User Manual

Tektronix

TDSCPM1
Communications Pulse Measurements Application

071-0605-00

This document supports software version 1.0.0 and above.

Warning
The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

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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.

Connect and Disconnect Properly. Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Disconnect the probe input and the probe ground from the circuit under test before disconnecting the probe from the measurement instrument.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Symbols and Terms

Terms in this Manual. This term may appear in this manual:

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

Preface

This manual contains operating information for the TDSCPM1 Communications Pulse Measurements Application. The manual consists of the following chapters:

- The *Getting Started* chapter briefly describes the TDSCPM1 Communications Pulse Measurements Application, lists oscilloscope compatibility, and provides installation instructions.
- The *Operating Basics* chapter covers basic operating principles of the application and includes a tutorial that teaches you how to set up the application to acquire a waveform, take measurements, and view the results.

  To show you how to operate the application using GPIB commands, this chapter includes a simple GPIB program.
- The *Reference* chapter includes a diagram of the menu structure and descriptions of parameters.
- The *Measurement Algorithms* appendix contains information on measurement guidelines and on how the application takes the measurements.
- The *GPIB Command Syntax* appendix contains a list of arguments and values that you can use with the GPIB commands and their associated parameters.

Related Documentation

The user manual for your oscilloscope provides general information on how to operate the oscilloscope.

Programmer information in the online help for your TDS500D, TDS700C, or TDS700D oscilloscope provides details on how to use GPIB commands to control the oscilloscope. You can also download the tdsprogm.zip file (online help) with examples from the www.Tektronix.com web site. Refer to *Updates Through a Web Browser* on page 2 for information on how to download the file.

The *ITU-T Recommendation G.704(07/95), General Aspects of Digital Transmission Systems* document provides information on the ITU-T G.703 standard.

The *American National Standard for Telecommunications – Digital Hierarchy – Electrical Interfaces* document provides information on the ANSI T1.102 standard.

Conventions

This manual uses the following conventions:

- This manual refers to the TDSCPM1 Communications Pulse Measurements Application as the TDSCPM1 application or as the application.
- When steps require that you make a sequence of selections using front-panel controls and menu buttons, an arrow (→) marks each transition between a front panel button and a menu, or between menus. Names that are for a main menu or side menu item are clearly indicated: Press VERTICAL MENU → Coupling (main) → DC (side) → Bandwidth (main) → 250 MHz (side).

Contacting Tektronix

Product support	For questions about using Tektronix measurement products, 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	Tektronix offers extended warranty and calibration programs as options on many products. Contact your local Tektronix distributor or sales office. For a listing of worldwide service centers, visit our web site.
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 USA
Web site	www.Tektronix.com

Getting Started

Product Description

The TDSCPM1 Communications Pulse Measurements Application is a Java™-based application that enhances basic capabilities of Tektronix oscilloscopes with Option 2C (Communications Signal Analyzer package).

The application provides pulse- and eye-mask pattern, spectral power, pulse amplitude, and pulse balance testing for data rates defined in the ITU-T G.703 and ANSI T1.102 communications standards.

Figure 1 shows an example of a pulse-mask pattern, a communications signal, and the Results readout.

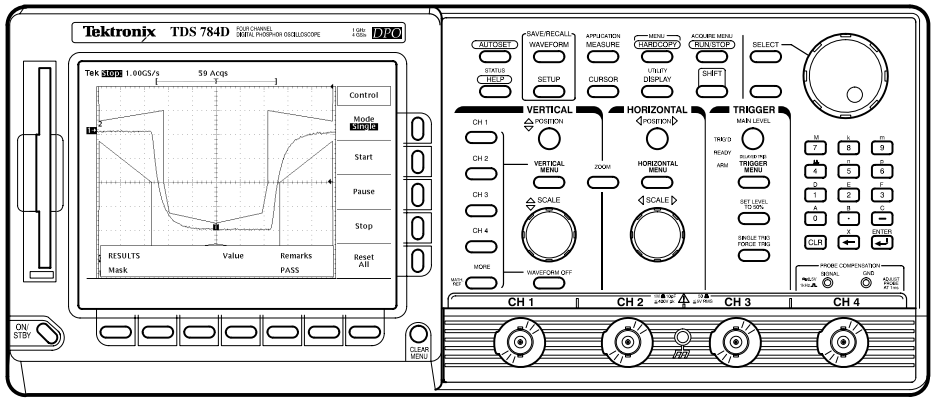


Figure 1: TDSCPM1 Communications Pulse Measurements Application

Compatibility

Table 1 lists the minimum Tektronix product requirements needed to operate the Communications Pulse Measurements Application.

