34 Mb/s, and 140 Mb/s rates. The CTS850 accepts Siemens connectors for 2 Mb/s Balanced signals.

Connecting Optical Signals

***NOTE**. The optical TRANSMIT output is produced by a Class 1 laser device. The output from a Class 1 laser is safe to view without special eye protection. However, because other optical signals in your environment may exceed the Class 1 limits, we recommend eye protection as a precaution.*

***NOTE**. When performing a loopback test with the CTS 850 and using the 1550 nm laser, always use 10 dB of attenuation. Always pad the input level to less than 10 dBm.*

To connect optical signals to the CTS850:

1. Unscrew the dustcap that covers the optical port on the CTS850.
2. Remove the dustcap (if present) covering the connector on the optical fiber.
3. Carefully insert the transmit end of the optical fiber into the **RECEIVE** port on the CTS850. Line up the key on the optical fiber connector with the cutout on the optical port connector. Make sure that the optical fiber connector is fully inserted into the optical port.
4. Tighten the optical fiber connector so it does not accidentally come loose during use.

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5. Carefully insert the receive end of the optical fiber into the **TRANSMIT** port on the CTS850 line up key. Make sure that the optical fiber connector is fully inserted into the optical port.
6. Tighten the optical fiber connector so it does not accidentally come loose during use. Tighten the connectors only finger tight; do not use a tool to tighten the connectors.



CAUTION. *To prevent damage to the optical port connectors and to keep them clean, always replace the dustcaps on the optical port connectors when not using the optical ports.*

Connecting SDH Electrical Signals

To connect SDH electrical signals to the CTS850:

1. Connect the transmit end of the cable to the **RECEIVE** connector on the CTS850.
2. Connect the receive end of the cable to the **TRANSMIT** connector on the CTS850.

Connecting PDH Electrical Signals

To connect electrical signals to the CTS850:

1. Connect the transmit end of the cable to the **IN** connector for the appropriate rate on the CTS850.
2. Connect the receive end of the cable to the **OUT** connector for the appropriate rate on the CTS850.

Initiating Autoscan

Autoscan is a feature that automatically scans the received signal and changes the CTS850 receive settings to match the received signal.

To initiate the autoscan feature, press the **AUTOSCAN** front-panel button. For detailed information on the AUTOSCAN function, see *Checking Signal Status* in Chapter 3 Reference. One limitation to be aware of is when the CTS 850 autoscans a TU. It is unable to directly recognize signals created by lower rate PDH signals (but can in later Autoscan steps).

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Changing Parameters

Most of the menu pages in the CTS850 contain parameters (or settings) that you can change. The choices available for a parameter appear in four ways (examples in parentheses):

- As a list (Test Pattern: PRBS 2^23 1, PRBS 2^20 1, ...)
- As a decimal number (Frequency Offset: 74.3 ppm)
- As a binary number (Z1 Byte: 10101111)
- As a text string (File Name: TEST_34)

Selecting Parameters

To change a parameter, use the knob to highlight it. As you turn the knob, the highlight moves from parameter to parameter (see Figure 2 12).

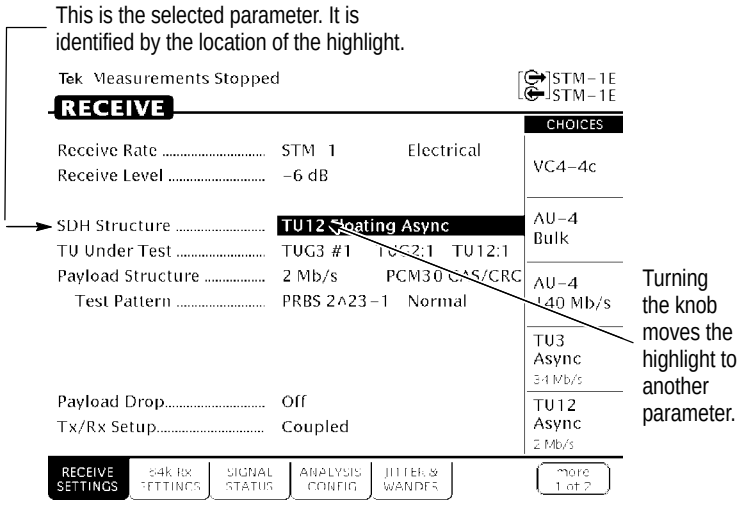


Figure 2 12: Selecting a Parameter

The parameter values displayed in high-intensity text indicate parameters that you can change. If a parameter is displayed in dimmed text, it cannot be selected under the current setup.

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Selecting from Lists

Most parameters have a group of choices available. The choices are presented as a list, located along the right side of the display. Press the button next to the choice to assign that choice to the highlighted parameter.

Sometimes parameters have more than five choices available. When more than five choices are available, the bottom choice changes to more . Selecting **more** displays additional choices. Each time you press more the next list of choices is displayed. Below more is a line that shows which list of choices is displayed. When the last list of choices is displayed, pressing **more** displays the first list of choices again (see Figure 2 13).

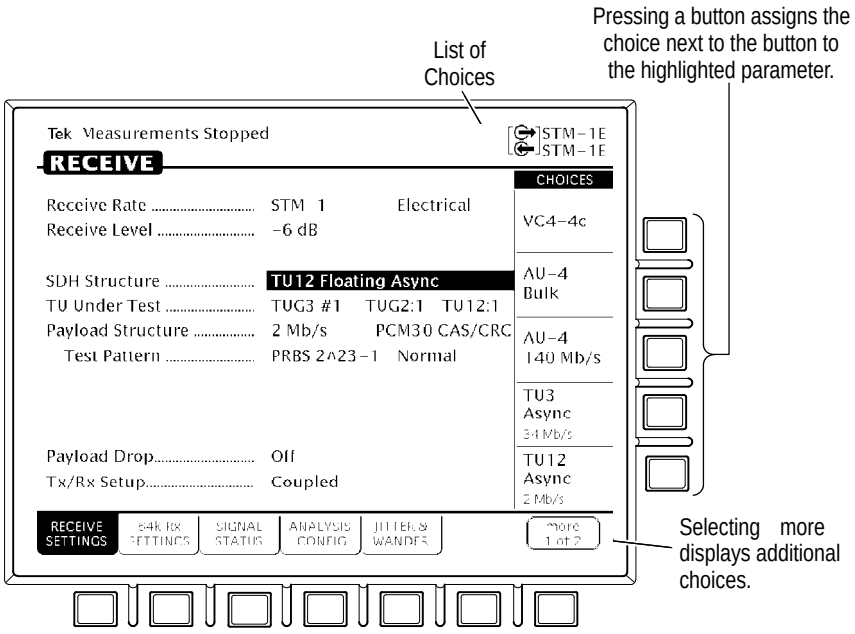


Figure 2 13: Selecting Choices From a List

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Changing Decimal Numbers

Some parameters allow you to set a numeric value for them. For these parameters, preset choices are always provided to save you time. However, if the preset choices are not appropriate for your needs, you can set specific values by selecting the **USER DEFINED** choice (see Figure 2 14).

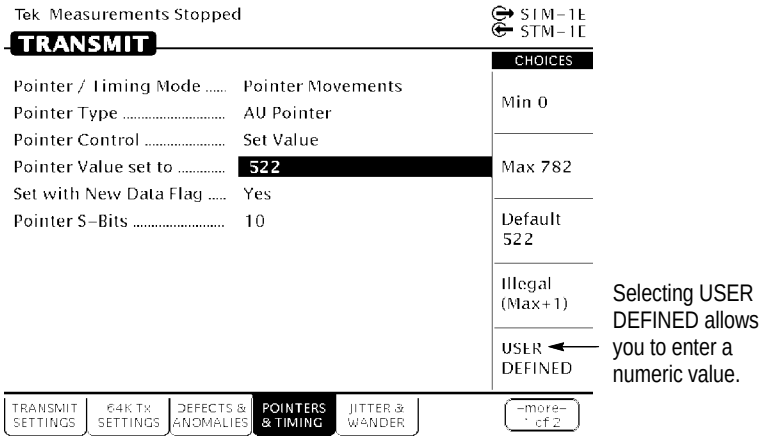


Figure 2 14: Selecting USER DEFINED

After you select USER DEFINED, the buttons at the right side of the display are reassigned, as shown in Figure 2 15.

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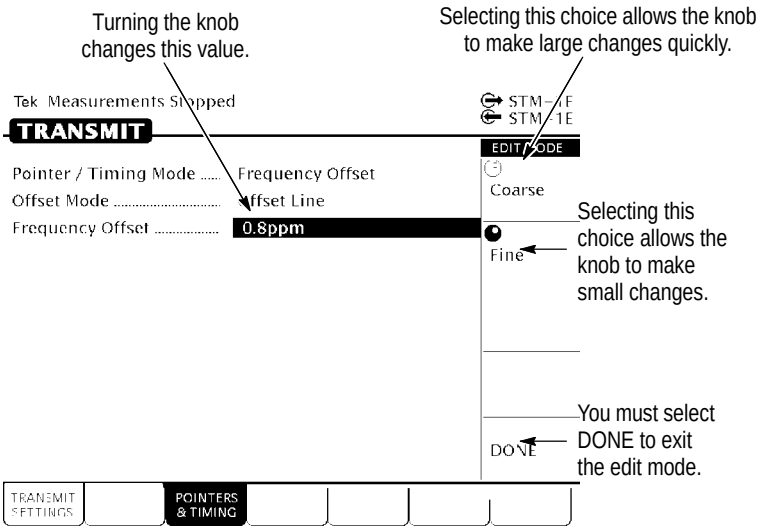


Figure 2 15: Entering a Numeric Value

After you press USER DEFINED, the CTS850 enters edit mode. In edit mode, you change the value of the highlighted parameter by turning the knob. When you have set the parameter to the desired value, select **DONE** to enter the value and exit edit mode.

***NOTE**. The new value does not take effect until DONE is selected.*

When in edit mode, the knob can work in several ways. As shown in Figure 2 15, the knob can be assigned to make either coarse or fine adjustments to the highlighted parameter. For other parameters, the knob is assigned to change different elements of the selected parameter. For example, when setting a test time, rather than making coarse or fine adjustments, the knob is assigned to change days, hours, minutes, or seconds.

The knob icon is displayed in solid form to indicate which function it is currently assigned to. The knob icon is displayed in outline form next to other possible choices.

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Changing Binary Numbers

There are two kinds of binary numbers that can be changed in the CTS850: payload patterns and overhead bytes. As with other numerical values, you can select preset values or enter specific values by selecting Edit Byte.

To change a byte:

1. Highlight the byte with the knob (see Figure 2 16).
2. Change the byte by selecting one of the preset choices at the right side of the display or to enter a different bit pattern, select **EDIT BYTE**. This places the CTS850 into edit mode.

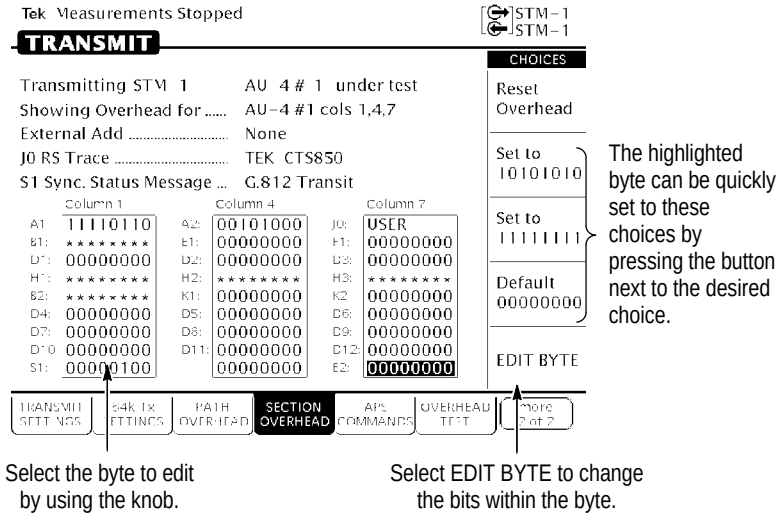


Figure 2 16: Selecting a Byte for Editing

When in edit mode, the choices along the right side of the display change (see Figure 2 17). The highlight now applies to a single bit.

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3. To change the value of the highlighted bit, select either **1** or **0**. Each time you select 1 or 0, the highlighted bit is changed and the highlight moves to the next bit.
4. To select a different bit for editing, select either the right or left arrow to move the highlight. When the desired bit is highlighted, select either **1** or **0**.
5. When you are finished editing the byte, select **DONE**. This enters the changes to the byte and exits edit mode.

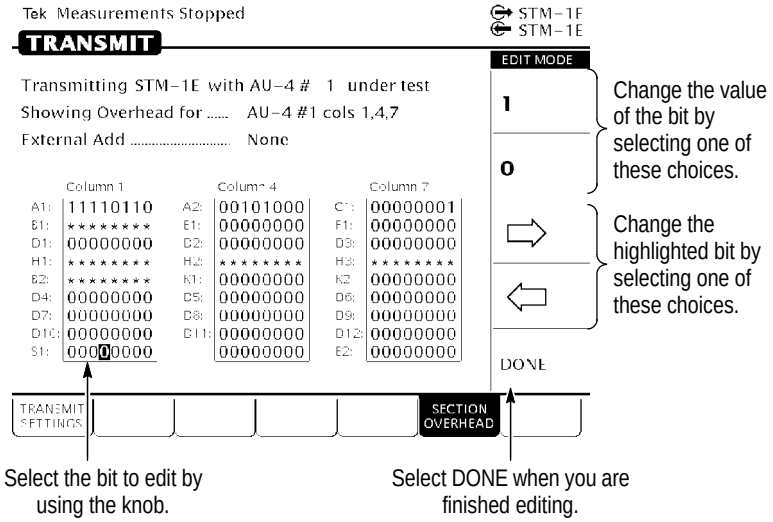


Figure 2 17: Editing a Byte

Entering Text

Several parameters, such as file names, operator prompts, and path trace messages, consist of text strings. You can set text strings to preset choices or enter your own text string. When you highlight a text parameter using the knob, the choices at the right side of the display change to present predefined text strings (if appropriate) and the option to edit the text string (see Figure 2 18).

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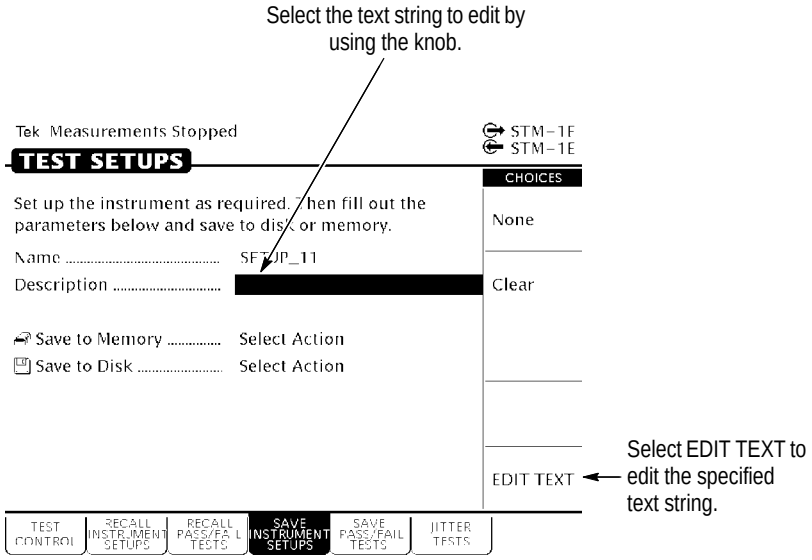


Figure 2 18: Selecting a Text String for Editing

Text strings (not file names) may contain both upper and lower case characters. Moving the selected characters (with the knob on the front panel) off the end of the selection string changes between upper and lower case.

To edit a text string:

1. Select the text string by turning the knob until the desired text string is highlighted (see Figure 2 18).
2. Select **EDIT TEXT**. This places the CTS850 into edit mode.

   When in edit mode, the choices along the right side of the display change (see Figure 2 19). In edit mode, the status line at the top of the display is replaced with a line that displays the characters available for placing into the text string. (Some characters available for message text are not available for file names.)
3. To change the highlighted character or enter a new one, select the character to enter by turning the knob.

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4. To enter the selected character, select **Enter <character>**.

   To delete a character already entered, use the arrows to highlight the character. Select **Delete** to delete the character.

5. When you are finished editing the text string, select **DONE**.

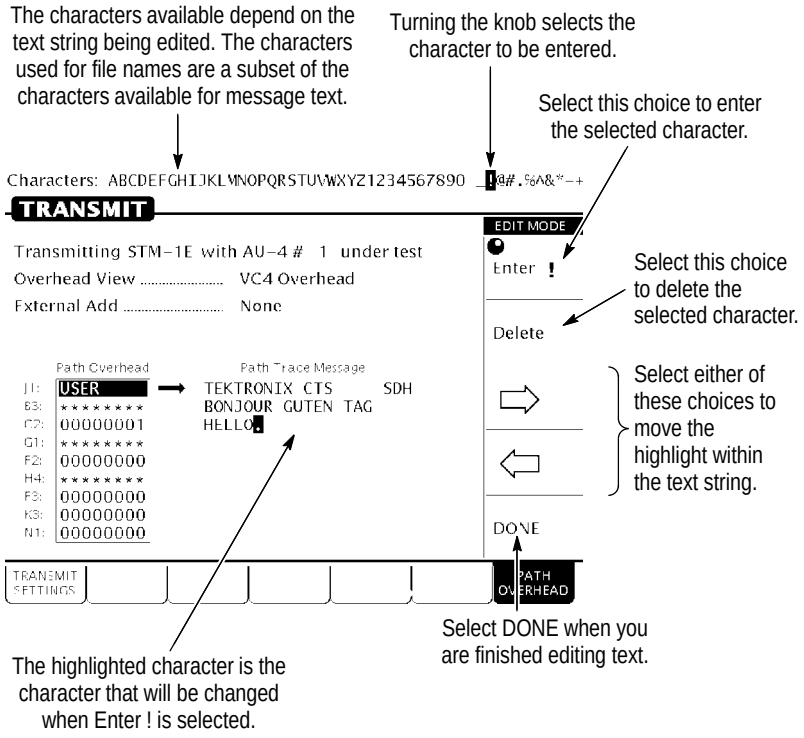


Figure 2 19: Editing a Text String

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Working with the Disk Drive

Use the disk drive in the CTS850 to save instrument setups, pass/fail tests, measurement results and measurement histories. The CTS850 reads disks formatted in MS-DOS format. It reads only 1.44 MB disks. The CTS850 does not format disks. Files written to disk consist of four types, as shown in Table 2 2.

Table 2 2: CTS850 Disk File Types

File Type	Description	File Extension
Instrument Setups	Complete instrument settings	.SET
Pass/Fail Tests	Complete instrument settings, operator prompts, and Fail If conditions	.TST
Measurement Results[1]	ASCII file listing the results of a test	.RES
Measurement History[1]	Binary file containing history of test results	.HIS
Jitter Tolerance Conformance Tests	ASCII file listing results of a conformance test	.JTL
	Microsoft Excel-compatible file containing test and mask data	.XTL
Jitter Transfer Conformance Tests	ASCII file listing results of a conformance test	.JTR
	Microsoft Excel-compatible file containing test and mask data	.XTR
Pointer Jitter Conformance Tests	ASCII file listing results of a conformance test	.PTR
Output Jitter Conformance Tests	ASCII file listing results of a conformance test	.OUT

1 The CTS850 creates two files (with extensions .RES and .HIS) when you save measurement test results.

The CTS850 displays only file names with the extensions shown in Table 2 2. Disk files with any other extensions do not appear in file name displays.

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Reading Files on Disk

You can display disk file names in three places: the RECALL INSTRUMENT SETUPS page and the RECALL PASS/FAIL TESTS page of the TEST SETUPS menu, and the RECALL RESULTS page of the RESULTS menu.

To view instrument setups files on a disk:

1. Insert the disk into the disk drive.
2. Press the **TEST SETUPS** front-panel button to display the TEST SETUPS menu.
3. Select the **RECALL INSTRUMENT SETUPS** page.
4. Select **Disk** to display the instrument setups on disk.

To view pass/fail files on a disk:

1. Insert the disk into the disk drive.
2. Press the **TEST SETUPS** front-panel button to display the TEST SETUPS menu.
3. Select the **RECALL PASS/FAIL TESTS** page.
4. Select **Disk** to display the pass/fail tests on disk.

To view test results files on a disk:

1. Insert the disk into the disk drive.
2. Press the **RESULTS** front-panel button to display the RESULTS menu.
3. Select the **RECALL RESULTS** page.
4. Select **Disk** to display the test results files on disk.

***NOTE**. Disk operations may take several seconds if there are many files on the disk. The light on the front of the disk drive turns off when the disk operation is complete.*

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Synchronous, Plesiochronous, Asynchronous

To understand correctly the concepts and details of SDH, it is important to be clear about the meaning of *Synchronous*, *Plesiochronous*, and *Asynchronous*.

In a set of **Synchronous** signals, the digital transitions in the signals occur at exactly the same rate. There may however be a phase difference between the transitions of the two signals, and this would lie within specified limits. These phase differences may be due to propagation time delays, or wander introduced in the transmission network. In a synchronous network, all the clocks are traceable to one Primary Reference Clock (PRC). The accuracy of the PRC is better than ± 1 in 10^{11} and is derived from a cesium atomic standard.

If two digital signals are **Plesiochronous**, then their transitions occur at ”almost” the same rate, with any variation being constrained within tight limits. These limits are set down in ITU T recommendation G.811. For example, if two networks need to interwork, their clocks may be derived from two different PRCs. Although these clocks are extremely accurate, there is a small frequency difference between one clock and the other. This is known as a plesiochronous difference.

In the case of **Asynchronous** signals, the transitions of the signals do not necessarily occur at the same nominal rate. Asynchronous, in this case, means that the difference between two clocks is much greater than a plesiochronous difference. For example, if two clocks are derived from free running quartz oscillators, they could be described as asynchronous.

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Plesiochronous Digital Hierarchy (PDH)

Traditionally, digital transmission systems and hierarchies have been based on multiplexing signals which are plesiochronous (running at almost the same speed). Also, various parts of the world use different hierarchies which lead to problems of international interworking, for example, between those countries using 1.544 Mbit/s systems (U.S.A. and Japan) and those using the 2.048 Mbit/s system.

In the PDH, tributaries and higher order bit streams are allowed to deviate from a pre defined bit rate by a specified amount. The justification (bit stuffing) process is required which brings all the tributaries up to the same bit rate before multiplexing takes place. However, the justification method makes it impossible to identify the location of specific tributary channels within a higher order bit stream, without demultiplexing back down to the 2 Mb/s tributaries.

To recover a 64 kbit/s channel from a 140 Mbit/s PDH signal, it is necessary to demultiplex the signal all the way down to the 2 Mbit/s level before the location of the 64 kbit/s channel can be identified. PDH requires ”steps” (140 34, 34 8, 8 2 demultiplex; 2 8, 8 34, 34 140 multiplex) to drop out or add an individual speech or data channel. This is due to the bit stuffing used at each level. Extra bits are added (stuffed) in to the digital tributaries which increases the speed of the tributaries until they are all identical.

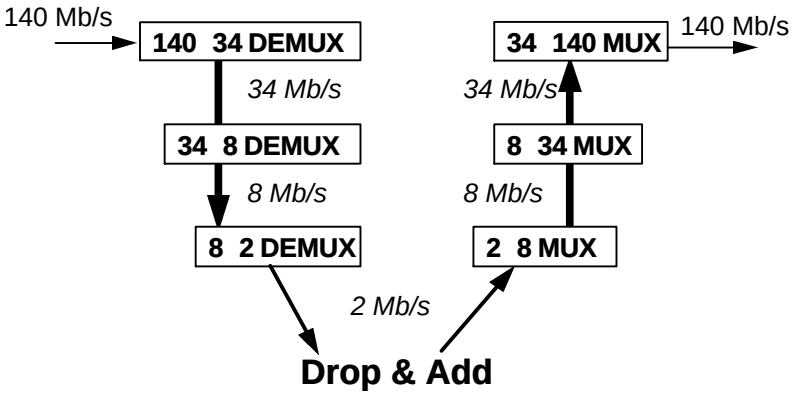


Figure 2 20: PDH Multiplexing by steps showing add/drop function

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Anomaly, Defect, Failure, Alarm

Anomaly The smallest discrepancy which can be observed between the actual and desired characteristics of an item. The occurrence of a single anomaly does not constitute an interruption in the ability to perform a required function.

Defect The density of anomalies has reached a level where the ability to perform a required function has been interrupted. Defects are used as input for performance monitoring, the control of consequent actions, and the determination of fault cause.

Failure The inability of a function to perform a required action persisted beyond a maximum time allocated.

Alarm The maintenance signal used in the digital network to alert downstream equipment that a defect or equipment failure has been detected.

SDH Multiplexing Principles

The multiplexing principles of SDH follow:

- **Mapping** A process used when tributaries are adapted into Virtual Containers (VCs) by adding justification bits and Path Overhead (POH) information.
- **Aligning** This process takes place when a pointer is included in a Tributary Unit (TU) or an Administrative Unit (AU), to allow the first byte of the Virtual Container to be located.
- **Multiplexing** This process is used when multiple lower order path layer signals are adapted into a higher order path signal, or when the higher order path signals are adapted into a Multiplex Section.
- **Stuffing** SDH has the ability to handle various input tributary rates from PDH. As the tributary signals are multiplexed and aligned, some spare capacity has been designed into the SDH frame to provide enough space for all these various tributary rates. Therefore, at certain points in the multiplexing hierarchy, this space capacity is filled with ”fixed stuffing” bits that carry no information, but are required to fill up the particular frame.

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The figure on the next page illustrates the ITU T SDH multiplexing structure. The notations in the boxes, such as C 1, VC 3, and AU 4, are explained in the table after the figure. Not all containers and rates shown in this figure are specifically handled by the CTS 850 test unit.

At the lowest level, containers (C) are input to virtual containers (VC). The purpose of this function is to create a uniform VC payload by using bit stuffing to bring all inputs to a common bit rate ready for synchronous multiplexing. Various containers (ranging from VC 11 at 1.728 Mb/s to VC 4 at 139.264 Mb/s) are covered by the SDH hierarchy. Next, VCs are aligned into tributary units (TUs), where pointer processing operations are implemented.

These initial functions allow the payload to be multiplexed into TU groups (TUGs). As the figure illustrates, the xN label indicates the multiplexing integer used to multiplex the TUs to the TUGs. The next step is the multiplexing of the TUGs to higher level VCs, and TUG 2 and TUG 3 are multiplexed into VC 3 (ANSI mappings) and VC 4. These VCs are multiplexed with fixed byte stuffing to form administration units (AUs) which are finally multiplexed into the AU group (AUG). This payload then is multiplexed into the Synchronous Transport Module (STM).

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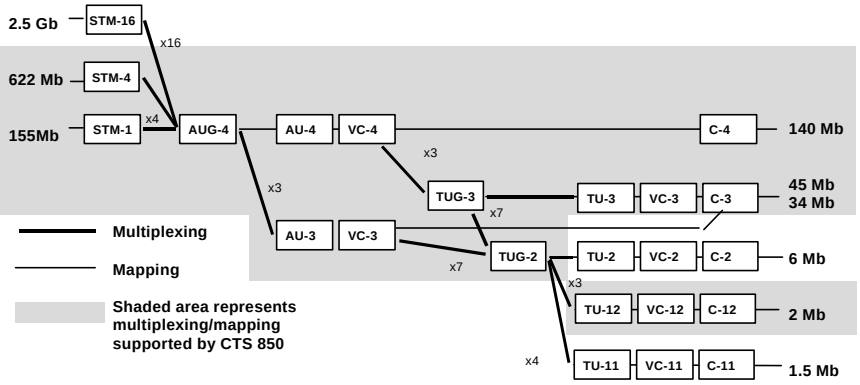


Figure 2 21: SDH Multiplexing Hierarchy

Table 2 3: SDH Multiplexing Structure

Term	Contents	Description
C n	n = 1 to 4	payload at lowest multiplexing level
VC n	n = 1,2	single C n plus VC POH
VC n	n = 3,4	C n, TUG 2s or TU 3s, plus POH for the specific level
TU n	n = 1 to 3	VC plus tributary unit pointer
TUG 2	(TU n) = 1,3,4	various TU ns
TUG 3	TU 3, 7 TUG 2s	TU 3, 7 TUG 2s
AU n	n = 3,4	VCs plus AU pointer
STM n	n = 1, 3 AUGs	n synchronously multiplexed STM 1 signals

POH = Path Overhead; C = Container; TU = Tributary Unit; AU = Administrative Unit; VC = Virtual Container; TUG = Tributary Unit Group; STM = Synchronous Transport Module

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Difference in Telecommunications Terms

Three sets of terms are listed here because it is important to see that they are not equivalent terms, which is how they get used in normal discussions. They are:

Add/ Drop

The process where a part of the information carried in a transmission system is extracted (dropped) at an intermediate point and different information is inserted (added) for subsequent transmission. The remaining traffic passes straight through the multiplexer without additional processing.

Map/ Demap

For the CTS 850, this term refers to putting PDH signals into and getting PDH signals out of a SDH signal.

Multiplex/ Demultiplex

Multiplex (MUX) To transmit two or more signals over a single channel. Demultiplex (DEMUX) To separate two or more signals previously combined by compatible multiplexing equipment.

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45 Mbit/s Map/Demap Implementation

If your CTS 850 test set supports the 45 Mb/s map/demap option (Option 55), the following is an overview of what the 45 Mb/s option offers.

To determine if Option 55 is present in the CTS 850 test set, press the Utility button on the front panel, then press the Instrument Configuration (INST CONFIG) softkey. In the menu that is displayed after pressing this button and softkey, there is a line that says Options. In this line, should be the number 55, for Option 55. Also, in the line that says PDH Options, should be the number 45, for 45 Mb/s.

45 Mbit/s is transmitted or received as a B3ZS or HDB3 encoded line rate, and mapped or demapped into a VC 3 structure into an STM 1. Mapping and demapping has the same configuration, options and nomenclature as the current TU 3 mapping/demapping selections available for 34 Mbit/s signals.

An external 45 Mbit/s payload is added when the signal is being mapped into an SDH output. The user can insert the same defects and anomalies as are supported in a 34 Mbit/s externally added signal.

Demapped payloads are dropped out through the front panel as a 45 Mbit/s line rate.

The payload for 45 Mbit/s is PRBS, a fixed 8, 16, or 24 bit pattern, or externally added data only. The payload can not be muxed or demuxed from or into DS1 or any PDH rates. The same PRBS patterns as for 34 Mbit/s are supported. Overhead bytes are the same as for TU 3 mapping and demapping. The default C2 value is the same for 34 Mbit/s (0x04).

There is no support for 45 Mbit/s bit slip measurements.

G.821, G.826 and M.2100 analysis is performed on the received 45 Mbit/s signal, subject to the same restrictions as other PDH signals.

Because of architectural limitations, the PDH rates (2 Mbit/s, 8 Mbit/s, 34 Mbit/s, and 140 Mbit/s) are not supported at the same time as 45 Mbit/s. The RX and TX sides of the tributary card are “linked” at 45 Mbit/s. The tributary board will run RX and TX at 45

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Mbit/s or RX and TX at any of the existing PDH rates, but 45 Mbit/s and 2/8/34/140 Mbit/s cannot be turn simultaneously.

The framing for 45 Mbit/s is C Bit, M13 or Unframed. From the user interface, external add will be handled as a framing option, in the same manner as the other PDH rates are handled.

RX signal level for 45 Mbit/s are Normal and Monitor.

Defect insertion for 45 Mbit/s is: Pattern Bit; Framed Bit (framed only); Frame Bit Burst; C bit parity (C bit framing only); P bit parity (M13 framing only); and, Code violations (45 Mbit/s only)

Anomaly insertion for 45 Mbit/s is RDI (frame signals only); AIS (framed only) and Idle (framed only).

Failure insertion for 45 Mbit/s is LOS (only when 45 Mbit/s is the TX line rate).

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Tutorial

The tutorial acquaints you with the features of the CTS850 by having you run a test while you explore specific features of the CTS850 SDH/PDH Test Set. For full details on how to use the CTS850, refer to Chapter 3 *Reference*.

The tutorial presents procedures in tables. Perform the procedure by 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 with Step 1	Step 2	Step 3	Step 4
		Step 5	Step 6
		Step 7	Step 8, CTS850 instruction is complete

Some procedures require several iterations of highlighting parameters and selecting choices. Some procedures may require more than one menu button or menu page selection as well.

Note: Use the buttons below the display to Select Menu Page. Use the rotary knob to Highlight Parameter. Use the buttons to the right of the display to Select Choice.

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Before Turning On the CTS850

This tutorial describes how to perform a bit-error rate (BER) test on an STM-1E signal. To perform the tutorial, you need a 75 coaxial cable with BNC connectors on each end. This tutorial assumes you have set up the CTS850 as described in *First Time Operation*, in Chapter 1 Getting Started.

To set up your CTS850 for the tutorial, perform these steps:

H Check to see that the CTS850 is turned off.

Connect the coaxial cable between the **TRANSMIT** and **RECEIVE** BNC connectors on the front panel (see Figure 2 22).

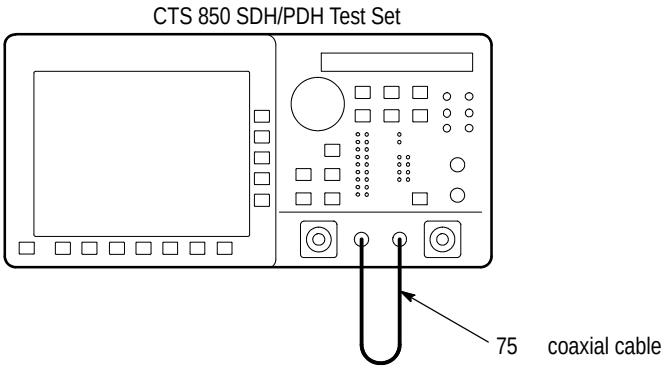


Figure 2 22: Setup for the Tutorial

Press the **ON/STBY** button to turn on the CTS850.

The CTS850 performs its power-on self test and then displays the TRANSMIT menu.

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Before proceeding with the tutorial, initialize the CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup

Setting Transmit Parameters

Before beginning the BER test, set the transmit and receive parameters.

To set the transmit and receive parameters:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate (see Figure 2 23)	STM-1E

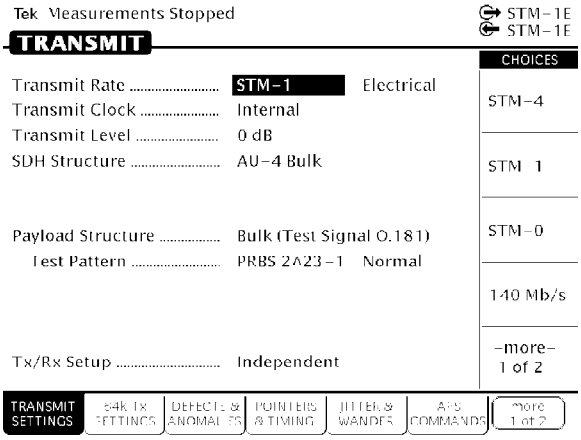


Figure 2 23: The TRANSMIT SETTINGS Page of the TRANSMIT Menu

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To set the payload and the test pattern:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Payload	Bulk (Equipped)
		Test Pattern	PRBS 2^20 1

Setting Receive Parameters

You can set receive parameters two ways. The first way is to set the parameters individually: display the RECEIVE menu and set each parameter manually on the RECEIVE SETTINGS page. The second way is to couple the receive settings to the transmit settings. To do this, use the Tx/Rx Setup line on the TRANSMIT SETTINGS page. (The Tx/Rx Setup line appears on both the TRANSMIT SETTINGS page and the RECEIVE SETTINGS page. To couple transmit settings to the receive settings, you would use the Tx/Rx Setup line on the RECEIVE SETTINGS page.)

To couple the receive settings to the transmit settings:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Coupled

As soon as you select Coupled, the icon in the status area changes to indicate the Tx/Rx Setup are coupled.

If the operator couples from the TRANSMIT SETTINGS menu, the TX settings copy to the Receive side of the test unit. If the operator couples from the RECEIVE SETTINGS menu, the RX settings copy to the Transmit side of the test unit.

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Setting the Test Time

Before beginning the BER test, you must specify the duration of the test.

To set the duration of the test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS (see Figure 2 24)	TEST CONTROL	Test Duration	15 min

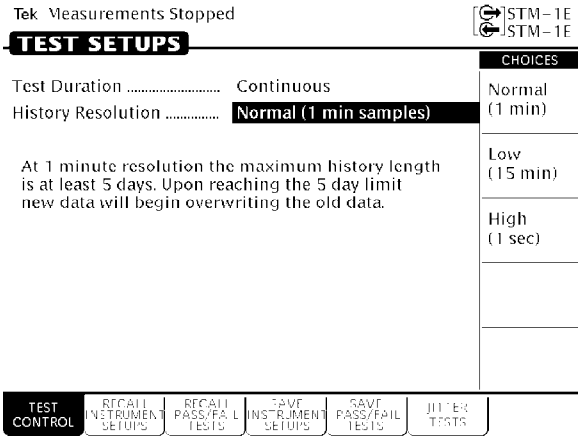


Figure 2 24: The TEST CONTROL Page of the TEST SETUPS Menu

Where Test Results Are Displayed

Once you have set the transmit and receive parameters and the test time, you can begin the test. However, before starting the test, look at the RESULTS menu where the results of the test appear.

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To display the RESULTS menu:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	TEST Summary	*none*	*none*

The TEST SUMMARY page contains a summary of the current or most recent test (see Figure 2 25). Just below the menu name is information about the current or most recent test. If the test detected no alarms or errors, the CTS850 displays the message No Alarms No Errors.

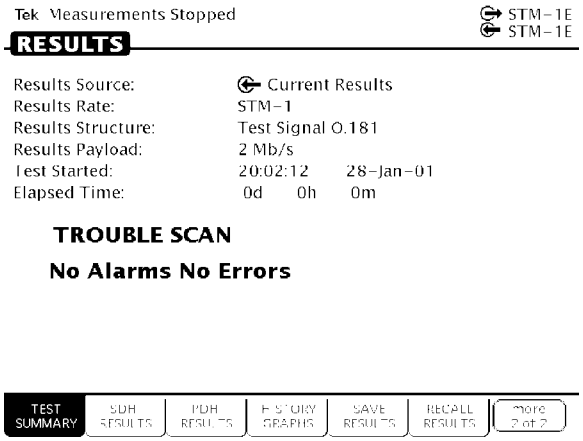


Figure 2 25: The TEST SUMMARY Page of the RESULTS Menu

The RESULTS menu contains ten pages on which results are displayed: TEST SUMMARY, SDH or PDH RESULTS, ERROR ANALYSIS, Performance Analysis, JITTER & WANDER, and HISTORY GRAPHS. Select **SDH RESULTS** to see one way test results are displayed (see Figure 2 26).

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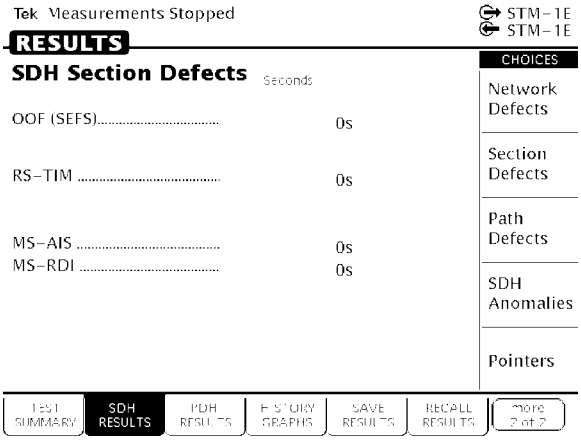


Figure 2 26: SDH Results, SDH Section Defects, from RESULTS menu

The SDH or PDH RESULTS page contains a listing of the different errors that can occur. Since you have not started your test yet, the values are those of the last test run. To continue with the test setup, select TEST SUMMARY.

Begin the Test

Note at the top of the display the message Measurements Stopped. When you start the test, this message will change. To start the test, press the front-panel **START/STOP** button.

Once a test starts, the display changes in two ways. First, the message Running appears at the top of the display (see Figure 2 27). This message line is always visible so you know that a test is running, even if a page is displayed that doesn't contain any information about tests. Second, the test status indicator appears.

There are two elements to the test status indicator. The text above the bar graph indicates how long the test has been running. The text lists the days, hours, minutes, and seconds the test has been running. The bar graph indicates what percentage of the test is complete (except when the test duration is set to continuous).

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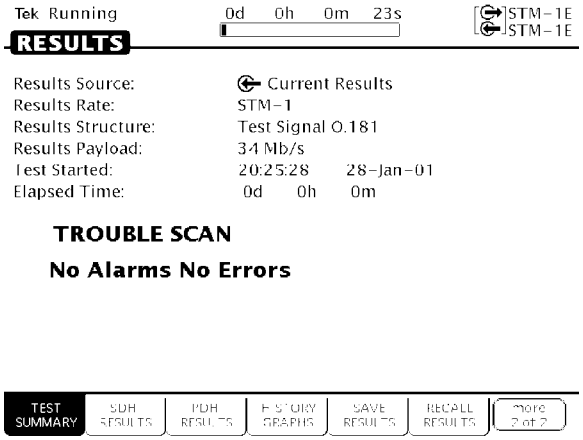


Figure 2 27: The Message Line and Test Status Indicator

Inserting Errors

Now that the test is running, you will insert some errors and see how the CTS850 responds. To set the error insertion parameters, first display the Defects & Anomalies page as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies (see Figure 2 28)	*none*	*none*

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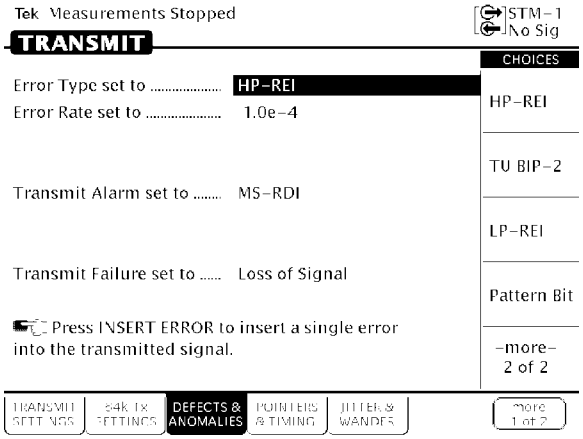


Figure 2 28: The Defects & Anomalies Page of the TRANSMIT Menu

There are two ways to insert errors into the transmitted signal. You can insert errors one at a time or you can set a rate at which the CTS850 inserts errors automatically. Before inserting errors, you must specify the type of error to be inserted. You specify the type of error to be inserted with the Error type set to parameter.

To set the type of error to insert:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Error type set to	Path B3 BIP

The rate at which errors are inserted is specified on the Error rate set to parameter. An error rate of None specifies that no errors are inserted unless the INSERT ERROR button is pressed. Any error rate

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other than None results in a continuous stream of errors being inserted into the transmitted signal.

To insert a single error, press the **INSERT ERROR** button located on the front panel.

When you press the INSERT ERROR button the red ERROR light flashes.

To insert a continuous stream of errors:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Error rate set to	1.0E-5

Note that the red ERROR light now stays on all the time; errors are being detected continually.

To turn off the automatic error insertion:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies	Error Rate set to	None

Now that errors are no longer being transmitted, the red ERROR light has gone out, although the yellow history light is still on. To clear the error history, press **CLEAR HISTORY**.

Adjusting Pointers

The CTS850 enables you to adjust or move pointers. Note that pointer movements are not necessarily errors. Pointer parameters are set on the POINTERS & TIMING page of the TRANSMIT menu.

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To display the POINTERS & TIMING page:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	POINTERS & TIMING (see Figure 2 29)	*none*	*none*

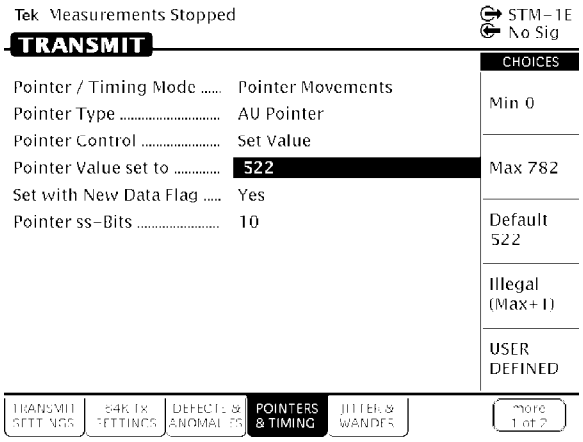


Figure 2 29: Example of Pointers & Timing Page of TRANSMIT Menu

Before adjusting a pointer, you must decide what mode of pointer movement to use. You can change a pointer by adjusting the pointer directly or by using frequency offset. The default mode is Pointer Movements, which allows you to adjust pointers directly.

To specify how the pointer will be adjusted:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Control	Single

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After selecting Single for pointer control, a message displays that tells you how to adjust the pointer. Pointer movement alternates between increment and decrement.

To adjust a pointer, press the **POINTER ACTION** button on the front panel of the test set.

Each time you press the **POINTER ACTION** button, a pointer adjusts and the **POINTER ACTION** light turns on. Also, a message appears at the top of the display that describes the type of pointer movement that occurs. On this page you can also adjust frequency offset which may cause a network element to generate pointer movements.

Be aware that it is necessary to press the Start/Stop button the front panel to see all the changes. To see the pointer value changing

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SDH or PDH RESULTS	*none*	Pointers

Now press the **POINTER ACTION** button again.

To adjust a pointer using frequency offset:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	POINTERS & TIMING	Pointer / Timing Mode	Frequency Offset

After selecting Frequency Offset, note that the available parameters change. When in Frequency Offset mode, the only parameters that can be set are Offset Mode and Frequency Offset.

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To change the frequency offset of the signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Frequency Offset	Stress +4.6ppm

If the preset choices do not match what you need, use USER DEFINED to define an alternative.

To define a specific frequency offset:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
			USER DEFINED

When you select USER DEFINED, the knob is assigned to adjust the frequency offset. Two choices are available in this mode: Coarse and Fine (see Figure 2 30). Coarse adjusts the frequency offset by 10 ppm. Fine adjusts the frequency offset by 0.1 ppm. The larger the value for frequency offset, the more often the pointer is adjusted.

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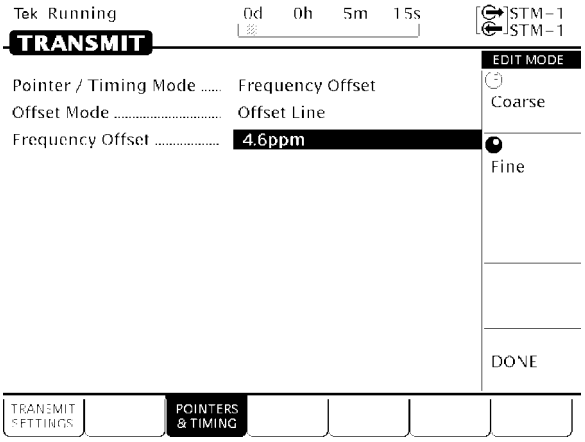


Figure 2 30: Adjusting Frequency Offset Using the Knob

Use the knob to change the value of Frequency Offset; select any value you wish. When you are finished selecting a frequency offset:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
			DONE

To turn off frequency offset:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	POINTERS & TIMING	Frequency Offset	Default 0ppm

Selecting Default 0ppm sets the Frequency Offset back to 0 ppm.

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Viewing Section Overhead

The CTS850 allows you to view the section overhead for the transmitted or received signal. To view the section overhead for the transmitted signal, press the MORE 1of 2 Key softkey at the bottom of the test set screen, in order to see more choices:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	SECTION OVERHEAD	*none*	*none*

The first line of text under the menu name describes the signal being received and the AU under test (see Figure 2 31).

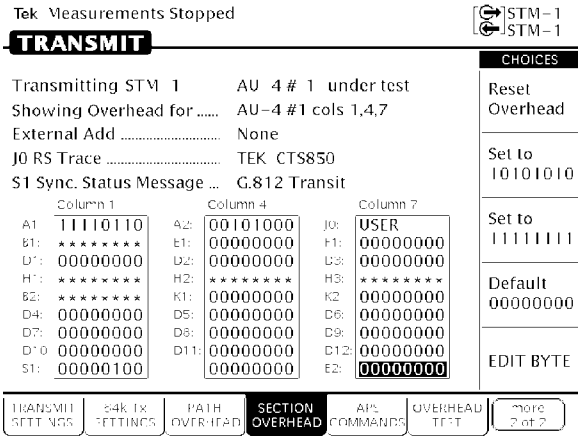


Figure 2 31: Example of Section Overhead Page of TRANSMIT Menu

The Showing Overhead for parameter identifies which columns of the section overhead are displayed. To display the overhead for other overhead columns within the signal, select the appropriate choice.

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Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Showing Overhead for	Cols 1, 4, 7

Editing the Section Overhead

Except for certain reserved bytes, you can edit the bytes of the section overhead of the transmitted signal. Reserved bytes are identified by asterisks (*) in the byte content area of the displayed column.

To edit a byte of the section overhead:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		S1 *byte*	**EDIT BYTE**

Once you have selected EDIT BYTE, the CTS850 enters the edit mode (see Figure 2 32).

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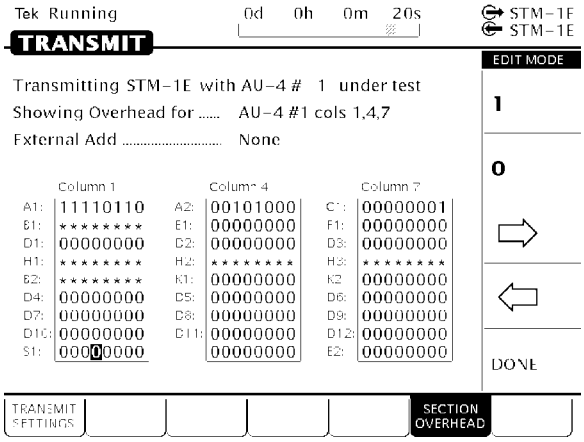


Figure 2 32: The Display in Edit Mode

To change the value of any bit within the byte, highlight the bit you wish to change. To change the value of the highlighted bit, select either 1 or 0. After you assign a value to the highlighted bit, the highlight moves to the next bit to be edited.

Edit the S1 byte to read **10101010**.

Select **DONE** when you have finished editing the byte.

You can assign preset values to the highlighted byte. For example, rather than editing each bit of the byte as you just did, you could also have selected Set to 10101010. To see that the CTS850 is now receiving the new value of the S1 byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	SECTION OVERHEAD	*none*	*none*

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Verify that the section overhead for columns 1, 4, and 7 is displayed. If it is not:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Showing Overhead for	Cols 1, 4, 7

Look at the value of the S1 byte. You will see that it is 10101010, as previously set.

Viewing Test Results

The test has been running for several minutes and errors have been transmitted. To see the test results, you must display the RESULTS menu. To display the RESULTS menu:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	TEST SUMMARY	*none*	*none*

The TEST SUMMARY page identifies the most common errors that the CTS850 has detected. You will see a line that identifies the worst error rate detected and may find listings for other types of errors (see Figure 2 33).

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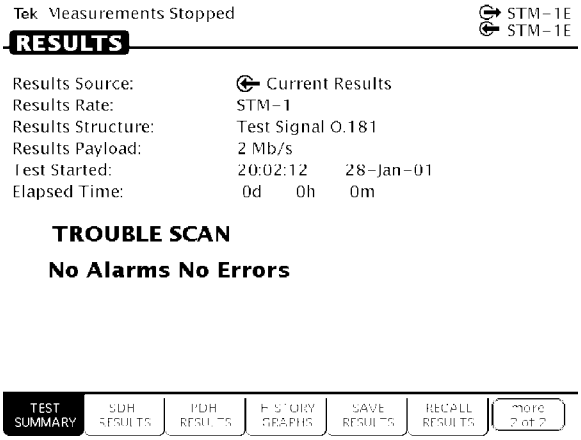


Figure 2 33: The TEST SUMMARY Page of the RESULTS Menu

The SDH or PDH RESULTS page displays all the errors that have been detected. It also displays the error ratio and the number of errored seconds that have been logged (see the following figure).

To display the SDH or PDH RESULTS page:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
	SDH or PDH RESULTS	*none*	*none*

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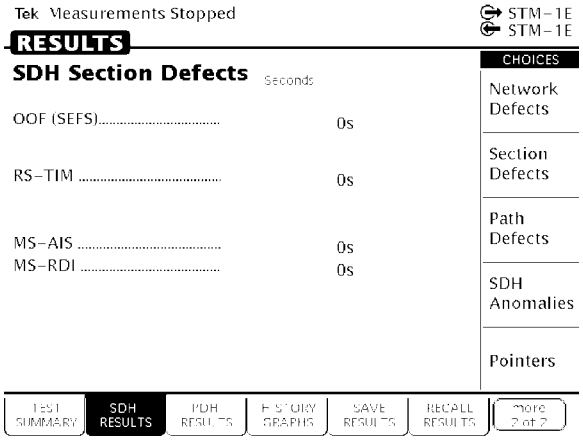


Figure 2 34: SDH Results, SDH Section Defects, from RESULTS menu

This completes the tutorial. For detailed information on CTS850 capabilities, refer to Chapter 3 *Reference*.

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Reference

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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:

- Network continuity checking
- Transmission signal quality testing
- Fault tolerance testing
- Performance monitoring
- Jitter and wander testing
- 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.

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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.

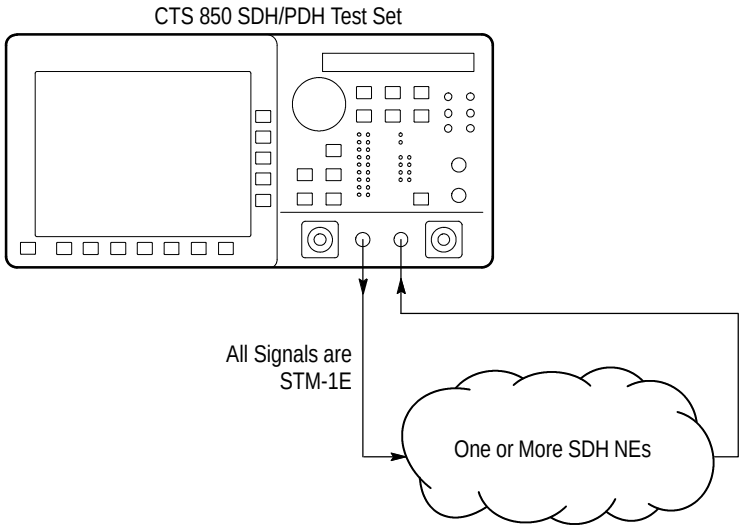


Figure 3 1: Setup to Check Network Continuity

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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.

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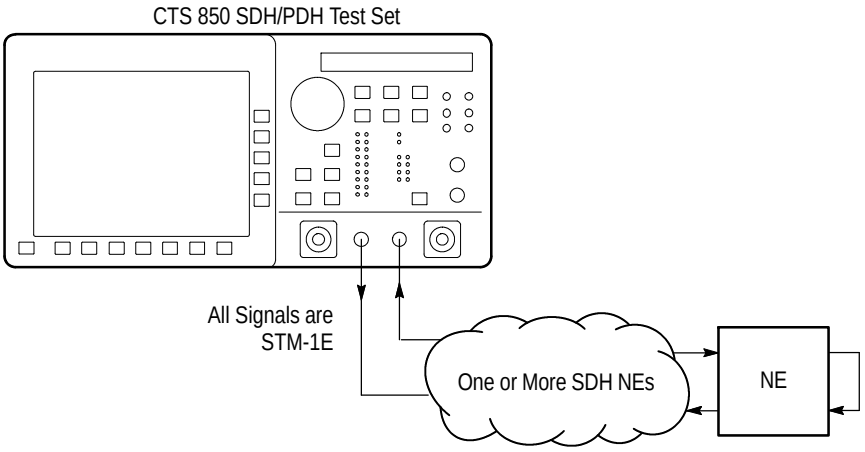


Figure 3 2: Setup to Check a Transmission Link

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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	*none*	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.

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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.

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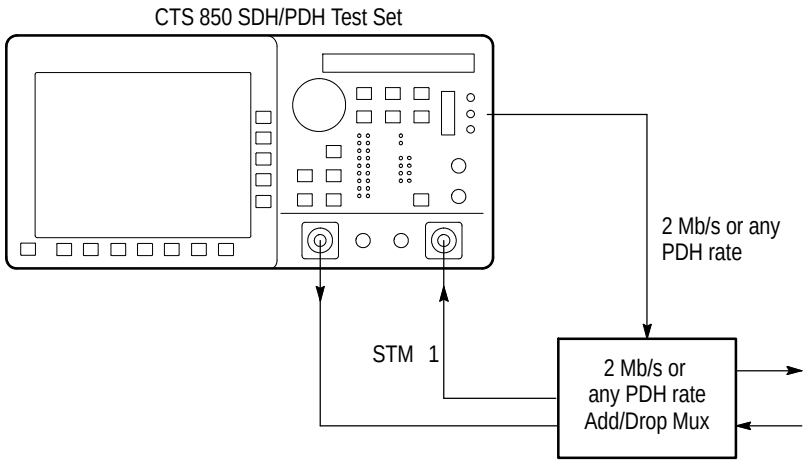


Figure 3 3: Setup to Test Mapping and Demapping

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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 12 Async or applicable TU x
		TU Under Test	*Set to match how the NE is provisioned*
		Payload	2 Mb/s Unframed or any PDH rate
TEST SETUPS	TEST CONTROL	Test Duration	15 Minutes
RESULTS	SDH RESULTS	*none*	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.

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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:

- Response to errors and alarms
- Response to pointer movements
- 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

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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 Down-stream Response
RS B1 Error	MS REI	*none*
MS AIS	MS RDI	AU AIS
HP RDI	*none*	HP RDI
LOS	MS RDI	AU AIS

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

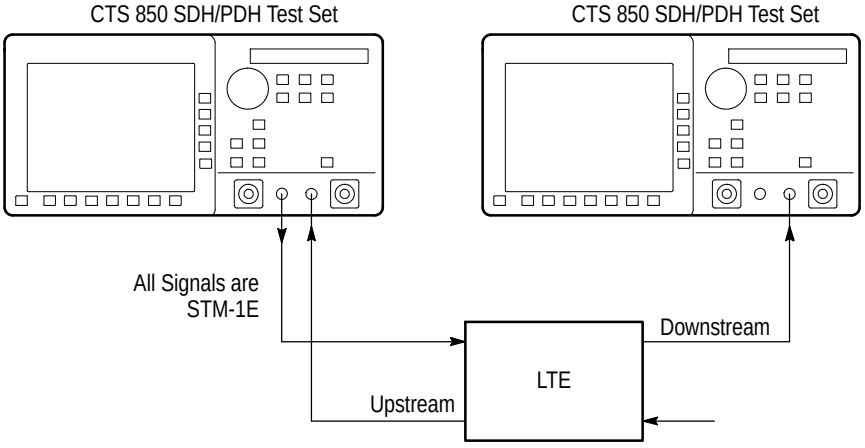


Figure 3 4: Setup to Check Error and Alarm Response

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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	*none*	SDH Anomalies

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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	*none*	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	*none*	SDH Defects

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9. Change the downstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
Results	Main Results	SDH Defects	*none*

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	*none*	Defects

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15. Change the downstream CTS850 as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SDH RESULTS	*none*	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.

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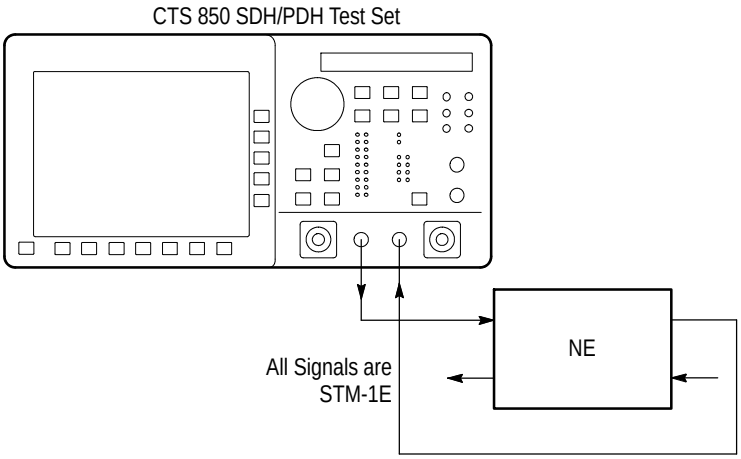


Figure 3 5: Setup to Check Pointer Movements

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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	*none*	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	*none*	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.

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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.

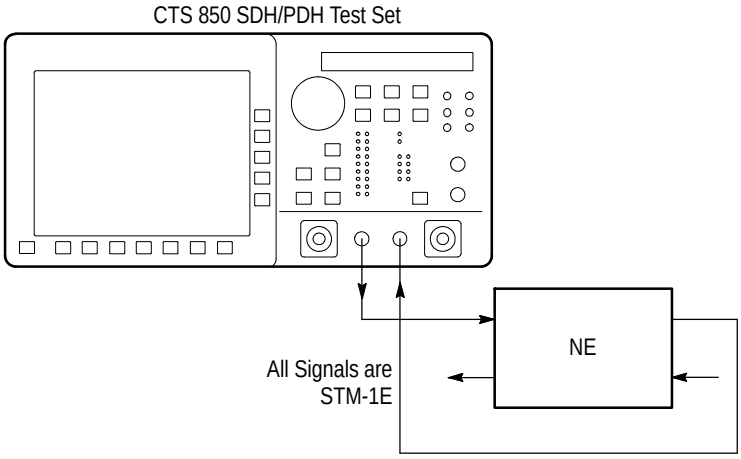


Figure 3 6: Setup to Check Line Frequency Offset Response

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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	*none*	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	*none*	Pointers

6. Verify that negative pointer justifications are being counted.

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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:

- In a brief summary
- In detail by type (defect, anomaly, alarm, failure)
- 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.

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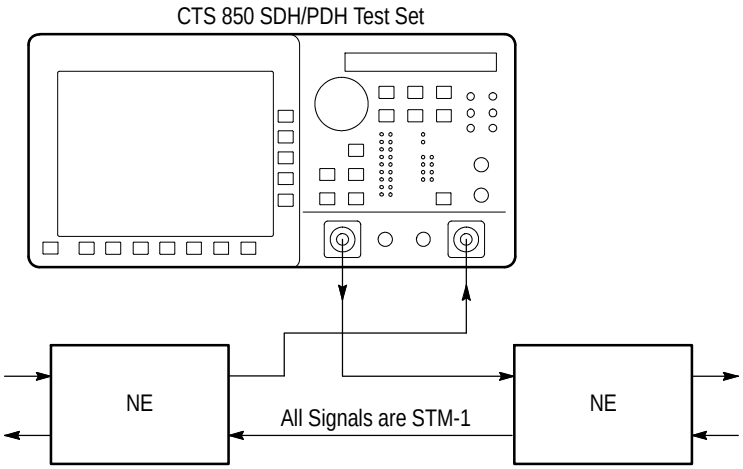


Figure 3 7: Setup to Monitor Performance

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	*none*	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

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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	*none*	*none*

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

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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	*none*	Change Bottom
		turn the knob to select the desired graph	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.

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Jitter/Wander Testing

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

- Jitter Tolerance
- Jitter Transfer
- Output Jitter (Jitter Generation)
- 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:

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

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

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

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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.

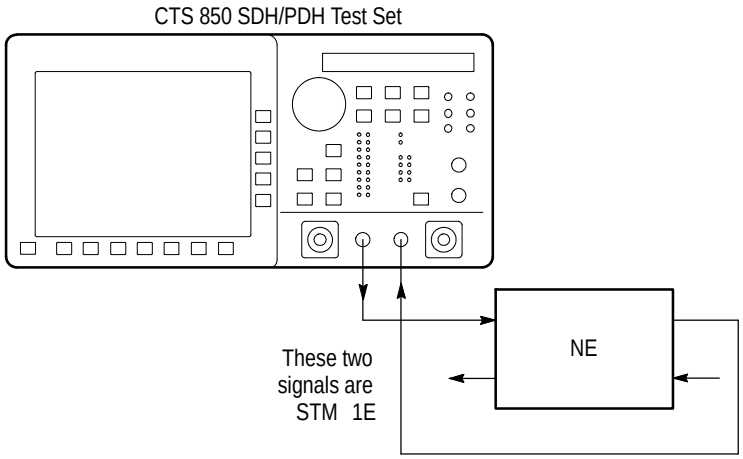


Figure 3 8: Setup to Check Onset-of-Errors Jitter Tolerance

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

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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	*as appropriate*
		Start Frequency	*as appropriate*
		End Frequency	*as appropriate*
		Number Freq Samples	*as appropriate*
		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.

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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.

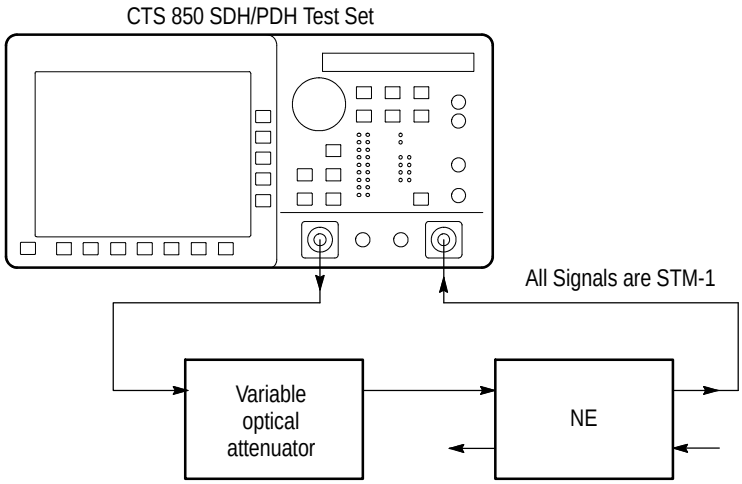


Figure 3 9: Setup to Check 1 dB Power Penalty Jitter Tolerance

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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	*as appropriate*
		Start Frequency	*as appropriate*
		End Frequency	*as appropriate*
		Number Freq Samples	*as appropriate*
		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.

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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:

- Mask type for jitter analysis
- Start frequency
- End frequency
- 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.

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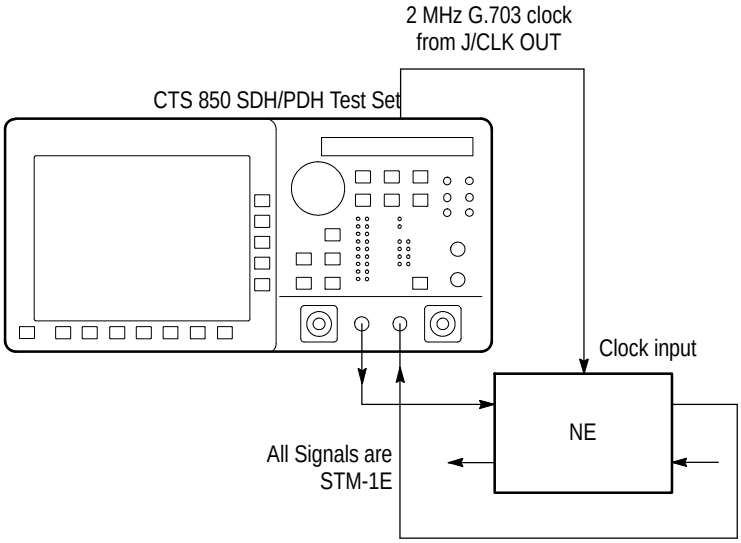


Figure 3 10: Setup to Check Clock-to-Line Jitter Transfer

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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	*as appropriate*
		Start Frequency	*as appropriate*
		End Frequency	*as appropriate*
		Number Freq Samples	*as appropriate*

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.

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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.

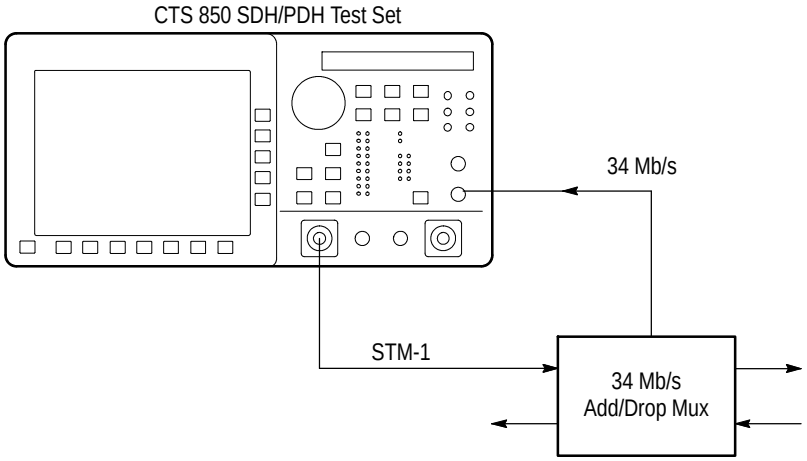


Figure 3 11: Setup to Check Video Timing Quality

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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	*none*	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.

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Setting Test Control Parameters

This section describes how to set the duration for a test, the resolution of the test history, how to start and stop a test, and how to calibrate the instrument for jitter tests. It also lists parameters that cannot be adjusted during a test and other actions that cannot be performed while a test is running.

CTS850 SDH/PDH Test Set

Setting the Test Time Duration

Before running a test, you must specify how long the test will run. The default test duration is continuous, which means a test runs until you stop it with the START/STOP button.

***NOTE**. Most jitter tests run for a fixed duration. You do not need to set test duration for jitter tests.*

To set the duration of a test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	TEST CONTROL (see Figure 3 12)	Test Duration	5 min
			15 min
			1 hour
			Continuous
			USER DEFINED

H Select **Continuous** to set the test to run until the START/STOP button is pressed. If you select Continuous, the CTS850

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accumulates measurements from the time you start the test until the time you stop the test.

Once the test duration is set, any time a test is started it will run for the time specified on the Test Duration line.

***NOTE**. If an instrument setup or pass/fail test is recalled from memory or disk, it overwrites the test duration specified on the TEST TIME page.*

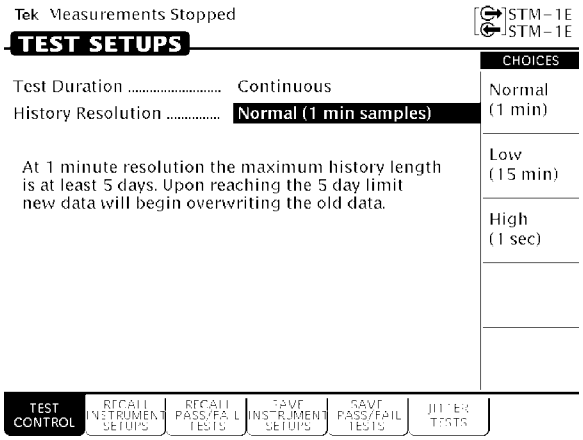


Figure 3 12: The Test Control Page

Setting a Unique Test Time Duration

To set a test duration time other than the three choices presented, use the USER DEFINED choice.

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To set a unique test duration:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	TEST CONTROL	*none*	USER DEFINED (see Figure 3 13)
			Day
			Hour
			Minute
			Second

- Select **Day**, **Hour**, **Minute**, or **Second** as appropriate, then use the knob to set the duration of the selected period. Set each choice as necessary.
- Select **DONE** when finished setting the duration to enter the specified test duration.

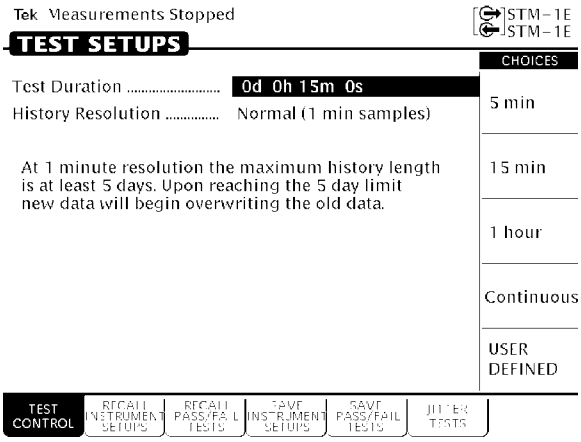


Figure 3 13: Setting a USER DEFINED Test Duration

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Table 3 2 lists the range limits for the test duration.

Table 3 2: Test Duration Limits

Choice	Range	Increment
Day	0 to 99	1
Hour	0 to 23	1
Minute	0 to 59	1
Second	0 to 59	1

***NOTE**. Although a test can be set to run up to 99 days, 23 hours, 59 minutes, and 59 seconds, only results from a limited period are saved in memory. The period of test results saved is determined by the History Resolution setting.*

Setting the History Resolution

The history of test results can be recorded at three resolutions, either 1 second, 1 minute, or 15 minutes. At 1-second resolution, 2 hours of test results can be recorded. At 1-minute resolution, 5 days of test results can be recorded. At 15-minute resolution, 75 days of test results can be recorded.

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To set the history resolution of a test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	TEST CONTROL (see Figure 3 12 on page 3 34)	History Resolution	High (1 sec)
			Normal (1 min)
			Low (15 min)

Starting and Stopping a Test

To start or stop a test:

H Press **START/STOP**.

When a test starts, the light next to the START/STOP button turns on and the status line displays the message, Running.

***NOTE**. Pressing START/STOP while a test is running stops the test immediately, even if the test time has not expired.*

While a test is running, the status line shows the elapsed time since the test began. If a limited test duration has been set (any setting other than Continuous), a bar graph indicates the current percentage of test completion. Elapsed time is also shown within the body of the Results menu, under the Test Started line. Figure 3 14 shows the locations of the elapsed time indicator and bar graph.

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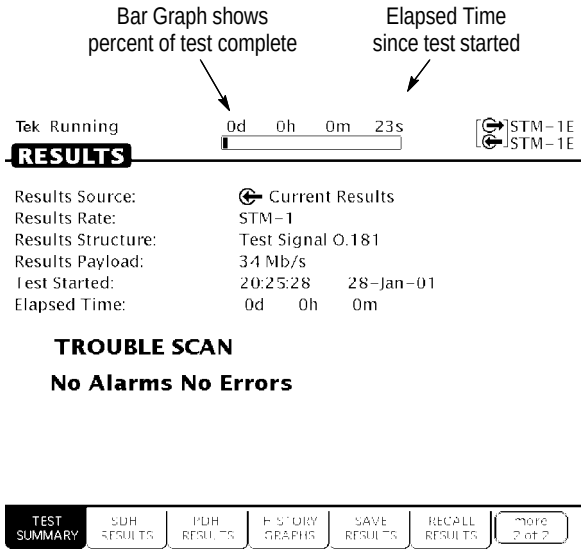


Figure 3 14: Elapsed Time and Bar Graph Indicators

Making Changes While Running a Test

If you change instrument receive settings while a test is running, the test is restarted. Error counts are cleared and the test begins again using the new settings. You can change transmitter settings while a test is running without restarting the test.

Actions You Cannot Perform While Running a Test

There are actions you cannot perform while a test is running (see Table 3 3). You cannot recall instrument settings, pass/fail tests, or results and you cannot save results while a test is running. If you try to perform a recall while a test is running, you are warned that a recall is not allowed while a test is running.

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Table 3 3: Actions You Cannot Perform While a Test is Running

Menu	Page	Action
TEST SETUPS	RECALL INSTRUMENT SETUPS	Recall an instrument setup
	RECALL PASS/FAIL TESTS	Recall a pass/fail test
RESULTS	RECALL RESULTS	Recall previous results
	SAVE RESULTS	Save current results to disk
UTILITY	SELF TEST	Execute self test or diagnostics
AUTOSCAN		Autoscan the received signal

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Working with Test Setups

This section describes how to do the following tasks:

- Save and recall instrument setups
- Create and run pass/fail tests

Instrument setups are files, stored in memory or on disk, that completely describe how the CTS850 is set up. You can use this feature to ensure that every time a test is run, using an instrument setup, that the CTS850 is configured the same way, thus ensuring consistent results. The disk file is an ASCII format file that consists of SCPI commands. The disk file can be edited with any ASCII file editor.

CTS850 SDH/PDH Test Set

Pass/fail tests are tests that display a message indicating whether the completed test encountered any of the specified failure conditions. Up to four failure conditions can be specified in a pass/fail test. Pass/fail tests can be configured to save test results to disk or to print out the test results when the test completes.

Jitter tests are a set of standard compliance tests that measure the jitter in a signal or the response of a network to applied jitter. These tests are defined by ITU Standards G.823, G.825, and G.783. For some tests, the CTS850 generates jitter to stimulate a network element and simultaneously measures its response. Results are displayed in numerical and graphical form. You can set parameters to customize most jitter tests.

Saving and Recalling Instrument Setups

Instrument setups are files stored in memory or on disk that define how the CTS850 is configured. If you regularly set up the CTS850 in the same way, you can save the instrument settings in an instrument setup. Then you can recall the instrument setup whenever you want the CTS850 configured a certain way. This capability saves you time and minimizes the chances of error when setting up the CTS850 for standard tasks.

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***NOTE**. Instrument setups saved to memory are retained when the instrument is turned off. Instrument setups are retained in memory even if power is removed from the* CTS850.

Saving Instrument Setups

To save an instrument setup:

1. Set up the CTS850 as desired. Set all instrument parameters as required.
2. To save an instrument setup to disk, it must have a name. Enter a file name as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE INSTRUMENT SETUPS (see Figure 3 15)	Name	SETUP_XX
			EDIT NAME

- If you wish to label the setup file as SETUP<Number>, you can save time by selecting **SETUP_XX**. Once you select SETUP_XX, select **EDIT NAME** and edit **XX** to the desired number (or letter). Select **DONE** when you are finished editing the setup name. The instrument setup name can be up to eight characters long.
- Select **EDIT NAME** to enter a name other than SETUP_XX. Select **DONE** when you are finished editing the setup name. The instrument setup name can be up to eight characters long.

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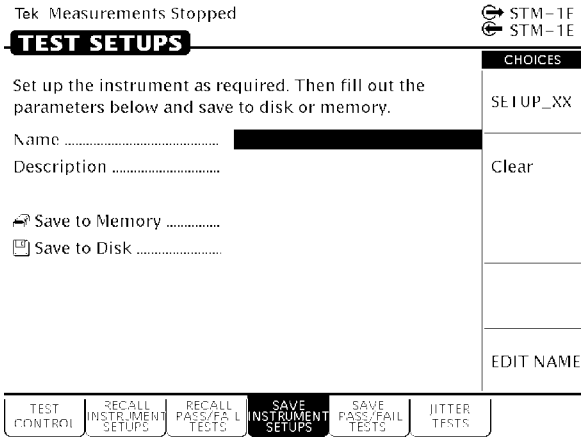


Figure 3 15: The SAVE INSTRUMENT SETUPS Page

3. Enter a description of the instrument setup as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Description	EDIT TEXT

H Select **EDIT TEXT** to edit the description of the instrument setup. The description can be up to 24 characters long. To remove an existing description, select **Clear** or **None**.

4. Save the instrument setup to memory as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Save to Memory	Memory n

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5. Save the instrument setup to disk as follows:

H Insert a disk to store the file on, if one has not already been inserted.

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

The instrument setup is saved to disk with the name specified on the Name line. Status messages indicate the progress of the file save. Once the file is written to disk, the CTS850 reads the disk directory and updates the file listing shown on the RECALL INSTRUMENT SETUPS page.

Recalling Instrument Setups

To recall an instrument setup from memory:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS (see Figure 3 16)	*none*	Memory
		none	Disk
		select setup	Recall Setup

H Use the knob to select the desired instrument setup.

H To recall setups from memory rather than disk, select **Memory** to highlight the Memory listing (see Figure 3 16).

H To recall setups from disk rather than memory, select **Disk** to highlight the Disk listing.

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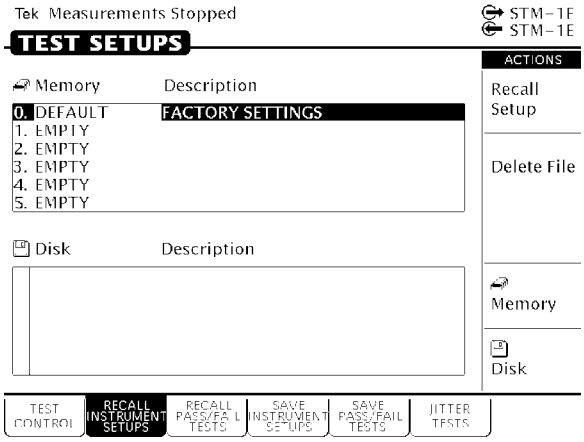


Figure 3 16: The RECALL INSTRUMENT SETUPS Page

The disk file listing displays up to six file names at a time. If more than six files are on disk, the file listing automatically scrolls when you turn the knob.

Recalling the Default Factory Setup

To recall the default factory setup (initialize the CTS850):

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS (see Figure 3 16)	*none*	Memory
		0. Default	Recall Setup

Recall the default settings whenever you want to restore the CTS850 to a known state. For a listing of the factory default settings, go to the Specifications section in the Appendix of this user manual.

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Deleting Instrument Setups from Disk

You can delete instrument setups from disk using the Delete File action.

To delete an instrument setup from disk:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS (see Figure 3 16)	*none*	Disk
		select setup	Delete File

H Use the knob to select the file to delete (see Figure 3 17).

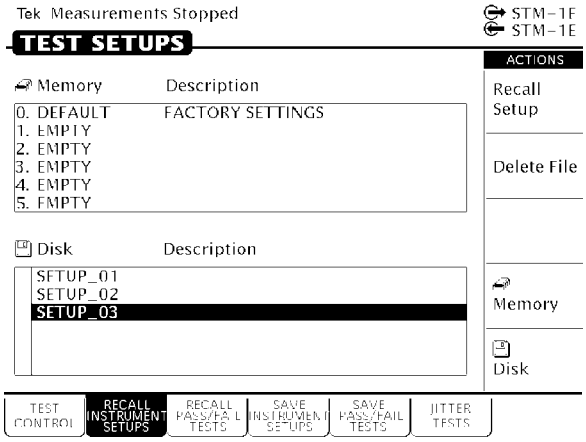


Figure 3 17: Selecting a Disk File for Deleting

After you select Delete File, status messages appear indicating the progress of the file deletion. When the file has been deleted, the file listing updates.

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Pass/Fail Tests

A pass/fail test is an easy way to run a test and get a simple response stating whether or not the CTS850 encountered the specified errors during the test. When a pass/fail test completes, the CTS850 displays a message stating that either the test passed or failed. Pass/fail tests are set up in the TEST SETUPS menu on the SAVE PASS/FAIL TESTS page (see figure below). A pass/fail test consists of instrument setup information and the parameters described in *Parameters of a Pass/Fail Test*.

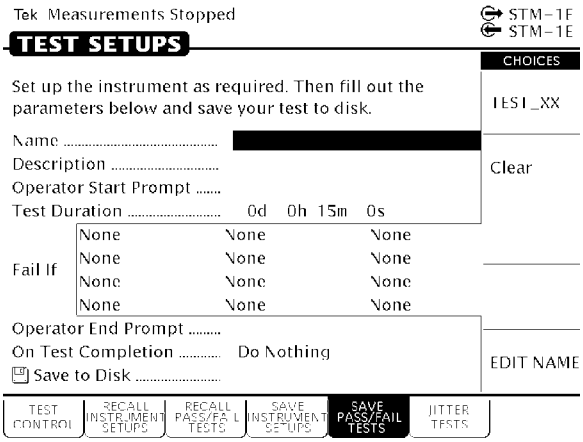


Figure 3 18: The SAVE PASS/FAIL TESTS Page

Parameters of a Pass/Fail Test

A pass/fail test has the following parameters (some parameters are optional):

- **Name.** The name of the test, a mandatory parameter. It can be up to eight-characters long. The name of the test also serves as the file name for the test when you save it to disk.

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***NOTE**. A pass/fail test can only be saved on disk. It cannot be saved in memory.*

- Description. An optional, 24-character field that describes the test.
- Operator Start Prompt. An optional, 72-character field that is displayed at the beginning of the test. You can use the operator start prompt to provide instruction to the operator prior to the beginning of the test.
- Test Duration. A required parameter that sets the length of the test.
- Fail If conditions. The specific conditions that define whether a test has failed.
- Operator End Prompt. An optional, 72-character field that is displayed at the end of the test. You can use the operator end prompt to provide instruction to the operator after the test is completed.
- On Test Completion. A required parameter that defines the action to be taken when a test completes.

Fail If Conditions

A Fail If condition is what determines if a test passes or fails. There are three elements to a Fail If condition: condition type, specific condition, and threshold (see Table 3 4).

The condition type describes the general condition that indicates a test has failed. For each condition type (except None), there is list of specific conditions and thresholds used to determine when a test fails. None indicates that no condition type has been assigned.

The specific condition describes the type of failure used to determine when a test fails. The specific conditions that define a failure depend on the condition type (see Table 3 4).

The threshold is the level at which a test fails (see Table 3 4). For example, for the condition types Alarm and Failure, the threshold for any specific condition is Detected or Not Detected.

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- Detected. If the specified condition is detected, the test fails.
- Not Detected. If the specified condition is not detected, the test fails.

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Table 3 4: Fail If Conditions of a Pass/Fail Test

Condition Type	Specific Condition	Threshold
Alarm SDH and/or PDH	Any	Detected/Not Detected
	MS AIS	Detected/Not Detected
	MS RDI	Detected/Not Detected
	AU AIS	Detected/Not Detected
	HP RDI	Detected/Not Detected
	TU AIS	Detected/Not Detected
	LP RDI	Detected/Not Detected
	PDH RAI	Detected/Not Detected
	PDH AIS	Detected/Not Detected
Failure	Any	Detected/Not Detected
	LOS (Loss of Signal)	Detected/Not Detected
	LOF (Loss of Frame)	Detected/Not Detected
	OOF (Out of Frame)	Detected/Not Detected
	AU LOP (Loss of AU Pointer)	Detected/Not Detected
	TU LOP (Loss of TU Pointer)	Detected/Not Detected
	TU LOM (Loss of TU Multiframe)	Detected/Not Detected
	Pattern Sync	Detected/Not Detected

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Table 3 4: Fail If Conditions of a Pass/Fail Test (Cont.)

Condition Type	Specific Condition	Threshold
Error Ratio	Any RS B1 MS B2 Path B3 TU Path BIP LP REI Payload Bit 2 Mb/s CRC	>1.0e 9 >1.0e 8 >1.0e 7 >1.0e 6 >1.0e 5 1.0e 4 1.0e 3 User Defined
Error Count	Any RS B1 MS B2 Path B3 TU Path BIP LP REI Payload Bit 2 Mb/s CRC	>0 >10 >100 >1000 User Defined
Errored Seconds	Any RS B1 MS B2 Path B3 TU Path BIP LP REI Payload Bit 2 Mb/s CRC	>0 >1 >10 >60 User Defined
Pointer	AU NDFs AU Ptr Justify TU NDFs TU Ptr Justify	>0 >1 >10 >60 USER DEFINED
Jitter	Hit Seconds	>0 >1 >10 >60 USER DEFINED

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Creating a Pass/Fail Test

To create a pass/fail test:

1. Set up the CTS850 as required to perform the desired test.

   Set all transmit and receive parameters as necessary. When the pass/fail test is recalled, the CTS850 is set up exactly as it was when the pass/fail test was saved.

2. Set the name of the pass/fail test as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS (see Figure 3 18)	Name	TEST_XX
			EDIT NAME
			Clear

- If you wish to name the test file as TEST<Number>, you can save time by selecting **TEST_XX**. Once you select TEST_XX, select **EDIT NAME** and edit XX to the desired number (or letter). Select **DONE** when you are finished editing the setup name.
- Select **EDIT NAME** to enter a name other than TEST_XX for the pass/fail test. Select **DONE** when you are finished editing the test name.
- Select **Clear** to remove an existing name.

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3. Enter a description of the pass/fail test as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS	Description	EDIT TEXT
			None
			Clear

- Select **EDIT TEXT** to enter a description of the test, up to 24 characters long. Select **DONE** when you are finished editing the description.
- Select **None** if you do not want to use a description.
- Select **Clear** to remove an existing description.

4. Enter an operator start prompt as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS	Operator Start Prompt	Default
			Clear
			Preview
			EDIT TEXT

- Select **Default** to enter the default prompt TEST IS ABOUT TO START!.
- Select **Clear** to remove any previously entered prompt text.
- Select **Preview** to see how the prompt text you have entered appears in the pass/fail test dialog box. Select **EXIT** to remove the preview.

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- Select **EDIT TEXT** to enter an operator start prompt, up to 72 characters long. The prompt appears on the display as three lines of 24 characters. Select **DONE** when you are finished editing the prompt.

5. Set the test duration as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS	Test Duration	5 min
			15 min
			1 hour
			Continuous
			USER DEFINED

- Select **USER DEFINED** to enter a time other than one of the preset choices. The maximum duration is 99 days, 23 hours, 59 minutes, 59 seconds.

6. Highlight the first entry in the first column of the Fail If table (see Figure 3 19). Select one of the preset choices to specify a condition type.

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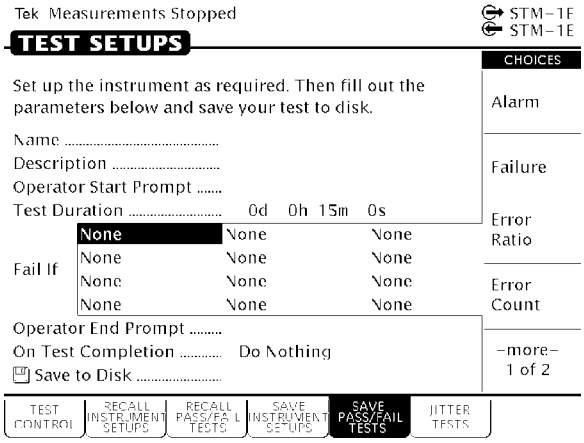


Figure 3 19: Entering Fail If Conditions

7. Highlight the first entry in the second column (see Figure 3 19). If you wish to specify a specific condition, select one of the preset choices.
8. Highlight the first entry in the third column (see Figure 3 19). Select one of the preset choices to set the threshold. Select **USER** to specify a threshold other than one of the preset choices. (USER is not available for Alarm or Failure condition types.)
9. Repeat steps 6 through 8 as necessary to specify additional Fail If conditions. A maximum of four Fail If conditions can be specified.

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10. Enter an operator end prompt as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS	Operator End Prompt	Default
			Clear
			Preview
			EDIT TEXT

- Select **Default** to enter the default prompt TEST HAS ENDED!.
- Select **Clear** to remove any previously entered prompt text.
- Select **Preview** to see how the prompt text you have entered appears in the pass/fail test dialog box. Select **Exit** to remove the preview.
- Select **EDIT TEXT** to enter an operator end prompt, up to 72 characters long. The prompt appears on the display as three lines of 24 characters. Select **DONE** when you are finished editing the prompt.

11. Specify the action to be taken when the test completes as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS	On Test Completion	Do Nothing
			Print Summary
			Save to Disk

- Select **Do Nothing** if you do not want any action taken at test completion.

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- Select **Print Summary** to print the test results when the test completes.
- Select **Save to Disk** to create a disk file of the test results when the test completes.

12. Save the pass/fail test to disk as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS	Save to Disk	Save File

Running a Pass/Fail Test

To run a pass/fail test:

1. Insert the disk containing the pass/fail test into the disk drive.

2. Select the pass/fail test to run as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL PASS/FAIL TESTS	*none*	Disk
		select disk file name	Recall

***NOTE**. The Disk action displays only files with the extension .TST.*

Selecting Recall begins the recall of the pass/fail test.

As the file recall begins, the TEST BEGIN dialog box appears (see Figure 3 20). The first line of text in the dialog box is the file name. The second line of text is the test description. The third line informs the user that the file was recalled successfully. The

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fourth line states how to begin the test. The fifth line is the operator start prompt.

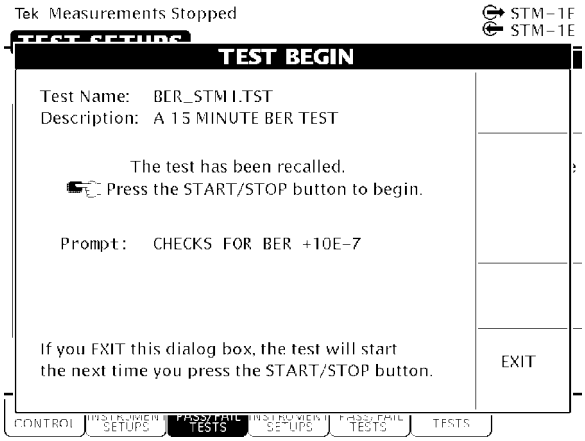


Figure 3 20: The TEST BEGIN Dialog Box

3. To run the pass/fail test immediately, press **START/STOP**.

   The pass/fail test will begin. When the test is completed, the CTS850 displays either TEST PASSED! or TEST FAILED!.

   If you decide not to run the test, select **EXIT** from the dialog box.

4. Select **EXIT** to remove the dialog box after the test completes.

5. Press **RESULTS** to see the detailed results of the test.

A test does not have to be run when it is recalled from disk. After the TEST BEGIN dialog box appears, you can exit the dialog box by selecting **EXIT**. You can then select the SAVE PASS/FAIL TESTS page and edit the parameters of the pass/fail test.

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Changing an Existing Pass/Fail Test

You do not have to create a pass/fail test from the beginning every time. You can recall an existing test, edit the parameters of the test, and then save it under a new name.

To change an existing pass/fail test:

1. Insert the disk containing the pass/fail test into the disk drive.
2. Select the pass/fail test to edit as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL PASS/FAIL TESTS	*none*	Disk
		select disk file name	Recall

***NOTE**. The Disk action displays only files with the extension .TST.*

As the file recall begins, the TEST BEGIN dialog box appears (see Figure 3 20).

3. Select **EXIT** to remove the dialog box.
4. Select **SAVE PASS/FAIL TESTS**.
5. Edit the parameters of the pass/fail test as necessary.
6. If you want to save the edited pass/fail test under a different name, change the Name of the test. You do not have to change the name of the test file to save it to disk.

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7. Save the pass/fail test to disk as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	SAVE PASS/FAIL TESTS	Save to Disk	Save File

H If you select Save File without changing the name of the file, a Disk dialog box appears asking if you want to overwrite the existing file. To overwrite the file, select **Overwrite**. If you do not want to overwrite the file, select **Cancel**.

Deleting a Pass/Fail Test from Disk

Delete a pass/fail test from disk as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL PASS/FAIL TESTS	select file name	Delete File

H If necessary, select **Disk** from the list of actions to display the names of the files on disk (see Figure 3 21).

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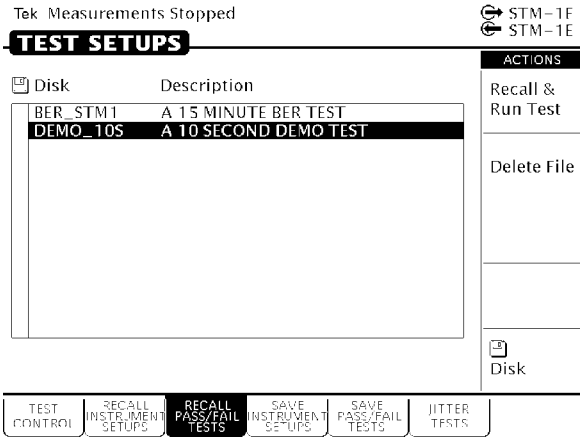


Figure 3 21: Selecting a Pass/Fail Test for Deleting

After you select Delete, status messages appear indicating the progress of the file deletion. The file list updates after the file is deleted.

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Checking Signal Status

This section describes how to use the CTS850 to check signal status. The CTS850 SDH/PDH Test Set continuously monitors the input signal for alarms, errors, and failures and provides indicators for the current signal status as well as indicating the history of the signal status.

Viewing Signal Structure

The quickest way to view the structure of a signal is to use AUTOSCAN. AUTOSCAN analyzes the input signal and once a signal is found, the CTS850 synchronizes with the signal and displays the structure of the signal.

To view signal structure using AUTOSCAN:

1. Connect a signal to the receiver input.
2. If a test is running, stop the test by pressing **START/STOP**.
3. Press the **AUTOSCAN** front-panel button.

While AUTOSCAN is running, several messages appear in the display. While the CTS850 searches for a signal it displays the message: Please wait, autosetting to received signal. The CTS850 scans all line rates and all receiver input connectors until it finds a valid SDH or PDH signal. When the CTS850 finds a valid signal, the instrument displays the message: Autosetting to received signal. If a signal is not found, a message to that effect is displayed.

When the AUTOSCAN finishes, the CTS850 displays the signal structure in graphical form (see Figure 3 22). Use the knob to scroll through the different active channels.

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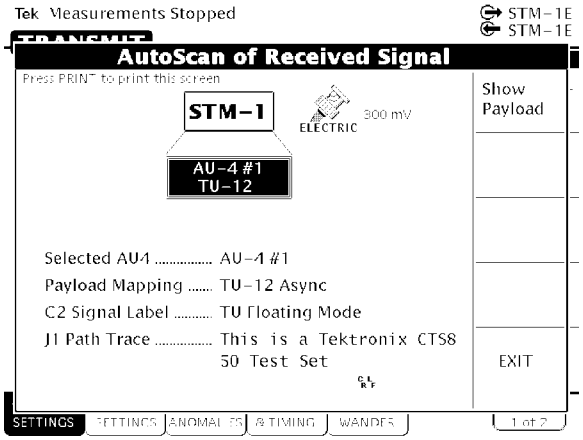


Figure 3 22: The AUTOSCAN Dialog Box Showing Signal Structure

Viewing the Payload

If the received signal uses tributary mapping, then Autoscan can display the different tributaries within the AU.

To display the tributary payload, highlight an AU-4 where TU12 or TU3 is shown as the mapping and select the **Show Payload** choice (see Figure 3 23).

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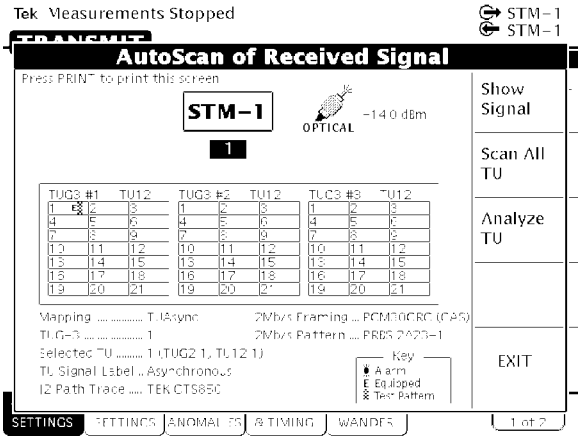


Figure 3 23: Viewing Tributary Signal Structure

Determining the Payload Pattern and Framing

To search for a pattern in the data of the received signal or determine the framing, select **Analyze TU**. After you select Analyze TU, the CTS850 scans the selected TU in the received signal to see if it there is a pattern within the data and if the signal is framed. If a pattern is found, it is displayed below the payload map on the Pattern line (for example, PRBS 2^23 1). If the CTS850 is unable to find a pattern within the signal, it displays Unknown on the Pattern line. The CTS850 will display the specific framing in use, on the Framing line.

To scan every TU in the received signal, select **Scan All TUs**. As the CTS850 scans the signal, it will indicate for each TU whether it has detected an alarm, whether the TU is equipped, and whether a test pattern was found in the TU. The key which describes each of the indicators is located in the lower right corner of the AutoScan dialog box (see Figures 3 23 and 3 24).

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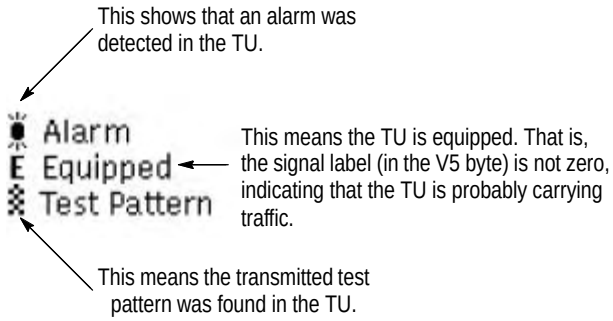


Figure 3 24: The Meaning of the Icons in the Autoscan Dialog Box

You exit the AUTOSCAN dialog box by selecting **EXIT**. When you exit the AUTOSCAN dialog box, the receiver settings are set to match the active channel most recently selected.

Printing the AutoScan Dialog Box

You can print the AutoScan dialog box by pressing the PRINT button on the upper right of the front panel. This prints the displayed dialog box using the settings on the PRINTER SETUP page of the UTILITY menu. The printout takes about two minutes.

Viewing the Signal State

Three colors are used to indicate signal state: green, red, and yellow (see Figure 3 25).

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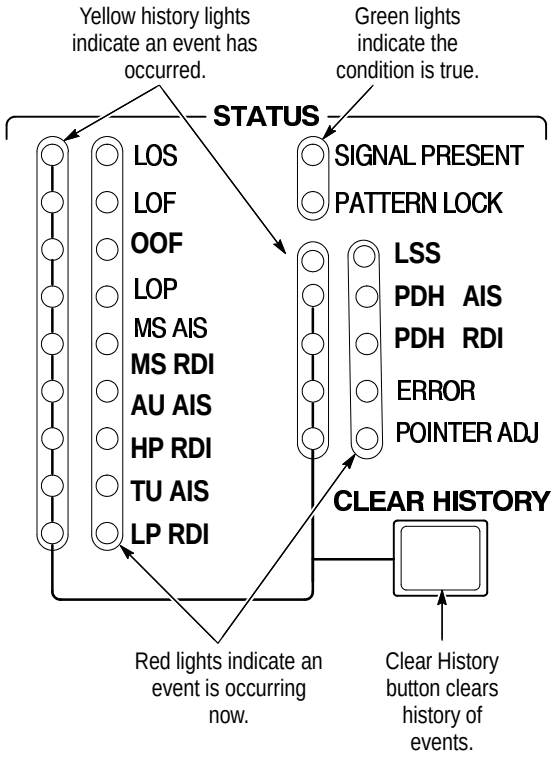


Figure 3 25: Front-Panel Status Lights

H Green lights indicate the condition is true. See Table 3 5.

Table 3 5: Green Status Lights

Label on Light	Meaning if Light is On
SIGNAL PRESENT	A signal at the line rate specified by the Receive Rate parameter is present.
PATTERN LOCK	Lock to a PRBS or fixed pattern has been achieved.

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- Red lights indicate the associated condition is valid. For example, if the red light next to LOS is on, no signal is being received. See Table 3 6.
- A yellow light is associated with each red light. The yellow lights are turned on when an error, alarm, or failure condition first occurs and then stay on to indicate the history even if the condition goes away (see Table 3 6). Press the **CLEAR HISTORY** button to clear the status history.

Table 3 6: Red and Yellow Status Lights

Label on Light	Meaning if Light is On
LOS	Loss of received signal.
LOF	Loss of frame of received signal.
OOF	Out of Frame signal.
LOP	Loss of AU or TU pointer for selected channel in received signal.
MS AIS	A multiplex section alarm indication signal is being received.
MS RDI	A multiplex section far end receive failure code is being received.
AU AIS	A path alarm indication signal is being received.
HP RDI	A path far end receive failure signal is being received.
TU AIS	A tributary alarm indication signal is being received.
LP RDI	A tributary far end receive failure is being received.
LSS	Loss of Synchronization Signal
PDH AIS	A tributary alarm indication signal is being received.
PDH RAI	A tributary remote alarm indication is being received.
ERROR	A bit, regenerator section, multiplex section, path, or TU parity error is detected; or a MS, path, or TU FEBE is being received.
POINTER ADJ	A pointer adjustment is being received.

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Extended Status

The red-yellow pair of ERROR lights on the front panel turn on when a variety of error conditions exist on the line. For more detail about the specific error types and frequency of occurrence, see the TEST SUMMARY, MAIN RESULTS, and ERROR ANALYSIS pages of the RESULTS menu.

Setting the Beeper

You can set a beeper to sound every time a red status light turns on.

To enable or disable the beeper:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	MISC SETTINGS	Beeper	On
			Off

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Setting SDH Transmit Parameters

This section describes how to set the transmit rate, specify the AU under test, set the payload mapping and content, and set the overhead bytes for SDH signals.

The CTS850 SDH/PDH Test Set contains independent transmitter and receiver modules. One set of parameters controls the transmitter module and another set controls the receiver module. You can set the parameters that control the transmitter independently or you can choose to link the parameters to the receiver settings.

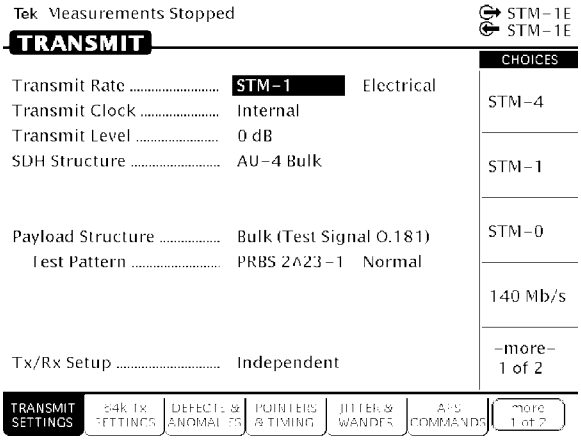


Figure 3 26: Transmit Settings Menu

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Steps for Setting Parameters

The sequence of steps for setting transmit parameters varies with the type of signal to be transmitted. The figures that follow show the sequence of steps required to set the transmit parameters of an SDH signal without a mapped PDH signal and an SDH signal with a mapped PDH signal. See the next section for details on setting PDH signal parameters (for example 2 Mb/s).

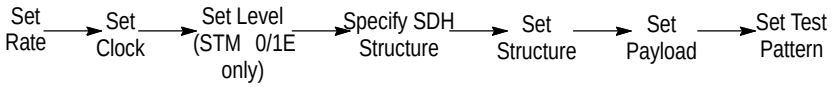


Figure 3 27: Sequence for Setting SDH Signal Parameters

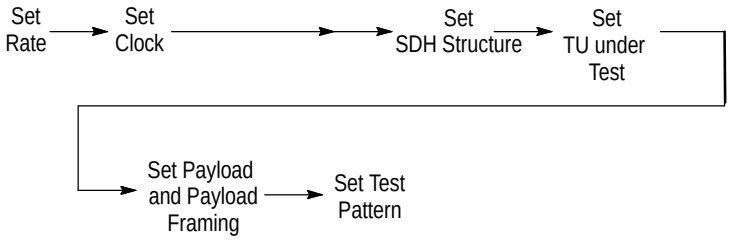


Figure 3 28: Sequence for Setting SDH Signal Parameters When Mapping a PDH Signal

Setting the Transmit Rate

To set the transmit rate:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate (see Figure 3 29 on page 3 74)	as appropriate

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- Select **STM-1E or 0E**, **STM-1**, **STM-4**, **STM-0E**, or **STM-0** to transmit an SDH signal.
- Select **2 Mb/s**, **34 Mb/s**, **140Mb/s** to transmit a PDH signal. See the next section for details on setting PDH signal parameters.
- If your CTS 850 test set supports the **45 Mb/s** option, there is also a 45 Mb/s signal available for selection.

***NOTE**. Even though there are output connectors for both SDH and PDH signals on the CTS850 front panel, the CTS850 can transmit only one type of signal at a time.*

Independent Transmit and Receive Settings

Generally, you can set the transmit and receive settings independently. For example, you can receive an electrical signal at the STM-1E or 0E rate while simultaneously transmitting an optical signal at the STM-4 rate.

Coupling Transmit and Receive Settings

If your application requires that the transmit settings and receive settings be identical, you can save time by coupling them together. After they are coupled, any change you make to a parameter on the TRANSMIT SETTINGS page will also be made to the corresponding setting in the RECEIVE SETTINGS page of the RECEIVE menu. The inverse is also true.

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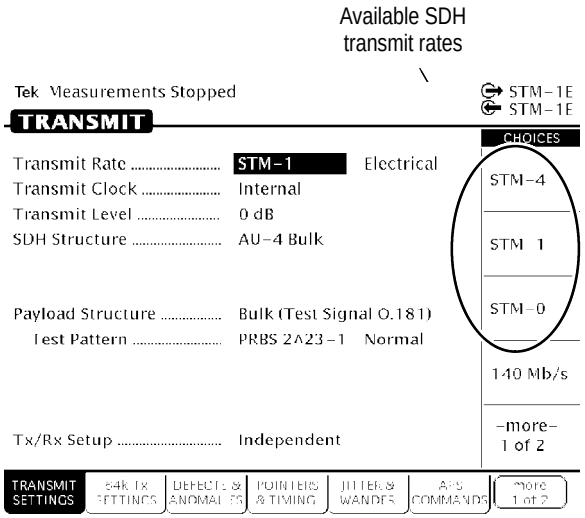


Figure 3 29: SDH Transmit Rates

To couple the transmit and receive settings together from the TRANSMIT SETTINGS page:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Coupled

***NOTE**. When settings are coupled from the TRANSMIT SETTINGS page, the receive parameters are changed to match the transmit parameters. Conversely, when settings are coupled from the RECEIVE SETTINGS page, the transmit parameters are changed to match the receive parameters.*

Notice that the signal status icons, in the upper-right corner of the display, changed to reflect the coupling of the settings.

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To change transmit and receive settings so that they are no longer coupled:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Independent

Notice that the signal status icons, in the upper-right corner of the display, changed to indicate that the settings are no longer coupled.

Through Mode

Use Through Mode to monitor a signal without changing it. In Through Mode, the rate and content of the transmitted signal is that of the received signal. You cannot make changes to pointers or timing, overhead bytes, or insert alarms or errors when the CTS850 is in Through Mode. Through Mode does not perform clock recovery before retransmitting the recovered signal. Through Mode is used for nonintrusive performance monitoring of the active signal.

To put the CTS850 into Through Mode:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Through Mode

To indicate when the CTS850 is in Through Mode, the transmit and receive icons at the upper-right corner of the display have an arrow linking them together and the parameters on the TRANSMIT SETTINGS page are replaced by a message stating that the CTS850 is in Through Mode (see Figure 3 30).

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To take the CTS850 out of Through Mode:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Independent

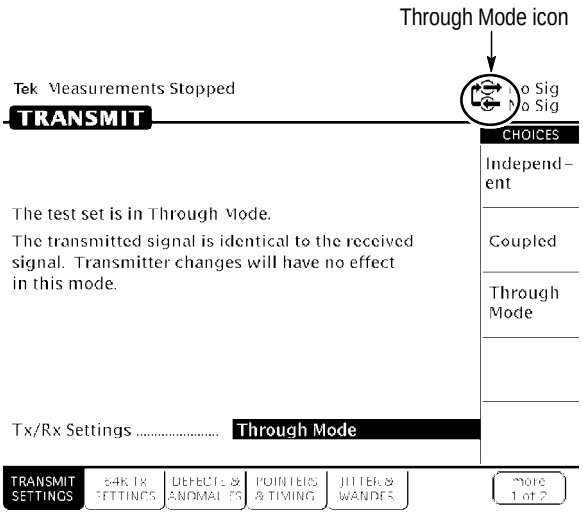


Figure 3 30: CTS850 in Through Mode

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Setting the Transmit Clock

To specify the transmit clock:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Clock	Internal
			Recovered
			External 2 Mb/s 2 MHz
			External 1.5 Mb/s BITS

- Select **Internal** to set the transmit clock to the internal clock.
- Select **Recovered** to use the clock recovered from an incoming signal.
- Select **External 2 Mb/s 2 MHz** to use the clock signal from an external clock input (2 Mb/s or 2 MHz) data timing reference. Attach an external 2 Mb/s or 2 MHz reference to the External Clock Input connector on the rear panel.
- Select **External 1.5 Mb/s BITS** to use the clock signal from an external 1.5 Mb/s BITS reference.

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Setting the Line Clock Offset

Line Clock offset is used for setting PDH Transmit Parameters. Range is ±100 ppm.

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Transmit Settings	Line Clock Offset	Max: +100 ppm
			Stress: +20 ppm
			Stress 20 ppm
			Default 0 ppm
			User Defined

Setting the value through the front panel knob will change to support setting the full valid range.

Setting the Transmit Level

Transmit Level is an option for STM 1E and STM 0E. Transmit Level will not be displayed for other rates.

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Level	0 dB
			6 dB

- Select **0 dB** to set the line level to high.
- Select **6 dB** to set the line level to the cross-connect level.

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Specifying the AU to Test

AU under test is only displayed when the input rate is STM 4 and the signal structure is 1 x AU 4. To designate which AU to test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	AU Under Test	1, 2, 3, 4

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Setting the SDH Structure

This selection sets the structure of the AU under Test (SDH input rates only). The VC4 4c choice requires a Transmit Rate of STM 4.

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Transmit Settings	Structure STM 4	VC4 4c Bulk AU 4 Bulk AU 4 140 Mb/s TU 3 Async TU 12 Async
		STM 1	AU 4 Bulk AU 4 140 Mb/s TU 3 Async TU 12 Async
		STM 0	AU 3 Bulk

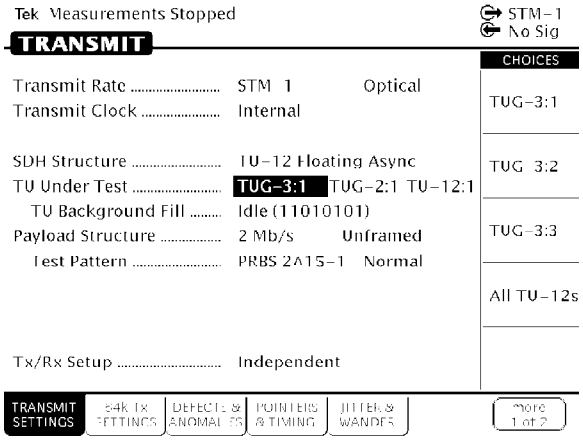


Figure 3 31: Chosing TU Under Test from SDH Structure

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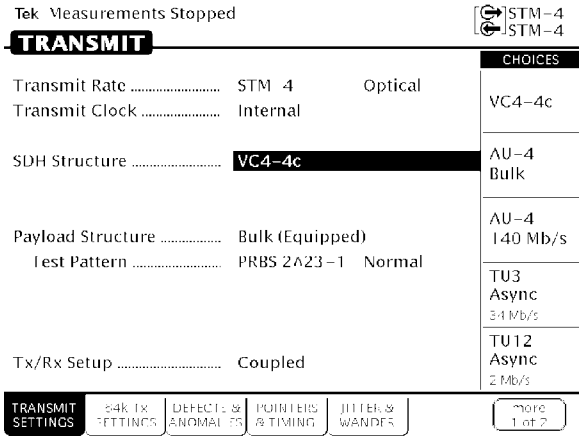


Figure 3 32: Chosing VC 4c from SDH Structure

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TU Under Test

When STM 1 is chosen as the Transmit Rate, and TU 12 or TU 3 chosen as the Structure, the TU under test selection permits the choice of the following (Selections are mutually exclusive): exclusive.

TU 12:	TUG3: TUG3:1, TUG3:2, TUG3:3
	TUG2: 1,2,3,4,5,6,7
	TU 12: 1,2,3
TU 3:	TU 3: 1,2,3
	TU3:1, TU3:2, TU3:3

Setting the TU Background Fill

When STM 1 is chosen at the Transmit Rate, and TU 12 or TU 3 chosen as the SDH Structure, the TU Background Fill permits the user to select the pattern inserted into the inactive TU 12s. Supported values for TU 12 are PRBS 2^15 1 or IDLE. TU 3 background channels are always filled with the idle pattern.

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Setting the SDH Ouput

SDH Output permits the test set to transmit a valid, bulk filled SDH signal when the primary test signal is PDH. The SDH output will be displayed whenever the Transmit Rate is 140 Mb/s or less. Output rate selections are STM 4, STM 1, STM 0 and Disabled. Output type is Optical or Electrical (Electrical is not available for STM 4).

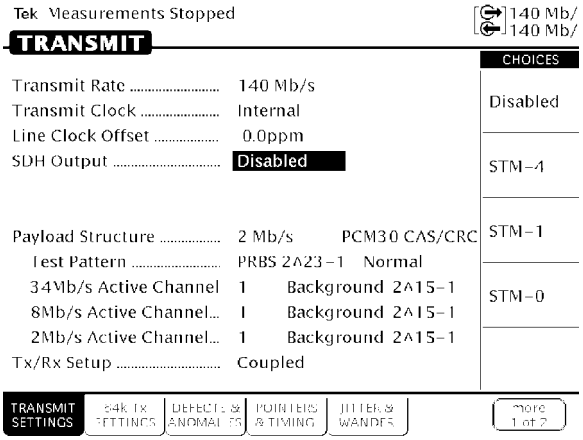


Figure 3 33: Choosing SDH Output

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Setting the Payload Structure

Payload sets the signal generation base rate. Because of the number of selections available, the rate and framing parameters have been split. If the payload rate is not the same as the mapping (SDH) or transmit (PDH) rate, then multiplexing is implied.