Table 1: Compatible products

Oscilloscope	Firmware	Required options
TDS500D	V 6.4e and up	Option 2C and Option HD (hard disk drive) or Option 2C and Option 2M (hard disk drive + 8 MB record)
TDS700D	V 6.4e and up	Option 2C and Option HD (hard disk drive) or Option 2C and Option 2M (hard disk drive + 8 MB record)
TDS700C. number B020100 and up	V 6.4e and up	Option 2C and Option HD (hard disk drive) or Option 2C and Option 2M (hard disk drive + 8 MB record)

For a current list of compatible oscilloscopes, check the Tektronix, Inc. web site in the Software and Drivers category.

Requirements and Restrictions

The TDS Run-Time Environment V1.2.0 and above must be installed on the oscilloscope to operate the TDSCPM1 application and use the GPIB commands.

Updates Through a Web Browser

You can find information about this and other applications at the Tektronix, Inc. web site, www.Tektronix.com/Measurement/Support/scopes/ in the Software and Drivers category. Check this site for application updates that you can download and for other free applications.

To install an application update, you will need to download it from the Tektronix ftp site to a hard disk, copy it to a blank DOS-formatted floppy disk, and then install it on your oscilloscope.

***NOTE**. More information about changes to the application or installation is in a Readme.txt file on the ftp site. You should read it before you continue.*

To copy an application from a web browser, follow these steps:

1. Access the ftp site at ftp://ftp.tek.com/mbd/support/00-index.html#1.
2. Scroll through the files to the application that you want, select the file, and download it to your hard disk drive. If necessary, unzip the file.
3. Copy the application from the hard disk to a blank, DOS-formatted floppy disk.
4. Follow the *Installing the Application* procedure on page 3.

Optional Accessories

The AFTDS Differential Signal Adapter and the AMT75 75/50Ω Adapter (5x) are accessories that you can use with this product. Information on these electrical communication adapters are included with Option 2C.

Accessories

There are no standard accessories for this product other than this manual.

Installation

The TDSCPM1 floppy disk contains the Communications Pulse Measurements Application. You can download updates, if any, from the Tektronix ftp site through a web browser.

NOTE. *To operate the TDSCPM1 application, the TDS Run-Time Environment V1.2.0 or above must be installed on your oscilloscope.*

Installing the Application

To install the application from the floppy disk to your oscilloscope, follow these steps:

1. Power off the oscilloscope.

NOTE. *Additional information about the application or installation is located in a* Readme.txt *file on the floppy disk. You should insert the floppy disk into a DOS-based personal computer and read the* Readme.txt *file before you continue.*

If you are updating the application, the Readme.txt *file on the Tektronix ftp site supercedes the* Readme.txt *file on the TDSCPM1 floppy disk.*

2. Insert the disk in the floppy disk drive, and power on the oscilloscope.

NOTE. *To verify that the TDS Run-Time Environment V1.2.0 or above is installed, watch for the abbreviated name, RTE, and version number to appear at the top of the display when you power on the oscilloscope. If they do not appear, contact your local Tektronix sales office.*

After performing the power-up selftest, the oscilloscope automatically begins the installation procedure.

As the application loads from the disk, the oscilloscope displays a clock icon to indicate that it is busy. Also, the floppy disk drive LED is on, indicating activity. If the clock icon continues to display after the floppy disk LED has gone out, a problem has occurred with the installation. Repeat the above procedure. If the problem persists, contact your Tektronix representative.

When the installation is complete, an Installation Complete message displays.

3. Remove the floppy disk, and cycle the power to the oscilloscope.

Connecting to a System Under Test

You can use an AFTDS or AMT75 electrical communication adapter to connect between your System Under Test (SUT) and the oscilloscope. These adapters reduce the output signal from 75 ohms to 50 ohms which is expected by the oscilloscope.