Table 3 7: TX Rates and Structures

TX Rate	TX Structure	Multiplexing combinations
STM 4 STM 1	VC4 4c (only for STM 4) AU 4 TU 12 TU 3 140 Mb/s	Bulkfill (Equipped or Unequipped only) 2Mb/s, 64k 34Mb/s, 8Mb/s, 2Mb/s, 64k 140, 34, 8, 2 Mb/s, 64k
STM 0	AU 3	Bulk Equipped & Unequipped
140 Mb/s	Not Applicable	34Mb/s, 8Mb/s, 2Mb/s, 64k
34 Mb/s 45 Mb/s	Not Applicable	34 Mb/s, 8Mb/s, 2 Mb/s, 64k
2 Mb/s	Not Applicable	2Mb/s, 64k

Bulk fill of a TU 12, TU 3 or VC4 4c is not supported.
To set the payload:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Payload	As appropriate

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Table 3 8: Payload Framing/ Source

Payload	Allowable choices
140 Mb/s	Framed, Unframed, External Add
34 Mb/s	Framed, Unframed, External Add
45 Mb/s	C Bit, M13, Unframed
8 Mb/s	Framed, Unframed
2 MB/s	Unframed, External Add Balanced, External Add Unbalanced, PCM 30 CAS/CRC, PCM31 CRC, PCM 30 CAS, PCM 31
64k	PCM 30 CAS/CRC, PCM31 CRC, PCM 30 CAS, PCM 31

When 64k is the payload, framing can also be set from the 64k Tx SETTING menu.

Setting the Test Pattern

Test pattern is selectable when the TX payload is not an externally added signal.

Table 3 9: Test Patterns, Background Patterns

Test Patterns	Applicable choices
PRBS 2^9 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k. Test Patterns: Normal (ITU); Inverted (Non ITU)
PRBS 2^11 1	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k. Test Patterns: Normal (ITU); Inverted (Non ITU)
PRBS 2^15 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k. Test Patterns: Normal (ITU); Inverted (Non ITU)
PRBS 2^20 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s 2 Mb/s; 64k, Test Patterns: Normal (ITU); Inverted (Non ITU)

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Table 3 9: Test Patterns, Background Patterns (Cont.)

Test Patterns	Applicable choices
PRBS 2^23 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k, Test Patterns: Normal (ITU); Inverted (Non ITU)
All Ones	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
All Zeros	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
10101010	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
1 in 8	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
8 bit fixed	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
16 bit fixed	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
24 bit fixed	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
TS Idle	64k
1020 Hz 0 dBm	64k
Background Patterns	
PRBS 2^23 1	34Mb/s; 8Mb/s
PRBS 2^20 1	34Mb/s; 8Mb/s
PRBS 2^15 1	34Mb/s; 8Mb/s; 2 Mb/s
All Ones	34Mb/s; 8Mb/s; 2 Mb/s
All Zeros	34Mb/s; 8Mb/s; 2 Mb/s
10101010	34Mb/s; 8Mb/s; 2 Mb/s

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Selecting the Tx/Rx Setup

Tx/Rx Setup permits the operator to couple Transmit and Receive settings, or select Through Mode. When coupled mode is selected, from the Transmit Setting menu, applicable Transmit Settings are copied to the Receive side of the tester.

Mapping a PDH Signal

To map a tributary signal, you first set the SDH Structure to the appropriate PDH mapping (as described in the previous section). When mapping a signal, you must also specify the payload. The payload can be either an external signal connected to the appropriate IN connector on the front panel or an internally generated signal.

When you use the TU12 Floating Async or TU3 Floating Async mapping, you must also specify the tributary unit under test and payload (see next Figure).

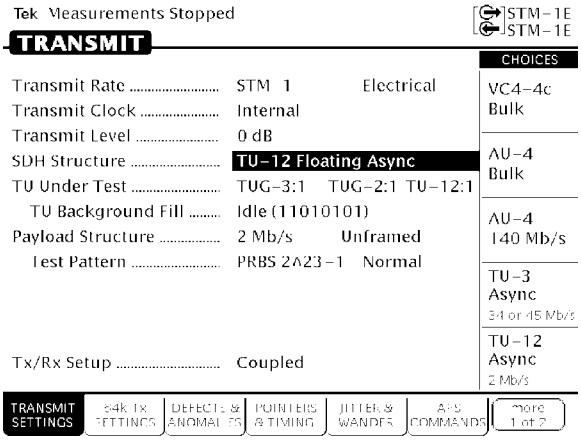


Figure 3 34: Mapping a Tributary Signal

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To configure the CTS850 for mapping a signal:

1. Set the Structure as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Structure	TU12 Async
			TU3 Async
			140 Mb/s

- Select **TU12 Async** to map an externally supplied or internally generated 2 Mb/s or 64k signal to the transmitted signal.
- Select **TU3 Async** to map an externally supplied or internally generated 34 Mb/s, 45 Mb/s, 8 Mb/s, 2 Mb/s or 64k signal to the transmitted signal.
- Select **140 Mb/s** to map an externally supplied or internally generated 140Mb/s, 34 Mb/s, 45 Mb/s, 8 Mb/s, 2 Mb/s, or 64k signal to the transmitted signal.

2. If the Structure is set to TU-12, specify the TU Under Test by first specifying the Tributary Unit Group (TUG) as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		TU Under Test *(TUG3 #n)*	TUG3 #1
			TUG3 #2
			TUG3 #3
			All TU12s

3. If TU12 Async is the selected Structure, specify the Tributary Unit (TU) as follows:

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Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		TU Under Test *(TU12 #n)*	*as appropriate*

4. If TU3 Async is the selected Structure, specify the Tributary Unit (TU) as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		TU3	TU3 #1
			TU3 #2
			TU3 #3
			All TU 3

H Select **TU3 #1**, **TU3 #2**, or **TU3 #3** to specify the TU Under Test.

5. Specify the payload as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Payload	*as appropriate*

NOTE*. The choices available for Payload depend on the selected Structure.*

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Setting the Test Pattern (User selectable)

You can select a test pattern to transmit in the TU.

To specify the test pattern to transmit (the choices available for Test Pattern depend on the selected Structure):

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Test Pattern	*as appropriate*

- Select **1 in 8** to set the test pattern to 10000000.
- For PDH Payloads only, select **User Word 8 bit**, **User Word 16 bit**, or **User Word 24 bit** to set a test pattern different from the preset choices. If you choose User Word, the test pattern description changes to display the byte selected.

If you select User Word 8 bit/16 bit/24 bit for the test pattern, set the value of the User Word as follows:

1. Set the contents of the User Word Byte(s) as follows (see Figure 3 35):

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Test Pattern	Set to 00000000
			Set to 11111111
			Default 10101010
			EDIT BYTE/ Edit XX bits

2. Select **EDIT BYTE/Edit XX bits** to specify a value different from the preset choices.
3. Select **DONE** when you are finished editing the pattern.

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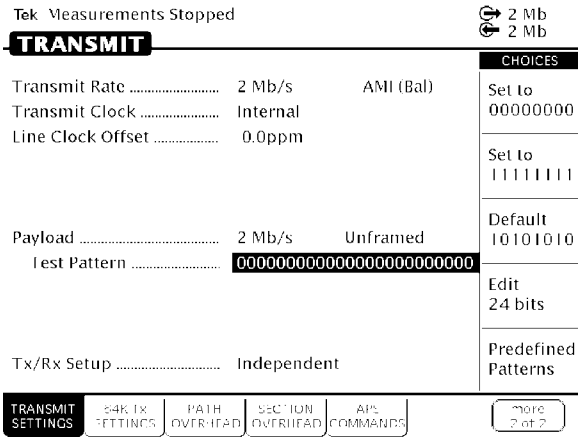


Figure 3 35: Editing the User Word Byte

Setting Overhead Bytes

To stress test a network, you sometimes need to simulate errors or alarms. Use the controls on the Defects & Anomalies page of the TRANSMIT menu to simulate errors or alarms. As an alternative, you can edit the transport overhead and path overhead bytes directly to simulate errors, alarms, and create other stress conditions. This section describes how to use the SECTION OVERHEAD and PATH OVERHEAD pages to edit overhead bytes.

How to Edit an Overhead Byte

The following procedure applies to editing either section overhead or path overhead bytes. However, when editing path overhead bytes, you must specify which overhead you want to edit (VC4, VC3, or VC12) before you can edit the overhead bytes.

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To edit overhead bytes:

1. Display the section overhead as follows, then select the columns you wish to edit. Press MORE 2 of 2 to see the Section Overhead Page choice.

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Section Overhead	Showing Overhead for	as appropriate

2. Turn the knob to highlight the byte you want to edit. See Figure 3 36.

When editing the S1 byte (shown in next figure), entering the following bits will result in the corresponding label in the line on the Section Overhead menu called Sync. Status Message (shown in next figure). This message line, showing the assignment of bit patterns, appears in both the **Transmit menu** and, and the **Receive menu** under the **Section Overhead** tab.

S1 bits b5 b8	Sync. Status Message
0000	Quality Unknown
0001	Reserved
0010	G.811 PRC
0011	Reserved
0100	G.812 transit
0101	Reserved
0110	Reserved
0111	Reserved
1000	G.812 local
1001	Reserved
1010	Reserved
1011	G.813 SETS (Synchronous Equipment Timing Source)
1100	Reserved
1101	Reserved
1110	Reserved
1111	Do not use

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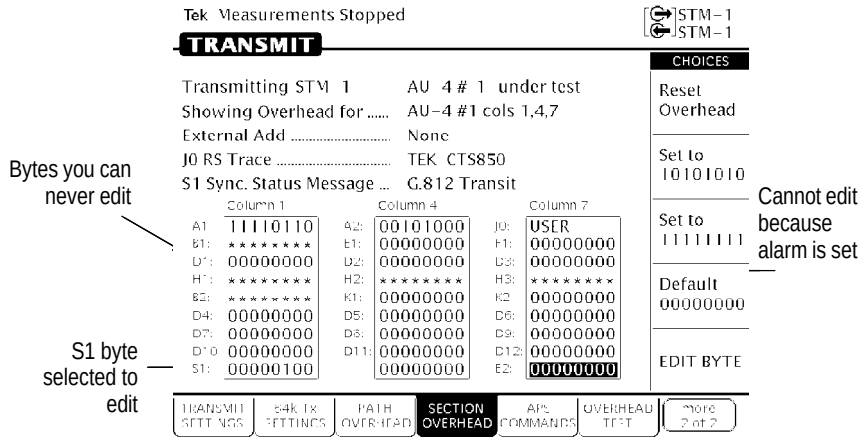


Figure 3 36: Editing the S1 Section Overhead Byte

There are several ways to edit the byte:

- Select **Reset Overhead** to set all bytes in the overhead to their individual default values. However, Reset Overhead does not remove simulated error conditions that have been set using controls in the Defects & Anomalies page. A simulated error condition overrides the default value of the overhead byte that signals that particular error condition.
- Select **Default (XXXXXXXX)** to set the selected byte to its default value. The specific default value depends on the selected byte and on the rate and structure of the signal.
- Select **EDIT BYTE** to define the byte as a value different from the preset choices.

3. To edit the selected byte to a value of your choice:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
			EDIT BYTE

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- Define your own byte with the buttons next to **1** and **0**. Use the left and right arrow buttons to move the cursor from one bit to the next. See Figure 3 37.
- When you finish editing the byte, select **DONE**.

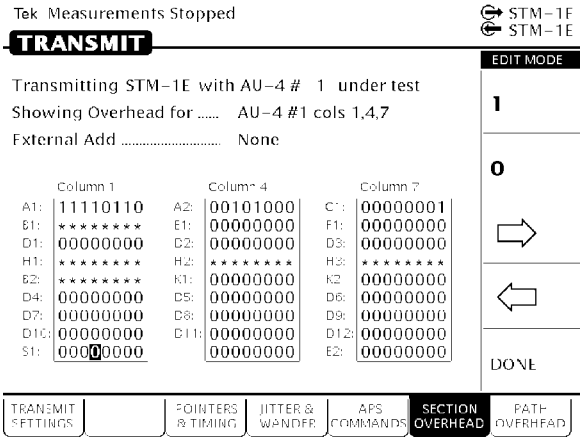


Figure 3 37: Editing an Overhead Byte

Editing the VC4, VC3, and VC12 Overhead Bytes

To edit the VC4, VC3 or VC12 overhead bytes:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD	Overhead View	VC4 Overhead
			VC3 Overhead
			VC12 Overhead

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***NOTE**. The choices available depend on the signal Structure.*

If the signal Structure is set to TU-12, you can edit the V5, N2, and K4 bytes after displaying the VC12 Overhead. The J2 trace byte is fixed and cannot be edited. Note that only bits 5, 6, and 7 (the signal label bits) of the V5 byte are editable. See Table 3 10.

Table 3 10: Choices for Bits 5, 6, and 7 of the V5 Byte

Choice
Unequip (000)
Equipped (001)
Async (010)
Bit Sync (011)
Byte Sync (100)
Reserved (101)
TSS4 (110)
VC AIS

Bytes You Cannot Edit

Certain bytes in the section overhead and path overhead cannot be edited in the SECTION OVERHEAD or PATH OVERHEAD pages. These uneditable bytes have calculated values that are based on the payload and signal structure (see Table 3 11).

Table 3 11: Overhead Bytes That Cannot Be Edited

Overhead Byte	Function
B1	Section level parity byte
B2	MS level parity byte
B3	Path level parity byte
G1	Path status

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Table 3 11: Overhead Bytes That Cannot Be Edited (Cont.)

Overhead Byte	Function
H1, H2, H3	Identify location of payload
H4	Multiframe indicator

The bytes that cannot be edited are marked with a line of asterisks on the SECTION OVERHEAD or PATH OVERHEAD pages (see Figure 3 36 on page 3 93).

In addition, there are bytes you may not be able to edit depending on parameter settings in the CTS850. As shown in Figure 3 36, a short text string replaces the binary values in the byte field of the SECTION OVERHEAD and PATH OVERHEAD pages when a byte cannot be edited. Table 3 12 shows the affected bytes, the text string, and a description of the parameter setting that prevents the byte from being edited.

Table 3 12: Bytes You Cannot Edit Due to Parameter Settings

Section and Path Overhead Byte(s)	Text String that Replaces the Binary Values	Parameter Setting Affecting Byte-Edit Capability
A1, A2	LOF SET	Loss of Frame Failure is being simulated
D1, D2, D3	EXT ADD	RS Data Communication Channel External Add is enabled
K1, K2	MS AIS SET	MS AIS is being simulated
	RDI SET	MS RDI is being simulated
D4, D5, D6, D7, D8, D9, D10, D11, D12	EXT ADD	MS Data Communication Channel External Add is enabled
S1	REI SET	MS REI is being simulated

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Table 3 12: Bytes You Cannot Edit Due to Parameter Settings (Cont.)

Section and Path Overhead Byte(s)	Text String that Replaces the Binary Values	Parameter Setting Affecting Byte-Edit Capability
G1	HP RDI SET	HP RDI is being simulated
	HP REI SET	HP REI is being simulated
All path overhead bytes set to ones	AU AIS SET	AU AIS is being simulated

Editing the J1 Path Trace Byte

The J1 Path Trace Byte carries a fixed-length, 16 or 64-byte string intended for sending user messages. The Path Trace Byte is a string consisting of ASCII characters (rather than the ones and zeros used to edit the other overhead bytes); the 16 byte format includes a CRC byte. 16 byte and 64 byte are two different formats.

To edit the J1 Path Trace Byte:

1. Display the Path Trace Byte as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	PATH OVERHEAD	J1 *byte*	Reset Overhead
			64 byte Format
			16 byte Format
			Edit Trace
			Default Trace

The text string USER is shown in place of the actual byte value. There are five ways you can change the Path Trace message.

H Select **Reset Overhead** to set all bytes in the path overhead to their default values.

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***NOTE**. Reset Overhead does not remove simulated error conditions that have been set using controls in the Defects & Anomalies page.*

- Select **Null Trace** to set all the J1 bytes in the string to the null character.
- Select **Default Trace** to set the J1 byte string to the default string “Tektronix CTS 850 SDH Test Set, hello, bonjour, guten tag.”
- Select **Default 64 Byte** to set the J1 byte string to the default string “Tektronix CTS 850 SDH Test Set, hello, bonjour, guten tag.”
- Select **User Trace** to set the J1 byte string to a string you can enter using the EDIT TRACE function.
- Select **Default 16 Byte** to set the J1 byte string to the string “Tek CTS 750” padded with spaces and ending with a carriage return/line feed.
- Select **EDIT TRACE** to define your own text string.

2. Select **EDIT TRACE** to edit the path trace message (see Figure 3 38).

   The string can contain a maximum of 64 characters, including spaces.

3. Select **DONE** when you have completed entering the string.

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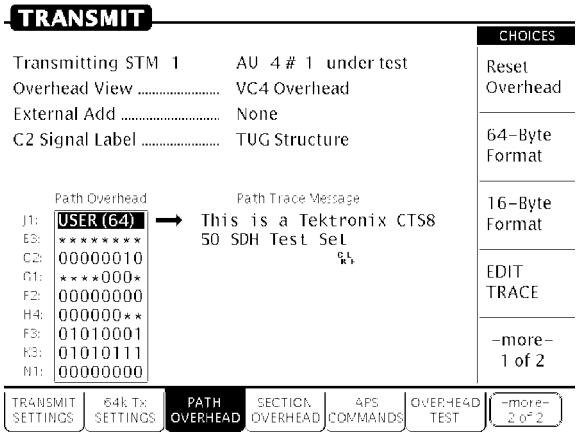


Figure 3 38: Editing the J1 Path Trace Byte

Adding DCC and User Channel Overhead Bytes

You can add data generated by an external protocol analyzer into the Data Communication Channel (DCC) and User Channel. The data from the protocol analyzer is added through the Overhead Add/Drop Port located on the rear panel. See *Appendix G* for detailed information on the port pin assignments.

To add external data into the DCC:

1. Connect an external protocol analyzer to the CTS850 using the Overhead Add/Drop Port on the rear panel of the CTS850.

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2. To configure the CTS850 to add the external data bytes:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	SECTION OVERHEAD	External Add	None
			D1 D3
			D4 D12
			F1
			E1
			E2
			E1 from Handset
			E2 from Handset

- Select **None** if you do not want to add external data.
- Select **D1 D3** to add data, generated by an external protocol analyzer, to the D1 D3 bytes of the DCC.
- Select **D4 D12** to add data, generated by an external protocol analyzer, to the D4 D12 bytes of the DCC.
- Select **F1** to add data, generated by an external protocol analyzer, to the F1 byte of the DCC.

As soon as you select which bytes to add data to, the CTS850 displays the words EXT ADD as the value for the selected bytes (see Figure 3 39).

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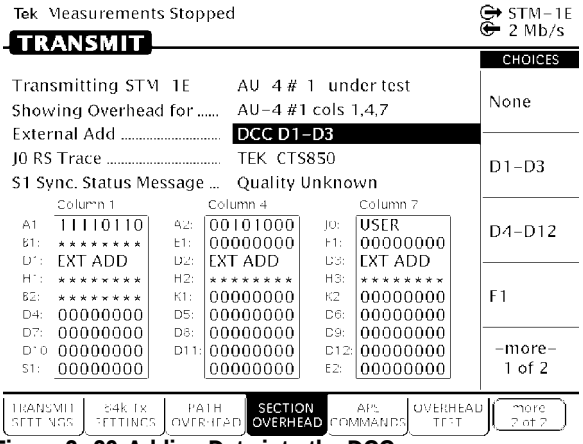


Figure 3 39: Adding Data into the DCC

To add external data into the User Channel:

1. Connect an external protocol analyzer to the CTS850 using the Overhead Add/Drop Port on the rear panel of the CTS850.
2. To configure the CTS850 to add the external data byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	PATH OVERHEAD	External Add	None
			F2

***NOTE**. The F2 byte cannot be externally generated for VC3 Overhead. However, the F2 byte can be edited from the PATH OVERHEAD page.*

- **None** if you do not want to add external data.
- **F2** to add data, generated by an external protocol analyzer, to the User Channel.

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As soon as you select F2, the CTS850 displays the words EXT ADD as the value for F2 (see Figure 3 40).

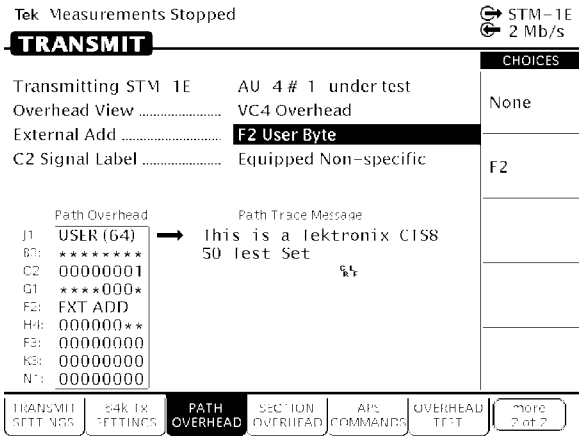


Figure 3 40: Adding Data into the User Channel

Trace Settings

The Trace Settings page available from the TRANSMIT Menu permits Trace Mismatch comparisons. This function is used for continuity testing. The J0 RS Trace can be chosen from the Section Overhead page of the TRANSMIT menu.

Table 3 13: Transmit TRACE SETTINGS Choices

Overhead Testing	Choices
Trace Select	Selects the trace for which information will be displayed. Valid selections depend on the current transmit and receive configurations. Values: J0, J1, J2
TX Trace	This displays the current TX trace.

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Table 3 13: Transmit TRACE SETTINGS Choices (Cont.)

Overhead Testing	Choices
RX Trace	This displays the current RX trace. The display will be be updated as new data is received.
Expected Trace	This field displays the trace value used for trace mismatch comparisions. The user may edit the expected value trace, or copy the value from the value being transmitted or received. The J0 RS Trace can be chosen in the Section Overhead page of the TRANSMIT menu.

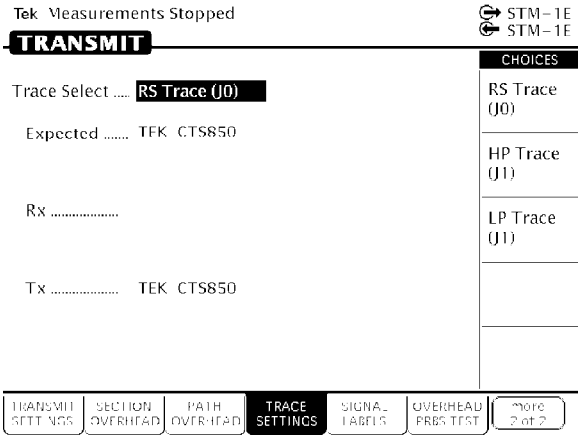


Figure 3 41: Choosing TRACE SETTINGS

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Signal Labels

The Signal Labels page available from the TRANSMIT Menu permits selection of the C2 HP Signal Label. The different Signal Label settings have a dependance on the menus accessible from **TRANSMIT, Transmit Setting, SDH Structure** choices (STM 4: VC4 4c Bulk, AU 4 Bulk, AU 4 140 Mb/s, TU 3 Async 34 Mb/s, TU 12 Async 2 Mb/s) and the **TRANSMIT, Path Overhead, C2 Signal Label** choices (Unequipped; Equipped; TUG; TU n; 34 Mb/s; 140 Mb/s; ATM; MAN (DQDB); FDDI; O.181; VC AIS).

The C2 HP Signal Label choice (VC4 Overhead) is enabled when the HP Signal Label Mismatch Detection choice enabled at the RECEIVE, Analysis Config page. The C2 LP Signal Label choice (VC3 Overhead, TU3 Mapped) is enabled when the LP Signal Label Mismatch Detection choice enabled at the RECEIVE, Analysis Config page. The C2 V5 Signal Label choice (VC12 Overhead, TU12 Mapped) is enabled when the LP Signal Label Mismatch Detection choice enabled at the RECEIVE, Analysis Config page.

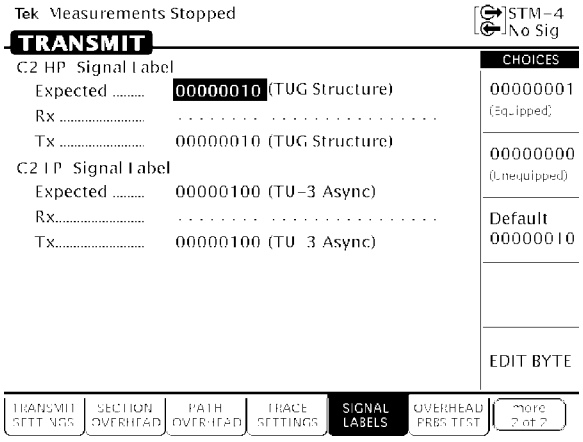


Figure 3 42: Choosing SIGNAL LABELS

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Overhead PRBS Test

The Overhead PRBS Test page available from the TRANSMIT Menu permits PRBS insertion into a selected overhead byte. This function is used for continuity testing.

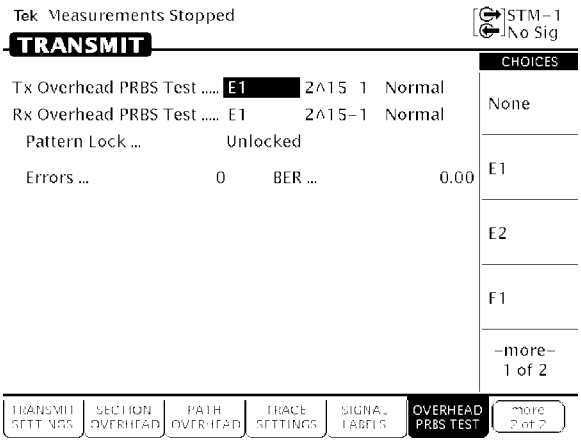


Figure 3 43: Choosing OVERHEAD PRBS TEST

Table 3 14: Transmit OVERHEAD PRBS TEST Choices

Overhead Testing	Choices
TX Overhead PRBS Test	Sets up PRBS insertion into a selected overhead byte for continuity testing. Three fields select the byte, PRBS pattern, and pattern inversion. Byte selections: None, D1 D3, D4 D12, E1, E2, F1, F2. Patterns: PRBS15, PRBS20, PRBS23. Inversion: Standard, Inverted.
RX Overhead PRBS Test	Sets up PRBS insertion into a selected overhead byte for continuity testing. Three fields select the byte, PRBS pattern, and pattern inversion. Byte selections: None, D1 D3, D4 D12, E1, E2, F1, F2. Patterns: PRBS15, PRBS20, PRBS23. Inversion: Standard, Inverted.

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Setting PDH Transmit Parameters

This section describes how to set the transmit rate, transmit clock, line clock offset, payload, framing, test pattern, active channel and background pattern for a PDH signal.

Steps for Setting Parameters

The sequence of steps for setting transmit parameters varies depending on the type of signal to be transmitted. Figure 3 44 shows the sequence of steps required to set the transmit parameters for a PDH signal (for example, 2 Mb/s).

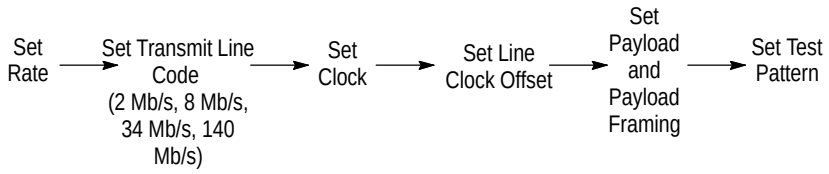


Figure 3 44: Sequence for Setting PDH Signal Parameters

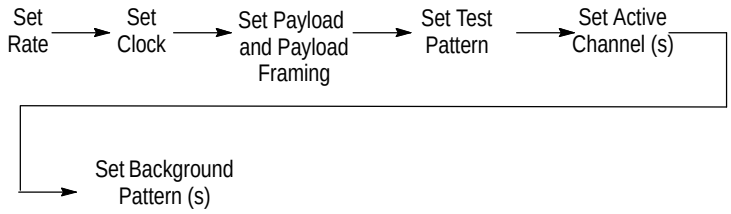


Figure 3 45: Sequence for Setting PDH Signal Parameters When Multiplexing a lower rate PDH Signal

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Selecting 64k TX Settings

If the operator selects a PDH Transmit Rate and a 64k payload on the Transmit Setting screen, the 64k Tx SETTINGS menu is enabled. This menu has all of the setup items required to configure a 64k or N x 64k payload as a base for the 2 Mb/s signal. This menu also is used for a PDH payload on a SDH signal.

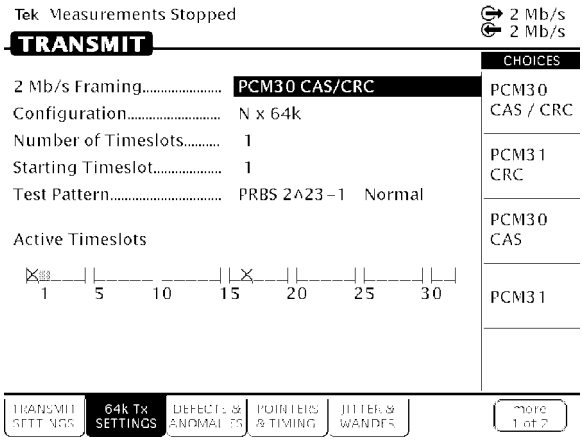


Figure 3 46: 64k Tx SETTINGS from TRANSMIT SETTING Menu

Table 3 15: 64k Tx SETTINGS Choices

64k TX Settings	Choices
Framing	Selects the framing for the signal. Choices are 2Mb/s PCM30 CAS/CRC, PCM31 CRC, PCM30CAS, and PCM31.
Configuration	Selects the 64k configuration. The menu choices are 1x64k, Nx64k Contiguous
Number of Timeslots	If the configuration is Nx64k, this selects the number of contiguous channels (N) that make up the signal. This choice will not display for a 1 x 64k configuration.

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Table 3 15:64k Tx SETTINGS Choices (Cont.)

64k TX Settings	Choices
Starting Timeslot	This selects the starting (or only) timeslot.
Test Pattern	This selection is a duplicate of the Test Pattern selection choice from the TRANSMIT SETTING menu.

Setting the Transmit Rate

To set the transmit rate:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate (see Figure 3 47)	2 Mb/s
			34Mb/s or 45 Mb/s
			140Mb/s

H Select **2 Mb/s**, **8 Mb/s, 34 Mb/s,** or **140 Mb/s** to transmit a PDH signal. If your CTS 850 test set supports the 45 Mb/s option, there is also a 45 Mb/s signal available for selection.

NOTE. *Even though there are output connectors for both SDH and PDH signals on the CTS850 front panel, the CTS850 can transmit only one type of signal at a time.*

Independent Transmit and Receive Settings

Generally, you can set the transmit and receive settings independently. For example, you can receive an electrical signal at the STM-1E rate while simultaneously transmitting an optical signal at the 140 Mb/s rate. PDH can also be an electrical signal.

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Coupling Transmit and Receive Settings

If your application requires that the transmit settings and receive settings be identical, you can save time by coupling them together. After they are coupled, any change you make to a parameter on the TRANSMIT SETTINGS page will also be made to the corresponding setting in the RECEIVE SETTINGS page of the RECEIVE menu. The inverse is also true.

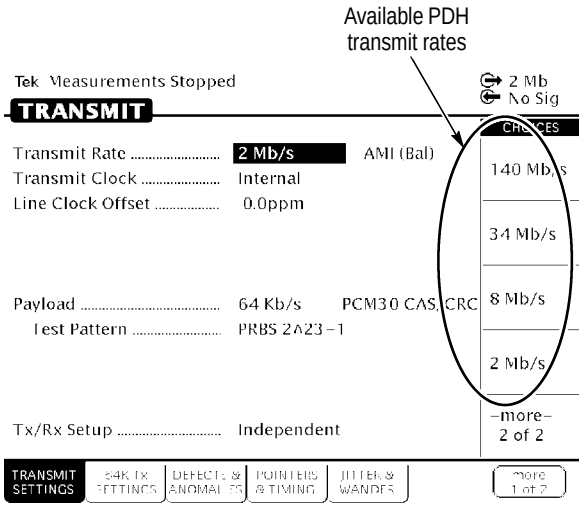


Figure 3 47: PDH Transmit Rates

To couple the transmit and receive settings together from the TRANSMIT SETTINGS page:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Coupled

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***NOTE**. When settings are coupled from the TRANSMIT SETTINGS page, the receive parameters are changed to match the transmit parameters. Conversely, when settings are coupled from the RECEIVE SETTINGS page, the transmit parameters are changed to match the receive parameters.*

Notice that the signal status icons, in the upper-right corner of the display, changed to reflect the coupling of the settings.

To change transmit and receive settings so that they are no longer coupled:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Independent

Notice that the signal status icons, in the upper-right corner of the display, changed to indicate that the settings are no longer coupled.

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Viewing the Transmit Line Code

To view the transmit line code for the PDH signal:

The line code for each PDH rate is listed in Table 3 16.

Table 3 16: PDH Rate Line Codes

Transmit Rate	Line Codes Available
8, 34 Mb/s	HDB3, AMI
45 Mb/s	HDB3, B3ZS
2 Mb/s	HDB3(Unbalanced), HDB3 (Unbalanced), AMI (Unbalanced) AMI (Balanced)

- CMI (Coded Mark Inversion) is the only line code available for the 140 Mb/s rate.

Setting the Transmit Clock

To specify the transmit clock:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Clock	Internal
			Recovered
			External 2 Mb/s/ 2 MHz
			External 1.5 Mb/s BITS

- Select **Internal** to set the transmit clock to the internal clock.

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- Select **Recovered** to use the clock recovered from an incoming signal.
- Select **External 2 Mb/s** to use an external 2 Mb/s clock.
- Select **External 2 MHz** to use the clock signal from an external 2 MHz clock.
- Select **External 1.5 Mb/s BITS** to use an external 1.5 Mb/s.

Setting the Line Clock Offset

To specify the line clock offset:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Transmit Settings	LIne Clock Offset	Max +100ppm
			Stress +50ppm
			Stress 50ppm
			Default 0 ppm
			USER DEFINED

The different PDH rates have different stress ratios:
140 Mb/s +/ 15 ppm; 34 Mb/s +/1 20 ppm; 8 Mb/s +/ 30 ppm; 2 Mb/s +/ 50 ppm.

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Specifying Payload and Payload Framing

The framing choices available depend on the selected transmit rate.

To set the framing for a 2 Mb/s signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Payload 2 Mb/s	Unframed
			External Add Balanced;
			External Add Unbalanced
			PCM 30 CAS/CRC, PCM31 CRC, PCM 30 CAS, PCM31

To set the framing for a 8 Mb/s, 34 Mb/s, or 140 Mb/s signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	**Payload** 8 Mb/s, 34 Mb/s or 140 Mb/s	Unframed
			Framed
			External Add

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To set the framing for a 45 Mb/s signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	**Payload** 45 Mb/s	C Bit
			M13
			Unframed

To set the framing for a 64k signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	**Payload** 64k	PCM30 CAS/CRC
			PCM31 CRC
			PCM30 CAS
			PCM31

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Specifying the Test Pattern

You can select a test pattern to transmit in the PDH signal.

To specify the test pattern to transmit:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Test Pattern	PRBS 2^23 1 PRBS 2^20 1 PRBS 2^15 1 PRBS 2^11 1 PRBS 2^9 1 1 in 8 All Ones All Zeros TS Idle 1020 Hz 0 dBM User Word 8 bit User Word 16 bit User Word 24 bit

- Select **1 in 8** to set the test pattern to 10000000.
- Select **User Word 8 bit**, **User Word 16 bit**, or **User Word 24 bit** to set a test pattern different from the preset choices. If you choose one of the User Word choices, the test pattern description changes to User Defined Byte.

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If you select User Word 8 bit/16 bit/24 bit for the test pattern, set the value of the User Word as follows:

1. Set the contents of the User Word as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Test Pattern	Set to 00000000
			Set to 11111111
			Default 10101010
			EDIT BYTE/ Edit XX bits

2. Select **EDIT BYTE/Edit XX bits** to specify a value different from the preset choices (see Figure 3 48).

3. Select **Predefined Patterns** if you decide to use the standard patterns.

4. Select **DONE** when you are finished editing the byte.

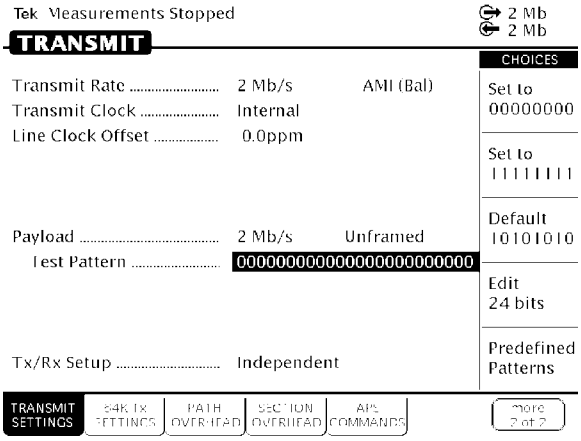


Figure 3 48: Editing the User Word

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Setting Jitter or Wander Generation

To test the response of a network to jitter, you may need to generate PDH signals that contain jitter. You can use the CTS850 to generate these signals with a controlled amount of jitter. Refer to *Setting Jitter and Wander Generation* in the separate section of this chapter on **Setting Jitter/Wander Parameters** for information about this topic.

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Setting SDH Receive Parameters

This section describes how to manually set the receive line rate, define the AU under test, set the payload mapping and content, check the received optical signal power, and view the overhead bytes.

The CTS850 SDH/PDH Test Set contains independent transmit and receive modules. One set of parameters controls the transmit module and a separate set controls the receive module. You can set the receive parameters independent of the transmit parameters or you can choose to link them to the transmit settings.

Pressing AUTOSCAN sets the receive parameters automatically based on the received signal.

Steps for Setting Parameters

The sequence of steps for setting receive parameters varies with the type of signal to be received. Figure 3 49 shows the sequence of steps required to set the receive parameters for an SDH signal without demapping a PDH signal. Figure 3 50 shows the steps required to set the receive parameters for an SDH signal when demapping a PDH signal. See a later section for details on setting PDH signal parameters (for example 2 Mb/s).

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Figure 3 49: Sequence for Setting SDH Signal Parameters

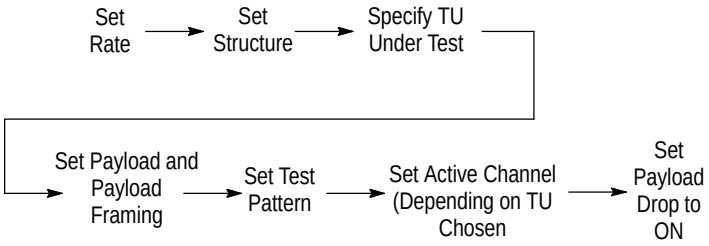


Figure 3 50: Sequence for Setting SDH Signal Parameters When Demapping a PDH Signal

Setting the Receive Rate

To set the receive rate:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS (see Figure 3 51)	Receive Rate	*as appropriate*

- Select **STM-1E**, **STM-1**, **STM-4**, **STM-0E**, or **STM 0** to receive an SDH signal.
- Select **2 Mb/s Balanced or Unbalanced**, **8 Mb/s, 34 Mb/s**, or **140 Mb/s** to receive a PDH signal.
- If your CTS 850 test set supports the 45 Mb/s option, there is also a **45 Mb/s** signal available for selection.

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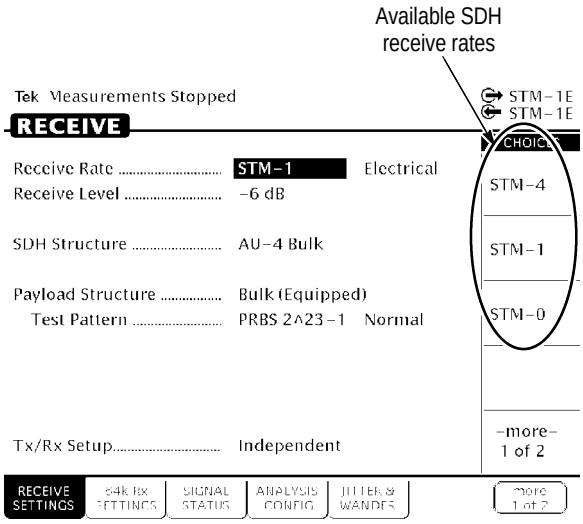


Figure 3 51: SDH Receive Rates

Independent Receive and Transmit Settings

Generally, you can set the receive and transmit settings independently. For example, you can receive an electrical signal at the STM-1E rate while simultaneously transmitting an optical signal at the STM-1 rate.

Coupling Receive and Transmit Settings

If your application requires that the receive settings and transmit settings be identical, you can save time by coupling them together. After they are coupled, any change you make to a parameter on the RECEIVE SETTINGS page will also be made to the corresponding setting in the Receive SETTINGS page of the RECEIVE menu. The inverse is also true.

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To couple the receive and transmit settings together from the RECEIVE SETTINGS page:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Tx/Rx Setup	Coupled

***NOTE**. When settings are coupled from the RECEIVE SETTINGS page, the transmit parameters are changed to match the receive parameters. Conversely, when settings are coupled from the Transmit Settings page, the receive parameters are changed to match the transmit parameters.*

To change receive and transmit settings so that they are no longer coupled:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Tx/Rx Setup	Independent

Notice that the signal status icons, in the upper-right corner of the display, changed to indicate that the settings are no longer coupled.

***NOTE**. When the incoming line rate changes, a valid LOS must occur between the old and new line rates; otherwise, the* CTS850 *might lose pattern lock and display an LOS or LOF status. If this occurs, reselect the correct Receive line rate after the change or initiate a valid LOS (for example, disconnect and reconnect the received signal or assert LOS at the source).*

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Specifying the AU to Test

AU under test is only displayed when the input rate is STM 4 and the signal structure is 1 x AU 4. To designate which AU to test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	Receive SETTINGS	AU Under Test	1, 2, 3, 4

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Setting the SDH Structure

This selection sets the structure of the AU or TU under Test (SDH input rates only).

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	Receive Settings	Structure STM 4	VC4 4c Bulk AU 4 Bulk AU 4 140 Mb/s TU 3 Async TU 12 Async
		STM 1	AU 4 Bulk AU 4 140 Mb/s TU 3 Async TU 12 Async
		STM 0	AU 3 only

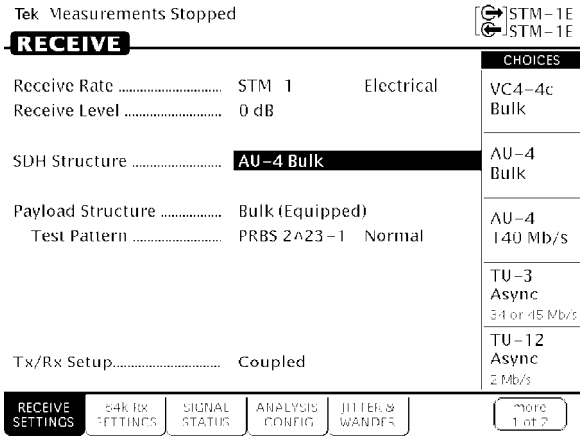


Figure 3 52: Example of SDH Structure

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TU Under Test

If the structure choice is TU 12 or TU 3, the TU under test selection is as follows (Selections are mutually exclusive).

TU 12:	TUG 3:1, TUG 3:2, TUG 3:3
	TUG 2:1 to TUG 2:7
	TU 12:1, TUG 12:2, TUG 12:3
TU 3:	TU 3:1, TUG 3:2, TUG 3:3

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Setting the Payload

Payload sets the final analysis rate. Because of the number of selections available, the rate and framing parameters have been split. If the payload rate is not the same as the mapping (SDH) or input (PDH) rate, then demultiplexing is implied.

Table 3 17: RX Rates and Structures

RX Rate	RX Structure	Demultiplexing combinations
STM 4 STM 1	VC4 4c AU 4 TU 12 TU 3 140 Mb/s	Bulk Equipped & Unequipped 2Mb/s, 64k 34Mb/s, 8Mb/s, 2Mb/s, 64k 140, 34, 8, 2 Mb/s, 64k
STM 0	AU 3	Bulk Equipped & Unequipped
140 Mb/s	Not Applicable	34Mb/s, 8Mb/s, 2Mb/s, 64k
34 Mb/s, 45 Mb/s	Not Applicable	34 Mb/s, 8Mb/s, 2 Mb/s, 64k
8 Mb/s	Not Applicable	8 Mb/s, 2Mb/s, 64k
2 Mb/s	Not Applicable	2Mb/s, 64k

Bulk fill of a TU 12 or TU 3 is not supported.

To set the payload:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
Receive	Receive SETTINGS	Payload	As appropriate

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Table 3 18: Payload Framing/ Source

Payload	Allowable choices
140 Mb/s	Framed, Unframed, External Add
34 Mb/s	Framed, Unframed, External Add
45 Mb/s	C Bit, M13, Unframed
8 Mb/s	Framed, Unframed, External Add
2 Mb/s	Unframed, External Add Unbalanced/balanced, PCM30 CAS CRC, PCM31 CRC, PCM30 CAS, PCM31
64k	64k payload does not have framing

When 64k is the payload, framing can also be set from the 64k Rx SETTING menu.

Setting the Test Pattern

The Live choice is a valid test pattern selection (see bottom of table). Live implies in service, and bit errors will not be checked. User defined 16 and 24 bit patterns are supported.

Table 3 19: Test Patterns

Test Patterns	Allowable choices
PRBS 2^9 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
PRBS 2^11 1	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
PRBS 2^15 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
PRBS 2^20 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
PRBS 2^23 1	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k

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Table 3 19: Test Patterns (Cont.)

Test Patterns	Allowable choices
All 1's	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
All 0's	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
10101010	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k
1 in 8	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
8 bit fixed	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
16 bit fixed	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
24 bit fixed	140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s
Live	STM 4; STM 1; STM 0; 140Mb/s; 34 Mb/s; 8Mb/s; 2 Mb/s; 64k

Selecting the Active Channel Selection

If the payload selection forces demultiplexing, active channel selections will be displayed. This allows the operator to specify which of the four channels from the next higher rate will be selected for analysis (for example, 34Mb/s Active Channel 1 picks the first channel from 140Mb/s).

Selecting the Payload Drop

If the Receive rate is any PDH or SDH rate, SDH is mapped for PDH, and the PDH payload is less than the line rate, then a selection appears at the bottom of Receive, Receive Settings menu. This selection permits the operator to drop a certain PDH payload. 8 Mb/s and 64k rates can not be dropped.

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Selecting the Tx/Rx Setup

Tx/Rx Setup permits the operator to couple Transmit and Receive settings, or select Through Mode. When coupled mode is selected, from the Receive Setting menu, applicable Receive Settings are copied to the Transmit side of the tester.

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Selecting Signal Status

The Signal Status menu adds PDH Payload Frequency and Round Trip Delay Offset. The following two menus are displayed when the Rate is STM 4, the structure is TU 12, and the payload is 2 Mb/s. Set these parameters in the Receive, Receive Settings menu. Then press the Receive, Signal Status softkey to access the following two menus.

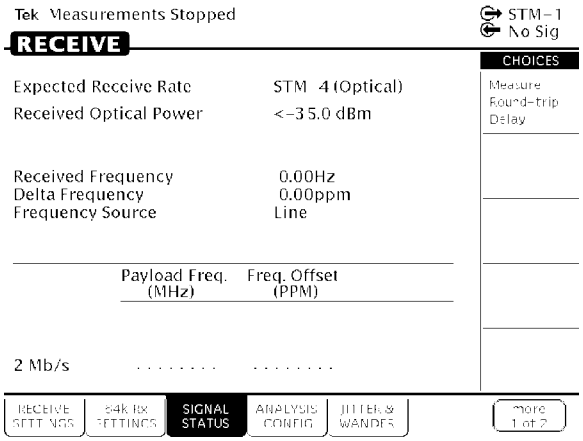


Figure 3 53: SIGNAL STATUS, Payload Frequency, from RECEIVE SETTINGS menu

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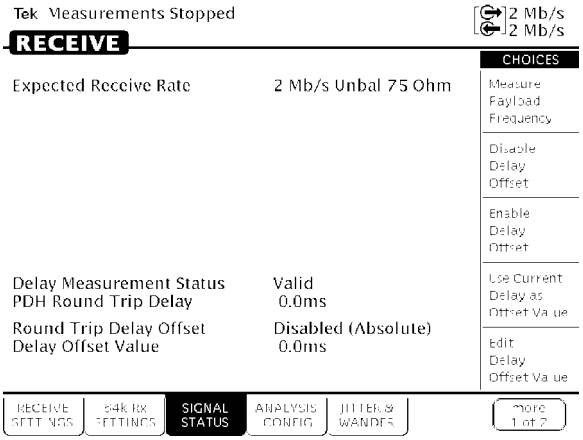


Figure 3 54: SIGNAL STATUS, Round Trip Delay Offset, from RECEIVE SETTINGS menu

Table 3 20: SIGNAL STATUS Choices

Signal Status	Choices
PDH Payload Frequency	PDH Payload Frequency is a direct measurement. Offset; Justification Ratios 140 Mb/s, 34 Mb/s, 8 Mb/s
Round Trip Delay Offset	Transmission of a long PRBS signal between the CTS850 TX and RX. A measurement, to 100 microseconds resolution, on how long it takes for this signal to travel through a DUT.

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Checking Received Optical Power or Received Peak Voltage

To check the optical power or the peak voltage of the received SDH signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	Signal Status	*none*	*none*

If Receive Rate, on the RECEIVE SETTINGS page, is set to an optical rate, the SIGNAL STATUS page displays the received optical power. If Receive Rate is set to an electrical rate, the SIGNAL STATUS page displays the received peak voltage.

The optical power of the received signal is displayed in dBm. The peak voltage of the received signal is displayed in volts. The SIGNAL STATUS page does not display results for PDH signals.

If the Jitter/Wander option is installed, three additional items are displayed and updated on the SIGNAL STATUS page:

- The actual received frequency in Hz
- The delta frequency from the the expected frequency to the actual frequency in ppm
- The frequency source, line or clock

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Selecting Analysis Configuration

Analysis configuration permits the operator to configure items that affect how incoming data is interpreted. These items cannot be changed once a test has been started. If the operator changes a selection, a warning message will be displayed.

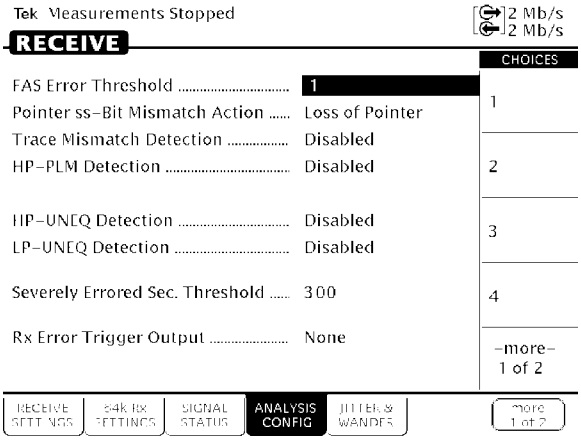


Figure 3 55: ANALYSIS CONFIG from Receive Setting Menu

Table 3 21: ANALYSIS CONFIG Choices

Analysis Config	Choices
FAS Error Threshold	The operator can set the number of consecutive errored frame alignment blocks that must be detected before an error is reported. The valid range for this parameter is 1 through 7, which would be set by the operator to match the provisioning of the equipment being used.
Pointer S Bit Mismatch Action	By definition, the pointer S bits should be 10 binary. This option allows the operator to choose to declare a loss of pointer error when the bits are incorrect, or ignore the error completely. Loss of Pointer, Ignore.

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Table 3 21: ANALYSIS CONFIG Choices (Cont.)

Analysis Config	Choices
Trace Mismatch Detection	Comparison of Received J0 Trace value vs. expected value. Measurement in error seconds. HP Unequipped Detection Choices: Disabled, Enabled LP Unequipped Detection Choices: Disabled, Enabled HP Signal Label Mismatch Detection Choices: Disabled, Enabled
2Mb/s CRC SES Error Threshold	CRC SES Error Threshold can only be enabled when the line rate is 2 Mb/s. Previous versions of M.2100 specified that an SES be declared when 805 CRC4 or E bit errors were detected in one second. The latest version of M.2100 sets this threshold at 300 errors. This selection allows for backwards compatible measurements. Selections: 300, 805. Default value is 300. 2 Mb/s rate: 300 (for G.826) or 805 (for G.821) 45 Mb/s rate: 2444 (for G.826) or 45 (for G.821)
Rx Error Trigger Output	Valid selections, depending on Receive setup, are: None, B1, B2, B3, and Pattern.

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Demapping a PDH Signal

To demap and test a PDH signal, you set Structure to the appropriate PDH mapping.

When you use tributary signal mapping, you must also specify the tributary under test and payload (see Figure 3 56).

When you use TU-12 or TU-3 signal mapping, you must also specify the tributary unit under test and payload (see Figure 3 56).

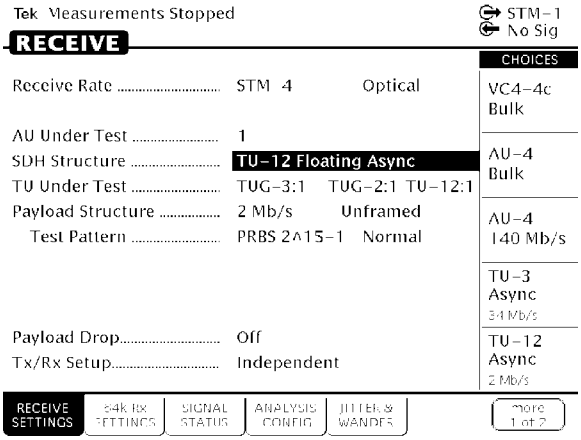


Figure 3 56: Setting PDH Mapping

To specify the TU Under Test and set the payload:

1. Specify the TU Under Test as follows:

***NOTE**. The choices available for TU Under Test depend on the selected Structure.*

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2. If the Structure is set to TU-12, specify the TU Under Test by first specifying the Tributary Unit Group (TUG) as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		TU Under Test *(TUG3 :n)*	TUG3 :1
			TUG3 :2
			TUG3 :3

3. If TU12 Async is the selected mapping, specify the Tributary Unit (TU) as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		TU Under Test *(TU12 :n)*	*as appropriate*

4. If TU3 Async is the selected mapping, specify the Tributary Unit (TU) as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
			TU3 :1
			TU3 :2
			TU3 :3

H Select **TU3:1**, **TU3:2**, or **TU3:3** to specify TU Under Test.

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5. Specify the payload as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Payload Structure	*as appropriate*

***NOTE**. The choices available for Payload depend on the selected Structure.*

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Dropping a PDH Signal

To drop a signal it must be demapped, as described previously, and you must turn on Payload Drop.

If the Receive rate is any PDH or SDH rate, SDH is mapped for PDH, and the PDH payload is less than the line rate, then a selection appears at the bottom of Receive, Receive Settings menu. This selection permits the operator to drop a certain PDH payload. 8 Mb/s and 64k rates can not be dropped.

To turn on Payload Drop:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Payload Drop	Off
			On Balanced
			On Unbalance

***NOTE**. The choices available for Tributary Drop depend on the selected Structure.*

H Select **On** to drop the signal specified on the Payload line. The signal will be dropped to the appropriate OUT connector on the front panel.

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Viewing Overhead Bytes

This section describes how to use the PATH OVERHEAD and PATH OVERHEAD pages to view overhead bytes. The display updates about once per second to track changes in the overhead. At any time, you can pause the updating process to analyze the bytes.

Viewing Section Overhead Bytes

To view section overhead bytes:

1. Display the section overhead as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD	*none*	*none*

If you are receiving a line rate higher than the SDH basic-level rates STM-1E or STM-1, you must indicate which overhead, at the STM-1 level, you want to display. One set of “columns” is the Section Overhead for an STM 0. STM 1 permits three choices; STM 4 permits three choices times four AU 4s; VC4 4c permits the same three choices as STM 1.

2. Select the columns you wish to display as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Showing Overhead for	*as appropriate*

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Viewing Path Overhead Bytes

To view path overhead bytes:

1. Display the path overhead as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD	Overhead View	VC4 Overhead
			VC3 Overhead
			VC12 Overhead

***NOTE**. The choices available depend on the mapping of the received signal.*

- Select **VC4 Overhead** to display the VC4 overhead bytes.
- Select **VC3 Overhead** to display the VC3 overhead bytes.
- Select **VC12 Overhead** to display the VC12 overhead bytes.

Displaying the J1 Path Trace Message

To view the Path Trace Message:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD (see Figure 3 57)	*none*	*none*

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Displaying the J2 Path Trace Message

To view the J2 path trace message:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD (see Figure 3 57)	Overhead View	VC12 Overhead

Displaying the V5 Byte

To view the V5 byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD (see Figure 3 57)	Overhead View	VC12 Overhead

***NOTE**. When the VC12 Overhead is displayed, the J2, N2, and K4 bytes will also be displayed.*

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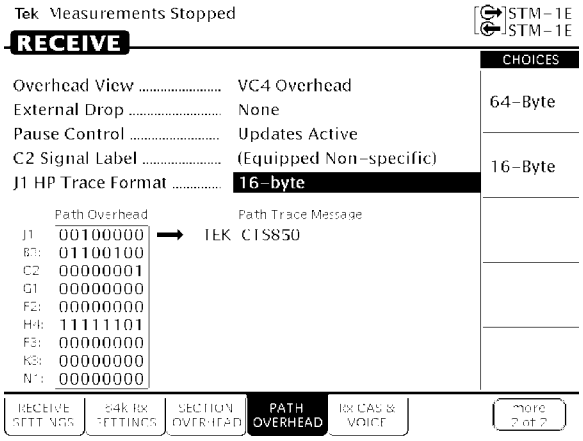


Figure 3 57: J1 Path Trace Message Received by the CTS850

Dropping DCC and User Channel Overhead Bytes

You drop the contents of the Data Communications Channel (DCC) and User Channel to an external protocol analyzer. The data from the DCC and User Channel is dropped through the Overhead Add/Drop Port located on the rear panel. See *Rear Panel Connectors in the Appendices* for detailed information on the port pin assignments.

To drop data from the DCC:

1. Connect an external protocol analyzer to the CTS850 using the Overhead Add/Drop Port on the rear panel of the CTS850.

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2. Configure the CTS850 to drop the DCC data bytes:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD	External Drop (see Figure 3 58)	None
			D1 D3
			D4 D12
			E1, E2
			E1, E2 to handset
			F1

- Select **None** if you do not want to drop the DCC bytes.
- Select **D1 D3** to drop the D1 D3 bytes of the DCC.
- Select **D4 D12** to drop the D4 D12 bytes of the DCC.
- Select **F1** to drop the F1 byte of the DCC.

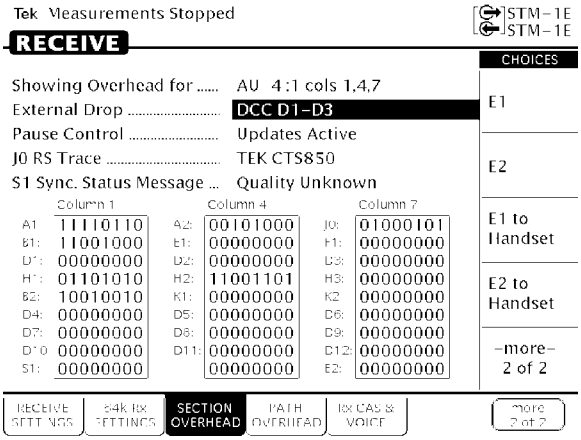


Figure 3 58: Dropping Data from the DCC

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To drop data from the User Channel:

1. Connect an external protocol analyzer to the CTS850 using the Overhead Add/Drop Port on the rear panel of the CTS850.
2. Configure the CTS850 to drop the User Channel data byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD	External Drop (see Figure 3 59)	None
			F2

- Select **None** if you do not want to drop the User Channel data.
- Select **F2** to drop the User Channel byte.

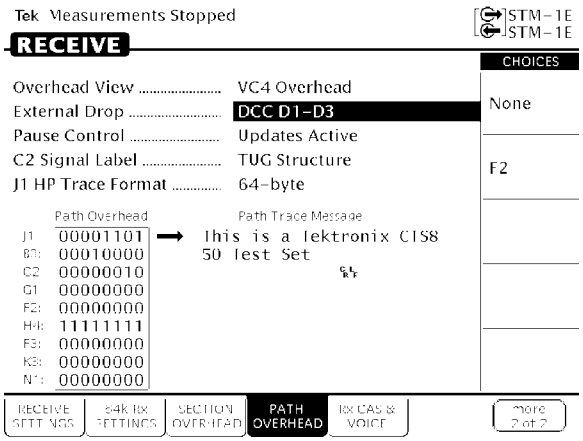


Figure 3 59: Dropping the User Channel Data Byte

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Controlling the Display Update

To pause or continue overhead byte updating:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	PATH OVERHEAD	Pause Control	Pause
			Continue

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Setting PDH Receive Parameters

This section describes how to manually set the receive rate, receive level, framing, and test pattern for PDH signals.

Pressing AUTOSCAN sets the receive parameters automatically based on the received signal.

Steps for Setting Parameters

The sequence of steps for setting receive parameters varies with signal to be received. Figure 3 60 shows the sequence of steps required to set the receive parameters for PDH signals (for example, 2 Mb/s).

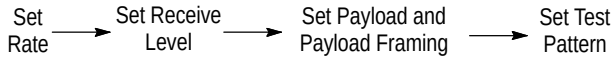


Figure 3 60: Sequence for Setting PDH Signal Parameters (non demuxed)

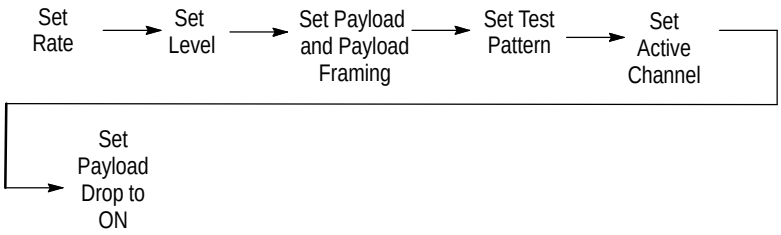


Figure 3 61: Sequence for Setting PDH Signal Parameters When demultiplexing a PDH Signal (demuxed)

CTS850 SDH/PDH Test Set

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Selecting 64k RX Settings

If the operator selects a SDH rate with PDH mapping or a PDH Transmit Rate and a 64k payload on the Receive Setting screen, the 64k Rx SETTINGS menu is enabled.
This menu has all of the setup items required to configure a 64k or N x 64k signal, along with duplicates of the framing selections and test pattern choices.

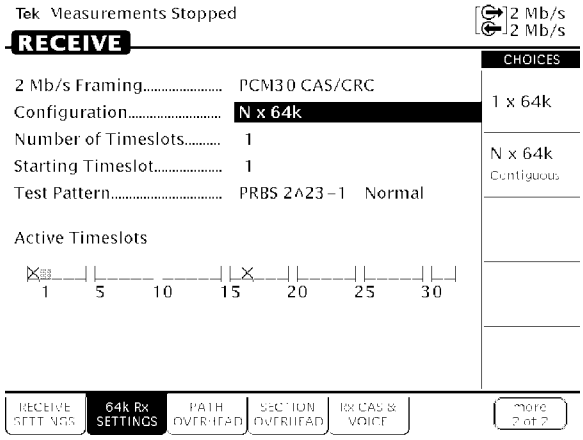


Figure 3 62: 64k Rx SETTINGS from RECEIVE SETTINGS menu

Table 3 22: 64k Rx SETTINGS Choices

64k RX Settings	Choices
Framing	Selects the framing for the underlying 2 Mb/s signal. Choices are 2Mb/s PCM30, PCM31, PCM30CRC, and PCM31CRC.
Configuration	Selects the 64k configuration. The menu choices are 1x64k, Nx64k Contiguous.
Number of Time-slots	If the configuration is N x 64 k, this selects the number of contiguous channels (N) that make up the signal. This choice will not display for a 64k configuration.

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Table 3 22:64k Rx SETTINGS Choices (Cont.)

64k RX Settings	Choices
Starting Timeslot	This selects the starting (or only) timeslot.
Test Pattern	This selection is a duplicate of the Test Pattern selection choice from the RECEIVE SETTING menu.

Setting the Receive Rate

To set the receive rate:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS (see Figure 3 63)	Receive Rate	*as appropriate*

- Select **2 Mb/s**, **8 Mb/s**, **34 Mb/s**, or **140 Mb/s** to receive a PDH signal.
- If your CTS 850 test set supports the 45 Mb/s option, there is also a **45 Mb/s** signal available for selection.

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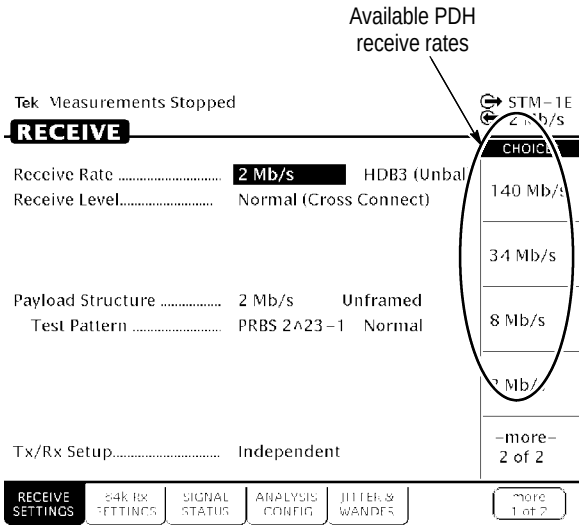


Figure 3 63: PDH Signal Receive Rates

Independent Receive and Transmit Settings

Generally, you can set the receive and transmit settings independently. For example, you can receive an electrical signal at the 34 Mb/s rate while simultaneously transmitting an optical signal at the STM-1 rate.

Coupling Receive and Transmit Settings

If your application requires that the receive settings and transmit settings be identical, you can save time by coupling them together. After they are coupled, any change you make to a parameter on the RECEIVE SETTINGS page will also be made to the corresponding setting in the TRANSMIT SETTINGS page of the RECEIVE menu. The inverse is also true.

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To couple the receive and transmit settings together from the RECEIVE SETTINGS page:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Tx/Rx Setup	Coupled

***NOTE**. When settings are coupled from the RECEIVE SETTINGS page, the transmit parameters are changed to match the receive parameters. Conversely, when settings are coupled from the TRANSMIT SETTINGS page, the receive parameters are changed to match the transmit parameters.*

To change receive and transmit settings so that they are no longer coupled:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Tx/Rx Setup	Independent

Notice that the signal status icons, in the upper-right corner of the display, changed to indicate that the settings are no longer coupled.

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Setting the Receive Level

For PDH Receive Paremeters, specify the receive level for electrical signals:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Receive Level	Normal
			Monitor 20 db
			Monitor 30 db

Setting Payload and Payload Framing

When receiving a PDH signal you can specify payload and payload framing of the signal.

To specify the framing of a received PDH signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Payload and Payload Framing	*as appropriate*

***NOTE**. The choices available for Framing depend on the selected Receive Rate.*

- Select **2 Mb/s Unframed** to receive an unframed 2 Mb/s signal.
- Select **2 Mb/s PCM30 CAS** to receive a framed, 30 channel 2 Mb/s signal with Channel Associated Signalling in Timeslot 16.

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- Select **2 Mb/s PCM31** to receive a framed, 31 channel 2 Mb/s signal.
- Select **2 Mb/s PCM30 CRC/CAS** to receive a framed, 30 channel 2 Mb/s signal with Channel Associated Signalling in Timeslot 16 with CRC4 multiframe.
- Select **2 Mb/s PCM31 CRC** to receive a framed, 31 channel 2 Mb/s signal with CRC4 multiframe.
- Select **8 Mb/s Unframed** to receive a unframed 34 Mb/s signal.
- Select **8 Mb/s Framed** to receive a framed 34 Mb/s signal.
- Select **34 Mb/s Unframed** to receive an unframed 34 Mb/s signal.
- Select **34 Mb/s Framed** to receive a framed 34 Mb/s signal.
- Select **140 Mb/s Unframed** to receive an unframed 140 Mb/s signal.
- Select **140 Mb/s Framed** to receive a framed 140 Mb/s signal.
- Select **64k** PCM30 CAS/CRC, 64k PCM31 CRC, 64k PCM30 CAS, or 64k PCM31.

Specifying the Test Pattern

To specify the test pattern of the received signal:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	RECEIVE SETTINGS	Test Pattern	*as appropriate*

***NOTE**. The choices available for Test Pattern depend on the selected Receive Rate.*

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- Select **1 in 8** to set the test pattern to 1000 0000.
- Select **User Word 8 bit**, **User Word 16 bit**, or **User Word 24 bit** to set a test pattern different from the preset choices. If you choose User Word, the test pattern description changes to User Defined Byte.
- Select **Unknown** when you do not know what test pattern is being transmitted or when the test pattern is not stable.

If you select User Word for the test pattern, set the value of the User Word as follows:

1. Select the line containing the byte to set the value of the User Defined Byte.
2. Define the contents of the User Defined Byte as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		select displayed byte	Set to 00000000
			Set to 11111111
			Default 10101010
			EDIT BYTE

- Select **Set to 00000000** to set the test pattern to all zeros.
- Select **Set to 11111111** to set the test pattern to all ones.
- Select **Default 10101010** to set the test pattern to alternating ones and zeros

3. Select **EDIT BYTE** to specify a value different from the preset choices.
4. Select **DONE** when you are finished editing the byte.

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Specifying the Payload Drop

If the Receive rate is any PDH or SDH rate, SDH is mapped for PDH, and the PDH payload is less than the line rate, then a selection appears at the bottom of Receive, Receive Settings menu. This selection permits the operator to drop a certain PDH payload. 8 Mb/s and 64k rates can not be dropped.

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Selecting RX CAS & Voice

RX CAS runs in scan mode, where it updates all values as frequently as possible, or single channel mode, which permits the operator to select a channel and have it dropped to the speaker. These selections are mutually exclusive because the same CAS channel selector is used for picking the timeslot for reading CAS bits and dropping to the speaker. This screen is only accessible when the receive payload is 64k. If CAS is disabled, it only permits timeslot selection and speaker control.
CAS is only available if the 2 Mb/s framing is PCM30 or PCM30 CRC.

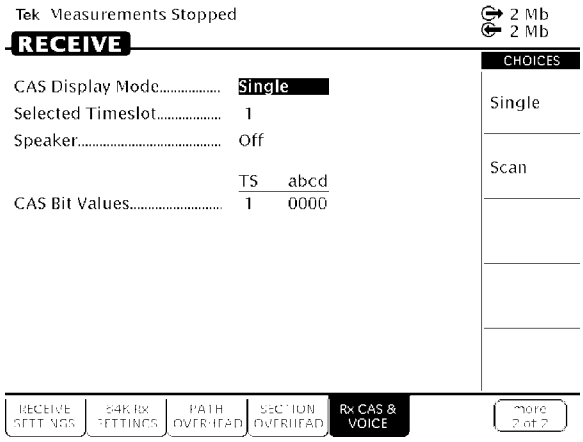


Figure 3 64: RX CAS & Voice from Receive Setting Menu

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Table 3 23: RX CAS & Voice Choices

Rx CAS & Voice	Choices
CAS Display Mode	The operator can select SINGLE mode, which selects a single timeslot and enables the speaker drop.
Selected Timeslot	In Single display mode, this permits selection of the timeslot of interest. This selection is not displayed in scan mode.
Speaker	In Single Display mode, the operator may drop the selected timeslot to the internal speaker. This field permits selection of OFF, LOW, MEDIUM, and LOUD volumes. Once enabled, the speaker drop will remain on until disabled from this screen, or the payload is changed for 64k.

Setting Jitter Receive Parameters

You can set the CTS850 to measure jitter or wander in PDH signals. Refer to *Setting Jitter Receive Parameters* in the separate section of this chapter on **Setting Jitter/Wander Parameters** for information about this topic.

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Setting Jitter/Wander Parameters

This section gives examples of how to work with Jitter/Wander test setups; Setting Jitter or Wander Generation; Setting Jitter Receive Parameters; and, Calibrating Jitter Systems.

Refer also to the **Telecommunications Technology** section within the *Appendices* (located on reference on CD)for theory of operation information on Jitter & Wander.

CTS850 SDH/PDH Test Set

Jitter/Wander Working with Test Setups

You can use the CTS850 to run the following types of jitter conformance tests:

- Jitter Tolerance
- Jitter Transfer
- Output Jitter
- Pointer Jitter (SDH rates only)

In each of these tests, the CTS850 measures the jitter on a signal at the output of a network element. For some tests, the CTS850 generates jitter to stimulate the network or a network element while it simultaneously measures the network response.

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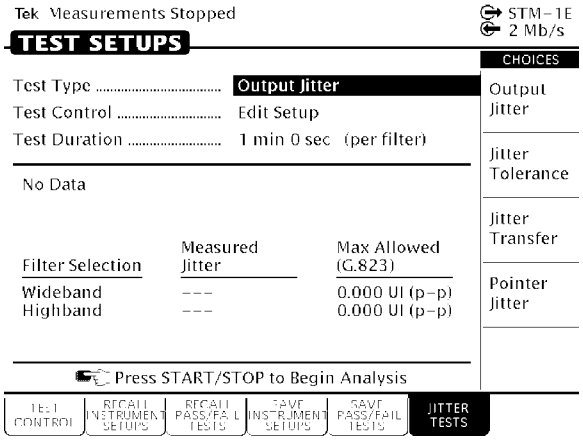


Figure 3 65: Example of TEST SETUP, Jitter & Wander screen

Before selecting a jitter test, set the specific jitter generation and measurement rates and payloads required by the test. For example, to perform an output jitter test on an STM 1 signal, set the receive line rate to STM 1 before selecting test setups.

It is not necessary to set the jitter and wander TRANSMIT or RECEIVE settings, since this is done automatically by the CTS850 software, depnding on the test type.

When the test is complete, you can save the results, print the results, or export the results data to bring into a spreadsheet. Refer to “Saving and Recalling Setups” later in this section for more information.

Setting Up a Jitter Test

To set up a jitter test:

1. If the jitter test requires the test set to measure jitter, use the RECEIVE menu to set the receive parameters that are appropriate for the signal you will be measuring. Refer to *Setting SDH Receive Parameters* for information about this topic.

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2. If the jitter test requires the CTS850 to generate jitter, use the TRANSMIT menu to set the transmit parameters that are appropriate for the signal you will be generating. Refer to *Setting SDH Transmit Parameters* for information about this topic.

3. To set the type of jitter test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Test Type	Output Jitter
			Jitter Tolerance
			Jitter Transfer
			Pointer Jitter

- Select **Output Jitter** to measure the jitter at the output of a network element. (The output jitter test does not use the CTS850 jitter-generation capability.)
- Select **Jitter Tolerance** to measure the tolerance of the input of a network element to applied jitter (this test uses bit error measurement).
- Select **Jitter Transfer** to measure the transfer of jitter from the input to the output of a network element.
- Select **Pointer Jitter** to measure jitter in PDH signals due to pointer movement in the SDH signal (this test does not use jitter generation).

The remaining parameters are dependent on the type of jitter test you select.

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Jitter Tolerance Test. Follow these additional steps to set up a jitter tolerance test.

1. Set the Test Type to Jitter Tolerance and set the mask type as appropriate. The available masks depend on the rate, as shown in the table below.

Rate	Available Masks
2 Mbit/s	G.823 (Standard), G.823 (National)
34 Mbit/s	G.823
45 Mbit/s *	G.824
140 Mbit/s	G.823
STM 0	GR 253
STM 1	G.825, G.958 (Type A), G.958 (Type B)
STM 4	G.825, G.958 (Type A), G.958 (Type B)

* If your CTS 850 test set supports the 45 Mb/s option.

The CTS850 modulates the transmitted line or clock frequency with sinusoidal jitter. The jitter generator begins at the start frequency and stops at the end frequency.

2. To set the start frequency for the jitter generator:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Start Frequency	*as appropriate*

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3. The available end frequencies are dependent on the current transmit rate. To set the end frequency for the jitter generator:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	End Frequency	*as appropriate*

4. The CTS850 can generate jitter at intermediate frequencies between the start frequency and end frequency. To set the total number of frequencies generated (including the start and end frequencies):

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Number Freq Samples	*as appropriate* *

* Number of samples change depending on Start/End frequencies.

5. To set the tolerance criteria:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
Press Menu Button	**Select Menu Page**	**Highlight Parameter**	**Select Choice**
TEST SETUPS	JITTER TESTS	Tolerance Criteria	Onset of Errors
			BER Penalty

- Select **Onset of Errors** to define the tolerance as two Errored Seconds in a 30-second time interval.
- Select **BER Penalty** to measure the amount of jitter that is equivalent to a 1 dB loss of signal power at the input of the network element (optical only).

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6. If you selected Onset of Errors, skip to step 12. If you selected BER Penalty, continue with step 7 (see the following figure).

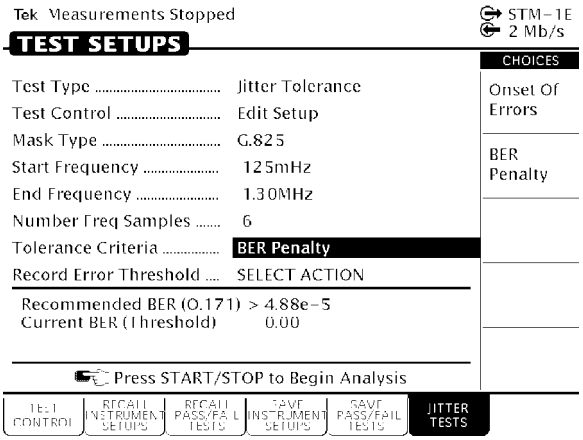


Figure 3 66: Example of TEST SETUP, Jitter Tests, BER Method

7. The CTS850 must be connected to a network element through an optical attenuator.

8. To set a baseline bit-error rate for the measurement:

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

9. 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.

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10. When the Current BER equals the Recommended BER to within an order of magnitude:

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

11. Increase the receive level by 1.0 dB (that is, reduce the attenuation by 1.0 dB).

12. Press the **START/STOP** button to run the jitter test. The results are displayed on screen in numerical and graphical form. This takes about 6 minutes for 6 points.

Transfer Jitter Test. Follow these additional steps to set up a jitter transfer test.

1. Set Test Type to Jitter Transfer. Set the mask type as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Mask Type	*as appropriate*

The available mask types are dependent on the current transmit rate. The CTS850 modulates the transmitted line with sinusoidal jitter. If the TX menu sets Jitter Output to Clock, the Jitter Transfer screen will indicate “Unsupported Settings”. The jitter generator begins at the start frequency and stops at the end frequency.

2. The available start frequencies are dependant on the current transmit rate. To set the start frequency for the jitter generator:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Start Frequency	*as appropriate*

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3. The available end frequencies are dependent on the current transmit rate. To set the end frequency for the jitter generator:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	End Frequency	*as appropriate*

4. The CTS850 can generate jitter at intermediate frequencies between the start frequency and end frequency. To set the total number of frequencies generated (including the start and end frequencies):

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Number Freq Samples	*as appropriate* *

* Points dependent on Start/End frequencies.

NOTE*. You can calibrate a 0 dB baseline, as described in ITU T O.171, prior to measuring transfer jitter if the folllowing conditions are met: the jitter generation output and measurement input are both set to line, and if the transmit and receive rates are set to the same rate. If either of the conditions can not be met, skip to step 10.*

5. Verify that the jitter generation output and measurement input are both set to Line.

6. Verify that the transmit and receive rates are set to the same rate.

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7. To calibrate a 0 dB baseline:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Action	Calibrate

8. Press the **START/STOP** button to run the 0 dB baseline calibration routine. This takes about 3 minutes.

9. To run the transfer jitter test after the calibration is complete, press Edit Setup:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Action	Jitter Transfer

10. Press the START/STOP button to run the jitter transfer test. The results are displayed on screen in numerical and graphical form. This takes abouts 4 minutes for 7 samples. Press View Data to see the data and whether or not the test passed. Press Edit Setup to return to Main Jitter Test menu.

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Output Jitter Test. Follow these steps to set up an output jitter test.

1. Set Test Type to Output Jitter. The recommended time duration for an output jitter test is one minute. To set the test duration to one minute (or any other duration of your choice),:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Test Duration	15 sec, 30 sec
			1 min, 15 min
			USER DEFINED

   H Select **USER DEFINED** to enter a time other than one of the preset choices. The maximum duration is 99 days, 23 hours, 59 minutes, 59 seconds.

2. Press the **START/STOP** button once or twice, light should be lit to run the jitter test. The results are displayed on screen in numerical form. After the test duration time has passed for each filter (wideband and highband), compare measured jitter with the maximum allowed to determine pass or fail. The resolution of these measurements are 0.001 UIpp.

Pointer Jitter Test. Follow these additional steps to set up a pointer jitter test. To select Pointer Jitter, the TX must be set to a SDH rate, and the RX set to a PDH rate.

1. Set Test Type to Pointer Jitter. To set the pointer sequence type:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Sequence Type	*as appropriate*

2. Press the **START/STOP** button to run the jitter test. The results are displayed on screen in numerical form, after about 6 minutes.

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Saving and Recalling Results

You can save one jitter test result to disk and recall that one test result for later display and analysis. If you want to save test results permanently, you must save the test results to a disk.

The CTS850 saves each type of jitter test result with a unique file-name extension. Because of the unique extensions, you can perform different types of jitter tests on a network element and give them a common results file name.

To save jitter test results:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	JITTER TESTS	Test Control	Save Results

Refer to *Saving and Recalling Results* for detailed information about using the disk drive to save and recall results.

Printing Results

You can print jitter test results using the “Print Last Screen” choice in the Print Control dialog box. Refer to *Printing Results* for detailed information about printing.

Exporting Results into a Document

You can export the jitter tolerance and jitter transfer test results in a Microsoft Excel compatible format to produce a graph for your documentation. Use the saved files with .XTL or .XTR for this purpose.

The file format consists of a header that identifies the type of test, the date and time, the transmit source, the transmit and receive rates, and the number of sample points in the graph. Data following the header is comma separated and consists of four values for each sample point in the graph: modulation frequency, mask amplitude, measured amplitude, and a status indicator that indicates an over range condition.

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Setting Jitter or Wander Generation

To test the response of a network to jitter, you may need to generate SDH signals, PDH signals, or clock signals that contain jitter. You can use the CTS850 to generate any of these signals with a controlled amount of jitter. This jitter is a sinusoidal modulation of the line rate or clock rate; you can specify the frequency and amplitude of the jitter.

Wander generation selection is identical to jitter generation except that it applies for modulation frequencies of 10 Hz or less. See the following figure.

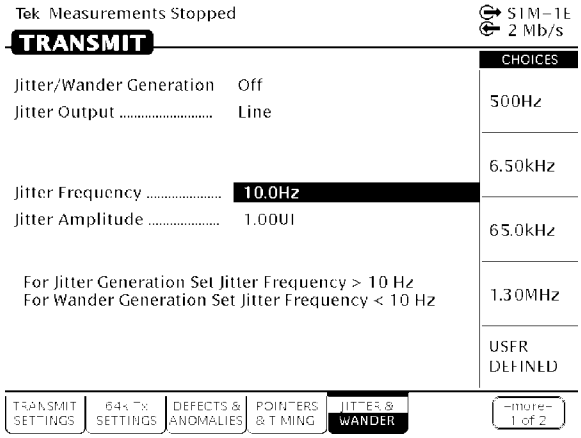


Figure 3 67: Example of TRANSMIT, Jitter menu

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***NOTE**. The jitter compliance tests, available through the JITTER TESTS page of the TEST SETUPS menu, automatically set the jitter generation parameters needed for the test. When you use the jitter compliance tests, you do not need to set the controls described below.*

Periodic calibration of the jitter generation system is recommended to maintain best accuracy. You can execute a built in calibration routine before making critical measurements. Refer to the Jitter Calibration *information located at the end of the this section.*

Turning on Jitter or Wander Generation

To turn on jitter or wander generation:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter/Wander Generation	Off
			On

- Select **Off** to disable jitter/wander generation.
- Select **On** to enable jitter/wander generation.

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Selecting the Jitter Output

To select the signal that you want to apply generated jitter to:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter Output	Line
			Clock 0.8 V
			2 MHz G.703

- Select **Line** to enable generated jitter on the transmitted line (SDH signal or PDH signal) that comes out of the front panel. This will also generate jitter on the rear-panel Jitter Clock Output, even though it may not be in use. Note: for 140 Mbit/s and STM 1E, line mode rear panel signal is twice the line rate.
- Select **Clock 0.8 V** to enable generated jitter on the rear-panel jitter clock output (J/CLK OUT) only (AC-coupled ECL). The transmitted line remains jitter free.
- Select **2 MHz G.703** to enable generated jitter on the rear-panel jitter clock output (J/CLK OUT) that meets the interface requirements for synchronization signals as specified in G.703. The transmitted SDH or PDH line signal remains jitter free.

You can independently set the Jitter Clock Output rate and frequency offset, regardless of the line rate and frequency offset of the transmitted signal. To set an independent rate for the Jitter Clock Output:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter Output	Clock 0.8V
		Jitter Clock Rate	*as appropriate*

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To set an independent frequency offset for the Jitter Clock Output:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter Output	Clock 0.8V
		Jitter Clock Offset	*as appropriate*

Setting the Jitter Frequency and Amplitude

The generated jitter is a sinusoidal modulation of the nominal line or clock rate. Refer to the *Modulation Range* specifications for details about jitter/wander generation capability. To set the modulation frequency:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter Frequency	*as appropriate*

H Select **USER DEFINED** to specify a jitter frequency different from the predefined choices. Use these choices: Course to adjust most significant digit or change decade scale; Medium to adjust second digit; Fine to adjust third digit.

***NOTE**. To generate jitter, set the Jitter Frequency to 10 Hz or greater. To generate wander, set the Jitter Frequency to less than 10 Hz.*

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To set the modulation amplitude (in unit intervals):

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	JITTER & WANDER	Jitter Amplitude	300.00 UI (Max) 150.00 UI (Max/2) 0.0 UI

- Select **USER DEFINED** to specify a jitter amplitude different from the predefined choices. Use choices Coarse, Medium or Fine.

Measure Wander on a 2 MHz clock output from a network element

When generating wander, synchronize the test system to an external timing source. This can be done by connecting a 2.048 MHz clck to the rear panel reference timing input and selecting timing source under TRANSMIT settings. Follow the steps below:

- Connect 2 MHz reference clock to 2 Mbps/ 2 MHz reference clock input on Rear Panel of test unit.
- Connect External 2 MHz clock to be measured to Jitter/ Clock input on Rear Panel of test unit.
- Go to TRANSMIT settings. Set the Transmit Clock to 2 MHz external. The Receive Clock is the Same. No Wander Measurements should be made with Internal Clock.
- Press Start/Stop twice to Start/Restart the test.
- For RESULTS, select the Jitter & Wander Screen, and view Wander Measurements.

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Setting Jitter Receive Parameters

You can set the CTS850 to measure jitter or wander on incoming SDH signals, PDH signals, or clock signals. First, set the jitter receive parameters below. Then, you can view jitter or wander measurement results in the Jitter & Wander Results page shown at the end of this section on Jitter.

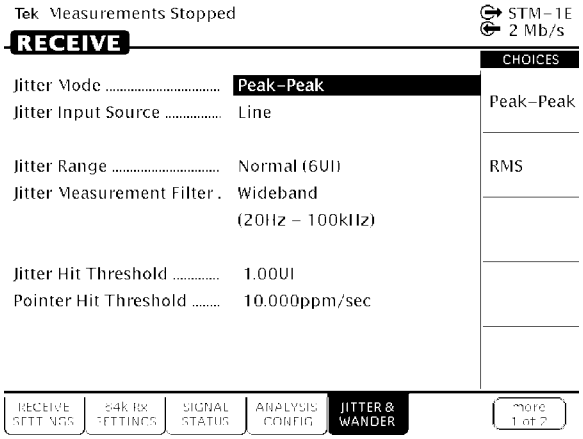


Figure 3 68: RECEIVE, Setting Jitter Mode, Peak to Peak

***NOTE**. The jitter compliance tests, available through the JITTER TESTS page of the TEST SETUPS menu, automatically set the jitter receive parameters needed for the test. When you use the jitter compliance tests, you do not need to set the controls described below.*

Periodic calibration of the jitter generation system is recommended to maintain best accuracy. You can execute a built in calibration routine before making critical measurements. Refer to the Jitter Calibration *information located at the end of this section.*

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Selecting the Jitter Mode

To select the jitter measurement mode:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	JITTER & WANDER	Jitter Mode	Peak-Peak
			RMS

- Select **Peak-Peak** to make peak-to-peak jitter measurements.
- Select **RMS** to make RMS jitter measurements. If you select RMS, the only available input filter is a 12 kHz high-pass filter.

Selecting the Input Source

To select the input source on which you want to measure jitter:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	JITTER & WANDER	Jitter Input Source	Line
			Clock

- Select **Line** to measure jitter in the received line (front-panel SDH or PDH signal) selected in the RECEIVE SETTINGS page.
- Select **Clock** to measure jitter on the rear-panel external jitter clock input (J/CLK IN). If you select Clock, you must set the external jitter clock input rate; that rate does not have to be the same as the Receive Rate selected in the RECEIVE SETTINGS page.

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Selecting the Jitter Range

The jitter range determines the maximum measureable jitter and the resolution of the measurement. To select the range:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	JITTER & WANDER	Jitter Range	Normal
			Extended

- Select **Normal** to measure jitter up to 6 UI_{p-p} with a resolution of 0.005 UI (frequency dependent). Refer to RX Range Mask in Specifictions section (in Appendix).
- Select **Extended** to extend the jitter measurement range up to 200 UI_{p-p} (frequency dependent) with a resolution of 0.01 UI.

Selecting the Jitter Input Filter

You can choose from three types of jitter measurement high pass filters defined by ITU-T standards: wideband, highband, and fullband. The passbands for the filters, shown in Figure 3 69, are dependent on the signal or clock rate settings; the 3 dB frequencies are described in the *Specifications* located in the Appendices at the back of this book.

The ITU T standard that applies to jitter input filters is contained in G.823, Table 1, Measurement Filter Bandwidth.

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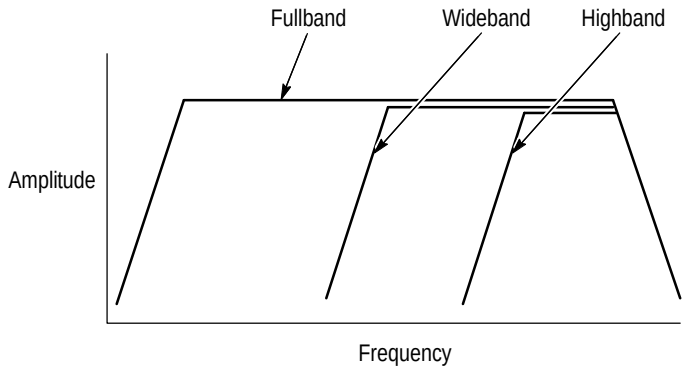


Figure 3 69: Jitter High Pass Filters

To select the jitter input filter:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	JITTER & WANDER	Jitter Measurement Filter	Wideband
			Highband
			Fullband

- Select **Wideband** to measure jitter using the wideband measurement filter (500 Hz 1.3 MHz).
- Select **Highband** to measure jitter using the highband measurement filter (65 kHz 1.3 MHz).
- Select **Fullband** to measure jitter over the wideband range plus very low frequency jitter that may affect timing quality for Video, PBX and GSM systems that derive an internal reference from the supplied line signal (10 Hz 1.3 MHz).

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***NOTE**. Separate Highband National and Highband Standard settings are available for the 2 Mb/s rate, as referenced in the ITU T standards.*

If you select the Fullband jitter input filter, perform the following steps to set the filter high-pass frequency:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	JITTER & WANDER	Fullband High-pass	0.1 Hz
			1 Hz
			10 Hz

Note that the lock time for 1 Hz and 10Hz settings are longer than other filter settings.

Setting the Jitter Hit Threshold

The jitter hit threshold determines the sensitivity of the Jitter Hit Seconds measurement, which is based on peak-to-peak jitter.

Jitter Hit Seconds is a count of how many seconds the threshold was exceeded since the beginning of the the measurement. Measurement will normally begin between 2 5 seconds after the start button on the front panel is pressed. You can set the threshold to any value between 0 and 200 UI, depending on the Range Setting.

Whenever the received jitter exceeds the range of the jitter measurement system, the Current Jitter reads Unlocked. Jitter Unlocked Seconds is a count of how many seconds the measurement system has been unlocked since the beginning of the the measurement.

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To set the jitter hit threshold:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	JITTER & WANDER	Jitter Hit Threshold	*as appropriate*

H Select **USER DEFINED** to specify a jitter hit threshold different from the predefined choices.

Setting the Pointer Hit Threshold

The pointer event threshold (available for PDH rates) determines the sensitivity of the Jitter Pointer Hits measurement, which is based on the frequency drift rate. To set the pointer event threshold:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RECEIVE	JITTER & WANDER	Pointer Hit Threshold	*as appropriate*

H Select **USER DEFINED** to specify a pointer hit threshold different from the predefined choices. You can set the threshold to any value between 0 and 10 ppm/sec.

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Example of Jitter Measurements

The RESULTS screen for Jitter/ Timing Quality follows.

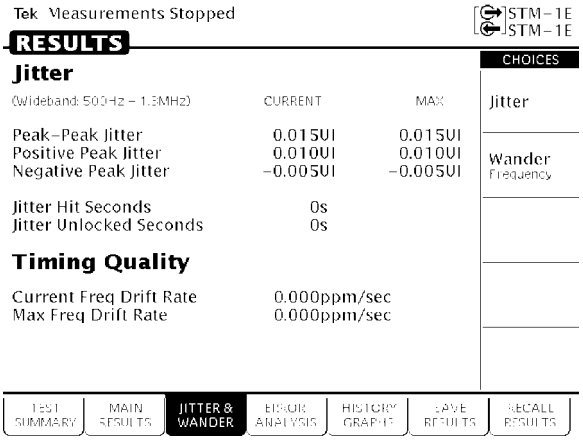


Figure 3 70: RESULTS, Jitter and Timing Quality

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Example of Wander Measurements

The “max” value shows the maximum peak to peak, positive peak, and negative peak since the beginning of the measurement.

When measuring wander, it is necessary to synchronize the test to an external timing source. This can be done by connecting a 2.048 MHz clock signal to the rear panel timing input and selecting the appropriate timing source under the TRANSMIT settings.

The RESULTS screen for Wander/ Line Frequency follows.

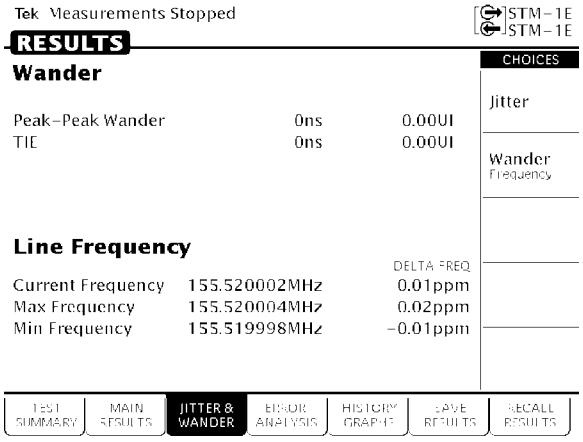


Figure 3 71: RESULTS, Wander and Line Frequency

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Calibrating Jitter Systems

Periodic calibration of the jitter generation and measurement systems is recommended to maintain best accuracy. You can execute built in Jitter Measurement calibration routines before making critical measurements.

Run Jitter Measurement before runing Jitter Generation Calibration. This Jitter Measurement calibration takes about 15 minutes for all rates. You can calibrate one particular rate by selecting the appropriate calibration routine.

If your CTS 850 test set supports a 45 Mb/s rate, this screen below will show that rate in addition to all the others displayed.

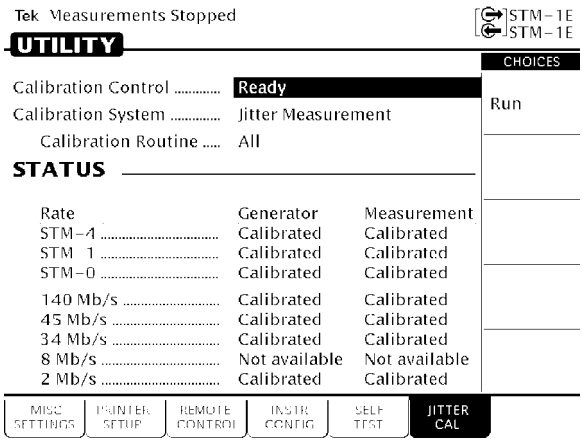


Figure 3 72: Example of UTILITY, Jitter Calibration

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Executing Jitter Calibration

To calibrate the jitter measurement system:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	CALIBRATION	System	Jitter Measurement
		Routine	All
		Calibration Control	Run

To calibrate the jitter generation system:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	CALIBRATION	System	Jitter Generation
		Routine	All STM 0 STM 1 STM 4 2 Mb/s 34 Mb/s 45 Mb/s 140 Mb/s Analog output
		Calibration Control	Run

Jitter Generation for all rates takes about 45 minutes to run.

A status message indicates that the calibration is running, has completed and has passed, or has failed.

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Setting Alarms and Inserting Errors

This section describes how to simulate error conditions, set alarms, and simulate network failures. To test the response of a network, you might need to simulate parity errors, send alarm signals, and simulate network failures. This type of testing is simple and convenient using the CTS850 SDH/PDH Test Set.

To insert PDH errors, it is necessary to set the layer in the mux chain where anomalies, defects and failures will be inserted. Some errors, like CRC, are specific to a particular layer (in this case, 2 Mb/s Multiframe). Insertion of a layer specific error will not change the insertion layer. Layer selection is not limited to active tributary rates. See the example of a TRANSMIT, Defects & Anomalies menu screen for PDH at the end of this section on how to set the layer for PDH Anomalies, Defects and Failures.

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Simulating Error Conditions

The specific errors the CTS850 simulates depend on the transmit rate and payload structure.

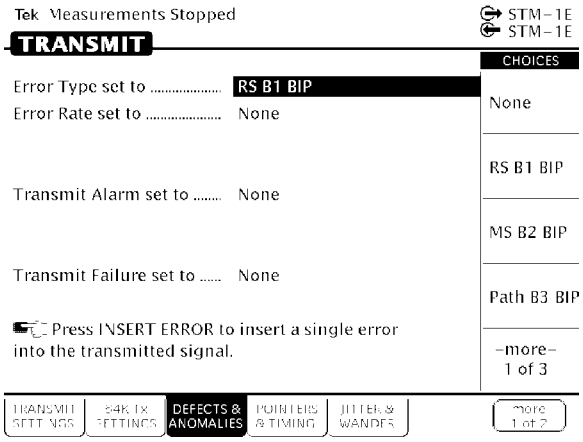


Figure 3 73: Example of TRANSMIT, Defects & Anomalies menu

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Specifying the Error to Insert

Specify the type of error transmitted as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies	Error type set to	None
			RS B1 BIP
			MS B2 BIP
			Path B3 BIP
			HP REI
			TU BIP
			TU Path BIP
			LP REI
			Pattern Bit
			PDH FAS Error
			PDH FAS Burst
			Code
			PDH CRC

***NOTE**. The errors available to insert depend on the Structure and Payload settings. Not all errors are available all the time.*
FAS Burst is defined in terms of M errors in N frames, rather than a rate.

Inserting Errors

You can choose to insert errors manually (one at a time) or you can have errors inserted automatically at a rate you specify.

To insert a single error, press the **INSERT ERROR** button.

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To have the CTS850 insert errors automatically:

1. Turn on automatic error insertion as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies	Error rate set to	None
			1e 3
			1e 4
			1e 5
			1e 6
			1e 7
			1e 8
			USER DEFINED

- Select **None** to turn off automatic error insertion. However, you can still insert errors manually using the front-panel INSERT ERROR button.
- The maximum allowable error rate depends on the transmit rate, signal structure, and error type (see Tables 3 24 and 3 25).

Table 3 24: Maximum Error Rates for SDH Signals

	Rate	
Error Type	**STM-1**	**STM-4**
RS B1 BIP	1E 4	1E 5
MS B2 BIP	1E 4	1E 4
Path B3 BIP	1E 4	1E 4
HP REI	1E 4	1E 4
Pattern Bit	1E 3	1E 3

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Table 3 25: Maximum Error Rates for TU Mappings and PDH Signals

	N x 64k		2 Mb/s		8, 34 Mb/s		140 Mb/s	
Error Type	**Min Rate**	**Max Rate**	**Min Rate**	**Max Rate**	**Min Rate**	**Max Rate**	**Min Rate**	**Max Rate**
TU BIP			1E 8	1E 4	1E 10	1E 4	N/A	N/A
LP REI			1E 8	1E 4	1E 10	1E 4	N/A	N/A
CRC			1E 8	1E 4	N/A	N/A	N/A	N/A
Frame			N<M<1000 M=Frame Count, N=Consecutive FAS Error Count					
Pattern Bit	1E 6	1E 2	1E 8	1E 2	1E 9	1E 2	1E 9	1E 2
Line Code	N/A	N/A	1E 8	1E 3	1E 10	1E 3	N/A	N/A

If your CTS 850 supports the 45 Mb/s option, the following Min/Max error rates for TU Mappings and PDH signals are available:

Parity (45 Mb/s P)	**Min. 1E 9**	**Max. 2E 4**
Parity (45 Mb/s CP)	**Min. 1E 9**	**Max. 2E 4**
REI (45 Mb/s)	**Min. 1E 9**	**Max. 2E 4**

2. Select **USER DEFINED** to specify an error rate different from the preset choices. The CTS850 enters edit mode.
   - **H** If the knob is assigned to Coarse, it changes the exponent.
   - **H** If the knob is assigned to Fine or Finer, it changes the decimal number.
3. Select **DONE** to enter the error rate you have specified.

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Setting Alarms

The CTS850 can simulate alarm conditions to test the response of the network.

To transmit an alarm:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies	Transmit alarm set to	None
			MS AIS
			MS RDI
			AU AIS
			HP RDI
			TU AIS
			LP RDI
			PDH RAI
			PDH AIS

- Select **None** to stop transmitting an alarm.
- Select **MS AIS** to transmit an MS AIS alarm.
- Select **MS RDI** to transmit an MS RDI alarm.
- Select **AU AIS** to transmit a AU AIS alarm.
- Select **HP RDI** to transmit a HP RDI alarm.
- Select **TU AIS** to transmit a TU AIS alarm.
- Select **LP RDI** to transmit a LP RDI alarm.
- Select **PDH RAI** to transmit a PDH RAI alarm.
- Select **PDH AIS** to transmit a PDH AIS alarm.

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***NOTE**. The TU AIS and LP RDI choices will be displayed only if Structure, on the TRANSMIT SETTINGS page, is set to TU-12 Async or TU 3 Async.*

All transmit alarm choices remain in effect until they are deliberately turned off.

Simulating Transmit Failures

The CTS850 can simulate transmit failure conditions to test the response of the network.

To simulate a transmit failure:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	Defects & Anomalies	Failure set to	None
			LOS
			LOF
			AU LOP
			TU LOP
			TU LOM

***NOTE**. TU LOP (TU LOP is TU3 or TU12 mapping) and TU LOM (TU LOM is TU12 only) can be selected only if Structure, on the TRANSMIT SETTINGS page, is set to TU-12 Async.*

- Select **None** to stop simulating failures.
- Select **LOS** to simulate a loss of signal failure.
- Select **LOF** to simulate a loss of frame failure.
- Select **AU LOP** to simulate a loss of pointer failure in the administrative unit.

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- Select **TU LOP** to simulate a loss of pointer failure in the tributary unit.
- Select **TU LOM** to simulate a loss of multiframe failure in the TU12 mapping.

All transmit failures remain in effect until they are deliberately turned off.

An exception to the previous sentence has to do with LOF and LOS transmit failures. The RX test unit will not reacquire a LOF transmit failure from a TX source, if the RX has experienced a loss of signal (LOS). The solution to this situation is to clear the TX source (either the CTS 850 operating in a loopback test or an external transmitter) that is sending a LOF transmit failure, so that the RX test unit can acquire the LOF transmit failure again. An indication of this situation is that the front panel of the RX test unit will initially register the LOF, but the red LED light will extinguish itself when the red LED of the LOS appears. As the signal is restored to the test unit, and the TX source is still transmitting LOF transmit failures, the front panel LED of the RX test unit will not light up.

PDH Defect & Anomaly Insertion

To insert PDH errors, it is necessary to set the layer in the mux chain where anomalies, defects and failures will be inserted. Some errors, like CRC, are specific to a particular layer (in this case, 2 Mb/s Multiframe). Insertion of a layer specific error will not change the insertion layer. Layer selection is limited to active tributary rates. See the example of a TRANSMIT, Defects & Anomalies menu screen for PDH at the end of this section on how to set the layer for PDH Anomalies, Defects and Failures.

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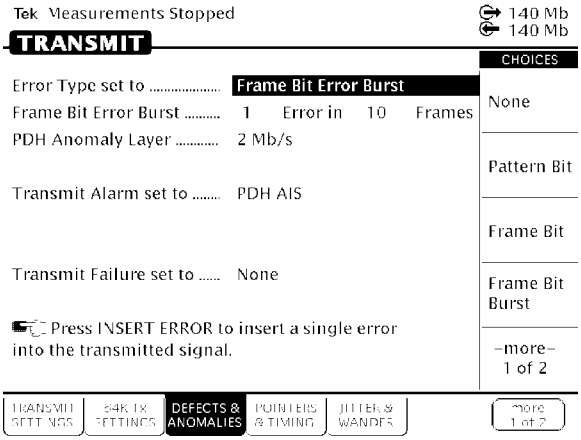


Figure 3 74: Set the Anomaly, Defect, Failure layer in the Mux chain

Table 3 26: Anomaly, Defect, Transmit Failure options

Type options	Choices
Anomaly	None, RS B1 BIP (1), MS B2 BIP (1), Path B3 BIP (1), HP REI (1), TU BIP (1), LP REI (1), Pattern Bit (1), FAS Error (1,2), FAS Burst (2,3), Code (4), CRC (1)
Defect	None, MS AIS, MS RDI, Path AIS, Path RDI, TU AIS, LP RDI, PDH RAI (2), PDH AIS
Transmit Failure	None, LOS, LOF, AU LOP, TU LOP, TU LOM

(1) Error insertion rate will be displayed

(2) PDH Layer selection will be displayed

(3) PDH FAS Burst error insertion will be displayed.

(4) Code error insertion is available for E1 E3 rates (2 Mb/s, 8 Mb/s, 34 Mb/s) only.

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Setting Pointers and Changing Timing

This section describes how to generate pointer movements within the transmitted SDH signal. When stress testing a network, you may want to move pointers or introduce a frequency offset. The CTS850 SDH/PDH Test Set allows you to control this type of testing five ways. You can:

- Make discrete pointer movements under manual control
- Make repetitive pointer movements at a rate you determine
- Generate sequences of pointer movements
- Introduce a frequency offset in the internally generated AU
- Introduce a frequency offset in the transmit rate

Setting Pointers

To set up the CTS850 to make discrete or repetitive pointer movements:

1. Specify the pointer mode as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	POINTERS & TIMING	Pointer / Timing Mode	Pointer Movement

The choices allow you to choose to move pointers using time parameters or with a frequency offset. Selecting Pointer Movements moves pointers utilizing time parameters.

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2. Specify the pointer type as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	POINTERS & TIMING	Pointer Type	AU Pointer
			TU Pointer

Manual Pointer Control

You can move pointers under manual control using the POINTER ACTION button on the front panel. To set up for this type of control, use the knob to highlight the **Pointer Control** line.

There are three types of manual pointer movements: Single, Burst, and Continuous (see Figure 3 75). The choices are described in detail below; some require additional setup.

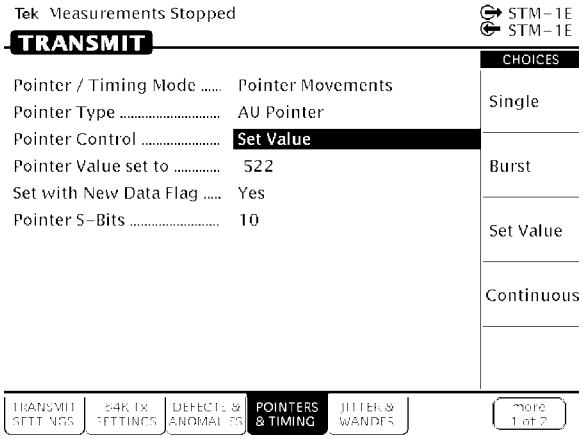


Figure 3 75: Manual Pointer Control Choices

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Single Pointer Movements. With Single selected, each press of the POINTER ACTION button on the front panel of the test set moves the pointer up or down by one location. The first press increments the pointer, the second press decrements it, the third press increments it, and so forth.

Burst Pointer Movements. With Burst selected, pressing the front-panel POINTER ACTION button starts a burst of pointer movements. Each burst consists of a series of one-location pointer movements that are spaced four frames apart. Pressing the POINTER ACTION button repeatedly alternates between an incrementing burst and a decrementing burst (see Figure 3 76).

To set the number of pointer movements in the burst:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Control	Burst
		Burst Size	2
			3
			4
			5
			6
			7
			8

To start a burst of pointer movements, press the **POINTER ACTION** button on the front panel of the test set.

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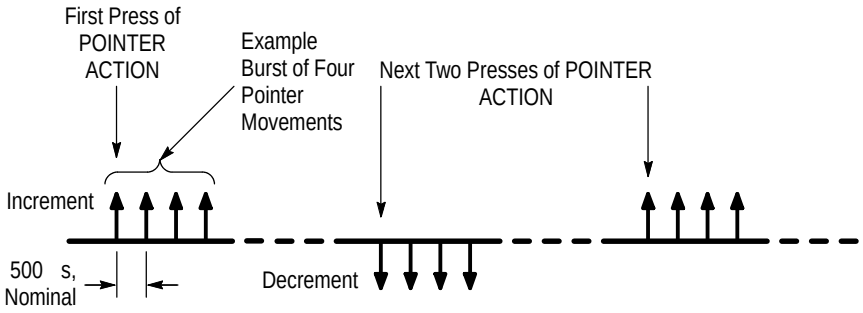


Figure 3 76: Alternating Burst Pointer Movement

Setting Pointer to a Specific Value. With Set to Value selected, you can move the pointer immediately to a new location, with or without a new data flag being set. Payload data can be lost when you use jump pointer movements of this type.

To set the new pointer value for an AU **pointer**:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Control	Set Value
		Pointer Value Set to	Min 0
			Max 782
			Default 522
			Illegal (Max + 1)
			USER DEFINED

H Select **Min 0** to set the pointer to location zero (points to the byte immediately following the H3 transport overhead byte). If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.

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- Select **Max 782** to set the pointer to location 782 (points to the byte immediately preceding the H1 transport overhead byte of the next frame). If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.
- Select **Default 522** to set the pointer to location 522 (points to the first payload byte in the next frame). If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.
- Select **Illegal (Max+1)** to move the pointer to illegal location 783 (the maximum allowed location + 1). Choosing the illegal pointer location may cause a loss-of-pointer failure. If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.
- Select **USER DEFINED** to set the pointer to a value different from the preset choices.

  Selecting USER DEFINED places the CTS850 into Edit Mode.
- Select **DONE** when you are finished setting the pointer value.

  As soon as you press DONE, the pointer is moved; you do not need to press POINTER ACTION.

To set the new pointer value for a **TU pointer:**

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Control	Set Value
		Pointer Value Set to	Min 0
			Max 139
			Default 0
			Illegal (Max + 1)
			USER DEFINED

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- Select **Min 0** to set the pointer to location zero. If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.
- Select **Max 139** to set the pointer to location 139. If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.
- Select **Default 0** to set the pointer to location 0. If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.
- Select **Illegal (Max+1)** to move the pointer to illegal location 140 (the maximum allowed location + 1). Choosing the illegal pointer location may cause a loss-of-pointer failure. If you choose this setting, the pointer is moved immediately; you do not need to press POINTER ACTION.

3. Specify whether a New Data Flag is set with the pointer movement as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Set with New Data Flag	Yes
			No

4. Set the Pointer ss-Bits as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer ss Bits	00
			01
			10
			11

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Continuous Pointer Movement

To make repetitive pointer movements:

1. Specify the type of pointer control and movement rate as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Control	Continuous
		Pointer Rate	Max 2ms
			Min 10000ms
			Default 50ms
			USER DEFINED

- Select **Max 2ms** to move the pointer one location every sixteen frames.
- Select **Min 10000ms** to move the pointer location one location every 10 seconds.
- Select **Default 50ms** to move the pointer one location every 50 ms.
- Select **USER DEFINED** to set continuous pointer movement at a rate different from the preset choices.

2. Select **USER DEFINED** to set the pointer movement to a value different from the preset choices.

Selecting USER DEFINED places the CTS850 into Edit Mode. Now you can set the rate to the exact value you want, with 1 ms resolution. The maximum rate is 1 ms. The minimum rate is 10000 ms.

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3. Specify the pointer movement direction as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Direction	Increment
			Decrement
			Alternate

- Selecting **Increment** causes the pointer to increment at the set rate.
- Selecting **Decrement** causes the pointer to decrement at the set rate.
- Selecting **Alternate** causes pointer movements at the set rate, but they alternate in incrementing and decrementing directions.

When using continuous pointer movement, a message line in the display tells you the equivalent payload frequency offset in parts per million if the pointer direction is set to either increment or decrement (see Figure 3 77).

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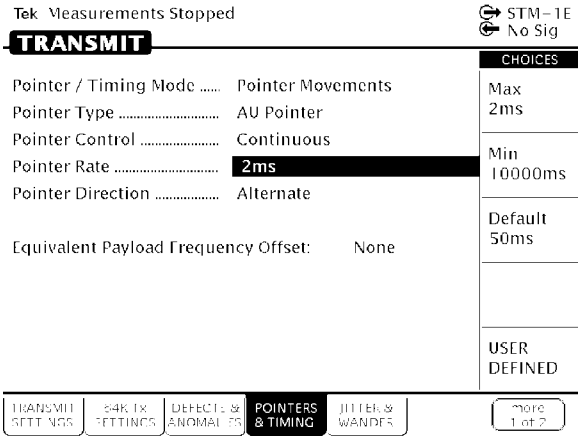


Figure 3 77: Incrementing Pointer Location Once Every Two Milliseconds

Changing Timing

As an alternative to setting pointer movements directly, you can introduce a frequency offset in the internally-generated AU, the transmit line rate, or both together.

To generate pointer movements using frequency offset:

1. Specify the pointer/timing mode as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	POINTERS & TIMING	Pointer / Timing Mode	Frequency Offset

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2. Specify the Offset Mode as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Offset Mode	Line
			Payload (AU Pointers)
			Tributary (Mapping)

- Select **Line** to change the transmit line rate. With this setting, the AU location (pointer) does not move relative to the transmitted frame.
- Select **Payload** to change the offset of the payload.
- Select **Tributary** to change the clock tributary offset.

3. Specify the frequency offset as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Frequency Offset	Max +100ppm
			Stress +4.6ppm
			Stress 4.6ppm
			Default 0ppm
			USER DEFINED

- Select **Max +100ppm** to set the frequency offset to the maximum available amount.
- Select **Stress +4.6ppm** to set the frequency offset at the upper SDH Equipment Clock (SEC) limit.
- Select **Stress 4.6ppm** to set the frequency offset at the lower SDH Equipment Clock (SEC) limit.

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- Select **Default 0ppm** to turn off frequency offset.
- Select **USER DEFINED** to set a frequency offset different from the preset choices.

Selecting USER DEFINED places the CTS850 in Edit Mode. The knob is assigned to change the value of the frequency offset.

- Coarse changes the frequency offset by 10.0 ppm.
- Fine changes the frequency offset by 0.1 ppm.

The frequency offset can be changed by ±100.0 ppm.

- Select **DONE** to enter the frequency offset when you are finished setting it.

When using a frequency offset, a message line in the display tells you the equivalent pointer movement rate. Figure 3 78 shows an example of frequency offset and the resulting message.

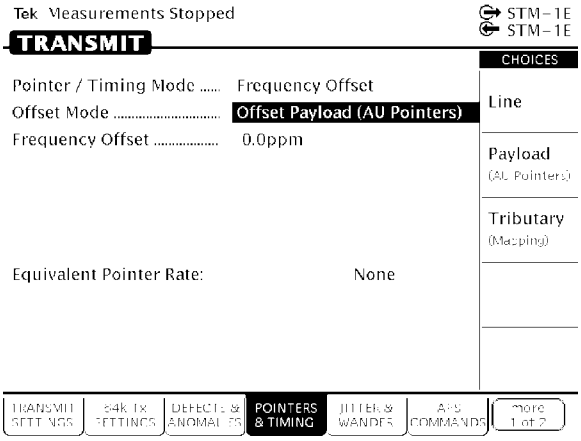


Figure 3 78: Offsetting the Payload

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Generating Pointer Sequences

In addition to the simpler pointer movements previously described, the CTS850 can generate pointer sequences (sequences of pointer movements). Pointer sequences are made up of three periods: the Initialization Period, the Cool Down Period, and the Sequence Period (see Figure 3 79).