To connect the electrical communication adapter between the SUT and the oscilloscope, refer to Figure 2 and follow these steps:

WARNING. *To avoid electric shock, you must ensure that power is removed from the SUT before attaching a probe to it. Do not touch exposed conductors except with the properly rated probe tips. Refer to the probe manual for proper use.*

1. Power off the SUT.
2. Connect the AFTDS or AMT75 electrical communication adapter to CH 1 of the oscilloscope.
3. Connect the electrical communication adapter to the appropriate communication signal in the SUT.

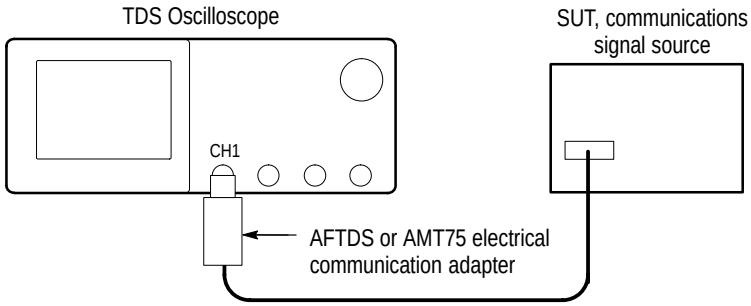


Figure 2: Connecting to the SUT

Operating Basics

Operating Basics

This section contains information on the following topics and tasks:

- Application menu structure
- Using basic oscilloscope functions
- Configuring the display
- Setting up the application
- Taking measurements
- Storing the results to a data log file
- Importing a data log file into a personal computer
- Viewing the results
- Saving and recalling setups
- Exiting the application

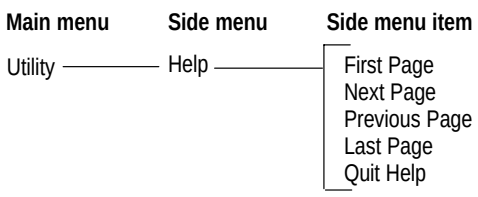
Application Menu Structure

There are two types of menus in the application menu structure: main menus and side menus. Some side menus contain common menu items as shown in Table 2.

Main and Side Menus

The main menu names appear in the bottom of the display and the side menu names appear on the right side of the display. To see the complete application menu structure, refer to Figure 13 on page 35.

When you press the front-panel button associated with a main menu, the side menu changes. In many cases, when you press a side menu, new side menu items appear. As an example, the next figure shows you how to access the Help selections through the main Utility menu and the Help side menu.



Common Menu Items

Table 2 lists common side menu items.

Table 2: Common menu items

Menu item	Description
Cancel	Cancels the message being displayed
Done	Indicates that you are through making changes to that set of side menus; the application returns to the previous menu
OK	Confirms an action

Utility Menus

Table 3 lists the Utility menus.

Table 3: Utility menus

Utility name	Description
Help	Accesses the online help pages and displays useful information on the application
Exit	Exits the application
Save/Recall Setup	Accesses the save and the recall menus for application setups
Display Options	Accesses other menus where you can change display settings, such as whether the dialog box is opaque or transparent

Using Basic Oscilloscope Functions

You can use the Utility menu to access help information about the application. You can also use other oscilloscope functions and easily return to the application.

Using Local Help

The application includes local help information about the measurements modes, with some explanation of the individual controls.

To display the local help, follow these steps:

1. Press Utility (main) → Help (side).
2. Use the side menu buttons to navigate through the help.

Returning to the Application

You can easily switch between the TDSCPM1 application and other oscilloscope functions.

To access other oscilloscope functions, press the desired front-panel control. To return to the application, push the SHIFT and then the APPLICATION front-panel menu buttons as shown in Figure 3.

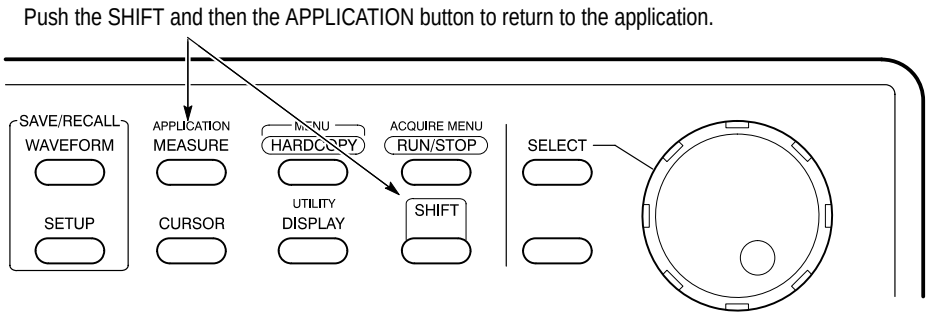


Figure 3: Returning to the application

Configuring the Display

You can change how dialog boxes appear on your oscilloscope, as well as the color of waveforms. The next figure shows how to access the Display Options menu and Table 4 lists the options with a brief description of each.