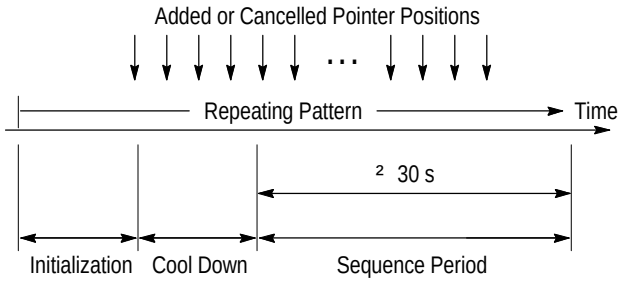


Figure 3 79: The Three Periods of a Pointer Sequence

- **H** Initialization Period a thirty second period where the CTS850 produces a 30 second burst of 1 pointer movement per second in the same direction as the specified pointer sequence. The Initialization time can be turned on or off.
- **H** Cool Down Period a period at least 60 seconds long, following the Initialization Period. Pointer activity can occur during this period. The Cool Down time can be turned on or off.
- **H** Sequence Period the period following the Cool Down period where the specified pointer sequence runs continuously.

The CTS850 generates the pointer sequences described in the revised ITU-T G.783 standard. An example of a pointer sequence is shown in Figure 3 80. The details of these sequences are shown in Table 3 27. Note that not all pointer sequences are available all the time. Some sequences are available only with one pointer type or with a specific mapping, as shown in Table 3 28 on page 3 211.

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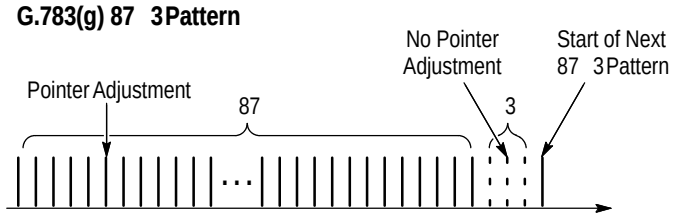


Figure 3 80: An Example of a Pointer Sequence

Table 3 27: Pointer Sequences Generated (as specified by G.783)

Pointer Sequence	Description
(a) Single Alternating	Alternating single pointer movement. The time between pointer movements is 30 s.
(b) Regular + Double	Time between added pointer movement and previous normal pointer movement for AU-4 and TU-3 pointers is 0.5 ms and for TU-12 pointers is 2 ms. Time between normal pointer movements is as follows: **D** AU-4 and TU-3 pointers have a range of 34 ms to 10 s with a resolution of 1 ms. **D** TU-12 pointer movements has a range of 760 ms to 10 s with a resolution of 1 ms. Time between added pointers is equal to: (the time between pointer movements ¢ N) where N is selected to be the smallest integer that makes the product ² 30 s.
(c) Regular + Missing	Time between AU pointers has a range of 34 ms to 10 s with a resolution of 1 ms. Time between missing pointers is equal to: (time between pointer movements ¢ N), where N is selected to be the smallest integer that makes the product ² 30 s.
(d) Double Alternating	Alternating double pointer movement. The time between the double pointer movements is 2 ms, and the time between each pair of pointer movements is 30 s.
(e) Single	Time between pointer adjustments is 30 s.

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Table 3 27: Pointer Sequences Generated (as specified by G.783) (Cont.)

Pointer Sequence	Description
(f) Burst	Time between bursts of 3 pointers for AU pointers is 0.5 ms and for TU pointers is 2 ms. Time between pointer bursts is 30 s.
(g) Periodic 87 3	Sequence pattern is 87 pointer movements followed by 3 missing pointer movements. Time between AU pointer movements has a range of 0.34 s to 10 s with a resolution of 1 ms.
(g) Periodic 87 3With Cancel	Sequence pattern is 87 pointer movements followed by 3 missing pointer movements with a cancelled pointer movement at the 87th pointer. Time between AU pointer movements has a range of 0.34 s to 10 s with a resolution of 1 ms. Time between cancelled pointers is equal to: (time between pointers ¢ 90 ¢ N) where N is selected to be the smallest integer that makes this product ² 30 s.
(g) Periodic 87 3With Add	Sequence pattern is 87 pointer movements followed by 3 missing pointer movements with an added pointer movement after the 43rd pointer. Time between AU pointer movements has a range of 34 ms to 10 s with a resolution of 1 ms; time between added pointer movement and previous normal pointer movement for AU pointers is 0.5 ms. Time between added pointers is equal to: (time between pointers ¢ 90 ¢ N) where N is selected to be the smallest integer that makes this product ² 30 s.
(h) Periodic Continuous	Time between AU pointers has a range of 34 ms to 10 s with a resolution of 1 ms.
(h) Periodic Continuous with Cancel	Time between AU pointers has a range of 34 ms to 10 s with a resolution of 1 ms. Time between cancelled pointers is equal to: (time between pointer movements ¢ N), where N is selected to be the smallest integer that makes the product ² 30 s.

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Table 3 27: Pointer Sequences Generated (as specified by G.783) (Cont.)

Pointer Sequence	Description
(h) Periodic with Add	Time between added pointer movement and previous normal pointer movement for AU-4 and TU-3 pointers is 0.5 ms and for TU-12 pointers is 2 ms. Time between normal pointer movements is as follows: **D** AU-4 and TU-3 pointers have a range of 34 ms to 10 s with a resolution of 1 ms. **D** TU-12 pointer movements has a range of 760 ms to 10 s with a resolution of 1 ms. Time between added pointers is equal to: (the time between pointer movements ¢ N) where N is selected to be the smallest integer that makes the product ² 30 s.
Phase Transient Pointer	Time between pointer movement burst of seven pointers is 0.25 s, 0.25 s, 0.5 s, 0.5 s, 0.5 s, 0.5 s. Time between pointer bursts is 30 s.
TU-3 Periodic 85 5	Sequence pattern is 85 pointer movements followed by 5 missing pointer movements. Time between pointer movements has a range of 34 ms to 10 s with a resolution of 1 ms.
TU-3 Periodic 85 5 With Cancel	Sequence pattern is 85 pointer movements followed by 5 missing pointer movements with a cancelled pointer movement at the 85th pointer, yielding a gap of 6. Time between pointer movements has a range of 34 ms to 10 s with a resolution of 1 ms. Time between cancelled pointers is equal to: (time between pointers ¢ 90 ¢ N) where N is selected to be the smallest integer that makes this product ² 30 s.

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Table 3 27: Pointer Sequences Generated (as specified by G.783) (Cont.)

Pointer Sequence	Description
TU-3 Periodic 85 5 With Add	Sequence pattern is 85 pointer movements followed by 5 missing pointer movements with an added pointer movement after the 43rd pointer. Time between AU pointer movements has a range of 34 ms to 10 s with a resolution of 1 ms; time between added pointer movement and previous normal pointer movement for AU pointers is 0.5 ms Time between added pointers is equal to: (time between pointers ¢ 90 ¢ N) where N is selected to be the smallest integer that makes this product ² 30 s.
TU-12 Periodic 35 1	Sequence pattern is 35 pointer movements followed by 1 missing pointer movement. Time between pointer movements has a range of 760 ms to 10 s with a resolution of 1 ms.
TU-12 Periodic 35 1 With Cancel	Sequence pattern is 35 pointer movements followed by 1 missing pointer movement with a cancelled pointer movement at the 35th pointer, yielding a gap of 2. Time between pointer movements has a range of 760 ms to 10 s with a resolution of 1 ms. Time between cancelled pointers is equal to: (time between pointers ¢ 36 ¢ N) where N is selected to be the smallest integer that makes this product ² 30 s.
TU-12 Periodic 35 1 With Add	Sequence pattern is 35 pointer movements followed by 1 missing pointer movement with an added pointer movement after the 17th pointer. Time between normal pointer movements has a range of 760 ms to 10 s with a resolution of 1 ms; time between added pointer movement and previous normal pointer movement is 2 ms. Time between added pointers is equal to: (time between pointers ¢ 36 ¢ N) where N is selected to be the smallest integer that makes this product ² 30 s.

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Table 3 28: Availability of Pointer Sequences

Pointer Sequence	Mapping		
	AU	TU-3	TU-12
(a) Single Alternating	✓	✓	✓
(d) Double Alternating	✓	✓	✓
(e) Single	✓	✓	✓
(f) Burst	✓	✓	✓
(g) Periodic 87 3	✓		
(g) Periodic 87 3 With Cancel	✓		
(g) Periodic 87 3 With Add	✓		
(h) Periodic Continuous	✓	✓	✓
(h) Periodic Continuous with Cancel	✓	✓	✓
(h) Periodic with Add	✓	✓	✓
Phase Transient Pointer	✓	✓	✓
TU-3 Periodic 85 5		✓	
TU-3 Periodic 85 5 With Cancel		✓	
TU-3 Periodic 85 5 With Add		✓	
TU-12 Periodic 35 1			✓
TU-12 Periodic 35 1 With Cancel			✓
TU-12 Periodic 35 1 With Add			✓

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Starting Pointer Sequences

To set up the CTS850 to make generate pointer sequences:

1. Specify the pointer mode as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	POINTERS & TIMING	Pointer / Timing Mode	Pointer Sequences

The choices allow you to move pointers using time parameters, with a frequency offset, or in sequences. Selecting Pointer Sequences moves pointers in sequential patterns.

2. Specify the pointer type as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Type	AU Pointer
			TU Pointer

3. Specify the Sequence Type as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Sequence Type	*as appropriate*

***NOTE**. The pointer sequences available depend on the selected Pointer Type.*

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4. If Sequence Type is set to anything other than Single or Double Alternating, set the pointer direction as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Direction	Increment
			Decrement

5. If Sequence Type is set to one of the continuous patterns, set the pointer rate as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Pointer Rate	1000ms
			2000ms
			5000ms
			10000ms
			USER DEFINED

H Select **USER DEFINED** to set a pointer rate different from the preset choices.

6. Specify whether Initialization Time is included as part of the pointer sequence as follows. If peforming conformance testing,

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set Initialization Time to ON. If testing in a laboratory and quicker results are sought, set Initialization Time to OFF.

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Initialization Time	On
			Off

***NOTE**. The Initialization Time is a set value (either 0 seconds or 30 seconds); it cannot be changed directly.*

7. Specify whether Cool Down Time is included as part of the pointer sequence as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Cool Down Time	On
			Off

***NOTE**. The Cool Down Time is a calculated value based on the sequence type; it cannot be changed directly.*

8. To initiate a pointer sequence, press **POINTER ACTION**.

Pointer sequences will continue to run until they are stopped.

9. To stop a pointer sequence, press **POINTER ACTION.**

After you press POINTER ACTION, the pointer sequence begins. The status area at the bottom of the display will change to indicate where the CTS850 is within the pointer sequence; see Figure 3 81. Table 3 29 describes the meaning of the lines in the status display.

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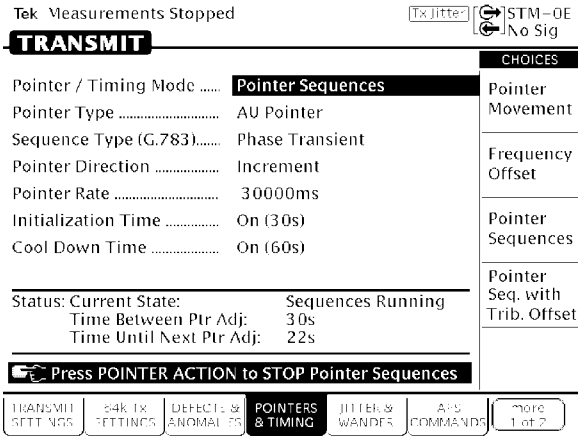


Figure 3 81: Status Display While Pointer Sequences are Running

Table 3 29: Status Lines for Pointer Sequences

Status Line	Description
Current State	Indicates the state of Pointer Sequences: Not Running, Initialization State, Cool Down, or Sequences Running
Time Between Anomalies[1]	Indicates the time between pointer anomalies
Time Until Next Anomaly[1]	Indicates the time remaining until the next anomaly occurs
Time Between Ptr Adj[1]	Indicates the time between pointer adjustments
Time Until Next Ptr Adj[1]	Indicates the time remaining until the next pointer adjustment occurs

1 **This information is displayed depending on sequence type. Not all information is displayed. When this information is displayed, Time Between Anomalies is displayed with Time Until Next Anomaly, and Time Between Ptr Adj is displayed with Time Until Next Ptr Adj.**

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Starting Pointer Sequences with Tributary Offset

This choice is identical to the **Pointer Sequences** choice, with the exception that it selects clock tributary offset and adds a menu item to set that offset. The transmit rate must be SDH, and the SDH structure must be TU 3 or TU 12 in order to access these menu choices.

When the selected mode for Pointers/ Timing is **Frequency Offset,** the selecton for Offset Mode has a third selection, Tributary (Mapping). This choice selects tributary offset.

This clock mode uses a different assignment of clock resources to system clocks. Disruptions in the output signal may occur when switching to or from this offset mode.

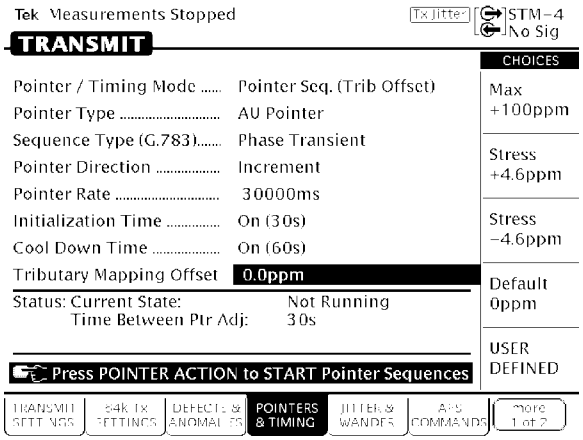


Figure 3 82: Example of Pointer Sequences (Tributary Offset)

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Testing Automatic Protection Switching

This section describes how to generate Automatic Protection Switching (APS) commands and view the network response.

APS commands are located in the K1 and K2 bytes of the section overhead. The K1 byte indicates a request for switch action. The K2 byte provides additional information about network architecture and alarm conditions.

Setting the APS Mode

The APS mode specifies whether the network is a ring network or a span network. The APS mode determines how the K1 and K2 bytes are interpreted and displayed by the CTS850.

To specify the APS mode:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS (see Figure 3 83)	APS Mode	Span
			Ring

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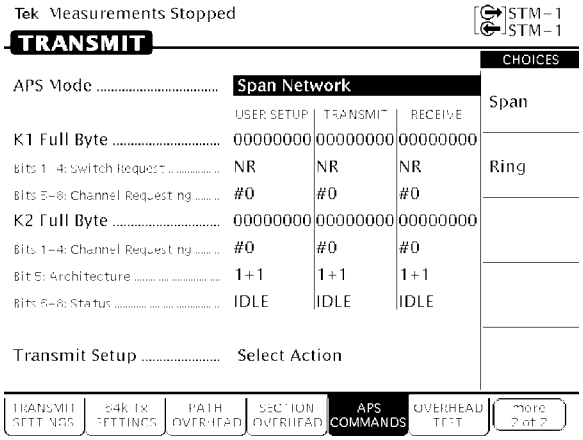


Figure 3 83: The APS COMMANDS Page

Setting the K1 Byte

There are two ways to edit the bits of the K1 byte. The first way is to set the value of each bit of the byte, one bit at a time. The second way is to assign values to the bits using preset choices, which use mnemonics to identify bit patterns.

To set the bit pattern of the K1 byte one bit at a time:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	K1 FULL BYTE	Set to 00000000
			Set to 11111111
			Default 10101010
			EDIT BYTE

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H Select **EDIT BYTE** to set the byte to a pattern different from the preset choices.

To set the bit pattern for the first four bits of the K1 byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	Bits 1 4: Switch Request *(under K1 FULL BYTE)*	*as appropriate*

The selections available for the first four bits of the K1 byte depend on whether the mode is set to Ring or Span. See Tables 3 30 and 3 31 for descriptions of the preset choices.

Table 3 30:
Choices for Bits 1 4 of K1 Byte When Mode Set to Ring

Main Screen Mnemonic	Choice Text	Bit Pattern
NR	NR No Request	0000
RR R	RR R Reverse Request Ring	0001
RR S	RR S Reverse Request Span	0010
EXER R	EXER R Exerciser Ring	0011
EXER S	EXER S Exerciser Span	0100
WTR	WTR Wait To Restore	0101
MS R	MS S Manual Switch Ring	0110
MS S	MS S Manual Switch Span	0111
SD R	SD R Signal Degrade Ring	1000
SD S	SD S Signal Degrade Span	1001
SD P	SD P Signal Degrade Prot	1010
SF R	SF R Signal Fail Ring	1011

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Table 3 30:
Choices for Bits 1 4 of K1 Byte When Mode Set to Ring (Cont.)

Main Screen Mnemonic	Choice Text	Bit Pattern
SF S	SF S Signal Fail Span	1100
FS R	FS R Forced Switch Ring	1101
FS S	FS S Forced Switch Span	1110
LP S	LP S Lockout of Protection Span	1111

Table 3 31:
Choices for Bits 1 4 of the K1 Byte When Mode is Set to Span

Main Screen Mnemonic	Choice Text	Bit Pattern
NR	NR No Request	0000
DNR	DNR Do Not Revert	0001
RR	RR Reverse Request	0010
Not Used	Not Used	0011
EXER	EXER Exerciser	0100
Not Used	Not Used	0101
WTR	WTR Wait to Restore	0110
Not Used	Not Used	0111
MS	MS Manual Switch	1000
Not Used	Not Used	1001
SD LP	SD Signal Degrade Low	1010
SD HP	SD Signal Degrade High	1011
SF LP	SF Signal Fail Low	1100

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Table 3 31:
Choices for Bits 1 4 of the K1 Byte When Mode is Set to Span (Cont.)

Main Screen Mnemonic	Choice Text	Bit Pattern
SF HP	SF Signal Fail High	1101
FS	FS Forced Switch	1110
LP	LP Lockout of Protection	1111

The label for Bits 5 8, of the K1 byte, is Destination Node ID when the mode is set to Span. The label for Bits 5 8 is Channel Requesting when the mode is set to Ring.

To set the bit pattern for the last four bits of the K1 byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	Bits 5 8: *(under K1 FULL BYTE)*	*as appropriate*

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See Table 3 32 for descriptions of the preset choices.

Table 3 32: Choices for Bits 5 8 of the K1 Byte

Main Screen Mnemonic	Choice Text	Bit Pattern
#0	#0 (0000)	0000
#1	#1 (0001)	0001
#2	#2 (0010)	0010
#3	#3 (0011)	0011
#4	#4 (0100)	0100
#5	#5 (0101)	0101
#6	#6 (0110)	0110
#7	#7 (0111)	0111
#8	#8 (1000)	1000
#9	#9 (1001)	1001
#10	#10 (1010)	1010
#11	#11 (1011)	1011
#12	#12 (1100)	1100
#13	#13 (1101)	1101
#14	#14 (1110)	1110
#15	#15 (1111)	1111

Setting the K2 Byte

There are two ways to edit the bits of the K2 byte. The first way is to set the value of each bit of the byte, one bit at a time. The second way is to assign values to the bits using preset choices, which use mnemonics to identify bit patterns.

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To set the bit pattern of the K2 byte one bit at a time:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	K2 FULL BYTE	Set to 00000000
			Set to 11111111
			Default 10101010
			EDIT BYTE

H Select **EDIT BYTE** to set the byte to a pattern different than the preset choices.

The label for Bits 1 4, of the K2 byte, is Channel Requesting when the mode is set to Span. The label for Bits 5 8 is Source Node ID when the mode is set to Ring.

To set the bit pattern for the first four bits of the K2 byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	Bits 1 4: *(under K2 FULL BYTE)*	*as appropriate*

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See Table 3 33 for descriptions of the preset choices.

Table 3 33: Choices for Bits 1 4 of the K2 Byte

Main Screen Mnemonic	Choice Text	Bit Pattern
#0	#0 (0000)	0000
#1	#1 (0001)	0001
#2	#2 (0010)	0010
#3	#3 (0011)	0011
#4	#4 (0100)	0100
#5	#5 (0101)	0101
#6	#6 (0110)	0110
#7	#7 (0111)	0111
#8	#8 (1000)	1000
#9	#9 (1001)	1001
#10	#10 (1010)	1010
#11	#11 (1011)	1011
#12	#12 (1100)	1100
#13	#13 (1101)	1101
#14	#14 (1110)	1110
#15	#15 (1111)	1111

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The label for Bit 5, of the K2 byte, is Architecture when the mode is set to Span. The label for Bit 5 is Path when the mode is set to Ring.

To set the value of the fifth bit of the K2 byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	Bit 5: *(under K2 FULL BYTE)*	*as appropriate*

See Tables 3 34 and 3 35 for descriptions of the preset choices for Bit 5.

Table 3 34: Choices for Bit 5 of the K2 Byte When Mode is Set to Span

Main Screen Mnemonic	Choice Text	Bit Value
1+1	1+1	0
1:N	1:N	1

Table 3 35: Choices for Bit 5 of the K2 Byte When Mode is Set to Ring

Main Screen Mnemonic	Choice Text	Bit Value
SHORT	SHORT	0
LONG	LONG	1

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The label for Bits 6 8, of the K2 byte, is Status whether the mode is set to Ring or Span.

To set the bit pattern for the last three bits of the K2 byte:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	Bits 6 8: *(under K2 FULL BYTE)*	*as appropriate*

See Table 3 36 for descriptions of the preset choices.

Table 3 36: Choices for Bits 6 8 of the K2 Byte

Main Screen Mnemonic	Choice Text	Bit Pattern
IDLE	IDLE	000
BR	BR Bridged	001
BR&SW	BR & SW Bridged & Switched	010
	Extra Traffic	011
Reserved	Reserved	100
Reserved	Reserved	101
RDI	RDI	110
AIS	AIS	111

NOTE. *You can edit the transmitted K1 and K2 bytes directly from the SECTION OVERHEAD page.*

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Transmitting the K1 and K2 Bytes

Changing the values of the K1 and K2 bytes, shown in the USER SETUP column, does not automatically change the values of the transmitted K1 and K2 bytes. The TRANSMIT column shows the K1 and K2 bytes that are being transmitted.

To transmit new K1 and K2 bytes:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	Transmit Setup	Transmit User Setup
			Transmit Default
			Transmit Illegal

***NOTE**. You cannot transmit new values for the K1 or K2 bytes when the* CTS850 *is transmitting an MS AIS or MS FERF.*

- Select **Transmit User Setup** to change the value of the K1 and K2 bytes to that shown under USER SETUP.
- Select **Transmit Default** to change all the bits in the K1 and K2 bytes to zeros.
- Select **Transmit Illegal** to change all the bits in the K1 and K2 bytes to ones.

When you select an action from the Transmit Setup line, the TRANSMIT column is updated.

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Viewing the Network Response to APS Commands

To view the network response to APS commands:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	APS COMMANDS	*none*	*none*

The network response to APS commands appears under the column labeled RECEIVE on the APS COMMANDS page (see Figure 3 84).

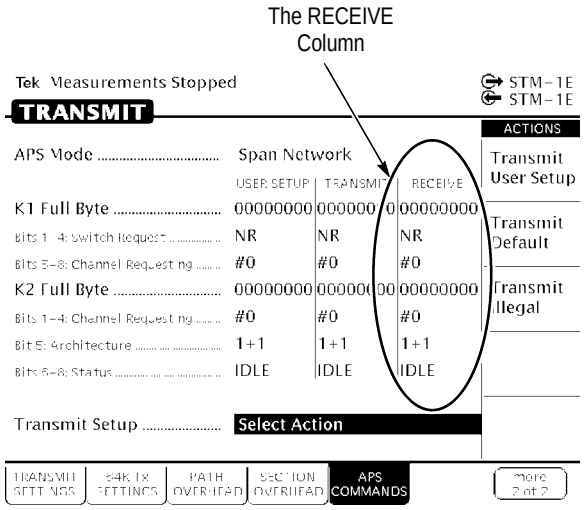


Figure 3 84: The RECEIVE Column on the APS COMMANDS Page

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Viewing Results

This section describes how to view, save, recall, and print test results.

You can look at test results while a test is running or after it has completed. The CTS850 SDH/PDH Test Set can display test results as a summary or in a more detailed tabular form. The CTS850 also displays measurement history in a graphical format.

Press the RESULTS button in the middle of the front panel to call up the RESULTS menus.

G.826, M.2101.1, M.2100, and G.821 Analysis

G.826 Error Performance By monitoring Severly Errored Seconds (SES) events for both directions at a single path end point, a network provider is able to determine the unavailable state of the path. This service measure is intended for in service quality measurements of 2 Mb/s and above (including SDH rates). G.826 uses block based measurements, that is, multiple errors in a block are counted as one block error.

PDH G.826 is based on frame and CRC errors and is an in service measurement. G.826 makes use of block based measurements to get media independent results and thus is more convenient for in service measurement.

M.2101.1 This ITU T provides limits for bringing into service (BIS), and limits for maintenance of international SDH paths and international SDH multiplex sections in order to achieve the performance objectives given for a multiservice environment. These objectives include error performance (Recommendation G.826) and unavailability (Recommendation G.827).

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M.2100 This measure of service quality is similar to G.821 in that is uses bit based error measurement. M.2100 combines all error sources during a one (1) errored second count without regard to source (for example, FAS, CRC 4, Code violation, etc.). Out of service measurements use a PRBS pattern, and count bit errors as well as frame related in service error types (for example, FAS, CRC 4). In service measurements count frame related in service error types only (FAS, CRC 4).

G.821 analysis is based on pattern bit errors occurring within the payload of an SDH or PDH rate signal. Bit based measurements are made on the payload with a PRBS pattern. G.821 is an out of service measurement since the normal traffic payload is replaced by a test pattern.

Viewing a Summary of Results

To display a summary of test results:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	TEST SUMMARY	*none*	*none*

Figure 3 85 shows the TEST SUMMARY page. The top half of the display shows the source of the displayed results, the rate of the displayed results, the structure and payload of the displayed results, when the displayed test results started and the duration of the test (elapsed time). The Results structure is the Receive Setup structure setting for the active test, Payload is the active payload.

The bottom half of the display is where the TroubleScan feature displays information. TroubleScan provides a quick overview of test results by displaying the four most significant alarm, failure, or error conditions that have occurred during the test. The specific conditions that TroubleScan displays depends on the problems detected in the signal during the test.

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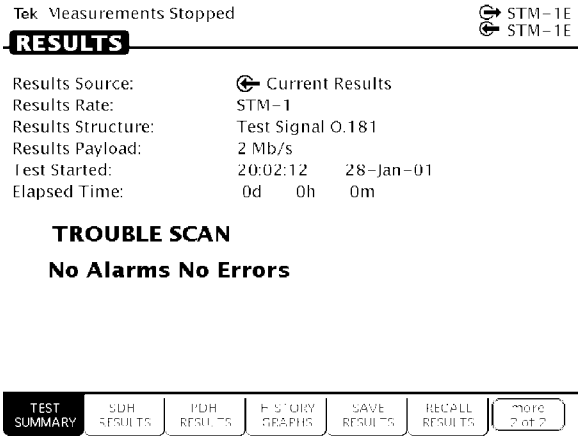


Figure 3 85: The Test Summary Page

Viewing Detailed Results

You can view results either as a summary or as a history. The summary format displays test results in a table. The history format displays test results in a graphical format.

The summary format is displayed on a number of pages in the RESULTS menu. The sub pages available under the RESULTS menu are shown in the table below.

RESULTS

Test Summary	SDH Results	PDH Results	Jitter & Wander	Error Analysis	Perf Analysis	More 1 of 2
Test Summary	SDH Results	PDH Results	History Graphs	Save Results	Recall Results	More 2 of 2

The choices available from each sub page are listed in the following table.

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Table 3 37: Vertical Menu Choices, from RESULTS Sub Pages

RESULTS Sub Page	Menu choices Displayed
SDH Results	Network Defects
	Section Defects
	Path Defects
	SDH Anomalies
	Pointers
PDH Results	Network Defects
	PDH Defects
	PDH Anomalies
	PDH Slips
Jitter & Wander	Jitter
	Wander frequency
Error Analysis	SDH G.826
	PDH G.826
	SDH M.2101.1
	PDH M.2100
	Pattern Bit G.821
Performance Analysis	G.826
	M.2101.1

The following menu screens illustrate examples of the sub pages available from the RESULTS menu.

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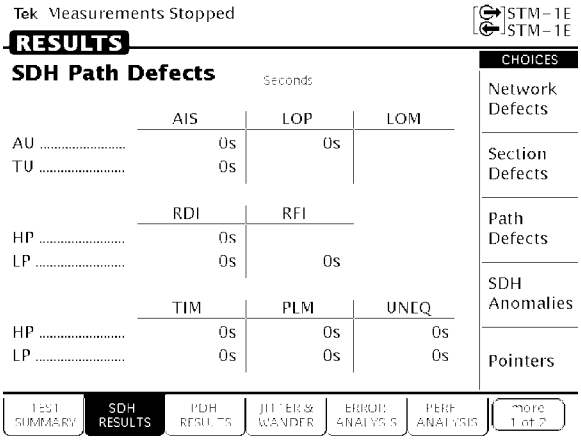


Figure 3 86: Example of RESULTS menu, SDH Results, SDH Path Defects

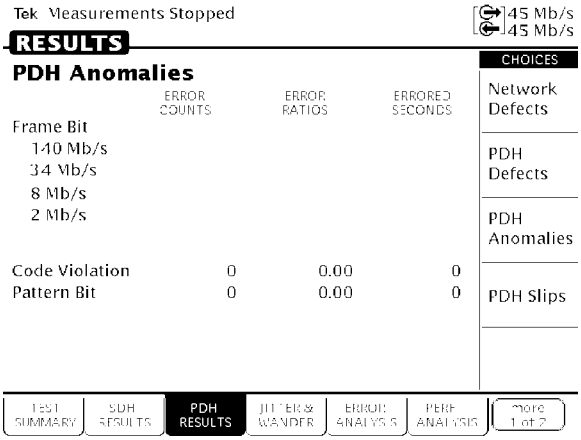


Figure 3 87: Example of RESULTS menu, PDH Results, PDH Anomalies

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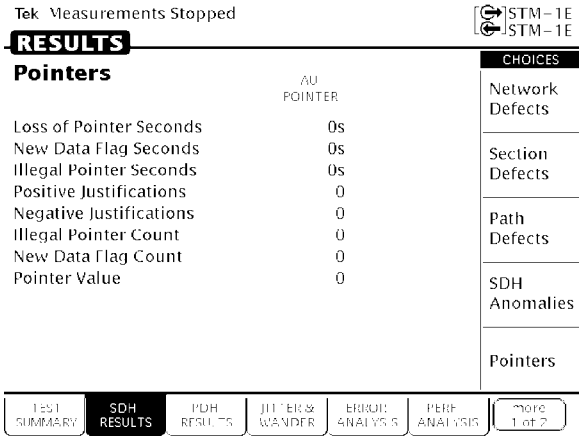


Figure 3 88: Example of RESULTS menu, SDH Results, Pointers

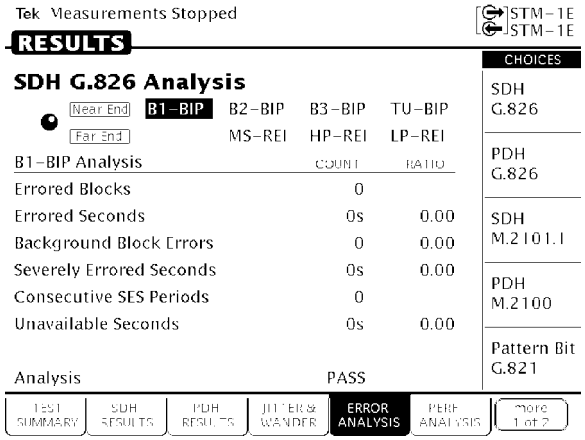


Figure 3 89: Example of RESULTS menu, Error Analysis, SDH G.826 Analysis

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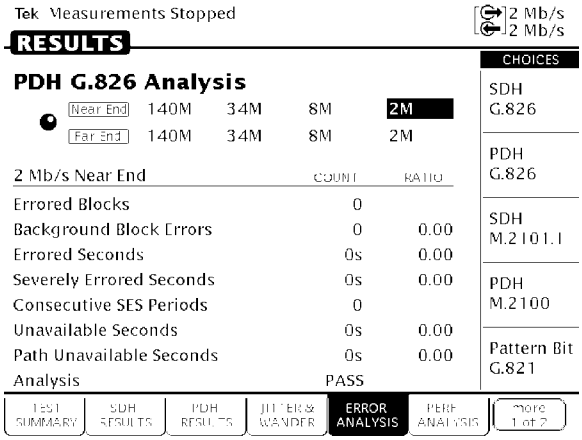


Figure 3 90: Example of RESULTS menu, Error Analysis, PDH G.826 Analysis

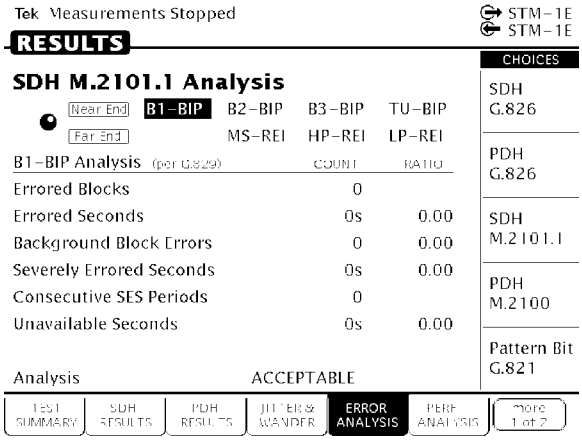


Figure 3 91: Example of RESULTS menu, Error Analysis, SDH M.2101.1 Analysis

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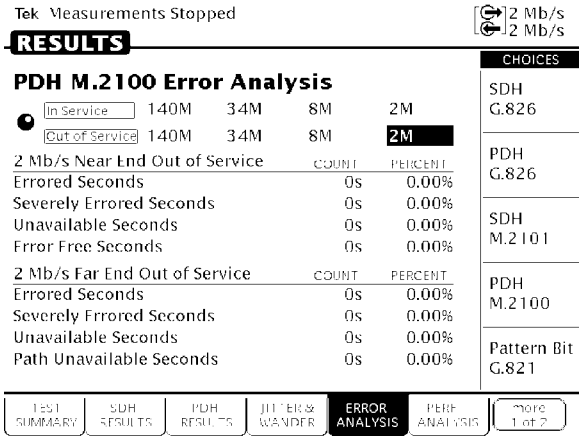


Figure 3 92: Example of RESULTS menu, Error Analysis, PDH M.2100 Analysis

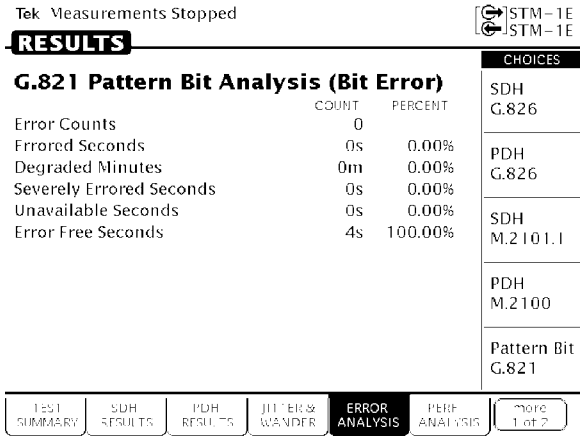


Figure 3 93: Example of RESULTS menu, Error Analysis, G.821 Pattern Bit Analysis

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Displaying an Analysis of Test Results

To display an analysis of test results:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	See specific choices	*see specific choices*	

Table 3 38 lists all of the test results that are displayed on the sub pages available from the RESULTS menu.

Table 3 38: SDH Results, from RESULTS menu

Category	Error Displayed
SDH Network Defects	Loss of Signal (Seconds)
	Loss of Frame (Seconds)
	Loss of Synchronization Seconds
	CTS Loss of Power
SDH Section Defects	HP TIM
	AU AIS
	HP RDI
	TU AIS
	LP RDI
	AU LOP
	TU LOP (with PDH mapping/structure)
	TU LOM (with PDH mapping/structure)
SDH Path Defects	AU AIS; AU LOP
	Out of Frame (SEFS); MS AIS; MS RDI; RS TIM
	TU AIS; TU LOP; TU LOM
	HP RDI

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Table 3 38: SDH Results, from RESULTS menu (Cont.)

Category	Error Displayed
	LP RDI; LP RFI
	HP TIM; HP PLM; HP UNEQ
	LP TIM; LP PLM; LP UNEQ
SDH Anomalies	STM FAS
	RS B1 BIP
	MS B2 BIP
	Path B3 BIP
	TU Path BIP
	Pattern Bit
	MS REI
	HP REI, LP REI
Pointers	Loss of Pointer Seconds
	New Data Flag Seconds
	Illegal Pointer Seconds
	Positive Justifications
	Negative Justifications
	Illegal Pointer Count
	New Data Flag Count
	Pointer Value

Table 3 39: PDH Results, from RESULTS menu

Category	Error Displayed
PDH Network Defects	Loss of Signal (Seconds)
	Loss of Frame (Seconds)

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Table 3 39: PDH Results, from RESULTS menu (Cont.)

Category	Error Displayed
	Loss of Synchronization Seconds
	CTS Loss of Power
PDH Defects	LOCRC (Loss of CRC), LOF, AIS. RDI
	LOMF (Loss of Multiframe)
	FEMFAS
	64k TS 16 AIS; Idle
PDH Anomalies	Frame Bits (140 Mb/s, 34, 8, 2)
	Pattern Bit
	CRC4; Code Violation
	E Bit
PDH Slips	Slip Seconds (Leading, Lagging)
	64k Commanded Slips

Table 3 40: Jitter & Wander, from RESULTS menu

Category	Displayed
Jitter	Peak Peak Jitter
	Positive Peak Jitter
	Negative Peak Jitter
	Jitter Hit Seconds
	Jitter Unlocked Seconds
Timing Quality	Current Frequency Drift Rate
	Maximum Frequency Drift Rate

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Table 3 40: Jitter & Wander, from RESULTS menu (Cont.)

Category	Displayed
Wander	Peak Peak Wander
	TIE
	Estimated Bit Slips (2 Mb/s rate only)
	Estimated Frame Slips (2 Mb/s rate only)
Line Frequency	Current Frequency
	Maximum Frequency
	Minimum Frequency

Table 3 41: Error Analysis, from RESULTS menu

Category	Error Displayed
SDH G.826	Near End B1 BIP; B2 BIP, B3 BIP, TU BIP *Use the front panel knob to select layer sub choices*
	Far End MS REI; HP REI; LP REI *Use the front panel knob to select layer sub choices*
	The following may or may not be available for each of the Near End & Far End sub choices above: Errored Blocks; Errored Seconds; Background Block Errors; Severely Erroed Seconds; Consecutive SES Periods; Unavailable Seconds; Path Unavailable Seconds; Analysis
PDH G.826	Near End 140M; 34M; 8M; 2M *Use the front panel knob to select parameters of interest*
	Far End 140M; 34M; 8M; 2M *Use the front panel knob to select layer sub choices*

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Table 3 41: Error Analysis, from RESULTS menu (Cont.)

Category	Error Displayed
PDH G.826	The following may or may not be available for each of the Near End & Far End sub choices above: Errored Blocks; Errored Seconds; Background Block Errors; Severely Erroed Seconds; Consecutive SES Periods; Unavailable Seconds; Path Unavailable Seconds; Analysis
SDH M.2101.1	Near End B1 BIP; B2 BIP; B3 BIP; TU BIP *Use the front panel knob to select parameters of interest*
	Far End MS REI; HP REI; LP REI *Use the front panel knob to select parameters of interest*
	The following may or may not be available for each of the Near End & Far End sub choices above: Errored Blocks; Errored Seconds; Background Block Errors; Severely Erroed Seconds; Consecutive SES Periods; Unavailable Seconds; Path Unavailable Seconds; Analysis
PDH M.2100	In Service 140M; 34M; 8M; 2M *Use the front panel knob to select layer sub choices*
	Out of Service 140M; 34M; 8M; 2M *Use the front panel knob to select layer sub choices*
	The following may or may not be available for each of the In Service or Out of Servi e sub choices above: Errored Seconds; Severely Erroed Seconds; Unavailable Seconds; Error Free Seconds; Path Unavailable Seconds
Pattern Bit G.821	Error Counts; Errored Seconds; Degraded Minutes; Severely Errored Seconds; Unavailable Seconds; Error Free Seconds

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Table 3 42: Performance Analysis, from RESULTS menu

The following are user selectable choices.

Category	Displayed
G.826	SDH Allocation
	PDH Allocation
	Include UAS
M.2101.1	Test Type: Bring Into Service (BIS); Performance After Repair (PAR); Maintenance; Custom
	Allocation
	Include UAS
	APO (Allocation Performance Objective) Multiplier Section ES; Path ES

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Viewing Measurement Histories

The CTS850 records measurement histories whenever you run a test. Measurement histories are displayed as graphs. The graph displays how an individual measurement changed over time. The vertical axis of a graph depends on what is displayed, but the horizontal axis always displays time.

To display a history graph:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	HISTORY GRAPHS	*none*	*none*

Types of Graphs

There are three types of history graphs: bar graphs, line graphs, and on/off graphs.

Bar Graphs. Bar graphs are used for most measurements (see Figure 3 94). There are two kinds of bar graphs: a count graph that displays code violations and pointer justifications and an errored seconds graph that displays errored seconds. Table 3 43 lists the different bar graphs that can be displayed.

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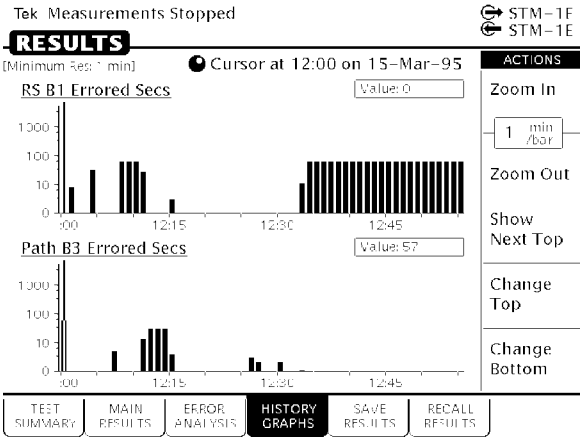


Figure 3 94: Bar Graphs Showing Code Violations and Errored Seconds

Table 3 43: Measurements Displayed as Bar Graphs

Measurement
RS B1 Error Counts
MS B2 Error Counts
MS REI Error Counts
Path B3 Error Counts
HP REI Error Counts
Pattern Error Counts
TU Path Error Counts
LP REI Error Counts
Pattern Error Counts
AU Pointer Justification
AU Pointer Value
TU Pointer Justification

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Table 3 43: Measurements Displayed as Bar Graphs (Cont.)

Measurement
TU 12 Pointer Value
E1 Frame Error Counts
CRC Error Counts
Max. Peak to PeakJitter, UI
Max. Peak to PeakJitter, Log Scale
Max. Rate of Frequency Drift, ppm/sec
Jitter Status

Line Graphs. A line graph is used to display pointer movement history (see Figure 3 95). The vertical axis of the line graph ranges from 0 to the maximum, which is different for AUs and TUs. There are several measurements displayed as a line graph, as shown in Table 3 44.

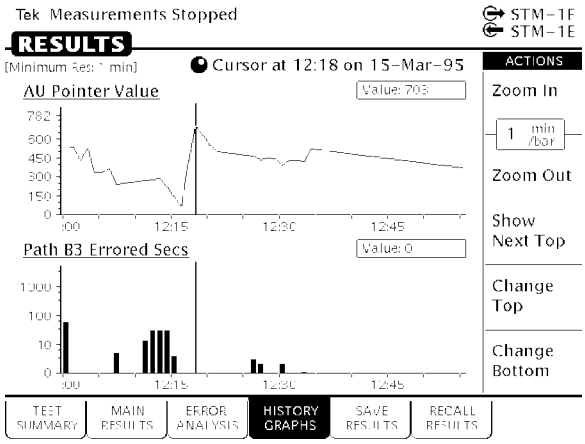


Figure 3 95: Line Graph Showing Pointer Value

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Table 3 44: Measurements Displayed as a Line Graph

Displayed Value
AU-4 Pointer Value
TU Pointer Value
Delta Frequency
TIE
Frequency Drift

On/Off Graphs. On/off graphs indicate whether alarms and failures were on or off (see Figure 3 96). There are only two types of on/off graphs, as shown in Table 3 45. One type displays alarms and the other type displays failures.

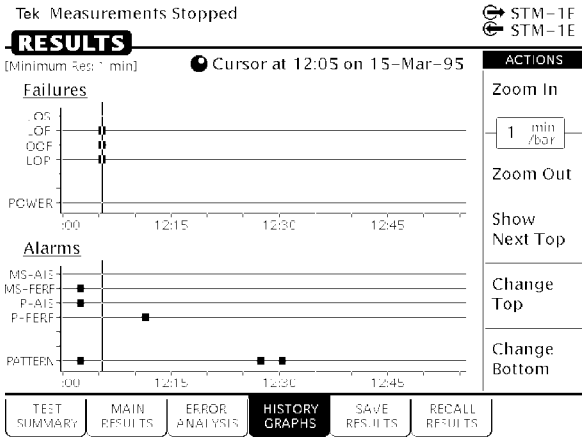


Figure 3 96: On/Off Graphs Showing Failures and Alarms

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Table 3 45: Measurements Displayed as On/Off Graphs for SDH Rates

Graph Type	Displayed Value
Failures	LOS
	LOF
	OOF
	AU LOP
	TU LOP
	TU LOM
	Power
SDH Defects	MS-AIS; MS RDI; AU AIS
	HP RDI; TU AIS; LP RDI
	Pattern Lock
	HP Line; LP Line
	HP PLM; LP PLM
	LP RFI

Table 3 46: Measurements Displayed as On/Off Graphs for PDH Rates

Graph Type	Displayed Value
PDH Defects	LOF
	AIS
	RDI
	LES; LAS
	LOCRC

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Elements of the History Graph Display

Figure 3 97 shows the elements of a typical history graph display. The HISTORY GRAPHS page always displays two graphs. The two graphs can be changed to display any measurement taken during a test.

Graph Name

Above each graph is a name that identifies the measurement the graph illustrates.

History Resolution

Above the graph name is a line that states the minimum resolution at which the graph can be displayed. The minimum resolution is set at the time the test is run.

Power Out Indicator

If the power to the CTS850 fails while a test is running, the CTS850 displays the words “POWEROUT” on the history graph. POWER-OUT is displayed vertically on the graph and spans the period of time the CTS850 was without power.

Cursor

The cursor is a line that is scrolled across the graph using the knob.

Cursor Position

Just below the menu name is a line that identifies the position of the cursor. Cursor position is identified by time and date.

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Measurement Results at Cursor Position

To the right of the graph name is a box that displays the value of the measurement at the cursor location (the box is not displayed for history graphs of alarms or failures). If the displayed graph represents errored seconds, the measurement results box displays the number of errored seconds that occurred during the interval indicated. If the displayed graph represents an error count, the measurement results box displays the number of errors counted during the indicated interval and the resulting bit error rate (BER).

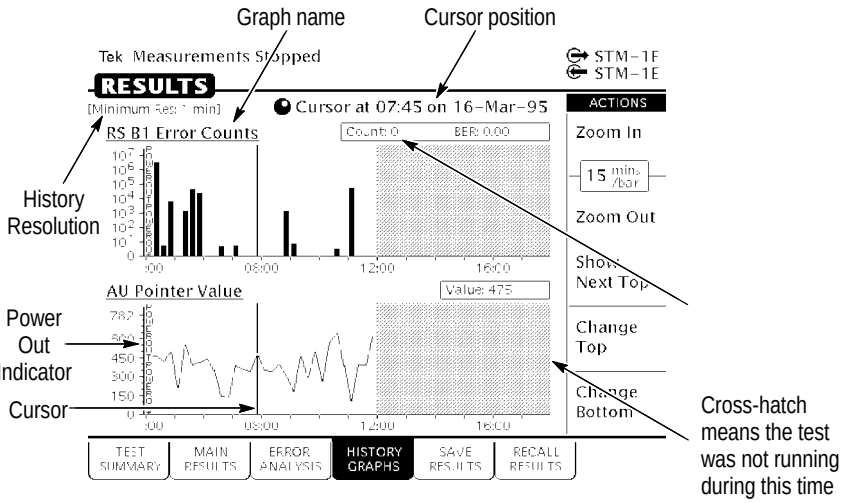


Figure 3 97: Elements of a History Graph

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Zooming History Graphs

History graphs display measurement history in intervals. Each interval is represented by a bar on the history graph. The interval of time represented by a bar can be changed. Changing the interval a bar represents is called zooming. History graphs can be zoomed out or in. When a history graph is zoomed out, a bar represents a longer period of time. When a history graph is zoomed in, a bar represents a decreasingly shorter period of time. Table 3 47 lists the intervals a bar can represent, depending on the history resolution setting when the test was run.

Table 3 47: Time Represented by Bars on History Graph

History Resolution = Normal (1 min. samples)	History Resolution = Low (15 min samples)	History Resolution = High (1 sec. samples)
		1 second
1 minute	15 minutes	1 minute
5 minutes	60 minutes	5 minutes
15 minutes	4 hours	15 minutes
60 minutes	12 hours	60 minutes

There are 56 intervals of a history graph displayed on the screen at a time. At a resolution of one minute per bar, a history graph displays test results for a period of 56 minutes. At a resolution of 15 minutes per bar, a history graph displays test results for a period of 840 minutes, or 14 hours.

The minimum test duration required to display results on a history graph is one minute. Tests shorter than one minute will not display any results on the HISTORY GRAPHS page. However, test results do appear on the SDH RESULTS and ERROR ANALYSIS pages for tests shorter than one minute.

The history of test results can be recorded at three resolutions, either 1 second, 1 minute or 15 minutes. At 1 second resolution, two hours of test results can be recorded. At 1 minute resolution, five

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days of test results can be recorded. At 15 minutes resolution, 75 days of test results can be recorded.

***NOTE**. When viewing long test durations (for example, five days) at a resolution of one minute, you might see a timestamp error. For example, you might see two one-minute intervals stamped with the same time. The timestamp error is simply revealing the clock accuracy. The correct number of intervals for the test duration are present.*

Panning History Graphs

You can display different portions of a history graph by panning the graph. Panning a history graph shifts the displayed section of the graph to the left or right.

At the maximum resolution of one second per bar, a history graph can display only about one hour of test results. To maintain maximum resolution, you can display the graph at maximum resolution (one second per bar) and pan to other portions of the history graph as necessary.

To pan a history graph, turn the knob.

When the knob is turned, the cursor moves across the history graph. If the history graph contains more data than will fit on the display, the history graph shifts to display additional information. The direction the display shifts depends on which direction the knob is turning.

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Changing the Displayed History Graph

To change the displayed history graph:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	HISTORY GRAPHS		Show Next Top
			Change Top
			Change Bottom
		select graph with knob (see Figure 3 98)	Select Graph

- Select **Show Next Top** to automatically display the next graph on the top half of the screen.
- Select **Change Top** to select a different graph for display on the top half of the screen.
- Select **Change Bottom** to select a different graph for display on the bottom half of the screen.
- Select **Cancel** if you decide not to change the displayed graph.

Displaying Mini-Graphs

When you select either Change Top or Change Bottom from the HISTORY GRAPHS page, the selected graph is replaced by three mini-graphs (see Figure 3 98). Each mini-graph is a reduced-size version of a normal graph. Turn the knob to display a different graph. The middle graph, which is highlighted, is the graph that will be displayed full-size when you choose Select Graph. When you turn the knob, the mini-graphs scroll either up or down depending on which direction you turn the knob. Whether the next mini-graph appears at the top or the bottom depends on the direction the knob turns.

Use the mini-graph capability to view several results at once. With mini-graphs displayed, the CTS850 displays four graphs at the same

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time. This will enable you to see relationships between different results that might otherwise be difficult to spot.

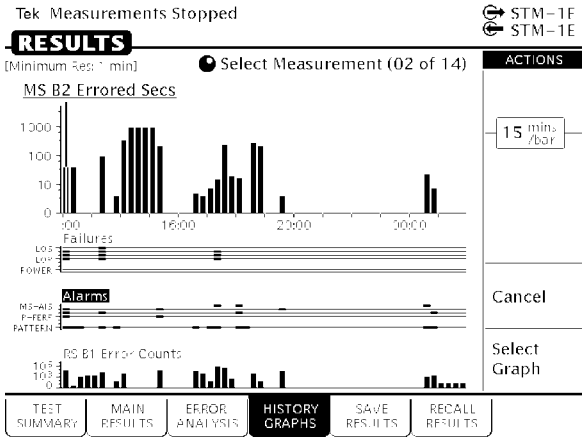


Figure 3 98: Changing the Displayed History Graph

Saving and Recalling Results

You can save the current test results to disk and recall that one set of test results for later display and analysis. If you want to save test results permanently, you must save the test results to disk.

Saving Test Results to Disk

***NOTE**. The CTS850 saves only the last 5 days (at a History Resolution of Normal) or 75 days (at a History Resolution of Low) of test results. If a test runs longer than these limits, the results older than 5 days/ 75 days are discarded.*

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To save test results to disk:

1. Name the test results file as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SAVE RESULTS (see Figure 3 99)	Name	RESLT_XX
			Clear
			EDIT NAME

- If you wish to name the results file as RESLT<Number>, you can save time by selecting **RESLT_XX**. Once you select RESLT_XX, select **EDIT NAME** and edit **XX** to the desired number (or letter). Select **DONE** when you are finished editing the setup name. Be aware that the test set only saves one set of test results to the unit's disk memory.
- Select **Clear** to remove an existing name. A message appears to remind you that you cannot save results to disk without a name.
- Select **EDIT NAME** to enter a name other than RESLT_XX for the pass/fail test. Select **DONE** when you are finished editing the test name.

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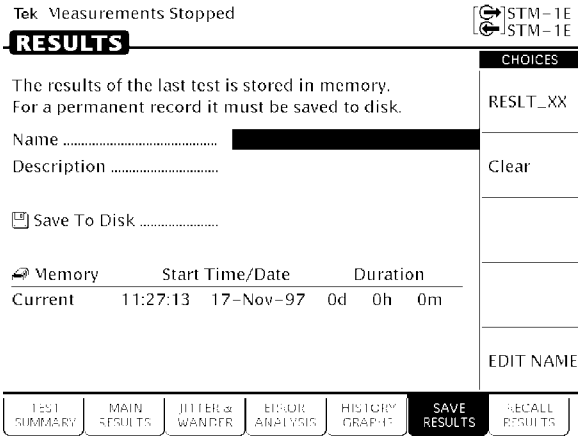


Figure 3 99: The SAVE RESULTS Page

2. Enter a description of the test results file as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	SAVE RESULTS	Description	EDIT TEXT
			None
			Clear

- **H** Select **EDIT TEXT** to enter a description of the test results, up to 24 characters long. Select **DONE** when you are finished editing the description.
- **H** Select **None** if you do not want to use a description.
- **H** Select **Clear** to remove an existing description.

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3. Save the test results to disk as follows:

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

At the bottom of the SAVE RESULTS page is one line that identifies the current test by start time/date and by duration.

H Select **Save Current** to save the current test results.

Recalling Test Results from Disk

To recall test results from disk:

1. Insert the disk containing the test results into the disk drive.

2. Select and recall the test results file as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	RECALL RESULTS (see Figure 3 100)		Disk
		select disk file name	Recall Result

***NOTE**. The Disk action displays only files with the extensions .HST and .MST. It does not display any other files on the disk.*

To verify that the file has been recalled, select the TEST SUMMARY page and look at the Results Source line at the top of the page. The Results Source line will display the name of the file recalled.

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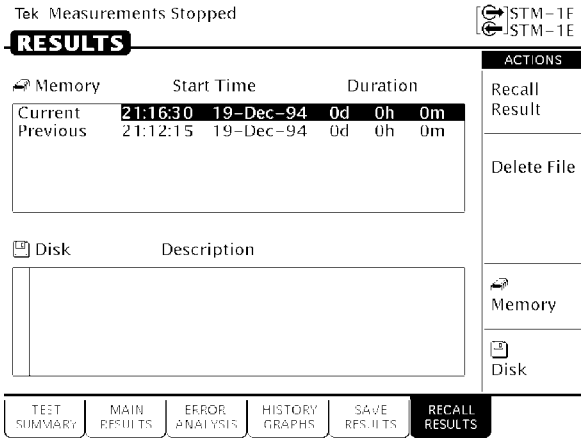


Figure 3 100: The RECALL RESULTS Page

Deleting Test Results from Disk

To delete test results from disk:

1. Insert the disk containing the test results into the disk drive.
2. Select the test results file to be deleted, as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	RECALL RESULTS (see Figure 3 100)		Disk
		select disk file name	Delete File

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Recalling Test Results from Memory

To recall test results from memory:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
RESULTS	RECALL RESULTS		Memory (see Figure 3 100)

Printing Results

There are two ways to print out the results of the current test. One way is to tell the CTS850 which results to print from the print dialog box. The second way is to display the results you wish to print out and then print the displayed screen (this is the only way to print out history graphs).

Results are printed according to the Printer Type, which is set on the PRINTER SETUP page. Results can be printed to a printer or to a disk file. Results can be printed to disk in four formats: Windows BMP format, Interleaf image format, Encapsulated PostScript format, and ASCII text.

Printing Results or Error Analysis

When the CTS850 prints test results, it prints out the contents of the SDH RESULTS page or the ERROR ANALYSIS page. The printed results are reformatted so that all results fit on a single page.

Before printing results, check that the printer setup is correct. The printer setup is displayed on the PRINTER SETUP page of the UTILITY menu.

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To print the results of the current test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
PRINT (see Figure 3 101)		Print Results	
		Print Error Analysis	Print
			Abort
			EXIT

- Highlight **Print Results** and then select **Print** to print the contents of the SDH RESULTS page.
- Highlight **Print Error Analysis** and then select **Print** to print the contents of the ERROR ANALYSIS page.
- Select **Abort** to cancel a printout in process.
- Select **EXIT** if you decide not to print out any test results.

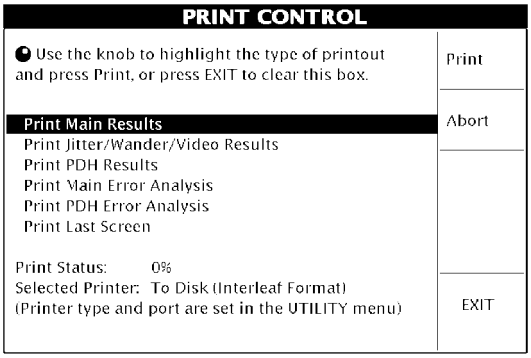


Figure 3 101: The PRINT CONTROL Dialog Box

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To print the results of a test saved on disk, recall the results (see page 3 256) and then print as previously described.

Printing History Graphs

To print a history graph from the CTS850:

1. Display the history graph you want to print.

   The history graph can be for the current test or it can be recalled from disk.

2. Print the history graph as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
PRINT (see Figure 3 101)		Print Last Screen	Print
			Abort
			EXIT

- Select **Print** to print the displayed history graph using the settings on the PRINTER SETUP page of the UTILITY menu.
- Select **EXIT** if you decide not to print any test results.
- Select **Abort** to cancel a printout in process.

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Changing Instrument Settings

This section describes how to change the date and time settings, printer settings, and the GPIB and RS-232 parameters. This section describes how to display a screen that details the CTS850 SDH/PDH Test Set configuration. You will also find a description of how to run the instrument self-test in this section.

Viewing the Instrument Configuration

You can display a page that describes how the CTS850 is configured as well as the installed options and the hardware and firmware revision level.

To display the instrument configuration:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	INSTR CONFIG	*none*	*none*

Table 3 48 describes the lines of the INSTR CONFIG page.

Table 3 48: Lines of the Instrument Configuration Page

Line	Description
Model	The model number of the instrument.
Serial Number	The serial number of the instrument.
Hardware Revision	The version of hardware.
Option Revision	The version of options.
Firmware Revision	The version of firmware.
Options	Lists the options and number of options

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Table 3 48: Lines of the Instrument Configuration Page (Cont.)

Line	Description
Interface Module	Displays which interface module is installed (supported transmit and receive rates) and wavelength of module, if optical.
PDH Option	Indicates whether the 2/8/34/45/140 Mb/s Mux/Demux options are installed.
Jitter Option	Indicates whether Jitter/Wander Option is installed
VC4 4c	BER test of Concatenated STM 4c signal

Setting the Display Brightness

You can set the display brightness to three levels: Low, Medium, and High.

To set the display brightness:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	MISC SETTINGS (see Figure 3 102)	Display Brightness	Low
			Medium
			High

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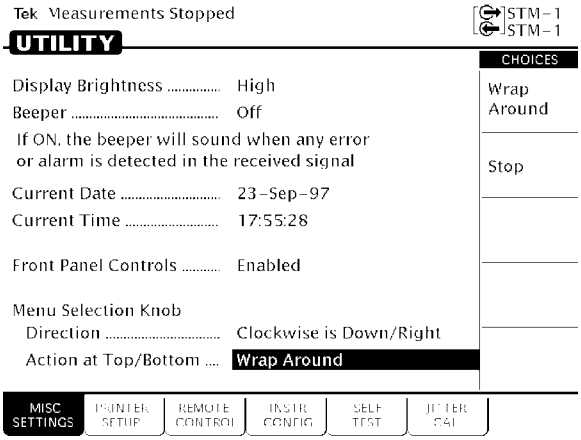


Figure 3 102: The MISC SETTINGS Page

Turning the Beeper On and Off

The CTS850 has a beeper. The beeper is used to alert you when a pass/fail test has completed, or when certain conditions occur. You can turn off the beeper if you wish.

To turn the beeper on or off:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	MISC SETTINGS (see Figure 3 102)	Beeper	On
			Off

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Setting the Date

The date is used when writing files to disk, it is used to track measurement history, and it is used when displaying history graphs.

To set the date:

1. Display the current date setting as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	MISC SETTINGS	Current Date	SET DATE

After you select SET DATE, the CTS850 enters Edit Mode.

2. Assign the knob by selecting **Year**, **Month**, or **Day** as necessary.
3. Turn the knob to change the setting.
4. Select **CANCEL** to abort any changes and exit Edit Mode.
5. Select **DONE** to enter your changes and exit Edit Mode.

Setting the Time

The time is used when writing files to disk, it is used to track measurement history, and it is used when displaying history graphs.

To set the time:

1. Display the current time as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	MISC SETTINGS (see Figure 3 102)	Current Time	SET TIME

After you select SET TIME, the CTS850 enters Edit Mode.

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***NOTE**. While you set the time in Edit Mode, the clock stops running.*

2. Assign the knob by selecting **Hour**, or **Minute** as necessary.
3. Turn the knob to change the setting.
4. Select **CANCEL** to abort any changes and exit Edit Mode.
5. Select **DONE** to enter your changes and exit Edit Mode.

Changing the Printer Setup

The CTS850 prints to Tek DPU-411 printers, Epson-compatible printers, Hewlett-Packard Thinkjet printers and ASCII text printers. It can also print to a file on disk. The print parameters are located on the PRINTER SETUP page of the UTILITY menu (see Figure 3 103). Printers are supported only by an RS-232 connection.

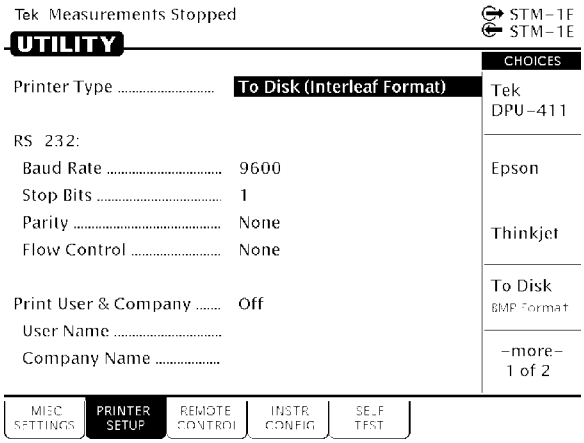


Figure 3 103: The PRINTER SETUP Page

Setting up the CTS850 for a printer consists of two steps, specifying the printer or file type and setting RS-232 parameters. Additionally,

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you can specify two lines of text to be included on any printout. The two lines of text identify the user name and the company name.

Specifying the Printer or File Type

To set the printer or file type:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	PRINTER SETUP	Printer Type	Tek DPU-411
			Epson
			Thinkjet
			To Disk BMP Format
			To Disk Ileaf Format
			To Disk EPS Format
			To Disk ASCII

- Select **To Disk BMP Format** to print a file to disk in Windows bitmap format.
- Select **To Disk Ileaf Format** to print a file to disk in Interleaf image format.
- Select **To Disk EPS Format** to print a file to disk in Encapsulated PostScript format.

Setting RS-232 Parameters

To determine the correct RS-232 settings for your printer, refer to the manual that came with your printer.

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To set the RS-232 parameters for the printer:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	PRINTER SETUP	Baud Rate	1200
			2400
			4800
			9600
		Stop Bits	1
			2
		Parity	None
			Odd
			Even
		Flow Control	None
			Software
			Hardware
			H/W & S/W

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Setting the Print User & Company Text

You can have the CTS850 include text on a printout that identifies the user name and company name. Including this text is optional.

To set the user name and company name:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	PRINTER SETUP	Print User & Company	On
			Off
		User Name	EDIT TEXT
		Company Name	EDIT TEXT

H The User Name and Company Name fields are 20 characters long. Select **DONE** when you are finished editing the name.

Setting Remote Control Parameters

You can control the CTS850 using a General Purpose Interface Bus (GPIB) or an RS-232 connection. For information on remote control commands, refer to the CTS850 *Programmer Manual*.

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Setting the GPIB Address

To set the CTS850 GPIB address:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	REMOTE CONTROL	GPIB Primary Address (see Figure 3 104)	Default 4
			Inc
			Dec
			Offline

- Select **Default 4** to set the GPIB address to its default value.
- Select **Inc** to increment the GPIB address.
- Select **Dec** to decrement the GPIB address.
- Select **Offline** to place the CTS850 in the offline state.
- The maximum GPIB address value is 30. The minimum GPIB address value is 0.

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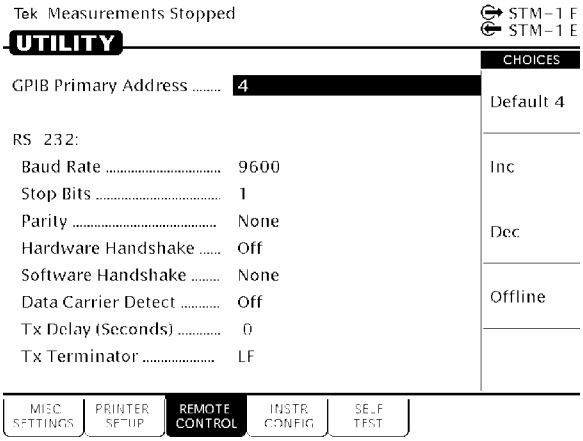


Figure 3 104: The REMOTE CONTROL Page

Setting RS-232 Parameters

The appropriate settings for RS-232 parameters depend on how the controller is set up. Refer to the user manual that came with your controller to determine the correct settings.

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To set the remote control RS-232 parameters:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	REMOTE CONTROL (see Figure 3 104)	Baud Rate	1200
			2400
			4800
			9600
		Stop Bits	1
			2
		Parity	None
			Odd
			Even
		Hardware Handshake	Off
			On
		Software Handshake	None
			Xon/Xoff
		Data Carrier Detect	Off
			On
		Tx Delay (Seconds)	0
			1
			5
			Inc
			Dec

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Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
		Tx Terminator	LF
			CR
			CR/LF
			LF/CR

- For Tx Delay, select one of the preset choices or use **Inc** and **Dec** to specify a value different from the preset choices.
- The maximum value for Tx Delay is 60. The minimum value is 0.

Running Instrument Self Tests

The CTS850 provides self-contained tests that can be run any time you suspect the CTS850 may not be performing properly.

The only test you might need to perform is the Power up Self Test. The other self tests available for selection are for servicing the instrument. Complete details on the self tests are located in the *CTS 850 SDH/PDH Test Set Service* manual.

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Running the Power Up Self Test

To run the power up self test:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	SELF TEST	Self Test Group	Power up Self Test
		Self Test Loop	Once
		Self Test Control	Run

H Select **Abort** to stop a self test in progress.

If your CTS850 fails the self test, contact the nearest Tektronix Service Center.

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Appendices

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Appendix A: Menu Maps

CTS 850 SDH/PDH Test Set

What is a Menu?

A menu groups related functions together. For example, all settings that affect the signal transmitted by the CTS 850 are located in the TRANSMIT menu. Each menu is made up of pages. A page is identified by a page tab located at the bottom of the display (see Figure A 1).

If the choice is not available, it is not displayed or it is not high-lighted.

The CTS 850 always displays a menu. The name of the current menu is shown near the top of the display. To change to another menu, press a menu button on the front panel.

***NOTE**. The only time pressing a menu button does not change menus is when a dialog box is displayed or when you are entering a value for a parameter. You must first exit the dialog box or finish entering the value before you can change menus.*

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TEST SETUPS						
Test Control	Recall Instrument Settings	Recall Pass/Fail Tests	Save Instrument Setups	Save Pass/Fail Tests	Jitter Tests	
TRANSMIT						
Transmit Settings	64k Tx Settings	Defects & Anomalies	Pointers & Timing	Jitter & Wander	APS Commands	More 1 of 2
Transmit Settings	Section Overhead	Path Overhead	Trace Settings	Signal Labels	Overhead PRBS Test	More 2 of 2
RECEIVE						
Receive Settings	64k Rx Settings	Signal Status	Analysis Config	Jitter & Wander		More 1 of 2
Receive Settings	64k Rx Settings	Section Overhead	Path Overhead	RX CAS & Voice		More 2 of 2
RESULTS						
Test Summary	SDH Results	PDH Results	Jitter & Wander	Error Analysis	Perf Analysis	More 1 of 2
Test Summary	SDH Results	PDH Results	History Graphs	Save Results	Recall Results	More 2 of 2
UTILITY						
Misc. Settings	Printer Setup	Remote Control	Instr Config	Self Test	Jitter Cal	

Figure A 1: CTS 850 Menus and Pages

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TRANSMIT

Transmit Settings

Function	Choices
Transmit Rate	STM 0, STM 0E, STM 1, STM 1E, STM 4, 2 Mb/s, 8 Mb/s, 34 Mb/s, 45 Mb/s (option), 140 Mb/s
Transmit Line Code (PDH)	8, 34 Mb/s: HDB3, AMI 2 Mb/s: HDB3 Balanced, Unbalanced; AMI Balanced, Unbalanced 140 Mb/s: CMI only
Transmit Clock	Internal, Recovered, External 2 Mb/s 2 MHz, External 1.5 Mb/s BITS
Line Clock Offset	Max: +100 ppm; Stress: +20 ppm; Stress: 20 ppm; Default 0 ppm; User defined
Transmit Level	0 dB, 6 dB
AU Under Test	1, 2, 3, 4
SDH Structure	STM 4: VC4 4c Bulk, AU 4 Bulk, AU 4 140 Mb/s, TU 3 Async 34 Mb/s, TU 12 Async 2 Mb/s
	STM 1: AU 4 Bulk, AU 4 140 Mb/s, TU 3 Aync 34 Mb/s, TU 12 Async 2 Mb/s
	STM 0: AU 3 Bulk
TU Under Test	TU 12: TUG3: TUG3:1, TUG3:2, TUG3:3 TUG2: 1,2,3,4,5,6,7 TU 12: 1,2,3
	TU 3: TU 3: 1,2,3 TU3:1, TUG3:2, TU3:3
TU Background Fill	TU 12: PRBS 2^15 1 or IDLE TU 3: IDLE
SDH Output	STM 4 (Optical only), STM 1 (Optical or Electrical), STM 0 (Optical or Electrical), Disabled.

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Function	Choices
Payload Structure	Payload sets the signal generation base rate. Because of the number of selection available, the rate and framing parameters are split. See the specific section in the SDH Transmit Parameters for all choices available.
Test Pattern	PRBS 2^9 1, PRBS 2^11 1, PRBS 2^15 1, PRBS 2^20 1, PRBS 2^23 1, All Ones, All Zeros, TS Idle, 01010101, 1 in 8, 8 bit fixed, 16 bit fixed, 24 bit fixed, 1020 Hz 0 dBm, User defined. See the specific section in the SDH Transmit Parameters for all choices available.
Background Pattern	PRBS 2^15 1, PRBS 2^20 1, PRBS 2^23 1, All Ones, All Zeros, 10101010. See the specific section in the SDH Transmit Parameters for all choices available.
Active Channel	If payload selection forces demultiplexing, active channel selections will be displayed.
Tx/Rx Setup	Independent, Coupled, Thorough Mode

The following menus are available from **MORE 1 of 2**.

64k TX Settings

Function	Choices
2 Mb/s Framing	PCM30 CAS/CRC, PCM31 CRC, PCM30 CAS, PCM31
Configuration	1x64k, Nx64k Contiguous
Number of Timeslots	If configuration is Nx64k, this selects the number of contiguous channels (N) that make up the signal. This choice will not display for 1 x 64k configuration.
Starting Timeslot	This selects the starting (or only) timeslot.
Test Pattern	This selection is a duplicate of the Test Pattern selection choice from the TRANSMIT SETTING menu.

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Defects & Anomalies TX

Function	Choices
Error Type set to	None, RS B1 BIP, MS B2 BIP, Path B3 BIP, HP REI, TU BIP, TU Path BIP, LP REI, Pattern Bit, PDH FAS Error, PDH FAS Burst, Code, PDH CRC
Error Rate set to	None, 1e 3, 1e 4, 1e 5, 1e 6, 1e 7, 1e 8, User defined
Transmit Alarm to	None, MS AIS, MS RDI, AU AIS, HP RDI, TU AIS, LP RDI, PDH RAI, PDH AIS
Transmit Failure to	None, LOS, LOP, AU LOP, TU LOP TU LOM

Pointers & Timing TX

Function	Choices
Pointer/Timing Mode	Pointer Movements, Frequency Offset, Pointer Sequences (see section on Setting Pointers and Changing Timing for long list of Pointer Sequences) Pointer Sequences (Tributary Offset) (TX rate must be SDH; SDH structure must be TU 3 or TU 12 in order to access the Trib Offset choices.)
Pointer Type	AU Pointer, TU Pointer
Pointer Control	Single, Burst, Set Value, Continuous
Sequence Type (G.783)	See section on Setting Pointers and Changing Timing for long list of Sequence Types
Pointer Value set to	Min 0, Max 782, Default 522, Illegal (Max + 1), User defined
Set with New Data Flag	Yes, No
Pointer S Bits	00, 01, 10, 11

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Jitter & Wander TX

Function	Choices
Jitter/Wander Generation	Off, On
Jitter Output	Line, Clock 0.8 V, 2 MHz G.703
Jitter Frequency	10.0 Hz, 500 Hz, 6.50 kHz, 65.0 kHz, 1.30 MHz, User defined
Jitter Amplitude	1.00UI, 300.00UI (Max), 150.00UI (Max/2), 0.0UI, User defined

APS Commands TX

Function	Choices
APS Mode	Span, Ring
K1 Full Byte	Set to 00000000, Set to 11111111, Default 10101010, Edit Byte
	Set bit pattern for Bits 1 4 of K1: Switch Request Set bit pattern for Bits 5 8 of K1: Channel Requesting
K2 Full Byte	Set to 00000000, Set to 11111111, Default 10101010, Edit Byte
	Set bit pattern for Bits 1 4 of K2: Bridged Channel Set bit pattern for Bit 5 of K2: Architecture Set bit pattern for Bits 6 8 of K2: Status
Transmit Setup	Transmit User Setup, Transmit Default, Transmit Illegal

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The following menus are available from **MORE 2 of 2**.

Section Overhead TX

Function	Choices
Showing Overhead for	Depends on transmit Rate
External Add	None, D1 D3, D4 D12, F1, E1, E2, E1 from Handset, E2 from Handset
J0 RS Trace	TEK CTS850, Disable Trace, Enable Trace, Null Trace, Default Trace, Edit Trace
S1 Sync Status Message	Quality Unknown, G.811, G.812 Transit, G.812 Local, G.813 SETS, Do not use

Path Overhead TX

Function	Choices
Overhead View	VC4 Overhead, VC3 Overhead, VC12 Overhead
External Add	None, F1 (or F2)
J1 Path Trace Byte	Reset Overhead, 64 byte Format, 16 byte Format, Edit Trace, Default Trace
C2 Signal Label	Unequipped, Equipped (Non specific), TUG, TU n Locked, 34 Mb/s Asynch, 140 Mb/s Asynch, ATM, MAN (DQDB), FDDI, 0.181 Test Signal, VC AIS

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Trace Settings TX

Function	Choices
Trace Select	RS Trace (J0) HP Trace (J1) LP Trace (J2)
Expected	Clear Trace; Copy Transmit; Copy Receive; Edit Trace

Signal Labels TX

Function	Choices
C2 HP Signal Label	Expected, RX, TX See the Signal Labels TX section in the SDH Transmit Parameters for a listing of dependent menu choices to enable this information.
C2 LP Signal Label	Expected, RX, TX See the Signal Labels TX section in the SDH Transmit Parameters for a listing of dependent menu choices to enable this information.
V5 LP Signal Label	Expected, RX, TX See the Signal Labels TX section in the SDH Transmit Parameters for a listing of dependent menu choices to enable this information.

Overhead PRBS Test TX

Function	Choices
Tx Overhead PRBS Test	Byte selections: None, D1 D3, D4 D12, E1, E2, F1, F2 Patterns: PRBS15, PRBS20, PRBS23 Inversion: Standard, Inverted
Rx Overhead Test	Byte selections: None, D1 D3, D4 D12, E1, E2, F1, F2 Patterns: PRBS15, PRBS20, PRBS23 Inversion: Standard, Inverted

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RECEIVE

Receive Settings

Function	Choices
Receive Rate	STM 0, STM 0E, STM 1, STM 1E, STM 4, 2 Mb/s, 8 Mb/s, 34 Mb/s, 140 Mb/s
Receive Level	Normal, Monitor 20 dB, Monitor 30 dB
AU Under Test	1, 2, 3, 4
SDH Structure	STM 4: VC4 4c Bulk, AU 4 Bulk, AU 4, TU 3 Async, TU 12 Async
	STM 1: AU 4 Bulk, AU 4 140 Mb/s, TU 3 Aync, TU 12 Async
	STM 0: AU 3 Bulk
TU Under Test	TU 12: TUG3: TUG3:1, TUG3:2, TUG3:3 TUG2: 1,2,3,4,5,6,7 TU 12: 1,2,3
	TU 3: TU 3: 1,2,3 TU3:1, TUG3:2, TU3:3
TU Background Fill	TU 12: PRBS 2^15 1 or IDLE TU 3: IDLE
Payload Structure	Payload sets the final analysis rate. Because of the number of selection available, the rate and framing parameters are split. See the specific section in the SDH Transmit Parameters for all choices available.
Test Pattern	PRBS 2^9 1, PRBS 2^11 1, PRBS 2^15 1, PRBS 2^20 1, PRBS 2^23 1, All Ones, All Zeros, TS Idle, 01010101, 1 in 8, 8 bit fixed, 16 bit fixed, 24 bit fixed, Live. See the specific section in the SDH Transmit Parameters for all choices available.
Active Channel	If payload selection forces demultiplexing, active channel selections will be displayed.
Payload Drop	Off, On Balanced, Off Balanced
Tx/Rx Setup	Independent, Coupled, Thorough Mode

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64k RX Settings

Function	Choices
2 Mb/s Framing	PCM30 CAS/CRC, PCM31 CRC, PCM30 CAS, PCM31
Configuration	1x64k, Nx64k Contiguous
Number of Timeslots	If configuration is Nx64k, this selects the number of contiguous channels (N) that make up the signal. This choice will not display for 1 x 64k configuration.
Starting Timeslot	This selects the starting (or only) timeslot.
Test Pattern	This selection is a duplicate of the Test Pattern selection choice from the RECEIVE SETTING menu.

Signal Status RX

Function	Choices
PDH Payload Frequency	Displays direct measurement
Round Trip Delay Offset	Displays measurement of how long PRBS signal takes to travel through a DUT.
Received Optical Power	Displays received optical power or received peak voltage (electrical signal)

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Analysis Config RX

Function	Choices
FAS Error Threshold	valid range: 1 7
Pointer ss Bit Mismatch Action	Loss of Pointer or Ignore
Trace Mismatch Detection	Comparison of Received J0 Trace value vs. expected value. Measurement in error seconds. HP Unequipped Detection Choices: Disabled, Enabled LP Unequipped Detection Choices: Disabled, Enabled HP Signal Label Mismatch Detection Choices: Disabled, Enabled
2 Mb/s CRC SES Threshold	2 Mb/s rate: 300 (for G.826) or 805 (for G.821) 45 Mb/s rate (option): 2444 (for G.826) or 45 (form G.821)
Rx Error Trigger Output	None, B1, B2, B3, Pattern

Jitter & Wander RX

Function	Choices
Jitter Mode	Peak Peak, RMS
Jitter Input Source	Line, Clock
Jitter Range	Normal (6.0UI), Extended
Jitter Measure-ment Filter	Wideband, Highband, Fullband (Range changes per signal rate)
Jitter Hit Threshold	0.10 UI, 0.50 UI, 1.00 UI, 1.50 UI, User defined
Pointer Hit Threshold	Min 0 ppm/sec, Max 10 ppm/sec, 0.023 ppm/sec

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Section Overhead RX

Function	Choices
Showing Overhead for	Depends on transmit Rate
External Drop	None, D1 D3, D4 D12, F1, E1, E2, E1 from Handset, E2 from Handset
Pause Control	Pause, Continue, Update Active
J0 RS Trace	Constant 0x01, Enable Trace, Disable Trace
S1 Sync Status Message	Quality Unknown, G.811, G.812 Transit, G.812 Local, G.813 SETS, Do not use

Path Overhead RX

Function	Choices
Overhead View	VC4 Overhead, VC3 Overhead, VC12 Overhead
External Drop	None, D1 D3, D4 D12, E1, E2, E1 from Handset, E2 from Handset, F1
Pause Control	Pause, Continue, Update Active
C2 Signal Label	Unequipped, Equipped (Non specific), TUG, TU n Locked, 34 Mb/s Asynch, 140 Mb/s Asynch, ATM, MAN (DQDB), FDDI, 0.181 Test Signal, VC AIS
J1 HP Trace Format	64 Bytes, 16 Bytes

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RX CAS & Voice

Function	Choices
CAS Display Mode	Single, Scan
Selected Timeslot	In Single display mode, this permits selection of the timeslot of interest. This selection is not displayed in scan mode.
Speaker	Off, Low, Medium, Loud
CAS Bit Values	Displays Time Slot and bit values

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TEST SETUPS

Test Control

Function	Choices
Test Duration	5 min, 15 min, 1 hour, Continuous, User defined
History Resolution	High (1 sec), Normal (1 min), Low (15 min)

Recall Instrument Setups

Function	Choices
Memory	0.Default, 1 5 Recall Setups
Disk	Choices depend on disk content Recall Setup, Delete File

Recall Pass/Fail Tests

Function	Choices
Disk	Choices depend on disk content Recall & Run Test, Delete File

Save Instrument Setups

Function	Choices
Name	SETUP_XX, Clear, EDIT NAME
Description	None, Clear, EDIT TEXT
Save to Memory	Memory 1 5
Save to Disk	Save File

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Save Pass/Fail Tests Test Setups

Function	Choices
Name	TEST_XX, Clear, EDIT NAME
Description	None, Clear, EDIT TEXT
Operator Start Prompt	Default, Clear, Preview, EDIT TEXT
Test Duration	5 min, 15 min, 1 hour, Continuous, User Defined
Fail If	*Up to four fail if conditions can be specified*
Operator End Prompt	Default, Clear, Preview, EDIT TEXT
On Test Completion	Do Nothing, Print Summary, Save to Disk
Save to Disk	Save File

Jitter Tests Test Setups

Function	Choices
Test Type	Output Jitter, Jitter Tolerance, Jitter Transfer, Pointer Jitter
Test Control	Edit Setup, View Graph, Save Results, Recall Results
Test Duration	(per filter) 15 sec, 30 sec, 1 min, 15 min, User defined
Mask Type	Dependent on Rate
Start Frequency	Set start frequency for jitter generator
End Frequency	Set end frequency for jitter generator
Number Freq Samples	Dependent on Test chosen
Tolerance Criteria	Onset of Errors, BER Penalty
Record Error Threshold	Select Action, Measure BER, Record BER

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RESULTS

Test Summary Results

Function	Choices
Results Source	*Displayed information is taken form last test run*
Results	
Results Structure	
Results Payload	
Test Started	
Elapsed Time	
Trouble Scan	

SDH Results

Function	Choices
SDH Network Defects	Loss of Signal, Loss of Frame, Loss of Synchronization Seconds (LSS), CTS Loss of Power
SDH Section Defects	Out of Frame (SEFS), MS AIS, MS RDI, RS TIM
SDH Path Defects	AU AIS, AU LOP, AU LOM, TU AIS, TU LOP, TU LOM, HP RDI, HP RFI, LP RDI, LP RFI, HP TIM, HP PLM, HP UNEQ, LP TIM, LP PLM, LP UNEQ
SDH Anomalies	STM FAS, RS B1 BIP, MS B2 BIP, Path B3 BIP, TU Path BIP, Pattern Bit, MS REI, HP REI, LP REI
Pointers	Loss of Pointer Seconds, New Data Flag Seconds, Illegal Pointer Seconds, Positive Justifications, Negative Justifications, Illegal Pointer Count, New Data Flag Count, Pointer Value

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PDH Results

Function	Choices
PDH Network Defects	Loss of Signal, Loss of Frame, Loss of Synchronization Seconds (LSS), CTS Loss of Power
PDH Defects	Loss of CRC, Loss of Multiframe, FEMFAS, 2 Mb/s LOF, AIS, RDI, 64k TS 16 AIS
PDH Anomalies	Frame Bits (140 Mb/s, 34, 8, 2) Error Counts, Error Ratios, Errored Seconds; Code Violation, Pattern Bit; CRC4; E Bit
PDH Slips	Slip Seconds (Leading, Lagging), 64k Commanded Slips

The following menus are available from **MORE 2 of 2**.

Jitter & Wander Results

Function	Choices
Jitter	Peak Peak Jitter, Positive Peak Jitter, Negative Peak Jitter, Jitter Hit Seconds, Jitter Unlocked Seconds
Timing Quality	Current Frequency Drift Rate, Maximum Frequency Drift Rate
Wander	Peak Peak Wander, TIE, Estimated Bit Slips (2 Mb/s rate only), Estimated Frame Slips (2 Mb/s rate only)
Line Frequency	Current Frequency, Maximum Frequency, Minimum Frequency

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Error Analysis Results

Function	Choices
SDH G.826	**Near End** or **Far End** Error Blocks, Errored Seconds, Background Block Errors, Severely Errored Seconds, Consecutive SES Periods, Unavailable Seconds
PDH G.826	**Near End** or **Far End** Error Blocks, Errored Seconds, Background Block Errors, Severely Errored Seconds, Consecutive SES Periods, Unavailable Seconds
SDH M.2101.1	**Near End** or **Far End** Error Blocks, Errored Seconds, Background Block Errors, Severely Errored Seconds, Consecutive SES Periods, Unavailable Seconds
PDH M.2100	**In Service** or **Out of Service** Error Blocks, Errored Seconds, Background Block Errors, Severely Errored Seconds, Consecutive SES Periods, Unavailable Seconds
Pattern Bit G.821	Error Counts, Errored Seconds, Degraded Minutes, Severely Errored Seconds, Unavailable Seconds, Error Free Seconds

Performance Analysis Results

Function	Choices
G.826	Analysis Type, SDH Allocation, PDH Allocation, Include UAS
M.2101.1	Test Type: Bring into Service (BIS); Performance After Repair; Maintenance; Custom
	Allocation
	Include UAS
	APO (Allocation Performance Objective) Multiplier Section ES; Path ES

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The following menus are available from **MORE 2 of 2**.

History Graphs Results

Function	Choices
Bar graphs	*See section on Viewing Results for specific measurements displayed*
Line graphs	
On/Off graphs	

Save Results

Function	Choices
Name	RESLT_XX, Clear, Edit Name
Description	Edit Text, None, Clear
Save to Disk	Save Current

Recall Results

Function	Choices
Memory	Recall Result
Disk	Recall Result, Delete File

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UTILITY

Misc Settings Utility

Function	Choices
Display Brightness	Low, Medium, High
Beeper	On, Off
Setting the Date	Set Date
Setting the Time	Set time
Front Panel Controls	Enabled, Locked When Test Running, Locked
Menu Selection Knob	Direction Clockwise Down, Clockwise Up Action at Top/Bottom Wrap Around, Stop

Printer Setup Utility

Function	Choices
Printer Type	Tek DPU 411, Epson, Thinkjet, ASCII test, To Disk BMP Format, To Disk Ileaf Format, To Disk EPS Format, To Disk ASCII
RS 232	Baud Rate, Stop Bits, Parity, Flow Control
Printer User & Company	User Name, Company Name

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Remote Control Utility

Function	Choices
GPIB Primary Address	Default 4, Inc, Dec. Offline
RS 232	Baud, Stop Bits, Parity, Hardware Handshake, Software Handshake, Data Carrier Detect, Tx Delay (Seconds), Tx Terminator

Instr Config Utility

Function	Choices
Model	Displays model number of instrument
Serial Number	Displays serial number of instrument
Hardware Revision	Displays version of hardware
Firmware Revision	Displays version of firmware
Options	Displays list of options and number of options in instrument

Self Test Utility

Function	Choices
Self Test Control	Ready, Run
Self Test Group	Power up Self Test, Self Test, SYS. Int., SYS. Ext.
Self Test Loop	Once, Ten, Thousand, Until Error, Forever

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Jitter Cal Utility

Function	Choices
Calibration Control	Ready, Run
Calibration System	Jitter Measurement, Jitter Generation
Calibration Routine	All or select a particular rate All, STM 0, STM 1, STM 4, Analog Output, 2 Mb/s, 34 Mb/s, 140 Mb/s

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Appendix B: Status and Error Messages

This appendix describes the status and error messages that appear on the CTS850 display. Status messages are statements about actions the CTS850 has completed. Status messages appear during normal operation. Error messages are statements about actions the CTS850 was unable to complete. Error messages appear when the CTS850 is unable to perform a requested action.

Status Messages

Autoscan complete. The CTS850 has successfully completed the Autoscan sequence.

Burst pointer movement transmitted. The POINTER ACTION button was pressed with the Pointer Control set to Burst.

Disk root directory read. The CTS850 has successfully read the disk directory.

Factory settings restored, non-volatile settings cleared. This message appears when the instrument is turned on after it was turned off during a state change. The instrument settings were corrupted during the shutdown and so the factory default settings were loaded at turn-on and all information stored in RAM was cleared.

File has been deleted. The CTS850 has successfully deleted the selected file.

Hardcopy complete. The CTS850 has successfully completed a printout.

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Instrument factory reset complete. The recall of default factory settings, from the RECALL INSTRUMENT SETUPS page, was completed successfully.

Instrument returned to previous setup. This message appears if you select Cancel while an Autoscan is in progress.

Instrument setup for received signal. The CTS850 has completed an Autoscan and has changed its settings to match those of the received signal.

Internal diagnostics completed. An instrument self test has been initiated and completed successfully.

No Setup file with '.SET' extension found. You selected the Disk action on the RECALL INSTRUMENT SETUPS page and no instrument setup files were found on the disk.

Previous power down instrument state restored. This message appears when the CTS850 turns on. It means that the settings in effect when the CTS850 was last turned off have been successfully restored.

Reading disk.... The CTS850 is reading the disk directory.

Recall of instrument setup complete. This message confirms that the recall of an instrument setup was successfully completed.

Recall of measurement results/histories complete. The CTS850 has successfully recalled the selected results from disk.

Recall of pass/fail test complete. The CTS850 has successfully recalled the selected pass/fail test from disk.

Save of instrument setup complete. This message confirms that an instrument setup was successfully written to disk.

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Save of measurement results/histories complete. The CTS850 has successfully saved test results to disk.

Save of pass/fail test complete. The CTS850 has successfully saved the pass/fail test to disk.

Single pointer movement transmitted. You pressed the POINTER ACTION button with the Pointer Control set to Single.

Test restarted due to change in receiver settings. You changed the receive settings while a test was running. When any settings are changed, a running test is restarted.

Transmit rate change complete. The CTS850 has successfully changed transmit rate. This message can occur when an instrument setup file is recalled from disk.

Error Messages

Alarm generation invalid while in through mode. You attempted to transmit an alarm while the CTS850 was in Through Mode. Transmit settings cannot be changed while the transmit rate is set to Through Mode.

Autoscan already in progress. You pressed the Autoscan front-panel button while an Autoscan was in progress.

Button disabled in edit mode. You pressed a front-panel button while the CTS850 was in edit mode. You must exit edit mode before you can use the front-panel buttons.

Button disabled when dialog box is displayed. You pressed a front-panel button while a dialog box (for example, PRINT CONTROL) was displayed. Some front-panel buttons are disabled while a dialog box is displayed. Exit the dialog box to enable all the front-panel buttons.

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Can not insert tributary error/alarm while adding external signal. An attempt was made to insert a PDH error or alarm while adding an external signal.

Could not create disk file. The CTS850 was unable to create a file on the disk. Try saving the file on a different disk.

Could not delete file. You attempted to a delete a file and a disk error occurred that prevented the CTS850 from deleting the file. The file is probably corrupted, though you might be able to fix the problem with an MS-DOS disk recovery program.

Could not open disk file. The CTS850 has attempted to read a file from disk and was unable to do so. The file is probably corrupted, though you might be able to recover the file using an MS-DOS file recovery program.

Could not read disk's root directory. The CTS850 was unable to read the disk directory. The disk directory is probably corrupted, though you might be able to recover files from the disk with an MS-DOS disk recovery utility.

Diagnostics invalid while disk or autoscan busy. You tried to run Self Test diagnostics while accessing the disk or completing an Autoscan. Wait until disk access is complete or the Autoscan is complete before running a self test routine.

Disk file too large for memory buffer, truncated. You recalled a file and it was too large to load into memory. This can occur if an instrument settings file is recalled that has been edited on a PC and the edited file is larger than the original file.

Disk has changed, operation aborted. You attempted to recall a disk file and the disk has been changed since the directory was read. Reinsert the original disk and recall the file again.

Disk is busy. You tried to save a file to disk while the disk was active. Wait until the disk activity light turns off and save to disk again.

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Disk is full. You tried to save a file to disk and there is not enough room on the disk for the file. Insert a disk with space available and save the file again.

Disk not present in drive. You tried to save a file to disk, but no disk is in the drive. Insert a formatted disk and save the file again.

Disk is write-protected, cannot write to file. You tried to save a file to a disk that is write-protected.

Disk operation failed. A disk error occurred while reading or writing to the disk. If you were trying to save a file to disk, save the file to a different disk. If you were trying to read a file from disk, you might be able to recover the file using an MS-DOS disk recovery program.

Error insertion disabled while in Through Mode. You pressed the INSERT ERROR button while the CTS850 was in Through Mode. You cannot insert errors while the CTS850 is in Through Mode because the transmit signal must match the received signal.

Errors in test recall, test not loaded. The CTS850 encountered disk errors while recalling a pass/fail test and the operation was aborted. You might be able to recover the file with an MS-DOS disk recovery program.

Extra data in history file ignored. You recalled a history file that contains extra data. This can occur if the history file has been edited with a file editor and the edited file contains inappropriate information.

Failure generation invalid while in through mode. You attempted to transmit a failure while the CTS850 was in Through Mode. Transmit settings cannot be changed while the transmit rate is set to Through Mode.

File name required. You entered a name for an instrument setup, a pass/fail test, or a results file and then you removed the name by selecting Clear. This message is just a reminder that a name must be

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entered for the file to be saved to disk; that is, there is no default file name.

Filename not found. This message appears if the disk was swapped after the directory was read and you attempted to recall a file. Insert the original disk and recall the file again.

File not read. A disk error occurred while reading a file. The file is probably corrupted, though you might be able to recover the file with an MS-DOS disk recovery program.

Frequency offset disabled with current transmit clock. You attempted to change from Pointer/Timing Mode to Frequency Offset while the transmit clock was set to External. Frequency Offset can be selected only when the transmit clock is set to Internal or Recovered.

Hardcopy already in progress. You tried to start a printout while a printout was already in progress. Wait until the current printout completes and then select Print again.

Instrument unable to drop signal while transmitting current rate. You attempted to turn on tributary drop while the transmit rate was set to a PDH rate. Because the PDH transmit connector and tributary drop connector are the same connector, you cannot transmit a PDH signal and drop a PDH signal at the same time.

Internal diagnostics failed. A malfunction has occurred that requires servicing. Contact a Tektronix representative for assistance.

Internal Error N: Contact Tektronix Service. A hardware malfunction has occurred that requires servicing. Contact a Tektronix representative for assistance.

Internal format of file incorrect; file not read. You recalled a file that does not contain data in the correct format. This occurs when a file is recalled that happens to have the same extension as the type of CTS850 file being recalled, but it is not a CTS850 file.

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Invalid history data format in file. You recalled a file that does not contain data in the correct format. This occurs when a file is recalled that happens to have the correct extension for a history file (and thus shows up on the RECALL RESULTS page) even though it is not a CTS850 history file.

Loss of added signal. You have selected an externally generated tributary signal, but no valid signal is present.

Loss of external clock. You have selected an external clock source that does not have a valid clock source attached.

Measurements are running, recall not allowed. You tried to recall instrument setups from memory or disk while a test is running. Wait until the test is completed and then recall the file.

Measurements are running, results cannot be saved. You attempted to save results to disk while a test was running. Wait until the test is completed and then save the results to disk.

No Result file with '.RES' extension found. This message appears when you select Disk (on the RECALL RESULTS page) but the disk does not contain any results files.

Not available without tributary option. The requested action requires that the Add/Drop/Test tributary option be installed.

No Test file with '.TST' extension found. This message appears when you select Disk (on the RECALL PASS/FAIL TESTS page) but the disk does not contain any pass/fail test files.

Numeric value greater than maximum limit. You attempted to enter a numeric value larger than the maximum value.

Numeric value less than minimum limit. You attempted to enter a numeric value smaller than the minimum value.

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Operation invalid while a test is running. You tried to perform an action that cannot be completed while a test is running. For example, this message would appear if you attempted to recall instrument settings while a test is running.

Optical power has been overloaded. You have connected an optical signal that has saturated the CTS850 optical receiver.

Pointer burst active, request ignored. You pressed the POINTER ACTION button while a pointer burst movement was occurring.

Pointer movements disabled while in Through Mode. You pressed the POINTER ACTION button while the CTS850 was in Through Mode. Pointer movements are not allowed while the CTS850 is in Through Mode because the transmit signal must match the received signal.

Root directory is full. You tried to save a file to disk but the directory shows that the disk is full. Insert a disk with space available and save the file again.

Through Mode invalid while receiving a tributary signal. You attempted to change the transmit rate to Through Mode while a test was running at a tributary rate. Any change in settings would invalidate the test, so no change was made.

Unexpected End Of File, file not read. You tried to recall an instrument setup file, a pass/fail file, or a history file and a disk error occurred. The file is corrupted and cannot be recovered.

Warning: No received signal currently identified. You started a test while there was no received signal.

Write Failure on Disk. The CTS850 was unable to write to the disk. Try saving the file on a different disk.

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Appendix C: Default Factory Settings

Table C 1 lists the instrument settings after Default Factory Settings have been recalled.

CTS 850 SDH/PDH Test Set

Table C 1: Default Factory Settings

Parameter	Default Value
Transmit Rate	STM-1E
Transmit Clock	Internal
Transmit Level	6 dB
AU Under Test	1
Mapping	Bulk Fill No Mapping (Equipped)
Transmit Test Pattern	PRBS 2^23 1
Transmit Overhead Path Trace	This is a Tektronix CTS Test Set
Transmit Overhead External Add	None
Transmit Error Rate	None
Transmit Error Type	None
Transmit Alarm	None
Transmit Failure	None
Transmit Pointer/Timing Mode	Pointer Movements
Transmit Pointer Type	AU
Transmit Pointer Control	Single
Transmit Pointer Value	522
Transmit Pointer Set with New Data Flag	Yes
APS Mode	SPAN
Receive Rate	STM-1E

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Table C 1: Default Factory Settings (Cont.)

Parameter	Default Value
Receive Level	Cross Connect
Receive AU Under Test	1
Receive Mapping	No Mapping (Equipped)
Receive Tributary Drop	Off
Receive Test Pattern	PRBS 2^23 1
Test Duration	Continuous
Receive Path Overhead External Drop	None
Beeper	Off
Display Brightness	Medium, high
Printer Type	TEK DPU-411
Print User & Company	Off

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Appendix D: Specifications

The organization of this section is as follows:

- General Specifications (Table 1)
- Option 38 PDH (Table 2)
- Option 14 Jitter/Wander (Table 3)
- Environmental Specifications (Table 4)
- Physical Specifications (Table 5)
- Certifications and Compliances (Table 6)

CTS850 SDH/PDH Test Set

Table D 1: General CTS850 Specifications

Characteristic	Description
SDH Generator Output	
Electrical Output	
Data Rates	STM-0: 51.84 Mb/s STM-1: 155.52 Mb/s
Data Formats	STM-0E: B3ZS STM-1E: CMI
Signal Level at Transmit Output	STM-0E: ±1.0 Vpk ±10% into 75 STM-0E (6dB) STM 0E output attenuated with 6 dB cable loss (12.7 dB √f characteristic cable) STM-1E : ±0.5 Vpk ±10% into 75 STM-1E (6dB) STM 0E output attentuated with 6 dB cable loss (12.7 dB √f characteristic cable)
Pulse Shape at Transmit Output	Meets ITU-T G.703 Pulse Masks

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
Return Loss	>15 dB
Connectors	Unbalanced BNC, 75 to ground Option 12 1.6/5.6, 75 Ohm to ground
Optical Output	
Data Rates	STM-0: 51.84 Mb/s STM-1: 155.52 Mb/s STM-4: 622.08 Mb/s
Optical Module Options	Opt. 01, Electrical only, STM 0/1E Opt. 03, 1310 nm, IR, STM-0/1 Opt. 04, 1310 nm, IR, STM-0/1/4 Opt. 05, 1550 nm, LR, STM-0/1/4 Opt. 06, 1310/1550 nm, STM 0/1/4
Signal Level & Wavelength	10 dBm, typical, 1310 nm, (Opt. 03, 04, 06) 0 dBm, typical, 1550 nm, (Opt. 05, 06)
Pulse Shape	Meets ITU-T G.957 Eye Pattern Masks
Wavelength	1308 nm, typical (Opt. 03, 04, 06) 1550 nm, typical (Opt. 05, 06)
Spectral Width	≤ 4 nm rms, 1310 nm (Opt. 03, 04, 06) ≤ 1 nm rms, 1550 nm (Opt. 05, 06)
Laser Classification	Class 1 laser, complies with 21 CFR 1040.10 and 1040.11, complies with IEC 825, Section 9.4
Connectors	User selectable when ordering Opt. 31: FC PC; Opt. 32: ST; Opt. 33: SC; Opt. 34: DIN. Other connector types consult factory
SDH Signal Structure	
Payload Channel (AU)	Concatenated VC4 4c signal in STM 4 One active AU 4 in STM-1 One active AU 4 in STM 4 (The other 3 channels are unequipped) One active AU 3 in STM-0
Unequipped Payload	C2 byte is set to 00 Bulk fill set to 00

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
SDH Internal Pattern Generator	
Patterns Bulk Fill in a selected AU channel (AU 3 or AU 4)	PRBS: 2^9 1, 2^{15} 1, 2^{20} 1, 2^{23} 1; All 1s, All 0s, 8-bit programmable word. PRBS patterns may be inverted *Overhead Test Patterns* RSOH Orderwire E1 RSOH User Byte F1 MSOH Orderwire E2 POH User Byte F2 D1 D3 DCC D4 D12 DCC PRBS: 2^{15} 1, 2^{20} 1, 2^{23} 1. PRBS patterns may be inverted.
Error Type and Insert Rates Single or Continuous rate	RS BIP B1 STM0: 1.0e 3 to 1.0e 10 STM1: 1.0e 4 to 1.0e 10 STM4: 1.0e 5 to 1.0e 10 MS BIP B2 STM0: 1.0e 3 to 1.0e 10 STM1/4: 1.0e 4 to 1.0e 10 Path BIP B3 STM0: 1.0e 3 to 1.0e 10 STM1/4: 1.0e 4 to 1.0e 10 HP REI G1 STM0: 1.0e 3 to 1.0e 10 STM1/4: 1.0e 4 to 1.0e 10 Payload (Pattern Bit Error) 1.0e 3 to 1.0e 10
Defects	LOS, LOF, LSS (Pattern Loss), RS TIM, MS AIS, MS RDI, AU LOP, AU AIS, HP RDI, HP TIM, HP PLM, HP UNEQ2, LP RDI, LP RFI, LP TIM, LP UNEQ, LP PLM, TU AIS

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
SDH Transmitter Clock	
Internal Clock	
Accuracy	±4.6 ppm, for instrument calibrated within 36 months
External Clock Reference	
Rates	2.048 Mb/s ± 50 ppm 2.048 MHz ± 50 ppm 1.544 Mb/s ± 50 ppm
Input	Unbalanced, 75 , BNC connector, G.703 signal format
Recovered Clock	
Loop timing	Clock is recovered from received signal
Transmit Line Frequency Offset rate	±100 ppm of nominal line rate, resolution 0.1 ppm
SDH Receiver Input	
Electrical Input	
Data Rates	STM-0: 51.84 Mb/s ±100 ppm STM-1: 155.52 Mb/s ±100 ppm
Data Formats	STM-0E: B3ZS STM-1E: CMI

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
Signal Sensitivity/Equalization	STM-0E: 0.5 Vpk min to 1.2 Vpk max STM-0E 6 dB[1]: 0.25 Vpk min to 0.6 Vpk max STM-0E 12dB[2]: 0.125 Vpk min to 0.35 Vpk max STM-0E Monitor: 20 dB of flat loss below 6 dB STM-1E: 0.35 Vpk min to 0.6 Vpk max STM-1E 6 dB[3]: 0.35 Vpk min to 0.6 Vpk max STM-1E 12dB[4]: 0.07 Vpk min to 0.3 Vpk max STM-1E Monitor: 26 dB of flat loss below STM 1E level
Signal Level Display	Readout for: Electrical signal level in mV
Return Loss	>15 dB
Connectors	Unbalanced BNC, 75 to ground Option 12 1.6//5.6, 75 Ohm to ground
SDH Optical Input	
Data Rates	STM-0: 51.84 Mb/s (±100 ppm) STM-1: 155.52 Mb/s (±100 ppm) STM-4: 622.08 Mb/s (±100 ppm)
Maximum Input Power	7 dBm: Opt. 05 and 06 include a 10 dB attenuator for use at 1550 nm
Operating Wavelength	1310 nm and 1550 nm: 1100 nm to 1570 nm operating range
Signal Sensitivity	28 dBm for BER ≤10^{10}
Optical Power Meter Accuracy	±2 dBm, typical: For input power in a range of 30 dBm to 6 dBm

1 **6 dB cable loss @ 25 MHz (12.7 dB √f characteristic cable)**

2 **12 dB cable loss @ 25 MHz (12.7 dB √f characteristic cable)**

3 **6 dB cable loss @ 78 MHz (12.7 dB √f characteristic cable)**

4 **12 dB cable loss @ 78 MHz (12.7 dB √f characteristic cable)**

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
Connectors	User selectable when ordering Opt. 31: FC PC; Opt. 32: ST; Opt.33: SC; Opt. 34: DIN. Other connector types consult factory.
Through Mode	Monitors a selected channel while passing the signal through unchanged (both electrical and optical)
Section Overhead	
Access	Set overhead bytes to any value from binary 00000000 to 11111111: A1, A2, J0, E1, F1, D1 D3, K1, K2, D4 D12, S1, M1, E2 View all Section Overhead bytes Clear text decode of S1 message byte provided per G.707
Add/Drop	Orderwire Access to E1 byte from RJ 11 jack. Insert data from the Overhead Add/Drop connector into the Section DCC, Line DCC, E1, E2 or F1 user byte. Drops data from the Section DCC, Line DCC, E1, E2, or F1 user byte out to the Overhead Add/Drop connector. PRBS evalution is provided internally for bytes E1, E2, F1, F2, D1 D3, D4 D12.
K1 and K2 (APS)	Set the APS Bytes, K1 and K2, to any code defined in ITU G.783 Annex A and G.841. Selectable by clear text for all Span and Ring messages
Path Overhead	
Access	Set Path Overhead bytes to any value from binary 00000000 to 11111111: C2, G1 (bits 5 7 only), F2, H4 (bits 1 6 only), F3, K3, N1 View all Path Overhead bytes Clear text decode of C2 signal label per ITU G.707

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
Add/Drop	Insert data from the Overhead Add/Drop connector into the F2 user byte PRBS can be used via F2 internally
Trace Bytes J1, J0	J1 HP Trace VC4 Overhead User defined 15 byte with CRC, 64 byte formats per ITU T G.707 J0 RS Trace User defined 15 byte with CRC per ITU T G.707
Pointer Control	
Single	Single pointer justification
Burst	Bursts of two to eight pointer justifications spaced four frames apart. All adjustments within a given burst are in the same direction. Subsequent bursts are in alternating directions
Continuous	Pointer justifications occur continuously at a predetermined rate in an incrementing, decrementing, or alternating direction. Rate between movements: 2 ms to 10 s, with a resolution of 1 ms.
Set to Value	Set to a new location with or without the NDF being set. Range is 0 to 1023 (783 1023 are illegal locations).

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
Pointer Test Sequences AU Pointer sequences available	G.783(a) Single Alternating G.783(b) Regular + Double G.783(c) Regular + Missing G.783(d) Double Alternating G.783(e) Single G.783(f) Burst G.783(g1) Periodic 87 3 G.783(g2) Periodic 87 3 With Add G.783(g3) Periodic 87 3 With Cancel G.783(h1) Periodic G.783(h2) Periodic with Add G.783(h3) Periodic with Cancel Phase Transient Pointer Adjustment Burst
Pointer Direction	Positive or Negative
Initialization Period	On or Off Thirty second burst of 1 pointer per second in the same direction as the selected test, per ITU T G.783
Cool Down Period	On or Off This will last at least 60 seconds, for an integral number of complete sequences, per ITU T G.783.
Combined Jitter	Simultaneous PDH mapping frequency offset with ITU t G.783 Pointer Sequences generation. To enable the measurement of combined mapping and pointer jitter. The range specification for this function is restricted to +/ 50 ppm if the Transmitter is using recovered clock for its reference and Pointer with Mapping Offset" is selected.
SDH Measurements	
SDH Anomalies Error Count, Error Rate, and Errored Seconds for:	B1, B2, B3, Payload, MS-REI, HP-REI, LP REI
Network Defects (Seconds)	LOS, LSS (Pattern Loss), CTS Loss of AC Power
SDH Defects (Seconds)	MS AIS, MS RDI, AU AIS, HP RDI, AU LOP, RS TIM, HP TIM, HP UNEQ, HP PLM, LP RDI, LP RFI, LP TIM, LP UNEQ, LP PLM, TU AIS

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
AU Pointer Measurements	NDF Sec., Illegal Sec., +Ve Just. Count, VE Just. Count, Illegal Count, NDF Count, Pointer Value
G.826 Performance Analysis	
RS B1, MS B2, Path B3, AU LOP, AU AIS, HP REI, HP TIM, HP PLM, HP UNEQ, LP REI, LP TIM, LP UNEQ, TU LOP, TU AIS Seconds and ratio	Errored Blocks, ES, %ES, SES, %SES, UAS, %UAS, CSES Periods, Background Block Errors, %Background Block Error, Path UAS, %Path UAS
G.826 Performance Analysis	
Performance analysis performed as per user settable allocation percentage for SDH and PDH.	Regeneration Section, Multiplex Section, high and low order path layers are individually evaluated. Analysis results: Pass or Fail
G.821 Performance Analysis	
Pattern Bit Seconds and % of total time	Error-Count, ES, DM, SES, UAS, EFS
M.2101.1 Error Analysis	
B1, B2, B2, TU BIP, RS TIM, MS REI, MS RDI, MS AIS, AU AIS, AU LOP, HP REI, HP TIM, HP UNEQ, HP PLM, HP RDI, LP REI, LP TIM, LP UNEQ, LP PLM, LP RDI, LOS, OOF, TU LOM, TU AIS, TU LOP	Errored blocks, ES, %ES, SES, %SES, CSES, UAS, %UAS, Background Block Errors, %Background Block Errors, Path UAS, %Path UAS
M.2101.1 Performance Analysis	
Test Types: BIS (Bring in Service); PAR (Performance After Repair); MAINT (Maintenance); Custom (User controls performance limits)	Automated test types allow Performance Analysis for Regeneration Section, Multiplex Section, high and low order path layers based on user settable allocation percentage. Custom test type allows user to select the performance objective limits. Analysis Results: Acceptable, Provisional/Degraded or Unacceptable.

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
SDH Standards Compliance	
SDH Framing	G.707
SDH Multiplexing	G.707
SDH Optical Interfaces	G.957
SDH Electrical Interfaces	G.703
SDH Jitter Tolerance	G.825 & G.958
SDH Pointer Sequences	G.783
MSP/APS Message	G.841, G.783
SDH Error Analysis	G.826, G.821
SDH Performance Analysis	M.2101.1
SDH Test Patterns	O.181, O.150, O.151
SDH Availability Performance	G.827
LEDs	
SDH Status Indicators	LOS, LOF, OOF, LOP, MS AIS, MS RDI, AU AIS, HP RDI, Signal Present, Pattern Lock, LSS, Error, Pointer Adj
SDH Histograms	
Error Count (General)	B1, B2, B3, MS-REI, HP-REI, Pattern Bit, Pointer Jitter
Defects On/Off	LOS, OOF, LOF, AU-LOP, MS-AIS, HP-RDI, AU-AIS, Pattern Loss, Loss of Power
Pointers	AU Pointer Value, Pointer Justification
Measurement Utilities	
Measurement Control	Manual Start/Stop Timed: 1 s to 99 days with 1 s resolution Continuous

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
Histogram Display Resolution	High: 1 sec (displays 2 hours with 1 sec resolution) Normal: 1 min, 5 min, 15 min, 1 hour (displays 5 days with 1 min resolution) Low: 15 min, 60 min, 4 hrs, 12 hrs (displays 75 days with 15 min resolution)
Result Logging	All measurements are recorded with start, stop time and date. Current results (totalized and graphical) are stored in memory. Both graphical and totalized results can be stored on disk.
LEDs	
PDH and TU Status Indicators	TU AIS, LP RDI, PDH AIS, PDH RAI
Histograms for PDH & TU	
Error Count (General)	E1 Anomalies, TU BIP, LP-REI, Pattern Bit, Pointer Jitter
PDH & TU Defects On/Off	LOS, LOF, PDH AIS, PDH RAI, TU-LOP, TU-AIS, LP-RDI, TU LOM, Pattern Loss, Loss of Power
TU Pointers	TU Pointer Value, Pointer Justification
Histograms for Jitter/Wander	Jitter (UIpp), Frequency Drift Rate (ppm/sec)
Utilities	
TroubleScan	Scans all measurement results for key violations
AutoScan	AutoScan to incoming signal (rate, mapping, framing and pattern). Identifies incoming signal and presents graphical display of AU and TU structure, and PDH mux structure. Identifies TU signal status by showing TU number, equipped vs unequipped, alarms, and pattern.
Stored Setups	5 front panel setups in memory 200 front panel setups per disk

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Table D 1: General CTS850 Specifications (Cont.)