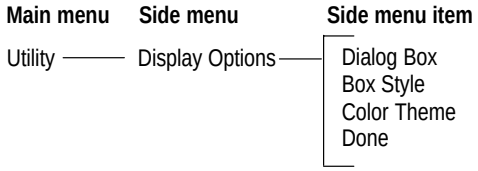


Table 4: Display Options menu selections

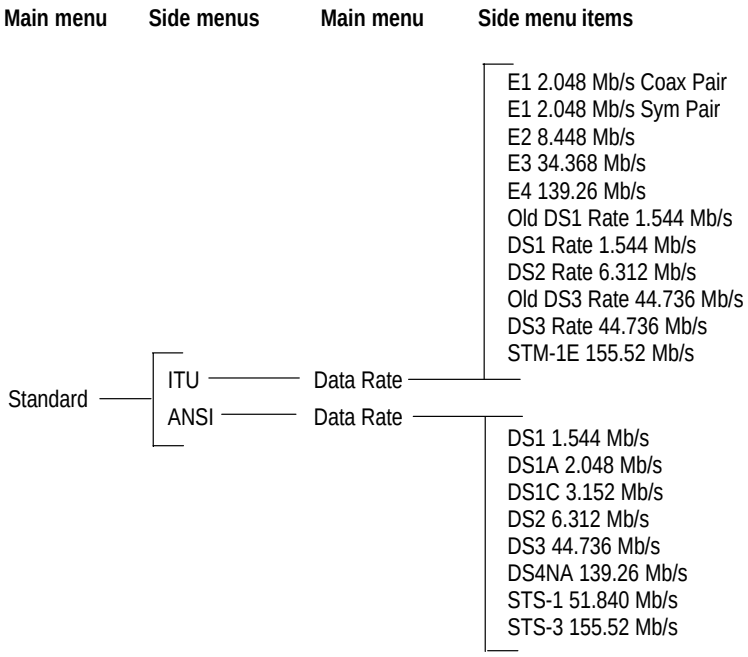
Option	Description
Dialog Box	Makes dialog boxes visible or invisible
Box Style	Selects the style of dialog boxes to be Opaque or Transparent
Color Theme	Selects a set of colors for waveforms and dialog boxes; the application offers seven color themes

Setting Up the Application

You can set up the application to take measurements for data rates defined in the ITU-T G.703 and ANSI T1.102 communications standards, and to display the results or save them to a data log file.

Communications Standards

The next figure shows how to access the selections in the Standard menu and the corresponding selections in the Data Rate menu.



Data Rates

The previous figure shows how to access selections in the Data Rate menu.

Table 5 lists the data rate selections for the ITU-T G.703 standard and contains references within the standard where you can find complete descriptions of each.

Table 5: Data Rate menu selections for the ITU-T G.703 standard

Selection	Description*
E1 2.048 Mb/s Coax Pair	Signal defined in Section 9, Table 7, and Figure 15 medium, 75 Ohm coaxial pair
E1 2.048 Mb/s Sym Pair	Signal defined in Section 9, Table 7, and Figure 16 medium, 120 Ohm symmetrical pair
E2 8.448 Mb/s	Signal defined in Section 10, Table 8, and Figure 16
E3 34.368 Mb/s	Signal defined in Section 11, Table 9, and Figure 17
E4 139.26 Mb/s	Signal defined in Section 12, Table 10, Figure 19, and Figure 20
Old DS1 Rate 1.544 Mb/s**	Signal defined in Section 2, Table 4, and Figure 10
DS1 Rate 1.544 Mb/s	Signal defined in Section 5, Table 4, and Figure 10
DS2 Rate 6.312 Mb/s	Signal defined in Section 6, Table 5, Figure 11, and Figure 12
Old DS3 Rate 44.736 Mb/s**	Signal defined in Section 5, and Figure 14
DS3 Rate 44.736 Mb/s	Signal defined in Section 8, Table 6, and Figure 14
STM-1E 155.52 Mb/s	Signal defined in Section 15, Table 12, Figure 22, and Figure 23