Characteristic	Description
Pass/Fail Tests	Predefined Pass/Fail Tests can be created, stored and executed Pass/Fail tests are stored on disk 200 Pass/Fail test setups per disk
Add/Drop Interface for Data Communication Channels and User Channels	A DB-37 female connector provides the interface to an external protocol analyzer. Clock and data signals are differential TTL, conform to RS-422 specifications, and are also compatible with single-ended TTL signals. Add/Drop: D1 D3, D4 D12, F1, F2, E1, E2 Connector: 37 Pin DIN (DTE and DCE) RJ11 style handset jack for analog access to E1/E2 bytes
Triggering	Pulse at start of each frame, (Tx and Rx), Connector: 37 Pin DIN
Error output	B1, B2, B3 bit error selectable
Disk Drive	3.5 inch, 1.44 MB, DOS compatible Measurement Results stored in ASCII Stored Setups and Pass/Fail Tests
Printer	Optional printer DPU 414 (DMAPRN) Printer support: Epson, HP Thinkjet, ASCII text Serial Printer Port: V.24 Print to disk: BMP format, Interleaf format, Encapsulated PostScript, ASCII text
Computer Interface	IEEE-488.2 interface RS-232-C interface (DB9)
Help Mode	Online task-oriented help
Display	7 inch diagonal CRT, green phosphor Resolution: 640 by 480 pixels VGA output: 15 pin connector

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications

Characteristic	Description
2 Mb/s, 8 Mb/s, 34 Mb/s, 140 Mb/s Generator	
Option 38 2 Mb/s, 8 Mb/s, 34 Mb/s, 140 Mb/s Tributaries	
Option 55 45 Mb/s map/demap capability only	
The data format can be built upon the pattern generator framed or unframed output at the PDH line/mapping rate, or upon multiple layers of user configurable sub multiplexing. A specific hierarchy or tributaries can be selected and filled with a background pattern.	
Electrical Output	
Data Rates	2 Mb/s (2.048 Mb/s) 8 Mb/s (8.448 Mb/s) 34 Mb/s (34.368 Mb/s) 45 Mb/s (44.736 Mb/s) 140 Mb/s (139.264 Mb/s)
Formats	2 Mb/s, 8 Mb/s, 34 Mb/s: HDB3, AMI 45 Mb/s: HDB3, B3ZS 140 Mb/s: CMI
Signal Level	2 Mb/s: 3 Vpk ±0.3 V into 120 (balanced) 2 Mb/s: 2.37 Vpk ±0.237 V into 75 8 Mb/s: 2.37 Vpk ±0.1 V into 75 34 Mb/s: 1 Vpk ±0.1 V into 75 45 Mb/s DS3 High: 0.9 Vpk ±0.2 V into 75 45 Mb/s DSX: 0.36 Vpk to 0.85 Vpk into 75 140 Mb/s: 1 Vpk pk ±0.1 V into 75
Pulse Shape	Meets ITU-T G.703 Pulse Masks
Connectors	2 Mb/s: 3 pin Siemens 120 2 Mb/s, 8 Mb/s, 34 Mb/s, 45 Mb/s, 140 Mb/s: BNC 75 Option 12: 1.6/5.6 75 Ohm

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
PDH Output Data Source	2 Mb/s: 2 Mb/s Internal Generator Configured from N x 64kbit/s Drop from SDH TU12 Drop from demuxed 8 Mb/s and above From 2 Mb/s input (through mode) 8 Mb/s: Internal Pattern Generator Muxed up from 2 Mb/s From 8 Mb/s input (through mode) 34 Mb/s: Internal Pattern Generator Muxed up from 8 Mb/s Drop from SDH TU3 Drop from demuxed 140 Mb/s From 34 Mb/s input (through mode) 45 Mb/s: Internal Pattern Generator Drop from SDH TU3 From 45 Mb/s input (through mode) 140 Mb/s: Internal Pattern Generator Muxed up from 34 Mb/s Drop from SDH VC4 From 140 Mb/s input (thorugh mode)
2 Mb/s, 8 Mb/s, 34 Mb/s, 140 Mb/s Internal Pattern Generator	
Framing	2 Mb/s: Unframed N x 64kbits/s (with starting TS, range) FAS (31 channel) FAS + CRC4 (31 channel) FAS + MFAS (30 channel) FAS + CRC4 + MFAS (30 channel) (G.704, G.737, G.732) 8 Mb/s: Unframed FAS (G.742) 34 Mb/s: Unframed FAS (G.751) 45 Mb/s: Unframed M13 (bulk filled) C bit Parity (bulk filled) 140 Mb/s: Unframed FAS (G.751)

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
Patterns (for PDH Testing Line/Mapped)	Active Channel Patterns in selected measurement channels. N x 64 Kb/s PRBS 2^9 1per O.153 PRBS 2^{11} 1per O.152 PRBS 2^{15} 1per O.151 PRBS 2^{20} 1per O.153 PRBS 2^{23} 1;per O.151 All the above may be inverted All 1s All 0s TS Idle 1020 Hz audio tone 2,8,34,45,140 Mb/s PRBS 2^9 1per O.153 PRBS 2^{11} 1per O.152 PRBS 2^{15} 1per O.151 PRBS 2^{20} 1per O.153 PRBS 2^{23} 1;per O.151 All the above may be inverted All 1s All 0s Alternating 1/0 1 in 8 8, 16, 24 bit User selectable pattern Fill Patterns in background non measurement channels. N x 64 Kbit/s TS Idle (55 H) 2 Mb/s PRBS 2E15 1 All 1s All 0s Alternating 1/0 8,34,45,140 Mb/s PRBS 2^{15} 1per O.151 PRBS 2^{20} 1per O.153 PRBS 2^{23} 1;per O.151 All the above may be inverted All 1s All 0s Alternating 1/0

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
Errors	Single, Continuous, Burst (all are mutually exclusive and effective on active channels only)
Error Type	CRC (2 Mb/s only) min. 1.0E 8, max 1.0E 4 Parity Bit Error (45 Mb/s only) P bit (M13, C bit); CP bit (C bit); REI (C bit) Frame Burst (available on any ONE enabled multiplexed level) (2,8,34,45,140 Mb/s) N<M<1000 M=frame count N= consecutive FAS Error count *Pattern Bit* first line is Payload Pattern bit at active pattern's rate; Second line is *Line Code* 64 kb/s, min. 1.0E 6, max 1.0E 2, *Line Code: not applicable* 2 Mb/s, min. 1.0E 8, max. 1.5E 2 *Line Code: min. 1.0E 8, max. 1.0E 3* 8 Mb/s, min. 1.0E 9, max. 1.0E 2 *Line Code:* min. 1.0E 10, max. 1.0E 3 34 Mb/s, min. 1.0E 9, max. 1.5E 2 *Line Code:* min. 1.0E 10, max. 1.0E 3 45 Mb/s, min. 1.0E 9, max. 1.5E 2 *Line Code:* min. 1.0E 10, max. 1.0E 3 140 Mb/s, min. 1.0E 9, max. 1.5E 2 *Line Code: not applicable*
Alarm Insertion	2 Mb/s: AIS, RAI NFAS bit 3=1 8 Mb/s: AIS, RAI NFAS bit 11=1 34 Mb/s: AIS, RAI NFAS bit 11=1 45 Mb/s: AIS, RAI NFAS bit 11=1 140 Mb/s: AIS, RAI NFAS bit 13=1
TU12/TU3/VC4 Mapping	
Mapping Signal Source for TU12, , and VC4	Internal Generator: / Received Signal: 2 Mb/s / 2 Mb/s 34 Mb/s / 2, 34 Mb/s 45 Mb/s / 45 Mb/s 140 Mb/s / 2, 34, 140 Mb/s
Mapping mode	Floating Asynchronous per G.707

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
TU12 Active Map Channel Selection	Allows selection of any one or all of 63 TU channels, or all TU 12s simultaneously Remaining 62 TU channels are background
TU3 Active Map Channel Selection	Allows selection of any one or all of 3 TU channels, or all TU 3s simultaneously Remaining 2 TU channels are background
140 Mb/s Active Map Channel Selection	Into selected STM-1 VC4
TU12 Background Channels	
TU Background Channel Content	When internal 2 Mb/s or 34 Mb/s generator is used: PRBS: 2^{15} 1 or Idle pattern (11010101) when external source is used: PRBS: 2^{15} 1
TU Background Channel Framing	All unframed unless All TUs
TU3 Background Channels	
TU Background Channel Content	When internal 34 Mb/s generator is used: VC3 is a Bulk filled pattern, Valid Pointer and BIP Bulk fill data is 01, 02, and 03 for TU3 #1, #2, and #3.
TU Errors (Single or Continuous)	TU12 BIP 2 TU3 BIP 8 LP REI
TU Defects	TU AIS LP RDI TU Loss of Pointer LP UNEQ TU Loss of Multiframe LP PLM LP RFI LP TIM
PDH Transmitter Clock	
Transmit Line Frequency Offset	±100 ppm of nominal line rate. Resolution, 0.1 ppm
2 Mb/s, 8 Mb/s, 34 Mb/s, 140 Mb/s Receiver	
Electrical Input	
Data Rates	2 Mb/s (2.048 Mb/s) ±150 ppm 8 Mbit/s ±150 ppm 34 Mb/s (34.368 Mb/s) ±150 ppm 45 Mb/s (44.736 Mb/s) ±150 ppm 140 Mb/s (139.264 Mb/s) ±150 ppm

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
Formats	2, 8, 34 Mb/s: HDB3, AMI 45 Mb/s: HDB3, B3ZS 140 Mb/s: CMI
Impedance	2 Mb/s: 120 balanced 2 Mb/s Bridged: 1 k balanced 2, 8, 34, 45, 140 Mb/s: 75 unbalanced
PDH Receive Signal Level	ITU TG.703 nominal pulse and signal level Normal: Auto equalization of root fcable loss to ITU TG.703 limits * 2 Mb/s Bridged: Auto equalization of root fcable loss to ITU TG.703 limits ** Protected Monitor Point 20dB: 15to 23dB flat loss Protected Monitor Point 30dB: 23to 31dB flat loss * 2 Mb/s & 8 Mb/s root fcable loss = 6 dB max * 34 Mb/s & 140 Mb/s root fcable loss= 12 dB max ** 2 Mb/s Bridged only specified for 120 Ohm balanced cable
Connectors	2 Mb/s: 3 pin Siemens 120 2 Mb/s, 8 Mb/s, 34 Mb/s, 45 Mb/s, 140 Mb/s: BNC 75
2 Mb/s, 8 Mb/s, 34 Mb/s 140 Mb/s Internal Pattern Receiver	
Pattern Receiver Source	N/Mx64 kbit/s & 2 Mb/s: 2 Mb/s External Drop from SDH TU12 Demuxed 8 Mb/s and above 8 Mb/s: 8 Mb/s External Demuxed 34 Mb/s 34 Mb/s: 34 Mb/s Internal Demuxed 140 Mb/s 45 Mb/s: 45 Mb/s External SDH TU3 Drop 140 Mb/s: 140 Mb/s External SDH VC4 Drop

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
Framing	N/Mx64kbit/s & 2 Mb/s: Unframed FAS (31 channel) FAS + CRC4 (31 channel) FAS + MFAS (30 channel) FAS + CRC4 + MFAS (30 channel) (G.704, G.737, G.732) 8 Mb/s: Unframed FAS (G.742) 34 Mb/s: Unframed FAS (G.751) 45 Mb/s: Unframed FAS (G.742) 140 Mb/s: Unframed FAS (G.751) CAS (Signalling in TS 16) Bits displayed: a,b,c,d VFchan. 1 to 30 Value displayed: 1 or 0
TU12/TU3/VC4 Demapping	
Demapping TU12, TU3 and VC4 Signal Drop to	Internal Receiver: / External Signal Output 2 Mb/s / 2 Mb/s 34 Mb/s / 34 Mb/s 45 Mb/s / 45 Mb/s 140 Mb/s / 140 Mb/s
Demapping mode	Floating Asynchronous
TU12 Active Demap Channel Selection	Allows selection of any one of 63 TU channels
TU3 Active Demap Channel Selection	Allows selection of any one of 3 TU channels
140 Mb/s Active Demap Channel from	Selected STM-1 VC4

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
TU Path Overhead	
TU12 Path Overhead Access, bits 5 7 only	V5 control (xxxx) Set Path Overhead bytes to any value from binary 00000000 to 11111111: N2 and K4 View all TU Path Overhead bytes
TU3 Path Overhead Access	Set Path Overhead bytes to any value from binary 00000000 to 11111111: (set G1 bits 5 7 only) C2, F3, K3, N1 (H4 bits 1 6 only) View all TU Path Overhead bytes
TU3 Path Trace Byte J1	Send user-defined 15 bytes & CRC sequence or set to all “space” characters View Path Trace J1
TU12 Path Trace Byte J2	Send user-defined 15-byte & CRC sequence, or set to 00000000 (Null) View Path Trace J2
TU Pointer Measurement	
TU Pointer Interaction	TU12, TU3, or AU4, but not at the same time
Single	Single pointer justification (increment or decrement)
Burst	Bursts of two to eight pointer justifications spaced four multi-frames apart. All adjustments within a given burst are in the same direction. Subsequent bursts are in alternating directions.
Continuous	Pointer justifications occur continuously at a predetermined rate in an incrementing, decrementing, or alternating direction. Rate between movements: 48 ms to 10 s, with a resolution of 1 ms.
Set to Value	Set to a new location with or without the NDF being set. TU12 Range is from 0 to 1023 (140 1023 are illegal locations). TU3 Range is from 0 to 1023 (783 1023 are illegal locations).

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
TU Pointer sequences available	G.783(a) Single Alternating G.783(b) Regular + Double G.783(c) Regular + Missing G.783(d) Double Alternating G.783(e) Single G.783(f) Burst G.783(g1) Periodic 87 3 G.783(g2) Periodic 87 3 With Add G.783(g3) Periodic 87 3 With Cancel G.783(h1) Periodic G.783(h2) Periodic with Add G.783(h3) Periodic with Cancel Phase Transient Pointer Adjustment Burst TU-3 Periodic 85 5 TU-3 Periodic 85 5 With Add TU-3 Periodic 85 5 With Cancel TU-12 Periodic 35 1 TU-12 Periodic 35 1 With Add TU-12 Periodic 35 1 With Cancel
Pointer Direction	Positive or Negative
Initialization Period	On or Off Thirty second burst of 1 pointer per second in the same direction as the selected test, per ITU T G.783
Cool Down Period	On or Off This will last at least 60 seconds, for an integratl number of complete sequences, per ITU T G.783
PDH & TU Measurements	
PDH Error Count, Error Rate and Error seconds for	FAS; CRC-4 (2 Mb/s only); Pattern Bit; Code Violation; 45 Mb/s Frame Bit Error; 45 Mb/s REI
TU Error Count, Error Rate and Error seconds for	TU12 BIP 2 TU3 BIP-8 TU12 REI TU3 REI
PDH Defect Seconds for	AIS; RDI; Loss of Sync Sequence (LSS); Loss of Frame (FAS); Loss of Signal

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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
TU Defect Seconds for	TU AIS LP RDI LP RFI LP PLM TU Loss of Pointer TU Loss of Multiframe LP TIM LP UNEQ
TU Pointer Measurements	Seconds: LOP Illegal pointers NDF Count: Illegal pointers Positive justifications Negative justifications
G.826 Performance Analysis for TUs	
TU12 BIP-2 & REI Seconds and ratio	Errored Blocks, ES, %ES, SES, %SES, UAS, %UAS, CSES Periods, Background Block Errors, %Background Block Errors, Path UAS, %Path UAS, Verdict Analysis
TU3 BIP-8 & REI Seconds and ratio	Errored Blocks, ES, %ES, SES, %SES, UAS, %UAS, CSES Periods, Background Block Errors, %Background Block Errors, Path UAS, %Path UAS, Verdict Analysis
G.821 Performance Analysis for PDH	
PDH Frame & CRC-4 Errors, Seconds, and % of total time	Errored Blocks, ES, %ES, SES, %SES, UAS, %UAS, CSES Periods, Background Block Errors, %Background Block Errors, Path UAS, %Path UAS, Verdict Analysis
Payload (Pattern Bit Errors), Seconds and % of total time	Error-Count, ES, SES, UAS, EFS, DM
M.2100 Analysis for PDH	
In Service Seconds and % of total time	Error-Count, ES, SES, UAS, EFS
Out of Service Seconds and % of total time	Error-Count, ES, SES, UAS, EFS

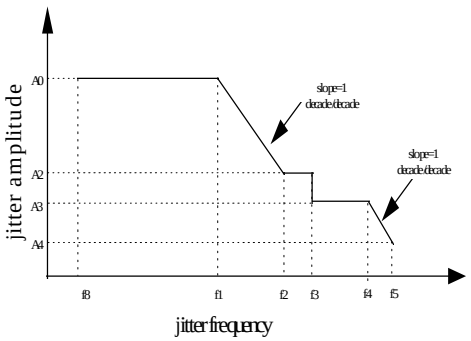
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Table D 2: CTS 850 Opt. 38 PDH Tributaries Specifications (Cont.)

Characteristic	Description
G.826 Analysis for PDH	
Near End & Far End In Service Seconds for selected rate (within channel(s) under test at all enabled MUX levels)	Errored Blocks, ES, %ES, SES, %SES, UAS, %UAS, CSES Periods, Background Block Errors, %Background Block Errors, Path UAS, %Path UAS
For remote selected rate (within channel(s) under test at all enabled MUX levels)	Errored Blocks, ES, %ES, SES, %SES, UAS, %UAS, CSES Periods, Background Block Errors, %Background Block Errors, Path UAS, %Path UAS
PDH Standards Compliance	
PDH Mapping/Demapping	G.707
PDH Line Interfaces	G.703
PDH Jitter Tolerance	G.823, G.824
PDH Error Analysis	G.821, G.826, M.2100
PDH Availability Performance	G.827
PRBS Test Patterns	O.151, O.152, O.153
Monitor Mode Levels	G.772
PDH Framing	G.704, G.727, G.732, G.742, G.751

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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications

Characteristic	Description
Jitter Generator (requires Option 14) Meets or exceeds the requirements of ITU TG.823, G.824, G.825, O.171. Confirms to new O.172	
Jittered Line Output	Sinusoidal modulation of transmit clock frequency, applicable to any SDH or PDH data rate, except 8 Mbit/s. Jitter is additional to any line frequency offset.
Modulation Range Modulation is selectable up to the following limits, which depend on the rate:	

Amplitude Scale in UI_{p-p}	A_0	$A2$	A_3	A_4
2 Mb/s rate	100000UI	10.0UI	3.0UI	1.00UI
34 Mb/s rate	100000UI	10.0UI	3.0UI	1.00UI
45 Mb/s	100000UI	10.0UI	3.00UI	1.00UI
140 Mb/s rate	100000UI	10.0UI	3.0UI	1.00UI
STM 0 (52 Mb/s rate)	100000UI*	10.0UI	3.0UI	1.00UI
STM 1 (155 Mb/s rate)	100000UI*	10.0UI	3.0UI	1.00UI
STM 4 (622 Mb/s rate)	100000UI*	10.0UI	3.0UI	1.00UI

* when equipped with bulk fill payload

Frequency Scale in Hz	f_0	f_1	f_2	f_3	f_4	f_5
2 Mb/s rate	12 Hz	30mHz	300Hz	9kHz	33.3kHz	100kHz
34 Mb/s rate	12 Hz	30mHz	300Hz	10kHz	267kHz	800K
45 Mb/s	12 Hz	30mHz	300Hz	16.7kHz	133kHz	400K
140 Mb/s rate	12 Hz	30mHz	300Hz	20kHz	1.17M	3.5M
STM 0 (52 Mb/s rate)	12 Hz	30mHz	300Hz	10kHz	133kHz	400K
STM 1 (155 Mb/s rate)	12 Hz	30mHz	300Hz	35kHz	433kHz	1.3M
STM 4 (622 Mb/s rate)	12 Hz	30mHz	300Hz	125kHz	1.67M	5.0M

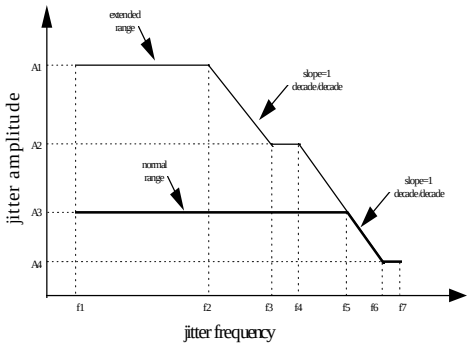
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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications (Cont.)

Characteristic	Description
Amplitude Accuracy	± 5% ± 0.06 UI at 622 Mb/s rate Line Output ± 5% ± 0.04 UI at 622 Mb/s rate Clock Output ± 5% ± 0.03 UI for all other rates. Line or Clock Output
Amplitude Resolution	0.01 UI
Frequency Accuracy	± 1% below 1.00 KHz ± 5 ppm, above 1.00 KHz
Frequency Resolution	3 decimal places
Jittered Clock Output	Operates in addition to the jittered line output.
Output Level, typical	0.8 V_{p-p} output (for all rates) is AC coupled and terminated with unbalanced 75 2 MHz G.703 output is compliant with G.703 2048 kHz synchronization interface specifications
Nominal Clock Rates	2 MHz, 34 MHz, 45 MHz, 140 MHz, 52 MHz, 155 MHz, or 622 MHz. Can be set independently of transmit line rate
Connector	Rear-panel, unbalanced 75 BNC
Jitter and Wander Analysis for SDH/PDH	Peak-to-peak or RMS jitter measurement of the Clock or Line input. Meets or exceeds the requirements of ITU-T G.783, G.823, G.824, G.825, G.958, O.171. Confirms to new O.172.
Jitter Measurements	Peak-to-peak Jitter (UI), Positive Peak Jitter (UI), Negative Peak Jitter (UI), Jitter Hit Seconds, Jitter Unlocked Seconds, RMS (UI)
Timing Quality (Video Related Jitter/Wander Hit Measurements	Pointer Event Seconds, Current Frequency Drift Rate (ppm/sec), Maximum Frequency Drift Rate (ppm/sec), Current Frequency, Maximum Frequency, Minimum Frequency

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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications (Cont.)

Characteristic	Description
Normal and Extended Jitter Measurement Resolution and Range Normal Resolution: 0.005UI. Resolution is 0.1UI for Fullband (0.1 Hz Highpass). Resolution for RMS is 0.001 UIrms Extended Resolution: 0.01 UI, except fullband 0.1 Hz, 0.1 UI Range: See graph	

Amplitude Scale in UI_{p-p}

A_1	A_2	A_3	A_4
200UI	10UI	6 UI	see below

Frequency Scale in Hz

	f_1	f_2	f_3	f_4	f_5	f_6
2 Mb/s rate	0.1Hz	15Hz	300Hz	1.9K	3.2K	38.4K
34 Mb/s rate	0.1Hz	15Hz	300Hz	8K	13.3K	160K
45 Mb/s rate	0.1Hz	15Hz	300Hz	16K	26.7K	320K
140 Mb/s rate	0.1Hz	15Hz	300Hz	16K	26.7K	320K
52 Mb/s rate	0.1Hz	15Hz	300Hz	16K	26.7K	320K
155 Mb/s rate	0.1Hz	15Hz	300Hz	16K	26.7K	320K
622 Mb/s rate	0.1Hz	15Hz	300Hz	40K	68K	1.33M

	f_7	A_4
2 Mb/s rate	100K	0.5UI
34 Mb/s rate	800K	0.5UI
45 Mb/s rate	400K	0.5UI
140 Mb/s rate	3.5M	0.5UI
52 Mb/s rate	400K	0.4UI
155 Mb/s rate	1.3M	0.3UI
622 Mb/s rate	5.0M	0.5UI

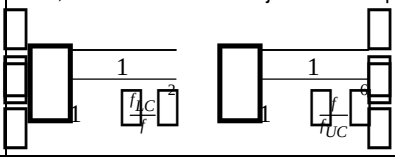
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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications (Cont.)

Characteristic	Description				
Fixed Error Noise with Clock, typical	For peak to peakmeasurement, in UIp p				
	Highband	*Wideband*	*Fullband (10Hz)*	*Full (1Hz)*	*Full (0.1Hz)*
2 Mb/s rate	± 0.01	± 0.15	± 0.1	± 0.2	± 0.3
34 Mb/s rate	± 0.02	± 0.03	± 0.1	± 0.2	± 0.3
45 Mb/s rate	± 0.02	± 0.03	± 0.1	± 0.2	± 0.3
140 Mb/s rate	± 0.04	± 0.05	± 0.1	± 0.2	± 0.3
52 Mb/s rate	± 0.02	± 0.03	± 0.1	± 0.2	± 0.3
155 Mb/s rate	± 0.02	± 0.03	± 0.1	± 0.2	± 0.3
622 Mb/s rate	± 0.03	± 0.05	± 0.7	± 0.7	± 1.0
	For extended range, fixed error shall be less than or equal to 0.1 UI, plus the value listed above. For RMS measurements, ± 0.01 UIrms at all rates				
Fixed Error with PRBS Data Signal, typical	For peak to peakmeasurement, in UIp p				
	Highband	*Wideband*	*Fullband (10Hz)*	*Full (1Hz)*	*Full (0.1Hz)*
2 Mb/s rate	± 0.025	± 0.035	± 0.1	± 0.2	± 0.3
34 Mb/s rate	± 0.025	± 0.035	± 0.1	± 0.2	± 0.3
45 Mb/s rate	± 0.025	± 0.035	± 0.1	± 0.2	± 0.3
140 Mb/s rate	± 0.025	± 0.035	± 0.1	± 0.2	± 0.3
52 Mb/s rate	± 0.025	± 0.035	± 0.1	± 0.2	± 0.3
155 Mb/s rate	± 0.025	± 0.035	± 0.1	± 0.2	± 0.3
622 Mb/s rate	± 0.050	± 0.070	± 0.75	± 0.7	± 1.0
	* For extended range, fixed error shall be less than or equal to 0.1 UI, plus the value listed above. For RMS measurements fixed error, ± 0.01 UIrms at all rates				

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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications (Cont.)

Characteristic	Description
Jitter Measurement Accuracy	Jitter measurement accuracy is a function of the modulation frequency and the highpass filter chosen. Measured jitter frequency response is expressed by the equation below, where f_{LC} is lower cutoff frequency and f_{UC} is high frequency cutoff (defined in table following). Pass band is from f_{LC} to f_{UC}. Uncertainity = ± 5%A ± fixed error, where A is the actual jitter at the input. 
Input Phase Tolerance	Input phase tolerance exceeds 200 UIp p, to accommodate worst case tributary pointerjitter, in conformance with new O.172.
Measurement Frequency Response	Measurement filters meet the requirements of ITU-T G.783, G.823, G.824, G.825, G.958, and O.172. Lower cutoff (high pass) is first order (20 dB/ decade). For 2 Mb/s, 34 Mb/s and 140 Mb/s, this reponse is 20 dB/decade down to 0.1 Hz in wideband mode, in conformance with new 0.172, Upper cutoff (low pass) is third order maximally flat Butterworth (60 dB/decade). Cutoff frequencies are ±10%, except 2 Mb/s is +100%/ 10%.
Fullband Filter Frequency Cutoff Values	2 Mb/s: 0.1, 1 or 10 Hz 34 Mb/s 0.1, 1 or 10 Hz 45 Mb/s 0.1, 1 or 10 Hz 140 Mb/s 0.1, 1 or 10 Hz STM-0: 0.1, 1 or 10 Hz STM-1: 0.1, 1 or 10 Hz STM-1: 0.1, 1 or 10 Hz STM-4: 0.1, 1 or 10 Hz

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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications (Cont.)

Characteristic	Description
Wideband Filter Frequency Cutoff Values	2 Mb/s: 20 Hz 34 Mb/s 100 kHz 45 Mb/s 10.0 Hz 140 Mb/s 200 Hz STM-0: 100 Hz STM-1: 500 Hz STM-4: 1000 Hz
Highband Filter Frequency Cutoff Values	2 Mb/s: 700 Hz or 18.0 kHz 34 Mb/s 10.0 kHz 45 Mb/s 30.0 kHz 140 Mb/s 10.0 kHz STM-0: 12.0 kHz STM-1: 65.0 kHz STM-4: 250 kHz
RMS Filter Frequency Cutoff Values	2 Mb/s: 12 kHz 34 Mb/s 12 kHz 45 Mb/s 12 kHz 140 Mb/s 12 kHz STM-0: 12 kHz STM-1: 12 kHz STM-4: 12 kHz
f_{uc} Frequency Cutoff Values	2 Mb/s: 100 kHz 34 Mb/s 800 kHz 45 Mb/s 400 kHz 140 Mb/s 3.50 MHz STM-0: 400 kHz STM-1: 1.3 MHz STM-4: 5.0 MHz

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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications

Characteristic	Description
Jitter Clock Input	Input to measure jitter on a clock signal.
Nominal Clock Rates	Any supported SDH or PDH rate, except 8 Mbit/s. Rate is independent of the receive line rate.
Frequency Tolerance	Nominal rate ±100 ppm
Input Amplitude, typical	0.4 V_{p-p} minimum, 1.5 V_{p-p} maximum amplitude
Connector	Rear-panel, unbalanced 75 BNC
Analog Jitter Output	Demodulated jitter from the receiver. The output is filtered by any measurement filters selected.
Connector	Rear-panel 50 BNC
Sensitivity, typical	Normal measurement range: 100 mV/UI Extended measurement range: 2.65 mV/UI
Output Level, typical	± 1V, centered at 0 V ± 100 mV
Accuracy	± 10%, in addition to measurement inaccuracy
Lock Time	<10 seconds wideband, highband, fullband (10 Hz) highpass filter <30 seconds fullband, 1.0 Hz highpass filter <60 seconds fullband, 0.1 highpass filter
Wander Measurements	According to ITU TG.813, G.812, ETS300 462 n. Conforms to new O.172 Peak-to-Peak Wander, TIE (Time Interval Error), MTIE (Maximum TIE), TDEV (Time Deviation) Current Frequency, Maximum Frequency, Minimum Frequency, Frequency Drift Rate
Peak to Peakand TIE Measurement	Fixed Error $Z_{0\ is\ TIE}$ (τ) is observation period Range: $2.1*10^{17}$ ns Accuracy ±0.5% ± Z_0 (τ) where Z_0 (τ)(nsec) observation interval, (τ)(nsec) 2.5 + 0.0275 (τ) 0.05 ± (τ) ± 1.000 29.0 + 0.010 (τ) (τ) is greater than 1.000 Bandwidth: 10 Hz ±10% Resolution: 0.3 ns or better

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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications (Cont.)

Characteristic	Description
MTIE Measurement	Z_1 error due to MTIE algorithm $Z_0 + Z_1 = Z_3$ Range: Limited only by disk space on the PC Calculation Accuracy ±1.0%.05 ± Z_3 (τ) where Z_1 (τ)(nsec) observation interval, (τ)(nsec) 2.0 + 0.0330 (τ) 0.05 ± (τ) ± 1.000 35.0 + 0.012 (τ) (τ) is greater than 1.000 Bandwidth: 10 Hz ±10% Resolution: 0.3 ns or better
TDEV Measurement	Z_2 is TDEV algorithm error $Z_0 + Z_2 = Z_4$ Range: 0.02 s to 167.700 s Calculation Accuracy ±1.0% ± Z_4 (τ) where Z_2 (τ)(nsec) observation interval, (τ)(nsec) 3.0 + 0.0330 (τ) 0.05 ± (τ) ± 1.000 35.0 + 0.012 (τ) (τ) is greater than 1.000 Bandwidth: 10 Hz ±10% Resolution: 0.3 ns or better
Frequency Measurement	Resolution: 1 Hz absolute (0.01 ppm relative) Accuracy: ±0.1 ppm (with respect to source clock)
Frequency Drift Rate	Range: 10,000 ppm/sec Accuracy: <1% ± 0.01 ppm/sec Bandwidth 0 Hz to 0.5 Hz Resolution: 0.001 ppm/sec
	Sample Rate: 50 Hz Anti alias filter: 10 Hz first order roll off, in conformance with new O.172

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Table D 3: CTS 850 Opt. 14 Jitter & Wander Specifications (Cont.)

Characteristic	Description
Real Time Wander Analyst software for TDEV/MTIE parameter analysis included with Option 14.	Wander Analyst software works in conjunction with the Tektronix CTS 850 or SJ300E test sets. The software provides full wander TIE, MTIE, and TDEV analysis according to the most recent ITU T, ETSI, ANSI and Bellcore standards. The Windows compatible PC software uploads TIE wander measurement data from the test set at a sampling rate of 50 Hz, stores the data at a rate of 50, 1 or 0.1 Hz (selectable) and simultaneously calculates MTIE and TDEV using efficient algorithms. In addition to the ITU T and European ETSI specifications, Wander Analyst also includes a full suite of North American SONET and ANSI specifications limits. The software provices a hi/lo envelope TIE plot to show transients, full zoom control via cursors and calculates frequency offset and drift rate in accordance with ANSI approved methodology.

Table D 4: Environmental Specifications

Characteristic	Description
Temperature	Operating: 0_ C to +40_ C Nonoperating: 40_ C to +70_ C
Altitude	Operating: 4,572 m (15,000 ft) Nonoperating: 12,192 m (40,000 ft)

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Table D 4: Environmental Specifications

Characteristic	Description
Humidity	Operating: To 95%, relative humidity at or below +40_ C for 2 hours or less To 90% relative humidity at or below 30_ C, continuous
Transportation Handling	Qualifies under National Safe Transit Association 1s Pre-shipment Test; 1A-B-1.

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Table D 5: Physical Characteristics

Characteristic	Description
Dimensions	Height: 165 mm (6.5 in) 191 mm (7.5 in) with accessory pouch Width: 362 mm (14.25 in) Depth: 490 mm (19.25 in) with front cover 564 mm (22.2 in) with handle extended
Weight	Net: Approximately 8.7 kg (19.3 lb) Shipping: Approximately 14.1 kg (31 lb)
Power Requirements	*Line Voltage* — *Line Frequency* 100 V to 132 V — 50/60 Hz 180 V to 250 V — 40 to 60 Hz 100 V to 132 V — 400 Hz Maximum current is 6 A_{RMS}

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Table D 6: Certifications and compliances

Characteristic	Description
FCC Compliance	Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits
EC Declaration of Conformity EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities: EN 55011 Class A Radiated and Conducted Emissions EN 50082-1 Immunity: Australia & New Zealand Declaration of Conformance for EMC: Meets Intent of Australian EMC Framework. Compliance demonstraed to standard AS/NZS 2064.1/2
EC Declaration of Conformity Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC Low Voltage Directive 73/23/EEC, Amended by 93/68/EEC EN 61010-1; Safety requirements for electrical equipment for measurement, control, and laboratory use

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Table D 6: Certifications and compliances

Characteristic	Description
Approvals	**U.S. Nationally Recognized Testing Laboratory Listing** UL3111 1 Standard for Electrical Measuring and Test Equipment **Canadian Certification** CAN/CSA-22.2 No. 1010.1 CSA Safety requirements for Electrical Equipment for Measurement, Control, and Laboratory Use **ANSI/ISA S82.02.01** Safety standard for electrical and Electronix Test, Measuring, Controlling and Related Equipment **IEC1010 1** Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use **China National Standard** GB/T 16814 1997 Methods of measurement for synchronous digital hierarchy (SDH) optical fiber cable line systems
Safety Certification Compliance	Operating temperature: +5 to +40 °C Max. Operating altitude: 2000 meters Relative Humidity (max. operating) 80% for temperatures up to 31 degrees C, decreasing linearly to 50% at 40 degrees C. Equipment Type: Test and measuring Safety Class: Class I, as defined in IEC 1010 1, Annex H) grounded product Overvoltage Category: CAT II (as defined in IEC1010-1, Annex J) Pollution Degree: Pollution Degree 2, (as defined in IEC 1010 1). Note: rated for indoor use only

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Appendix E: Incoming Inspection Test

The purpose of the incoming inspection test is to verify that the CTS850 SDH Test Set is functioning properly. The incoming inspection test relies on the front panel status lights to indicate the results of the test. Figure E 1 shows the location of the status lights used in these procedures.

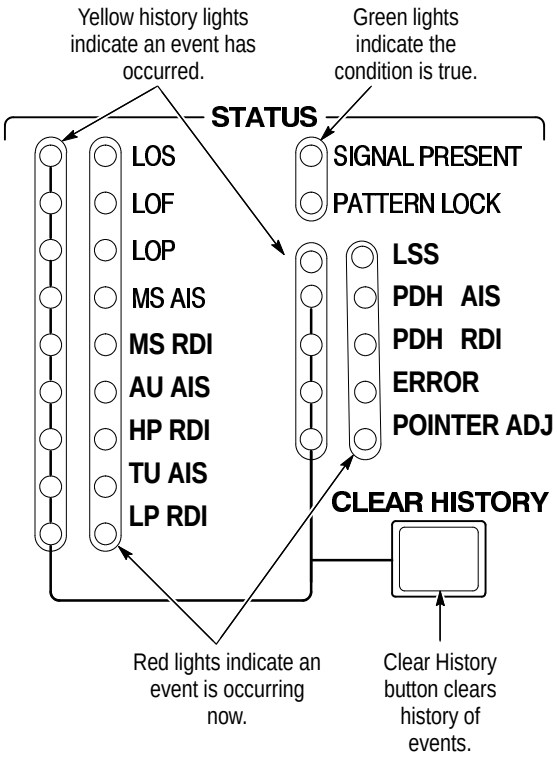


Figure E 1: Front-Panel Status Lights

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Table E 1 details the equipment required to complete the incoming inspection test.

Table E 1: Required Equipment

Item Number and Description		Minimum Requirements	Example	Purpose
1	Optical Fiber Cable[1]	62.5/125 m multimode fiber; FC/PC connector on one end; compatible with CTS850 connector option on other end	FC/PC to FC/PC, Tektronix part number 174-2322-00	Interconnect optical signals
2	10 dB Optical Attenuator[2]	10 dB at = 1550 nm, with connectors compatible with item 1 and CTS connector option	Tektronix part number 119-5118-00 (included with Option 05)	Provide optical attenuation at 1550 nm
3	75 Coaxial Cable	75 impedance; ≈1 m length, BNC connectors	Tektronix part number 012-1338-00	Interconnect electrical signals
4	120 Siemens Cable	120 impedance; ≈2 m length, banana plugs	Tektronix part number 012-1469-00	Interconnect electrical signals

1 This equipment is required to test a CTS850 with any one of the optional Optical/Electrical Plug-in Interface Modules installed; otherwise, it is not required.

2 This equipment is only required if Option 05 is installed.

Loop-Back Connection

The incoming inspection test requires an external loop-back connection from the TRANSMIT/OUT output to the RECEIVE/IN input. For the SDH rate electrical loop-back, you can use the 75

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BNC coaxial cable provided as a standard accessory to the CTS850. If the Add/Drop/Test Option is installed, you can use the 75 coaxial cable for checking 2 Mb/s Balanced, 34 Mb/s, and 140 Mb/s operation. You will need to use a 120 Siemens cable (a standard accessory with the Add/Drop/Test Option) to check 2 Mb/s Unbalanced operation. If one of the Electrical/Optical Plug-in Interface Modules is installed in your CTS850, you also need a short optical cable that is compatible with the optical connectors on your instrument. Optical cables are not included as standard accessories to the CTS850.

How to Proceed

If the CTS850 fails any of these tests, it has failed the incoming inspection test. Double check the electrical and optical connections and repeat any failed test. If the failure persists, contact your local Tektronix field office or representative for assistance.

You can perform the following tests in any order. Each test is independent and does not depend on the setup from the previous test.

H Turn on the CTS850. Allow it to warm up for 20 minutes before proceeding with the tests.

System Self Test with External Loop-Back

This test executes the Self Test including coverage of the transmitter and receiver I/O circuitry.

Equipment Required	75 BNC coaxial cable for electrical loop-back Optical loop-back cable if Electrical/Optical Plug-in Interface Module is installed 10 dB optical attenuator if Option 05 is installed
Prerequisites	CTS850 warmed-up at least twenty minutes
Time Required	Approximately two minutes

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1. Attach electrical and optical loop-back cables from the TRANSMIT/OUT outputs to the RECEIVE/IN inputs.

***NOTE**. Connectors labeled OUT and IN are present only on instruments equipped with the Add/Drop/Test Option.*

2. Set up and execute the system self test with the following sequence:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
UTILITY	SELF TEST	Self Test Group	Sys: Ext
		Self Test Control	Run

SDH Signals

This test checks that the CTS850 transmits and receives error-free signals at all SDH rates.

Equipment Required	75 BNC coaxial cable for electrical loop-back Optical loop-back cable if Electrical/Optical Plug-in Interface Module is installed 10 dB optical attenuator if Option 05 is installed
Prerequisites	CTS850 warmed up at least twenty minutes
Time Required	Approximately five minutes

1. Attach electrical and optical loop-back cables from the TRANSMIT outputs to the RECEIVE inputs.

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2. Perform the initial setup of the CTS850 with the following sequence:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Coupled
	POINTERS & TIMING	Pointer Control	Set Value
		Pointer Value set to	Default 522

3. To check the rate, press the **CLEAR HISTORY** button, wait two seconds, and then verify that no yellow history lights are on.

***NOTE**. When changing the transmit rate, the LOP, LOS, and LOF history lights may turn on; this is normal. However, the red event lights should not stay on.*

4. Steps 5 through 8 of this procedure apply only if one of the Electrical/Optical Plug-in Interface Modules (Option 03 or Option 04) is installed in your CTS850.

5. To check the STM-1 rate, perform the setup sequence:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-1

6. Press the **CLEAR HISTORY** button, wait two seconds, and then verify that no yellow history lights are on.

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7. If your CTS850 does not have STM-4 capability, you have completed the incoming inspection test. To check the STM-4 rate, perform the setup sequence:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	STM-4

8. Press the **CLEAR HISTORY** button, wait two seconds, and then verify that no yellow history lights are on.

PDH Signals

This test checks that the CTS850 transmits and receives error-free signals at all PDH rates.

Equipment Required	75 BNC coaxial cable for 2 Mb/s Unbalanced, 34 Mb/s and 140 Mb/s electrical loop-back 120 Siemens Cable for 2 Mb/s Balanced electrical loop-back
Prerequisites	CTS850 warmed up at least twenty minutes
Time Required	Approximately five minutes

1. Attach electrical and optical loop-back cables from the OUT outputs to the IN inputs.

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2. Perform the initial setup of the CTS850 with the following sequence:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TEST SETUPS	RECALL INSTRUMENT SETUPS	DEFAULT FACTORY SETTINGS	Recall Setup
TRANSMIT	TRANSMIT SETTINGS	Tx/Rx Setup	Coupled
		Transmit Rate	2 Mb/s Balanced

3. To check the 2 Mb/s Balanced rate, press the **CLEAR HISTORY** button, wait two seconds, and then verify that no yellow history lights are on.

4. To check the 2 Mb/s Unbalanced rate, set the transmit rate as follows:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	2 Mb/s Unbalanced

***NOTE**. When changing the transmit rate, the LOP, LOS, and LOF history lights may turn on; this is normal. However, the red error lights should not stay on.*

5. Press the **CLEAR HISTORY** button, wait two seconds, and then verify that no yellow history lights are on.

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6. To check the 34 Mb/s rate, perform the setup sequence:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	34 Mb/s

7. Press the **CLEAR HISTORY** button, wait two seconds, and then verify that no yellow history lights are on.

8. To check the 140 Mb/s rate, perform the setup sequence:

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Rate	140 Mb/s

9. Press the **CLEAR HISTORY** button, wait two seconds, and then verify that no yellow history lights are on.

This completes the incoming inspection test.

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Appendix F: Example Disk Contents

This manual ships with a disk containing files that you can load into your CTS850. The files are PC programs and examples of instrument setups, test results and pass/fail tests. The files contained on the disk are described in the following paragraphs.

CTSVIEW Print Capture Program

CTSVIEW.EXE, in directory CTSVIEW on the Example Disk, is a PC program that captures CTS printer output over an RS 232 serial link connection. This program displays the output and, optionally, writes it to a file.

This program is a DOS executable file that can run under Windows 3.1 or Windows 95. The program requires VGA display and a mouse. Typing **ctsview ?** at the command line displays a list of options.

The text file CTSVIEW.TXT in the CTSVIEW directory contains full instructions on its use.

To use this program, the user must connect the CTS printer (RS 232) port to a PC serial port with a null modem cable and set the CTS to print in “Thinkjet” (graphics) or “ASCII Text” format. The program waits for input and displays the input as text or graphics.

After viewing the input, the user can save graphical data to a file in .BMP, .EPS or Interleaf format, or ASCII data to a standard PC text file.

Note: CTSVIEW expects to run in VGA full screen mode. While Windows 95 can emulate DOS graphics in a window, the performance is slow and will not keep up with the incoming serial data. It is recommended to transfer data in full screen mode. Use the keys ALT and Enter to switch between full screen and Windows display, or use the command line **w** option to prevent displaying graphics output while reading data.

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CTSHIST Results History File Reader Program

CTSHIST.EXE, in directory CTSHIST on the Example Disk, reads the test history files written by a CTS “Save Results” operation and writes an ASCII text file containing the data.

This program is a DOS executable file that can run under Windows 3.1 or Windows 95. It is run from a DOS command prompt and takes its arguments and option settings from the command line. Typing **ctshist ?** at the command line displays a list of options.

The text file CTSHIST.TXT in the CTSHIST directory contains full instructions on its use.

Instrument Setups

The STRESS file is an instrument setup file. The file sets up the CTS850 to generate an STM-1E signal that contains alarms, errors and pointer movements. The STRESS file is an example of how the CTS850 can save you time by storing instrument setups on disk for later recall.

Test Results

There are three test results file on the the Examples diskette. They are: Oneday.res; 15min.res; and, 1min.res. These files contain one day (24 hours); 15 minutes; and, 1 minute of test results. Recall the files from the RECALL RESULTS page of the RESULTS menu. You can view the test results on the MAIN RESULTS and ERROR ANALYSIS pages of the RESULTS menu. You can view a graph of the test results on the HISTORY GRAPHS page of the RESULTS menu (The relevant files are Oneday.his; 15min.his; and, 1min.his. The HISTORY GRAPHS page shows when alarms, errors and pointer movements occurred.

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Pass/Fail Tests

The DEMO_10S file is a pass/fail test that runs for just 10 seconds. To make the test fail, press the INSERT ERROR button on the front panel. To run the test, connect an electrical cable between the TRANSMIT and RECEIVE connectors on the front panel and then recall the test from the RECALL PASS/FAIL TESTS page of the TEST SETUPS menu. You can see how the test was set up by viewing the test parameters on the SAVE PASS/FAIL TESTS page of the TEST SETUPS menu after you recall the test.

The BER_STM1 file is a 15-minute BER test. The test passes if the BER is better than 10E 7. To run the test, connect an electrical cable between the TRANSMIT and RECEIVE connectors on the front panel and then recall the test from the RECALL PASS/FAIL TESTS page of the TEST SETUPS menu. You can see how the test was set up by viewing the test parameters on the SAVE PASS/FAIL TESTS page of the TEST SETUPS menu after you recall the test.

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Appendix G: Rear-Panel Connectors

This appendix describes the connectors located on the rear panel of the CTS850.

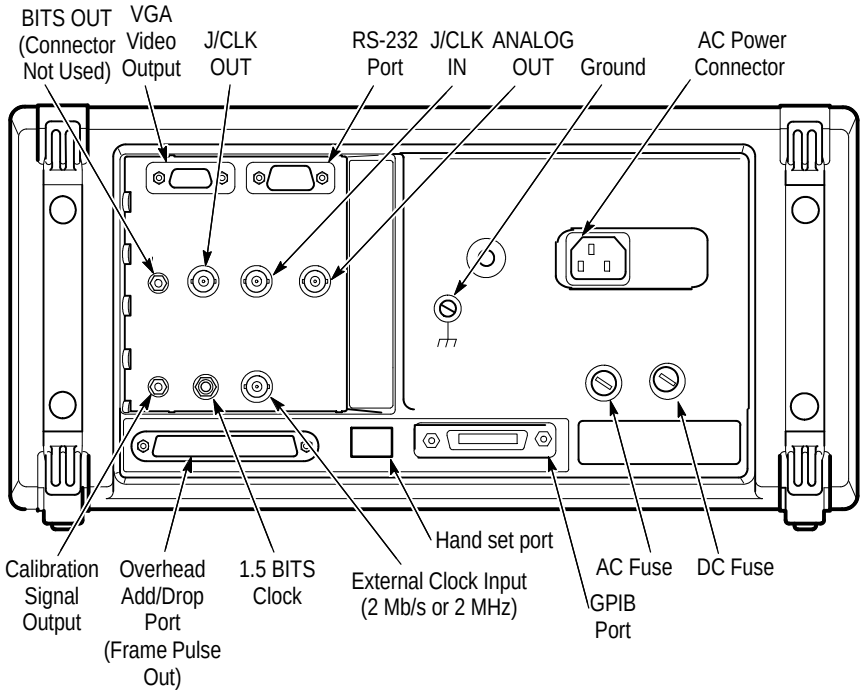


Figure G 1: CTS850 Rear Panel Connectors

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Table G 1: Voltage Range, Input Frequency, and Fuses

Voltage Range	Input Frequency	Fuse (250V) 3AG UL198G	Fuse (250V) IEC127, SH1	Max Input
100 132V	50/60 Hz	8A Fast	6.3A Fast	6A
180 250V				

Voltage Range automatically selected.

VGA Video Output

The CTS850 can drive an external IBM-compatible VGA monitor. There are no parameters to set in order to drive an external monitor. The output is monochrome (green only); the resolution is 640 pixels × 480 pixels. Figure G 2 shows how the pins are numbered on the VGA (female) connector. Table G 2 lists the pin assignment for the rear-panel VGA connector.

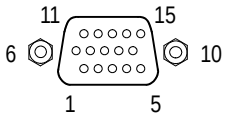


Figure G 2: The VGA Video Output Connector

Table G 2: VGA Video Output Connector Pin Assignment

Pin Number	Description
1	Ground
2	Video Signal (Green)
3	Ground
4	
5	
6	Ground
7	Ground
8	Ground

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Table G 2: VGA Video Output Connector Pin Assignment (Cont.)

Pin Number	Description
9	
10	Ground
11	Ground
12	
13	Horizontal Sync
14	Vertical Sync
15	

GPIB Port

The GPIB (General Purpose Interface Bus) port is used for remote control of the CTS850. For detailed information on remote control of the CTS850, see the CTS850 SDH Test Set *Programmer Manual* (Tektronix part number 070-8925-XX)

RS-232 Port

The rear panel RS-232 (male) connector is used to connect to printers and instrument controllers. Set the RS-232 parameters for printers on the PRINTER SETUP page of the UTILITY menu. Set the RS-232 parameters for instrument controllers on the REMOTE CONTROL page of the UTILITY menu. You can find more detailed information on remote control of the CTS850 in the CTS850 SDH Test Set *Programmer Manual*. Figure G 3 shows how the pins are numbered on the RS-232 port. Table G 3 lists the pin assignment for the RS-232 port on the CTS850 rear panel.

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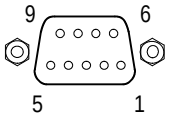


Figure G 3: The RS-232 Port

Table G 3: RS-232 Rear Panel Connector Pin Assignment

Pin Number	Name	Description
1	DCD	Data Carrier Detect
2	RxD	Receive Data
3	TxD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Signal Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

Calibration Signal Output

You use the calibration signal output for servicing the CTS850. Information on servicing the CTS850 is located in the *CTS850 SDH/PDH Test Set Service Manual*, Tektronix part number 070-9991-XX.

Overhead Add/Drop Port

You use the Overhead Add/Drop (female) connector to add/drop the section and line data communication channels (DCC), and the section and line user channels. The DCC and user channel add/drop

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functions are independent; for example, you can add a DCC while dropping a user channel. Only one DCC or user channel can be added or dropped at a time. The parameters for adding a DCC or a user channel are located on the SECTION OVERHEAD and PATH OVERHEAD pages of the TRANSMIT menu. The parameters for dropping a DCC or a user channel are located on the SECTION OVERHEAD and PATH OVERHEAD pages of the RECEIVE menu.

TX and RX Frame Pulse outputs are made available on the Add/Drop Connector. The TX Frame Pulse Connection is RS449, Add/Drop connector pin 15. The RX Frame Pulse Connection is RS449, Add/Drop connector pin 36.

The Overhead Add/Drop port uses a gapped clock. Figure G 4 shows how the pins are numbered on the Overhead Add/Drop port. Tables G 4 and G 5 summarize the different communication channels.

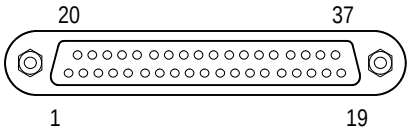


Figure G 4: The Overhead Add/Drop Port

Table G 4: Overhead Channels Added

Added Channel	Bytes Added	Data Rate	Clock Rate
DCC	D1, D2, D3	192 kbps	216 kHz
DCC	D4, D5, D6, D7, D8, D9, D10, D11, D12	576 kbps	2.16 MHz[1]
User Channel	F1	64 kbps	72 kHz
User Channel	F2	64 kbps	72 kHz

[1] The DCC signal has a 1/3 2/3 duty ratio.

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Table G 5: Overhead Channels Dropped

Dropped Channel	Bytes Dropped	Data Rate	Clock Rate
Section DCC	D1, D2, D3	192 kbps	216 kHz
Line DCC	D4, D5, D6, D7, D8, D9, D10, D11, D12	576 kbps	2.16 MHz
Section User Channel	F1	64 kbps	72 kHz
Path User Channel	F2	64 kbps	72 kHz

Table G 6 summarizes the data signal pin assignments on the Overhead Add/Drop port. Table G 7 summarizes the additional pin assignments on the Overhead Add/Drop port. The signal lines listed in Table G 6 can drive 100 , differential TTL lines. The signal lines are terminated with a 100 impedance and can drive 100 lines.

Table G 6: Overhead Add/Drop Port Data Signal Pin Assignments

Signal	+Pin	Pin
Added Tx Data (input)	4	22
Added Tx Clock (output) Error Pulse Output	5	23
Tx Common (ground)	37	
Dropped Rx Data (output)	6	24
Dropped Rx Clock (output)	8	26
Rx Common (ground)	20	

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Table G 7: Overhead Add/Drop Port Additional Pin Assignments

Signal	Pin
Shield (ground)	1
Signal Ground (ground)	19
Reserved	33
Tx Frame Pulse (output)[1]	15
Rx Frame Pulse (output)[1]	36

[1] The Frame Pulse signals are nominal 8 kHz, TTL, single-ended signals.

External Clock Input (2 Mb/s or 2 MHz)

To synchronize the CTS850 transmit clock with a 2 Mb/s or 2 MHz reference, connect a 2 Mb/s or 2 MHz reference to the External Clock Input connector.

The 1.5 BITS clock can also be used to time the transmitter. The 1.5 BITS clock an its own input connector on the rear panel.

Press Menu Button	Select Menu Page	Highlight Parameter	Select Choice
TRANSMIT	TRANSMIT SETTINGS	Transmit Clock	External 2 Mb/s

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Handset Interface

The following handset interface specifications are compatible with an Audiosears handset, 2600 A 00 JAFC AAJ 05. This Audiosears handset uses a 2212 speaker (receiver) and a 2251 Amplified Electret microphone (transmitter). Other handsets with similar specifications will also work. Handsets with non amplified Electret (Standard) microphones may also be used.

Table G 8: Handset Interface Specifications

Handset microphone voltage	3.0 V ± 10% (standard mic selected) 1.25 V ± 10% (Electret mic selected)
Handset microphone impedance	130 Ohms (standard mic selected) 1k Ohm (Electret mic selected)
Handset microphone operating current	15 mA (standard mic selected) 350 uA (Electret mic selected)
Handset Speaker Impedance	150 Ohms
Handset Speaker Volumne	Speaker volume will depend upon the speaker sensitivity
Handset Audio Mixing	Sidetone Gain: 20 dB
Handset CODEC Coding	A Law for CTS850
Handset Interface Noise	< 3 mV RMS at handset speaker output

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Jitter Inputs and Outputs

If the CTS850 SDH Test Set has the Jitter Test Option (Option 14) installed, four additional connectors are located on the rear panel in the JITTER/WANDER group. The connections in order from left to right in the listing below. If measuring Jitter and/or Wander at line rates, use the regular connections on the front panel of the CTS850 Test Set.

BITS OUT (Connector Not Used)

The BITS OUT connector is not used by the CTS850 SDH Test Set.

J/CLK OUT

J/CLK OUT (jittered clock output) provides a clock line rate signal modulated by generated jitter. You can choose any SDH or PDH rate. In addition, the J/CLK OUT connector can provide a 2.048 MHz G.703 synchronization signal. Refer to *Setting Jitter or Wander Generation* in Chapter 3 ***Reference*** for information about controlling the signal type, rate, jitter, and frequency offset.

The J/CLK OUT connector is a 75 BNC. The output is ECL compatible when terminated by 75 .

J/CLK IN

J/CLK IN (jitter clock input) is an input you can use to measure the jitter on a MHz clock signal. The signal must be NRZ coded and at an SDH or PDH rate. Refer to *Setting Jitter Receive Parameters* in Chapter 3 ***Reference*** for information about setting the jitter measurement source and rate.

The J/CLK IN connector is a 75 BNC. The input is AC coupled. Typical sensitivity is 0.4 V_{p-p}.

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ANALOG OUT

The ANALOG OUT connector provides the demodulated jitter from the receiver as an analog waveform. You can use an oscilloscope or spectrum analyzer to analyze this waveform, as long as you realize the limitations of an oscilloscope or spectrum analyzer at looking at this type of telecommunications information.

The ANALOG OUT signal is not calibrated; the amplitude has low accuracy, but the spectral content is valid. The spectral content is dependent on the measurement filter you select. Refer to *Setting Jitter Receive Parameters* in Chapter 3 ***Reference*** for information about controlling the measurement range and filter.

The ANALOG OUT connector is a 75 BNC. The signal level is typically ±1V or less and is centered at 0 V. Typical sensitivity is 125 mV/UI in normal mode and 3.5 mV/UI in extended mode.

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Appendix H: Changing Optical Port Connectors

The following procedures are discussed in this appendix:

- Cleaning the Optical Ports
- Changing the Optical Port Connectors

Cleaning the Optical Ports

If the CTS850 performance appears degraded, the optical fiber and optical port may be dirty. Clean the fiber connector with a clean cloth.

To clean an optical port:

1. Turn off the CTS850 from the power switch located on the front panel.
2. Remove the four screws that attach the bulkhead connector to the front panel (see Figure H 1).
3. Gently pull the bulkhead out of the unit and unscrew the fiber connector. Be careful not to pull beyond the fiber slack.
4. Using a soft, lint-free cloth with a high-quality glass cleaner, clean the tip of the fiber cable.
5. If available, use low-pressure compressed air or canned air to blow any dirt out of the bulkhead connector. If compressed air is not available, then the bulkhead will have to be taken apart and cleaned. Refer to the *Changing the Optical Port Connectors* procedure, on page H 2, for information about bulkhead disassembly.
6. After cleaning the bulkhead, reconnect the fiber and install the bulkhead. Be sure to reinstall the dustcap chain.

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***NOTE**. To keep cleaning to a minimum, install the dustcap when no fiber is connected to the optical port.*

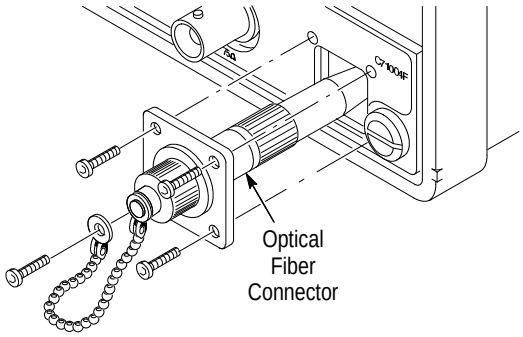


Figure H 1: Removing the Optical Bulkhead Connector

Changing the Optical Port Connectors

The CTS850 is shipped with the FC connector bulkhead and dustcap installed. If you wish to change to the ST, DIN 47256, or SC connectors perform the following procedure:

1. Turn off the CTS850 from the power switch located on the front panel.CTS850
2. Remove the four screws that attach the bulkhead connector to the front panel (see Figure H 1).
3. Gently pull the bulkhead out of the unit and unscrew the fiber connector. Be careful not to pull beyond the fiber slack.
4. Disassemble the bulkhead as shown in Figures H 2 through H 5.