*** Found in ITU-T G.703, the *ITU-T Recommendation G.704 (07/95), General Aspects of Digital Transmission Systems* printed in October of 1998**

**** Found in ITU-T G.703 printed in 1991**

Table 6 lists the data rate selections for the ANSI T1.102 standard and contains references within the standard where you can find complete descriptions of each.

Table 6: Data Rate menu selections for the ANSI T1.102 standard

Selection	Description*
DSI 1.544 Mb/s	Signal defined in Section 6.1, Table 1, and Figure 1
DSIA 2.048 Mb/s	Signal defined in Section 7.1, Table 8, and Figure 11
DS1C 3.152 Mb/s	Signal defined in Section 6.2, Table 2, and Figure 2
DS2 6.312 Mb/s	Signal defined in Section 6.3, Table 3, and Figure 3
DS3 44.736 Mb/s	Signal defined in Section 6.4, Table 4, and Figure 4
DS4NA 139.26 Mb/s	Signal defined in Section 6.6, Table 6, Figure 7, and Figure 8
STS-1 51.840 Mb/s	Signal defined in Section 6.5, Table 5, and Figure 5
STS-3 155.52 Mb/s	Signal defined in Section 6.7, Table 7, Figure 9, and Figure 10

*** Found in ANSI T1.102-1993, the *American National Standard for Telecommunications – Digital Hierarchy – Electrical Interfaces***

Tests

Table 7 lists all of the tests with a brief description of each.

NOTE. *Available tests depend on the selected standard and data rate. Table 9 on page 12 lists test selections for ITU-T G.703 data rates and Table 11 on page 13 lists test selections for ANSI T1.102 data rates.*

The figure on page 12 shows how to access tests for the ITU-T G.703 data rates.

The figure on page 13 shows how to access tests for the ANSI T1.102 data rates.

Table 7: Test menu selections

Test	Description
Pulse Amplitude	Measures the amplitudes of isolated positive and negative pulses relative to the zero level on data rates that use AMI coding (binary or pseudoternary coding)
Peak-Peak	Measures the peak-to-peak amplitude of CMI signals (such as for the E4 and STM-1E ITU-T G.703 data rates)
Pulse Imbalance Variation	Measures the variation of pulse amplitudes and widths on the Old DS1 Rate and the DS1 Rate for the ITU-T G.703 standard, and the DS1 for the ANSI T1.102 standard 1.544 Mb/s data rate; you must ensure that the signal being measured contains an “all ones” variation
Pulse Imbalance: Amp Ratio	Calculates the amplitude ratio of positive and negative isolated pulses on most lower data rate ANSI T1.102 signals
Pulse Symmetry	Calculates the ratio of pulse amplitudes and widths of positive and negative isolated pulses on some ITU-T G.703 data rates
Zero Level	Verifies whether the maximum and minimum values of a logical zero (such as no pulse) are within 10% of the nominal amplitude
Spectral Power	Determines whether a communications waveform is within the spectral power level constraints set by the standards Narrowband: Measures transmitted power of an “all ones” signal in two frequency bands, each 3 kHz $\pm$ 1 kHz; the center frequencies of the two bands are half the bit rate (fundamental) and the bit rate (2^{nd} harmonic); the power at the fundamental must fall within a specified range and the power in the 2^{nd} harmonic must be lower than the fundamental by at least a specified amount Wideband: Measures the total power below a designated bandwidth as specified, usually in a frame structure (not an “all ones” signal); the bandwidth limit is three to four times the bit rate
Mask	Takes measurements based on the pulse- or eye-shaped mask associated with the selected data rate and the setup parameters that correspond with the selected test

Setup Parameters

The Setup menu names are the same as the Test menu names. Table 8 lists all of the setup parameters with a brief description of each.

***NOTE**. Setup parameters vary by data rate for the Mask test. Table 10 on page 12 lists Mask setup parameters for ITU-T G.703* data rates and *Table 12 on page 13 lists Mask setup parameters for ANSI T1.102 data rates.*

The figure on page 12 shows how to access setup parameters for ITU-T G.703 data rates.