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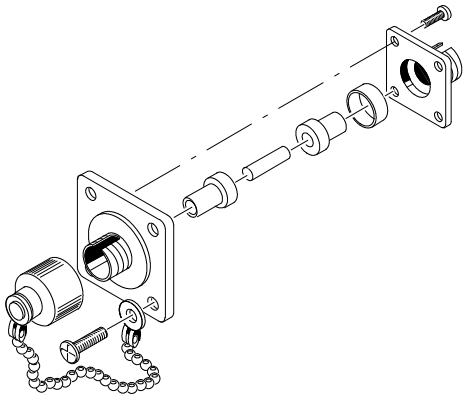


Figure H 2: FC Optical Bulkhead Assembly

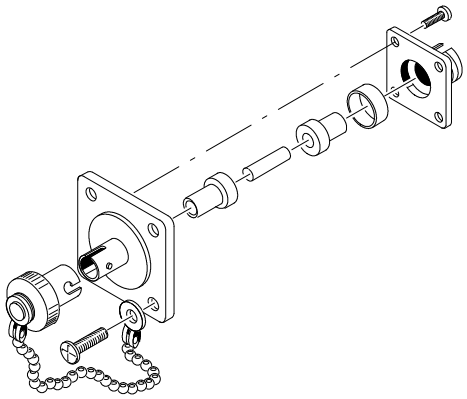


Figure H 3: ST Optical Bulkhead Assembly

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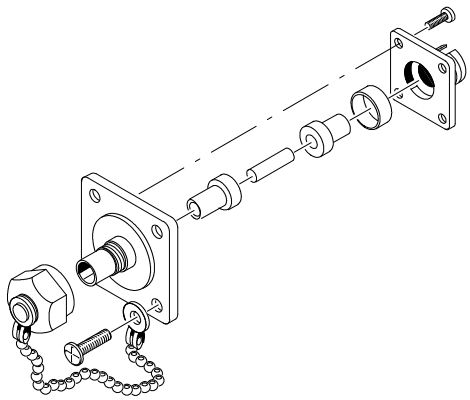


Figure H 4: DIN 47256 Optical Bulkhead Assembly

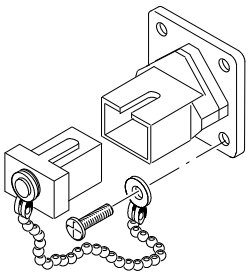


Figure H 5: SC Optical Bulkhead Assembly

5. Replace the current bulkhead with the one you wish to use and reassemble.
6. Installation is the reverse of steps 1 through 3.

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Appendix I: Packing for Shipment

If you ship the CTS850, pack it in the original shipping carton and packing material. If the original packing material is not available, package the instrument as follows:

1. Obtain a corrugated cardboard shipping carton with inside dimensions at least 15 cm (6 in) taller, wider, and deeper than the CTS850. The shipping carton must be constructed of cardboard with 170 kg (375 lb) test strength.
2. If you are shipping the CTS850 to a Tektronix field office for repair, attach a tag to the CTS850 showing the instrument owner and address, the name of the person to contact about the instrument, the instrument type, and the serial number.
3. Wrap the CTS850 with polyethylene sheeting or equivalent material to protect the finish.
4. Cushion the CTS850 in the shipping carton by tightly packing dunnage or urethane foam on all sides between the carton and the CTS850. Allow 7.5 cm (3 in) on all sides, top, and bottom.
5. Seal the shipping carton with shipping tape or an industrial stapler.

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Appendix J: Telecom Technology

Basic SDH Signal

The basic format of an SDH signal allows it to carry many different services in its Virtual Container (VC) because it is bandwidth flexible. This capability will allow for such things as the transmission of high speed, packet switched services, ATM, contribution video and distribution video. However, SDH still permits transport and networking at the 2 Mbit/s, 34 Mbit/s and 140 Mbit/s levels, accommodating the existing digital hierarchy signals. In addition, SDH supports the transport of signals based on the 1.5 Mbit/s hierarchy.

CTS850 Test Set, SDH/PDH

Transmission hierarchies

The following tables compare the Non synchronous and Synchronous transmission hierarchies.

Table J 1. Non Synchronous Hierarchy

Signal	Digital Bit Rate	Channels
64 kbit/s	64 kbit/s	One 64 kbit/s
E1	2.048 Mbit/s	32 E0
E2	8.448 Mbit/s	128 E0
E3	34.368 Mbit/s	16 E1
E4	139.264 Mbit/s	64 E1

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Table J 2. SDH Hierarchy

Bit Rate	Abbr.	SDH	SDH Capacity
51.840 Mbit/s	51 Mbit/s	STM 0	21 E1
155.520 Mbit/s	155 Mbit/s	STM 1	63 E1 or 1 E4
622.080 Mbit/s	622 Mbit/s	STM 4	252 E1 or 4 E4
2488.320 Mbit/s	2.4 Gbit/s	STM 16	1008 E1 or 16 E4
9953.280 Mbit/s	10 Gbit/s	STM 64	4032 E1 or 64 E4

STM = Synchronous Transport Module

PDH Basics

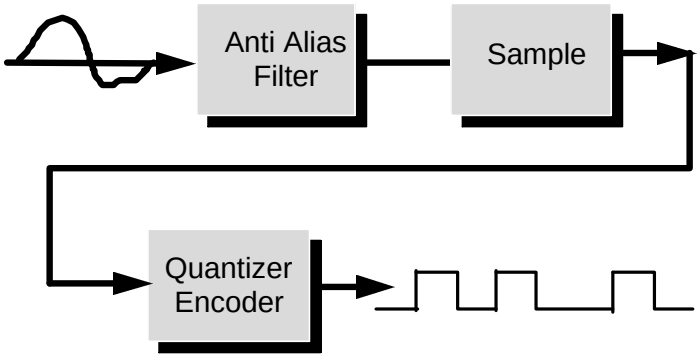
Plesiochronous Data Hierarchy (PDH) is a telecommunications transmission technology, implemented thirty years ago, based on PCM (Pulse Code Modulation) and TDM (time division multiplexing).

PDH is tailored to voice communication; has dedicated bandwidth for each voice channel and a fixed channel assignment. PDH is worldwide compatible only at the 64 kbit/s digitized voice level.

Pulse Code Modulation (PCM)

In the early 1970's, digital transmission began to appear in the world's telephone network, utilizing a method known as Pulse Code Modulation. PCM allowed analogue waveforms, such as the human voice, to be represented in binary form. Using this PCM method, it was possible to represent a standard 4 kHz analogue telephone signal as a 64 kbit/s digital bit stream.

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8,000 samples/second x 8 bits/sample =
64 kb/s digital bit stream (one timeslot)

Figure J 1: Pulse Code Modulation

Engineers saw the potential to produce more cost effective transmission systems by combining several PCM channels and transmitting them down the same copper twisted pair as had previously been occupied by a single analogue signal.

The method used to combine multiple 64 kbit/s channels into a single high speed bit stream is known as Time Division Multiplexing (TDM). In simple terms, a byte from each incoming channel is transmitted in turn down the outgoing high speed channel. This process is sometimes referred to as ”sequential byte interleaving.”

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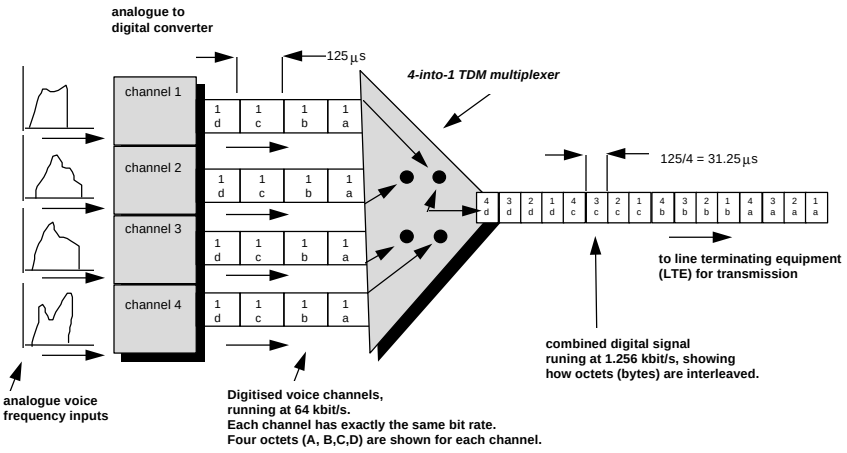


Figure J 2: Time Division Multiplexing

In Europe, and other parts of the world, a standard TDM scheme was adopted where thirty 64 kbit/s channels were combined, together with two additional channels carrying control information, to produce a channel with a bit rate of 2.048 Mb/s.

As demand for voice telephony increased, and levels of traffic in the network grew, it became clear that the standard 2 Mb/s signal was not sufficient to cope with the traffic loads occurring in the trunk network. In order to avoid having to use excessively large numbers of 2 Mb/s links, it was decided to create a further level of multiplexing. The standard adopted in Europe involved the combination of four 2 Mb/s channels to produce a single 8 Mb/s channel. This level of multiplexing differed slightly for the previous in that the incoming signals were combined one bit at a time, instead of one byte at a time, that is, bit interleaving was used instead of byte interleaving.

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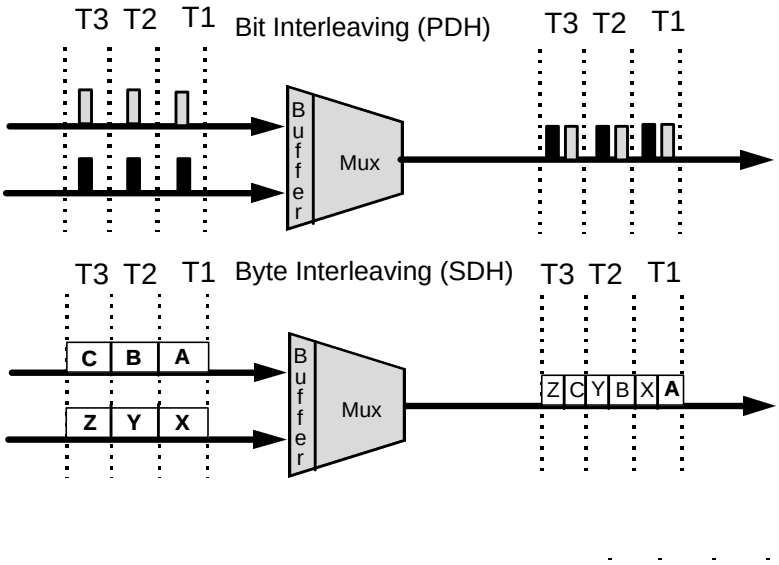


Figure J 3: Bit & Byte Interleaving

As the need arose, further levels of multiplexing were added to the PDH standard at 34 Mb/s, 140 Mb/s and 565 Mb/s to produce a full hierarchy of bit rates.

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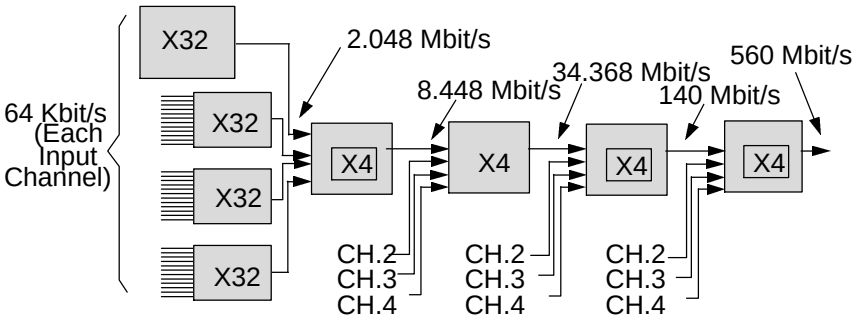


Figure J 4: Higher Order Multiplexing Hierarchy

Asynchronous Multiplexing

Traditionally, transmission systems have been asynchronous, with each terminal in the network running on its own recovered clock timing. In digital transmission, ”timing” is one of the most fundamental operations.

Since these clocks are not synchronised, large variations can occur in the clock rate and thus the signal bit rate. For example, a E3 signal specified at 34 Mbit/s ± 20 ppm (parts per million) can produce a timing difference of up to 1789 bit/s between one incoming E3 signal and another.

Asynchronous multiplexing uses multiple stages. Signals such as asynchronous E1s (2 Mbit/s) are multiplexed (bit interleaving), extra bits are added (bit stuffing) to account for the variations of each individual stream and are combined with other bits (framing bits) to form an E2 (8 Mbit/s) stream. Bit interleaving and bit stuffing is used again to multiplex up to E3 (34 Mbit/s). The E1s are neither visible nor accessible within an E3 frame. E3s are multiplexed up to

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higher rates in the same manner. At the higher asynchronous rate, they cannot be accessed without demultiplexing.

In a synchronous system, such as SDH, the average frequency of all clocks in the system will be the same. Every slave clock can be traced back to a highly stable reference clock. Thus, the STM 1 rate remains at a nominal 155.52 Mbit/s, allowing many synchronous STM 1 signals to be multiplexed without any bit stuffing. Thus, the STM 1s are easily accessed at a higher STM–N rate.

Low speed synchronous virtual container (VC) signals are also simple to interleave and transport at higher rates. At low speeds, 2.048 Mbit/s E1 signals are transported within synchronous VC 12 signals which run at a constant rate of 2.304 Mbit/s. Single step multiplexing up to STM 1 requires no bit stuffing and VCs are easily accessed.

A mechanism known as ”pointers” accommodates differences in the reference source frequencies and phase wander, and so prevents data loss during synchronisation failures.

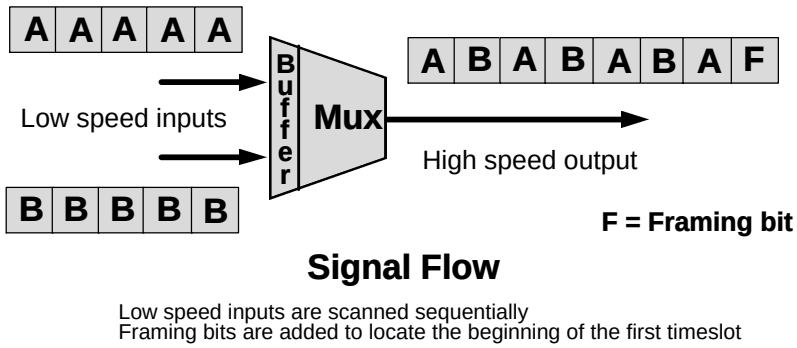
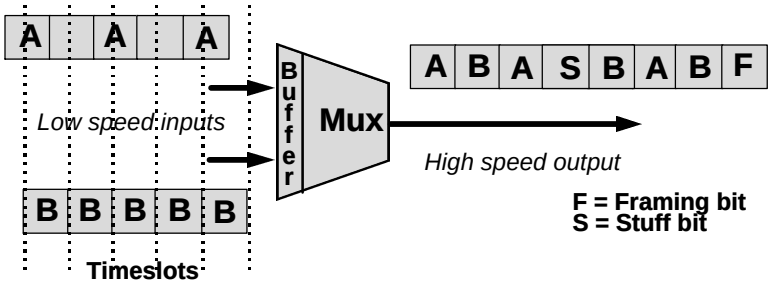


Figure J 5: Multiplexing and Digital Transmission

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Asynchronous Multiplexing is designed to accommodate timing differences in low speed speed signals. Sometimes input timeslots are not available for multiplexing; the input timeslot is filled with a “stuff” bit. Control bits are used to indicate this condition (not shown).

Figure J 6: Asynchronous Multiplexing

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PDH Multiplexing

Traditionally, digital transmission systems and hierarchies have been based on multiplexing signals which are plesiochronous (running at almost the same speed). Also, various parts of the world use different hierarchies which lead to problems of international interworking, for example, between those countries using 1.544 Mbit/s systems (U.S.A. and Japan) and those using the 2.048 Mbit/s system.

In the PDH, tributaries and higher order bit streams are allowed to deviate from a pre defined bit rate by a specified amount. The justification (bit stuffing) process is required which brings all the tributaries up to the same bit rate before multiplexing takes place. However, the justification method makes it impossible to identify the location of specific tributary channels within a higher order bit stream, without demultiplexing back down to the 2 Mb/s tributaries.

To recover a 64 kbit/s channel from a 140 Mbit/s PDH signal, it is necessary to demultiplex the signal all the way down to the 2 Mbit/s level before the location of the 64 kbit/s channel can be identified. PDH requires ”steps” (140 34, 34 8, 8 2 demultiplex; 2 8, 8 34, 34 140 multiplex) to drop out or add an individual speech or data channel. This is due to the bit stuffing used at each level. Extra bits are added (stuffed) in to the digital tributaries which increases the speed of the tributaries until they are all identical.

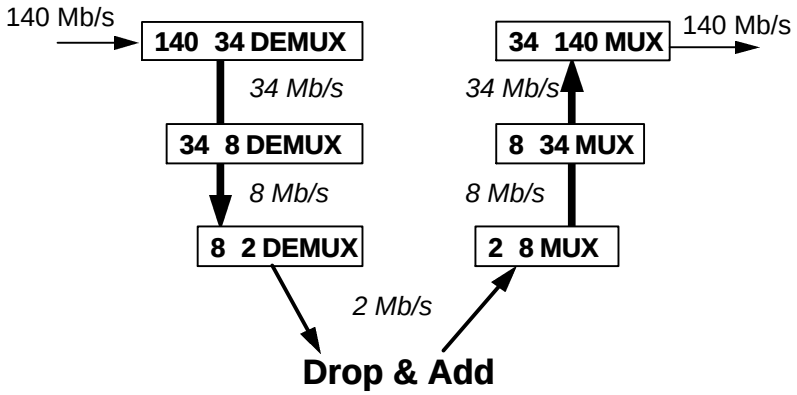


Figure J 7: PDH Multiplexing by steps showing add/drop function

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G.826, M.2101.1, M.2100, and G.821 Analysis

G.826 Error Performance By monitoring Severly Errored Seconds (SES) events for both directions at a single path end point, a network provider is able to determine the unavailable state of the path. This service measure is intended for in service quality measurements of 2 Mb/s and above (including SDH rates). G.826 uses block based measurements, that is, multiple errors in a block are counted as one block error.

PDH G.826 is based on frame and CRC errors and is an in service measurement. G.826 makes use of block based measurements to get media independent results and thus is more convenient for in service measurement.

M.2101.1 This ITU T provides limits for bringing into service (BIS), and limits for maintenance of international SDH paths and international SDH multiplex sections in order to achieve the performance objectives given for a multiservice environment. These objectives include error performance (Recommendation G.826) and unavailability (Recommendation G.827).

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M.2100 This measure of service quality is similar to G.821 in that is uses bit based error measurement. M.2100 combines all error sources during a one (1) errored second count without regard to source (for example, FAS, CRC 4, Code violation, etc.). Out of service measurements use a PRBS pattern, and count bit errors as well as frame related in service error types (for example, FAS, CRC 4). In service measurements count frame related in service error types only (FAS, CRC 4).

G.821 analysis is based on pattern bit errors occurring within the payload of an SDH or PDH rate signal. Bit based measurements are made on the payload with a PRBS pattern. G.821 is an out of service measurement since the normal traffic payload is replaced by a test pattern.

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G.821 Service Quality (PDH/SDH)

The G.821 standard was originally intended to measure 64 kbit/s circuits. Extrapolation is necessary for higher PDH rates (8 Mb/s, 34 Mb/s, and 140 Mb/s). Bit based measurements are made on the payload with a PRBS pattern.

Service quality, per the G.821 ITU T standard involves the following error categories:

- Errored Seconds (ES) a count of seconds which had at least one error during a period of availability;
- Severely Errored Seconds (SES) Number of seconds with a Bit Error Rate (BER) worse than 1×10^{-3};
- Unavailable Seconds (UAS) Unavailable seconds start counting after ten contiguous SES;
- Degraded Minutes (DM) A count of the number of minutes where the BER is worse than 1×10^{-6} and better than 1×10^{-3}; and,
- Error Free Seconds (EFS) Number of seconds that contained no errors.

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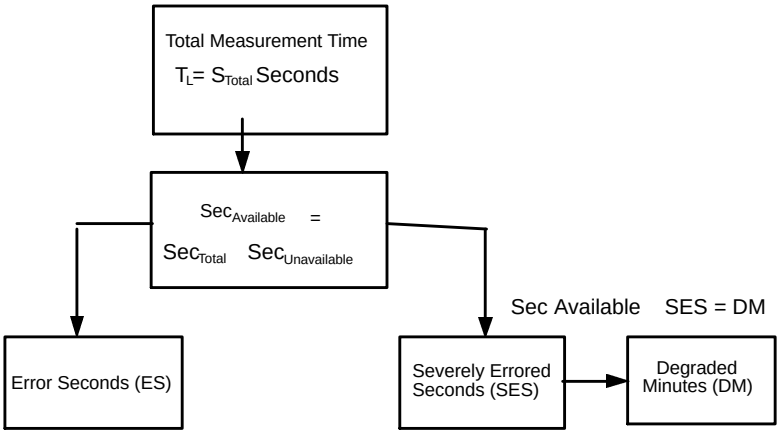


Figure J 8: Guaranteeing G.821 Service Quality

M.2100 Service Quality (PDH)

This measure of service quality is similar to G.821 in that is used bit based error measurement, however it also specifies availability limits. M.2100 combines all error sources during a one (1) errored second count without regard to source (for example, FAS, CRC 4, Code violation, etc.). Out of service measurements use a PRBS pattern, and count bit errors as well as frame related in service error types (for example, FAS, CRC 4). In service measurements count frame related in service error types only (FAS, CRC 4).

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G.826 Service Quality (PDH/SDH)

This service measure is intended for in service quality measurements of 2 Mb/s and above (including SDH rates). G.826 uses block based measurements, that is, multiple errors in a block are counted as one block error. CRC error checks (for PDH) and BIP n (for SDH) are utilized by G.826.

G.826 Error Events are:

- Errored Block A block in which one or more bits are errored.
- Errored Seconds (ES) A one second interval containing one or more errored block(s).
- Severely Errored Seconds (SES) A one second interval containing at least 30% errored blocks or a defect.
- Background Block Error (BBE) An errored block which does not belong to a SES.

G.826 Relative Error parameters (only measured during availability) are:

- Errored Second Ratio The ratio of errored seconds to the total number of seconds in the measurement interval.
- Severely Errored Seconds Ratio (SESR) The ratio of severely errored seconds to the total number of seconds in the measurement interval.
- Background Block Error Ratio (BBER) The ratio of errored blocks not belonging to a SES to the total number of blocks in the measurement interval.

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Error Counts (PDH/SDH)

Error counts are used to determine if the circuit is basically working. Every error is counted. Every second with an error is counted. This measure is used to derive the Bit Error Rate (BER).

Error analysis is used for formal performance testing. It is also used to determine who or what in the network is at fault. Error counts/ error seconds are not counted during ”unavailable” time. A circuit is declared ”unavailable” when there are ten consecutive ES. A circuit is declared as ”available” when there are ten consecutive error free seconds.

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Jitter & Wander Tutorial

Timing & sync working together in the Network?

Summary As little as one or two years ago, network synchronisation was something invisible. It worked and the PDH technology was mature and stable. Now the technology has become unstable and timing/sync has become the first point of contention between inter connected operators.

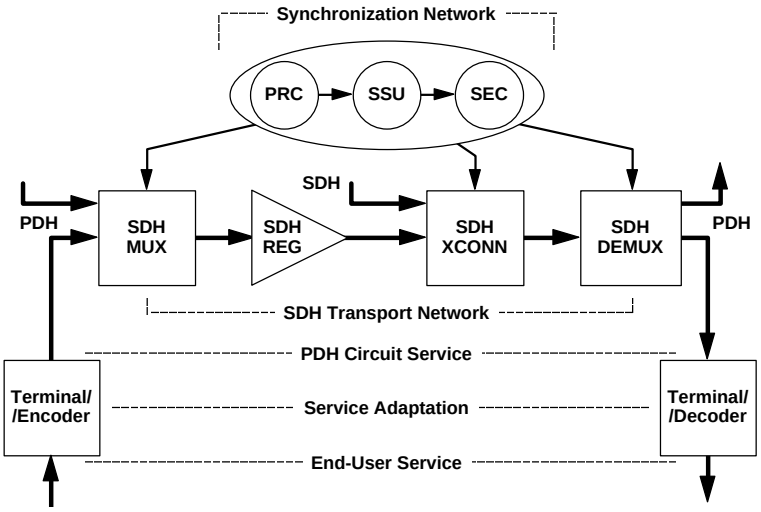
Telecommunication networks transport two entities data and timing as part of a service. As a result, timing has always been very carefully specified, controlled and distributed within networks, across network interfaces and between customers.

To deliver the timing part of the service, the network must be properly synchronised. Good synchronisation is the foundation of Convergence (integrated voice, video and data services). Without management of timing and synchronisation, Convergence just cannot happen. Tektronix is pioneering new measurement methods, particularly in the area of jitter and wander, that can help to establish timing quality parameters.

The new SDH equipment being installed in public networks around the world represents a quantum leap in performance, management and flexibility for network operators. However, the behavior of a working SDH (and/or SONET) network is very different from today's existing PDH networks, something that is being more widely recognised as new networks continue their expansion.

As a consequence, timing and synchronisation are of strategic importance to network operators as they work in the new deregulated environment of the 1990's.

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PRC = Primary Reference Clock
SEC Synchronous Equipment Clock
SSU = Synchronization Supply Unit

Figure J 9: Simple SDH/PDH network model

In the figure above, a PDH circuit is transported over an SDH path, while being multiplexed with other PDH circuits, cross connected with other SDH payloads and regenerated. The model network is synchronized from a logically separate sync network, although it is likely that sync signals will be physically carried on parts of the SDH network.

In the figure above, the middle cross connect (SDH XCONN) takes several AU 4 payloads from its inputs and generates a new aggregate output signal. The timing of its outgoing STM N signal is determined by a separate synchronization reference signal from the sync network.

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Jitter & Wander in the Network

Jitter is defined as the *short term*, and wander is defined as the *long term*, variations of the significant instants of a digital signal from their ideal positions in time

Jitter and wander have both an amplitude (how much the signal is shifting in phase), and a frequency (how quickly the signal is shifting in phase). Jitter is defined in the ITU T G.810 standard as phase variation with frequency components greater than or equal to 10 Hz. Wander is defined as phase variations at a rate less than 10 Hz.

PDH Network Systems

In an asynchronous system, timing is derived by phase locked loops that track the slow phase variations (the wander), so wander is not seen by the system. The jitter component of the phase, which is not tracked, reduces the operating margins of the system. Therefore in an asynchronous system, jitter is the main parameter of interest.

SDH Network Systems

In a synchronous system, such as the Synchronous Digital Hierarchy (SDH), both jitter and wander are of interest. There are still phase locked loops for clock recovery which are sensitive to jitter. But there are also First In, First Out (FIFO) data buffers that are sensitive to wander. These FIFOs operate open loop, depending on inherent synchronisation between the write clock and the read clock. Therefore a key parameter of interest is the variation of phase from 10 Hz all the way down to dc, i.e., wander.

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Consequences in the Network

There are four major consequences of excessive jitter on a received signal:

Bit errors can be produced because decision logic circuits do not operate at the optimum time. At high jitter frequencies, the clock recovery circuitry can no longer keep up with the rapid phase changes of the incoming signal. And when the recovered clock gets out of step with the incoming signal by more than 0.5 UI, the signal bit is incorrectly sampled and may cause an error.

Data can be lost because input buffers can either become empty (too little data being received) or overflow (too much data), causing frame slips, data loss or data repetition resulting in Severely Errored Seconds (SES) and other defects. Particularly at low jitter frequencies, jitter amplitude can become extremely large (and is theoretically unbounded). The consequences of interconnecting and meshing new synchronous networks together is still largely uncharacterised.

If the SDH (SONET) transport is carrying a coded analogue signal, degradation will occur when the analogue signal is reconstructed after it has been demapped from the SDH payload. Jitter on the output digital signal directly causes unwanted phase modulation of the analogue signal. This is not normally a problem with voice and data services, but can be a significant degradation for digitized TV signals which depend on maintaining good low frequency phase information within tight specifications.

In new hybrid SDH/PDH networks, a major cause of payload jitter is upstream wander. This wander forces pointer adjustments, which jitter the payload, which leads to FIFO slips. These slips prompt Severely Errored Seconds (SES), which force a retransmission of the data, tying up the circuit, and preventing the circuit from earning additional revenue.

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Principles & Metrics of Jitter and Wander

Jitter and wander are defined respectively as “the *short term* and the *long term* variations of the significant instants of a digital signal from their ideal positions in time”. One way to think of this is a digital signal continually varying its position in time by moving backwards and forwards with respect to an ideal clock source. Most engineers’ first introduction to jitter is viewed on an oscilloscope (Figure J 10). When triggered from a stable reference clock, jittered data is clearly seen to be moving in relation to a reference clock.

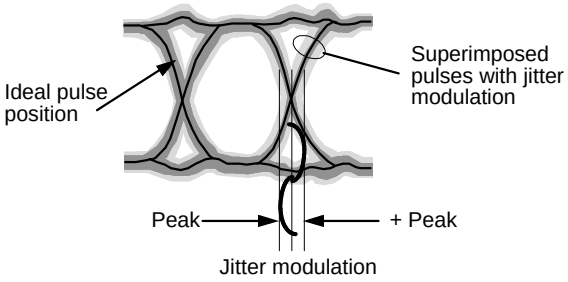


Figure J 10: Jitter as viewed on an oscilloscope

In fact, jitter and wander on a data signal are equivalent to a phase modulation of the clock signal used to generate the data (Figure J 11). Naturally, in a practical situation, jitter will be composed of a broad range of frequencies at different amplitudes.

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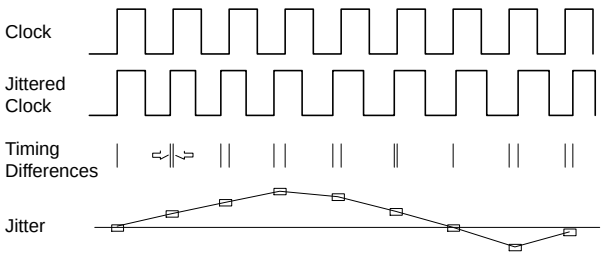


Figure J 11: Phase variation between two signals

Jitter and wander have both an amplitude: how much the signal is shifting in phase and a frequency: how quickly the signal is shifting in phase. Jitter is defined in the ITU T G.810 standard as phase variation with frequency components greater than or equal to 10 Hz whilst wander is defined as phase variations at a rate less than 10 Hz (Figure J 12).

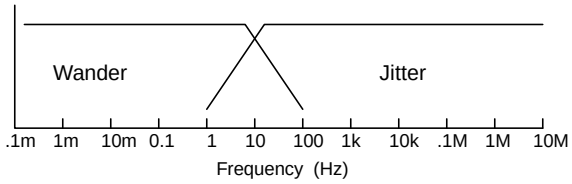


Figure J 12: Frequency ranges of jitter & wander (ref. G.810)

When measuring jitter or wander, always be sure what the reference clock is. By definition, a signal has no phase variation when referenced to itself jitter or wander always refers to a difference between one timed signal and another.

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Metrics for Jitter

Jitter is normally specified and measured as a maximum phase amplitude within one or more measurement bandwidths. A single interface may be specified using several different bandwidths since the effect of jitter varies depending on its frequency, as well as its amplitude.

UI (Unit Intervals)

Jitter amplitude is specified in Unit Intervals (UI), such that one UI of jitter is equal to one data bit width, irrespective of the data rate. For example, at a data rate of 2048 kbit/s, one UI is equivalent to 488 ns, whereas at a data rate of 155.52 Mbit/s, one UI is equivalent to 6.4 ns.

Jitter amplitude is normally quantified as a Peak to Peakvalue rather than an RMS value, since it is the peak jitter that would cause a bit error to be made in network equipment.

However, RMS values are useful for characterising or modelling jitter accumulation in long line systems using SDH regenerators, for example, and the appropriate specifications use this metric instead of Peak to Peak.

Metrics for Wander

A wander measurement requires a “wander free” reference, relative to which the wander of another signal is measured. Any Primary Reference Clock (PRC) can serve as a reference because of its long term accuracy (10^{-11} or better) and good short term stability. A PRC is usually realised with a caesium based clock, although it may also be realised using GPS technology.

Because it involves low frequencies with long periods, wander data can consist of hours of phase information. However, because phase

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transients are of importance, high temporal resolution is also needed. So to provide a concise measure of synchronisation quality, three wander parameters have been defined and are used to specify performance limits:

- TIE: Time Interval Error (wander in ns)
- MTIE: Maximum Time Interval Error (related to Peak to Peakwander)
- TDEV: Time Deviation (related to rms wander)

Formal mathematical definitions of these and other parameters can be found in ITU T G.810 standard.

TIE (Time Interval Error)

TIE is defined as the phase difference between the signal being measured and the reference clock, typically measured in ns. TIE is conventionally set to zero at the start of the total measurement period *T*. Therefore TIE gives the phase change since the measurement began. An example is given in Figure J 13. The increasing trend shown is due to a frequency offset of about 1 ns per 10 s, or 10^{-10} in this case.

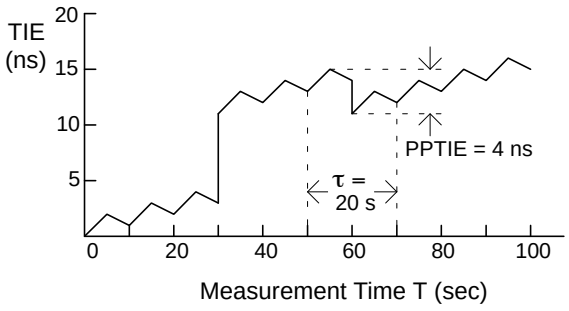


Figure J 13: Example of TIE wander measurement

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MTIE (Maximum Time Interval Error)

MTIE is a measure of wander that characterises frequency offsets and phase transients. It is a function of a parameter τ called the *Observation Interval.* The definition (Figure J 14) is:

MTIE(τ) is the largest Peak to PeakTIE (i.e.,. wander) in any observation interval of length τ.

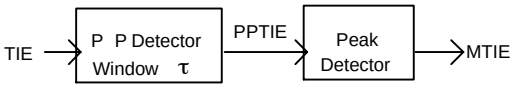


Figure J 14: Functional definition of MTIE

In order to calculate MTIE at a certain observation interval τ from the measurement of TIE, a time window of length τ is moved across the entire duration of TIE data, storing the peak value. The peak value is the MTIE(τ) at that particular τ. This process is repeated for each value of τ desired.

For example, Figure J 13 shows a window of length τ=20 sec at a particular position. The Peak to PeakTIE for that window is 4 ns. However, as the 20 sec window is slid through the entire measurement period, the largest value of ppTIE is actually 11 ns (at about 30 sec into the measurement). Therefore MTIE(20 s) = 11 ns.

The next figure J 15 shows the complete plot of MTIE(τ) corresponding to the plot of TIE in Figure J 13. The rapid 8 ns transient at *t* = 30 s is reflected in the value MTIE(τ) = 8 ns for very small τ.

It should be noted that the MTIE plot is monotonically increasing with observation interval and that the largest transient masks events of lesser amplitude.

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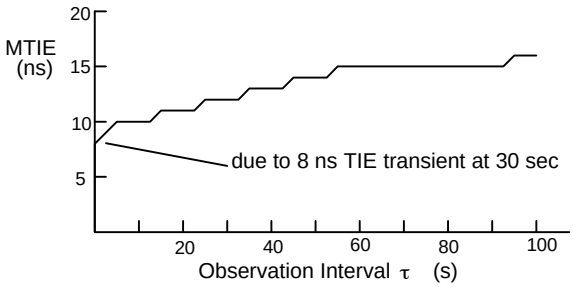


Figure J 15: Example of MTIE wander measurement (corresponding to Figure J 13)

TDEV (Time Deviation)

TDEV is a measure of wander that characterises its spectral content. It is also a function of the parameter τ called *Observation Interval.* The definition (Figure J 16) is:

TDEV(τ) is the rms of filtered TIE, where the bandpass filter (BPF) is centred on a frequency of 0.42/τ.

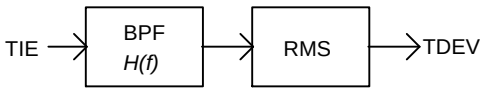


Figure J 16: Functional definition of TDEV

Figure J 17 shows two plots of TDEV(τ). The first plot (for *T*=100s), corresponding to the TIE data of Figure J 13 shows TDEV rising with τ. This is because, for the short measurement period *T*=100s, the two transients in 5 dominate.

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If we were to make a longer TIE measurement out to T = 250s, the effect of the two transients on TDEV would become less, assuming there are no more transients. The TDEV characteristic labelled T=250 s would be the result.

It should also be noted that TDEV is insensitive to constant phase slope (frequency offset).

To calculate TDEV for a particular τ, the overall measurement period T must be at least 3τ. For an *accurate* measure of TDEV, a measurement period of at least 12τ is required. This is because the rms part of the TDEV calculation requires sufficient time to get a good statistical average.

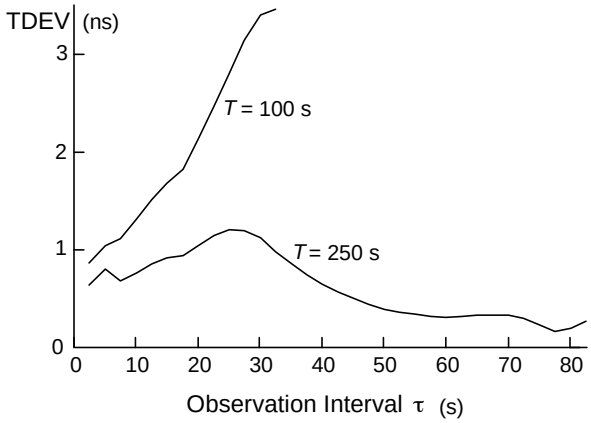


Figure J 17: Example of TDEV wander measurement (corresponding to Figure J 13)

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Appendix K: Cleaning Instructions

Clean the CTS850 often enough to prevent dust and dirt from accumulating. Dirt acts as a thermal insulator, preventing effective heat dissipation, and can also provide high-resistance leakage paths between conductors or components in a humid environment.



CAUTION. *To avoid damage to the optical ports, refer to Appendix H for specific instructions on how to clean the optical ports.*

Cleaning the Exterior

Clean the dust from the outside of the instrument with a soft, clean cloth or small brush. A brush is especially useful for removing dust from around the buttons and connectors. Remove hardened dirt with a soft cloth dampened with a mild detergent and water solution. Do not use abrasive cleaners.

Cleaning the CRT

Clean the light filter and CRT face with a soft, lint-free cloth dampened in denatured alcohol. Do not use abrasive cleaners.

Cleaning the Interior

Interior cleaning and maintenance should be performed by qualified service personnel only. Instructions for interior maintenance are provided in the service manual.

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Glossary and Index

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Glossary & ITU T Standards

CT850 Test Set SDH/PDH, Jitter/Wander

Included in this section along with the glossary of terms is a listing of ITU T standards for SDH and PDH.

Three sets of terms are arranged at the beginning of this section because it is important to see that they are not equivalent terms, which is how they get used in normal discussions. They are:

Add/ Drop

The process where a part of the information carried in a transmission system is extracted (dropped) at an intermediate point and different information is inserted (added) for subsequent transmission. The remaining traffic passes straight through the multiplexer without additional processing.

Map/ Demap

A term for multiplexing, implying more visibility inside the resultant multiplexed bit stream than available with conventional asynchronous techniques.

Multiplex/ Demultiplex

Multiplex (MUX) To transmit two or more signals over a single channel. Demultiplex (DEMUX) To separate two or more signals previously combined by compatible multiplexing equipment. Demultiplexing A process applied to a multiplex signal for recovering signals combined within it and for restoring the distinct individual channels of the signals.

An alphabetical list of glossary terms follows.

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Add/Drop Multiplexer (ADM)

A multiplexer capable of extracting and inserting lower rate signals from a higher rate multiplexed signal without completely demultiplexing the signal.

Administrative Unit (AU)

An Administrative Unit is the information structure which provides adaptation between the higher order path layer and the Multiplex Section layer. The Virtual Container (VC) plus the pointers (H1, H2, H3 bytes) is called the Administrative Unit (AU).

AIS (Alarm Indicating Signal)

A code sent downstream indicating an upstream failure has occurred.

AMI

Alternate Mark Inversion. The line coding format in transmission systems where successive ones (marks) are alternatively inverted (sent with polarity opposite that of the preceding mark).

Analog Jitter Out

A signal that contains the demodulated jitter from a line or clock input.

ANSI

American National Standards Institute. A standards setting, non government organization, which develops and publishes standards for ”voluntary” use in the United States.

Asynchronous

A network where transmission system payloads are not synchronized and each network terminal runs on its own clock.

Asynchronous Transfer Mode (ATM)

A multiplexing/switching technique in which information is organized into fixed length cells with each cell consisting of an identification header field and an information field. The transfer mode is asynchronous in the sense that the use of the cells depends on the required or instantaneous bit rate.

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Attenuation
Reduction of signal magnitude or signal loss, usually expressed in decibels.

AU-4
Virtual Container (VC) plus the Transport Overhead pointers.

AU N
Administrative Unit N; a discrete unit of the SDH payload carrying one or more VC N

Automatic Protection Switching (APS)
The ability of a network element to detect a failed working line and switch the service to a spare (protection) line. 1+1 APS pairs a protection line with each working line. 1:N APS provides one protection line for every N working lines.

Backhauling
Cumbersome traffic management technique used to reduce the expense of multiplexing/demultiplexing.

Bandwidth
Information carrying capacity of a communication channel. Analog bandwidth is the range of signal frequencies that can be transmitted by a communication channel or network.

Bidirectional
Operating in both directions. Bi directional APS allows protection switching to be initiated by either end of the line.

Binary N Zero Suppression (BNZS)
Line coding system that replaces N number of zeros with a special code to maintain pulse density required for clock recovery. N is typically 3, 6, or 8.

BIP 8 (Bit Interleaved Parity 8)
A method of error checking in SDH which allows in service performance monitoring. For example, a BIP 8 creates eight bit (one byte) groups, then does a parity check for each of the eight bit positions in the byte.

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B ISDN (Broadband Integrated Services Digital Network)
A single ISDN network which can handle voice, data, and eventually video services.

Bit
One binary digit; a pulse of data.

Bit Error vs. Block Error

Error rate statistics play a key role in measuring the performance of a network. As errors increase, user payload (especially data) must be re transmitted, or lost entirely.

Bit Error Rate (BER) The number of bit errors detected in a unit of time, usually one second. Bit Error rate (BER) is calculated with this formula:

BER = errored bits received/ total bits sent.

Block Error Rate (BLER) One of the underlying concepts of error performance is the notion of Errored Blocks, i.e., blocks in which one or more bits are in error. A block is a set of consecutive bits associated with the path or section monitored by means of an Error Detection Code (EDC), such as Bit Interleaved Parity (BIP). Block Error rate (BLER) is calculated with this formula:

BLER = errored blocks received/ total blocks sent.

Bit Interleaved Parity (BIP)
A parity check that groups all the bits in a block into units (such as byte), then performs a parity check for each bit position in the group.

Bit Stuffing
In asynchronous systems, a technique used to synchronize asynchronous signals to a common rate before multiplexing.

Bits per second (bit/s)
The number of bits passing a point every second. The transmission rate for digital information.

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Broadband
Services requiring over 2 Mbit/s transport capacity.

CCITT
See ITU.

Channel
The smallest subdivision of a circuit that provides a type of communication service; usually a path with only one direction.

Circuit
A communications path or network; usually a pair of channels providing bi directional communication.

Circuit Switching
Basic switching process whereby a circuit between two users is opened on demand and maintained for their exclusive use for the duration of the transmission.

Coding Violation (CV)
A transmission error detected by the difference between the transmitted line code and that expected at the receive end by the logical coding rules.

Concatenation
The linking together of various data structures, for example two channels joined to form a single channel. In SDH, a number (M) of TUs can be linked together to produce a concatenated container, M times the size of the TU. An example of this is the concatenation of five TU 2s to carry a 32 Mbit/s video signal, known as VC 2 5c. Once assembled, any concatenated VC structure is multiplexed, switched and transported through the network as a single entity.

Conformance Tests
Conformance Tests (also know as Standards Conformance Tests) are predefined tests that measure the impact of jitter or wander on networks or network elements. They are defined in the ITU-T Recommendations.

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Cyclic Redundancy Check (CRC)
A technique for using overhead bits to detect transmission errors.

Data Communications Channel (DCC)
Data channels in SDH that enable OAM communications between intelligent controllers and individual network nodes as well as inter node communications.

dB
The symbol for decibels.

dBm
The symbol for power level in decibels relative to 1 mW.

Defect
A limited interruption in the ability of an item to perform a required function. Persistence of a defect can cause a failure.

Digital Cross connect (DCS)
An electronic cross connect which has access to lower rate channels in higher rate multiplexed signals and can electronically rearrange (cross connect) those channels.

Digital Signal
An electrical or optical signal that varies in discrete steps. Electrical signals are coded as voltages, optical signals are coded as pulses of light.

E1, E2, E3, E4
Alternative names for the ITU T 2 Mb/s, 8 Mb/s, 32 Mb/s, and 140 Mb/s tributary signals.

ES
Errored Second; measure of network or equipment performance

ETSI (European Telecommunications Standards Institute)
Organization responsible for defining and maintaining European standards, including SDH.

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Failure
A termination of the ability of an item to perform a required function. A failure is caused by the persistence of a defect.

FEBE (Far End Block Error)
See Remote Error Indication (REI).

FERF (Far End Receive Failure)
See Remote Defect Indication (RDI).

FIFO
First In First Out; a type of data buffer

Fixed Stuff
A bit or byte whose function is reserved. Fixed stuff locations, sometimes called reserved locations, do not carry overhead or payload.

Floating mode
A virtual tributary mode that allows the VC synchronous payload envelope to begin anywhere in the VC.

Framing
Method of distinguishing digital channels that have been multiplexed together.

Frequency
The number of cycles of periodic activity that occur in a discrete amount of time.

Frequency Drift Rate
The rate of change of a line or clock frequency, measured in ppm/sec. A new measure of tining quality.

Fullband
A jitter filter range that includes the wideband range but extends the low-frequency cutoff to 10 Hz or below. This filter is useful when analyzing video timing quality.

Grooming
Consolidating or segregating traffic for efficiency.

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HDB3

High Density Bipolar 3. A bipolar coding method that does not allow more than three consecutive zeros.

Highband

A jitter filter range that measures high-frequency jitter. The band pass filters are defined in ITU-T standards (where they are sometimes referred to as HP2 LP1).

Highpass

The lower 3 dB corner frequency of a filter. The filter passes frequencies higher than this frequency.

HP PLM

High order path, payload label mismatch (or path label mismatch). This measurement is classifed as a defect. Disable or Enable this choice at the RX Analysis Configuration, *Trace Mismatch Detection* menu.

HP UNEQ

High order path, unequipped. This measurement is classifed as a defect. Disable or Enable this choice at the RX Analysis Configuration, *Trace Mismatch Detection* menu.

Interleave

The ability of SDH to mix together and transport different types of input signals in an efficient manner, thus allowing higher transmission rates.

ITU (International Telecommunications Union)

An agency of the United Nations responsible for the regulation, standardization, co ordination and development of international telecommunications as well as the harmonization of national policies. It functions through international committees of telecommunications administrations, operators, manufacturers and scientific/industrial organizations.

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Jitter
The short term variations of the significant instants of a timing signal from their ideal positions in time (where short term implies that these variations are of frequency greater than or equal to 10 Hz).

Jitter Hit
When peak-to-peak jitter crosses a predetermined threshold.

Jitter Tolerance
A conformance test that measures the susceptability of a network element input to incoming jitter.

Jitter Transfer
A conformance test that measures the transfer of jitter from the input to the output of a network element.

Jitter Transfer Function
A graph that shows jitter gain as a function of jitter frequency.

Line Alarm Indication Signal (AIS)
A Line AIS is generated by Section Terminating Equipment upon Loss of Signal or Loss of Frame.

Line Coding Violation (LCV)
The sum of the BIP errors detected at the Line layer. Line CVs are collected using the BIP codes in the B2 bytes of the Line Overhead.

Line Errored Second (ES)
A second during which at least one Line CV occurred, or a second during which the line was in the Line AIS state.

Line Overhead (LOH)
Controls the payload information using the section layer and provides alarm indications, error monitoring, and message signalling between two LTEs.

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Line Severely Errored Second (SES)
A second with N or more Line CVs, or a second during which the line was in the Line AIS state. The value of N varies with the transmit rate, but corresponds to a 2×10^{-7} BER.

Locked Mode
A virtual tributary mode that fixes the starting location of the VC. Locked mode has less pointer processing than floating mode.

LOF
An acronym for Loss of Frame.

LOP
An acronym for Loss of Pointer.

LOS
An acronym for Loss of Signal.

Low Frequency Jitter
Jitter that crosses the wander threshold (approximately 0.1 Hz to 500 Hz). Low frequency jitter is often the result of pointer movement.

Lowpass
The upper 3 dB corner frequency of a filter. The filter passes frequencies lower than this frequency.

LP PLM
Low order path, payload label mismatch (or path label mismatch). This measurement is classifed as a defect. Disable or Enable this choice at the RX Analysis Configuration, *Trace Mismatch Detection* menu.

LP RFI
Low order path, remote failure indication. This measurement is classifed as a defect. Disable or Enable this choice at the RX Analysis Configuration, *Trace Mismatch Detection* menu.

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LP UNEQ
Low order path, unequipped. This measurement is classifed as a defect. Disable or Enable this choice at the RX Analysis Configuration, *Trace Mismatch Detection* menu.

LTE
An acronym for Line Terminating Equipment.

Mapping
The process of associating each bit transmitted by a service into the SDH payload structure that carries the service. For example, mapping a E1 service into a SDH VC 12 associates each bit of the E1 with a location in the VC 12.

MTIE
Maximum Time Interval Error Related to Peak to Peak Wander.

Multiframe
Any structure made of multiple frames. SDH has facilities to recognize multiframes at the E1 level and at the VC n level.

Multiplex Section Alarm Indication Signal (MS AIS)
MS AIS is generated by Section Terminating Equipment (STE) upon the detection of a Loss of Signal or Loss of Frame defect, on an equipment failure. MS AIS maintains operation of the downstream regenerators, and therefore prevents generation of unnecessary alarms. At the same time, data and orderwire communication is retained with the downstream Line Terminating Equipment (LTE).

Multiplex Section Remote Defect Indication (MS RDI)
A signal returned to the transmitting Line Terminating Equipment (LTE) upon detecting a Loss of Signal, Loss of Frame, or MS AIS defect. MS RDI was previously known as Multiplex Section FERF.

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Multiplex Section Overhead (MSOH)
18 bytes of overhead accessed, generated, and processed by MS terminating equipment. This overhead supports functions such as locating the payload in the frame, multiplexing or concatenating signals, performance monitoring, automatic protection switching and line maintenance.

Multiplexer
A device for combining several channels to be carried by a single physical channel.

Narrowband
Services requiring up to 2 Mbit/s transport capacity.

Network Element (NE) In SDH, the five basic network elements are:
add/drop multiplexer;
broadband digital cross connect;
wideband digital cross connect;
flexible multiplexer; and,
regenerator.

Any device which is part of a SDH transmission path and serves one or more of the section, line and path terminating functions.

OAM
Operations, Administration, and Maintenance. Also called OAM&P.

OAM&P (Operations, Administration, Maintenance, and Provisioning)
Provides the facilities and personnel required to manage a network.

Orderwire
A dedicated voice channel used by installers to expedite the provisioning of lines.

OOF
An acronym for Out of Frame.

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OS (Operations System)
Sophisticated applications software that manages operation of the entire network.

OSI Seven layer Model
A standard architecture for data communications. Layers define hardware and software required for multi vendor information processing equipment to be mutually compatible. The seven layers from lowest to highest are: physical, link, network, transport, session, presentation, and application.

Output Jitter
A compliance test the measures the output jitter of a network or network element.

Overhead
Extra bits in a digital stream used to carry information besides traffic signals. Orderwire, for example, would be considered overhead information.

Packet Switching
An efficient method for breaking down and handling high volume traffic in a network. A transmission technique that segments and routes information into discrete units. Packet switching allows for efficient sharing of network resources as packets from different sources can all be sent over the same channel in the same bitstream.

Parity check
An error checking scheme which examines the number of transmitted bits in a block which hold the value of ”one”. For even parity, an overhead parity bit is set to either one or zero to make the total number of transmitted ones in the data block plus parity bit an even number. For odd parity, the parity bit is set to make the total number of ones in the block an odd number.

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Path
A logical connection between a point where a service in a VC is multiplexed to the point where it is demultiplexed.

Path Overhead (POH)
Overhead accessed, generated, and processed by path terminating equipment.

Path Terminating Equipment (PTE)
Network elements such as fibre optic terminating systems which can access, generate, and process Path Overhead.

Payload
The portion of the SDH signal available to carry service signals such as E1 and E3. The contents of a VC.

Payload Pointer
Indicates the beginning of a Virtual Container.

Payload capacity
The number of bytes the payload of a single frame can carry.

Plesiochronous
A network with nodes timed by separate clock sources with almost the same timing.

PLL
Phase Locked Loop; method of timing recovery

Pointer
A part of the SDH overhead that locates a floating payload structure. AU n pointers locate the payload. TU m Pointers locate floating mode virtual tributaries. All SDH frames use AU pointers; only floating mode virtual containers use TU pointers.

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Pointer Hit

When the line or clock frequency drift crosses a predetermined threshold.

Pointer Jitter

A measure of the jitter output of a network when specified pointer test sequences are applied to its input.

ppTIE

Peak to PeakTime Interval Error , a measure of wander

PRC (Primary Reference Clock)

In a synchronous network, all the clocks are traceable to one highly stable reference supply, the Primary Reference Clock (PRC). The accuracy of the PRC is better than ±1 in 10^{11} and is derived from a cesium atomic standard.

Remote Alarm Indication (RAI)

A code sent upstream in a E *n* network as a notification that a failure condition has been declared downstream. (RAI signals were previously referred to as Yellow signals.)

Remote Defect Indication (RDI)

A signal returned to the transmitting Terminating Equipment when the receiving Terminating Equipment detects a Loss of Signal, Loss of Frame, or AIS defect. RDI was previously known as FERF.

Remote Error Indication (REI)

An indication returned to a transmitting node (source) that an errored block has been detected at the receiving node (sink). This indication was formerly known as Far End Block Error (FEBE).

Remote Failure Indication (RFI)

A failure is a defect that persists beyond the maximum time allocated to the transmission system protection mechanisms. When this situation occurs, an RFI is sent to the far end and will initiate a protection switch if this function has been enabled.

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Regenerator
Device that restores a degraded digital signal for continued transmission; also called a repeater.

rms
Root Mean Square; calculation often applied to power and noise measurements

SDH (Synchronous Digital Hierarchy)
The ITU defined international networking standard whose base transmission level is 155 Mbit/s (STM 1). SDH standards were first published in 1989 to address interworking between the ITU and ANSI transmission hierarchies.

SEC (Synchronous Equipment Clock)
G.813 slave clock contained within a SDH network element.

Section
The span between two SDH network elements capable of accessing, generating, and processing only SDH Section overhead.

Section Overhead
Nine columns of overhead accessed, generated, and processed by section terminating equipment. This overhead supports functions such as framing the signal and performance monitoring.

Section Terminating Equipment (STE)
Equipment that terminates the SDH Section layer. STE interprets and modifies or creates the Section Overhead.

SES
Severely Errored Second; measure of network performance

Slip
An overflow (deletion) or underflow (repetition) of one frame of a signal in a receiving buffer.

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SONET (Synchronous Optical Network)
A standard for optical transport in the United, States, Canada, Japan, Korea and Hong Kong that defines optical carrier levels and their electrically equivalent synchronous transport signals. SONET allows for a multi vendor environment and positions the network for transport of new services, synchronous networking, and enhanced OAM&P.

SSM (Synchronisation Status Message)
Bits 5 to 8 of SDH overhead byte S1 are allocated for Synchronisation Status Messages. See further details on the assignment of bit patterns for byte S1 in the section of this primer on Multiplex Section Overhead.

Stuffing
see bit stuffing

Synchronous
A network where transmission system payloads are synchronized to a master (network) clock and traced to a reference clock. A network where all clocks have the same long term accuracy under normal operating conditions.

Synchronous Equipment Timing Source (SETS)
A network equipment clock.

Synchronous Transport Module (STM)
A structure in the SDH transmission hierarchy. STM 1 is SDH's base level transmission rate equal to 155 Mbit/s. Higher rates of STM 4, STM 16, and STM 64 are also defined.

TDEV
Time Deviation; a measure of wander

Through Mode
The ability to retransmit the incoming signal and manipulate its contents.

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TIE
Time Interval Error is the time difference in nanoseconds between the nominal value of a line or clock period and the actual received period.

Tributary
The lower rate signal that is input to a multiplexer for combination (multiplexing) with other low rate signals to form a higher rate signal.

Tributary Unit (TU)
A Tributary Unit is an information structure which provides adaptation between the lower order path layer and the higher order path layer. It contains the Virtual Container (VC) plus a tributary unit pointer.

Tributary Unit Group (TUG)
Contains several Tributary Units.

UI
Unit Interval; a measure of jitter

UIpp
Unit Interval Peak to Peak;a common measure of jitter

UIrms
Unit Interval rms; a measure of jitter in line systems

Virtual Container (VC)
A signal designed for transport and switching of sub SDH payloads.

Wander
The long term variations of the significant instants of a digital signal from their ideal position in time (where long term implies that these variations are of frequency less than 10 Hz).

Wideband
A jitter filter range that measures jitter over a wide range. The band pass filters are defined in ITU-T standards (where they are sometimes referred to as HP1 LP1).

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Yellow Signal
See Remote Alarm Indication (RAI).

SDH & PDH Standards for ITU T

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Vocabulary of digital transmission and multiplexing and PCM terms

G.702
Digital Hierarchy bit rates

G.703
Physical/ electrical characteristics of hierarchical digital interfaces PDH/SDH

G.704
Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44736 kbit/s hierarchical levels

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Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704

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SDH Framing & Multiplexing; PDH Mapping/Demapping; Network Node Interface for the SDH

G.732
2 Mb/s TimeSlot 16 AIS definition

G.742
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G.751
PDH Frame Structure for 34 Mb/s, 140 Mb/s

G.752
PDH Framing Structure for 45 Mb/s (M23 positive justification)

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G.772
PDH Monitor Mode Levels Protected monitoring points provided on digital transmission systems

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G.780
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PDH/SDH Error Analysis Perfomance/block measurements for rates below primary rate

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SDH Jitter Tolerance; Digital line systems based on SDH for use on optical fibre cables

I.432
B ISDN User network interface Physical layer specification

M.2100
PDH Error Analysis

M.2101.1
Performance Limits for BIS and Maintenance of Int' SDH Paths and Multiplex Sections

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General requirements for instrumentation for performance measurements on digital transmission equipment

O.151, O.152, O.153
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O.171
Specifications for Measuring Equipment Thru Mode Jitter

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O.181
Equipment to assess error performance on STM N interfaces

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