The figure on page 13 shows how to access setup parameters for ANSI T1.102 data rates.

Table 8: Setup menu parameters

Parameter	Description
Input	Selects the source for the measurement
Num Avg	Specifies the number of waveform acquisitions that are averaged prior to testing
Mask Symbol	Accesses the binary zeros versus the binary ones pulse-shaped mask option for the E4 and STM1-E data rates on the oscilloscope
Mask Time Base Adj	Tries to find a passing condition, if enabled, when the standard Mask measurement test on the oscilloscope fails; the application tries small time offsets from a threshold crossing set by the oscilloscope at a certain time location within the mask
Mask Offset Adj	Enables or disables the Standard Mask Offset Adjustment feature on the oscilloscope accessible through the Measure → Masks → /Mask Options → Std Mask Offset Adj (side) menu
Mask Margin ##.#	Sets the value of the Mask Margins feature on the oscilloscope accessible through the Measure → Masks → /Mask Margin → Margin Percentage (side) menu
Mask Time Base	Accesses the two mask solutions for the DS3 data rate on the oscilloscope
Max Output Mask	Accesses the two eye options for the DS4NA and STS-3 data rates on the oscilloscope
Mask Type	Accesses the two eye and pulse options for the STS-1 data rate on the oscilloscope

ITU-T G.703 Data Rates and Selections

The next figure shows how to access Test menu selections and Setup menu parameters that are valid for ITU-T G.703 data rates. (Table 7 lists the tests with brief descriptions, and Table 8 lists the setup parameters with brief descriptions.)

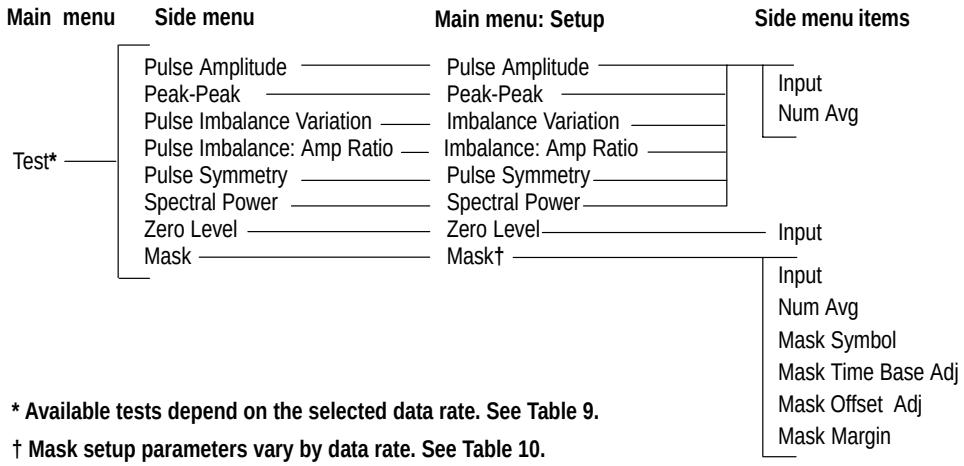


Table 9 lists the ITU-T G.703 data rate selections and shows the tests that are valid for each.

Table 9: ITU-T G.703 data rates and tests

Test	E1, both	E2	E3	E4	DS1, both	DS2	DS3, both	STM-1E
Pulse Amplitude	Yes	Yes	Yes	– – –	Yes	– – –	Yes	– – –
Peak-Peak	– – –	– – –	– – –	Yes	– – –	– – –	– – –	Yes
Pulse Imbalance: Variation	– – –	– – –	– – –	– – –	Yes	– – –	– – –	– – –
Pulse Imbalance: Amp Ratio	– – –	– – –	– – –	– – –	– – –	– – –	Yes	– – –
Pulse Symmetry	Yes	Yes	Yes	– – –	– – –	– – –	– – –	– – –
Zero Level	Yes	Yes	Yes	– – –	– – –	Yes	– – –	– – –
Spectral Power	– – –	– – –	– – –	– – –	Yes	Yes	Yes	– – –
Mask	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10 lists Mask setup parameters for each ITU-T G.703 data rate.

Table 10: ITU-T G.703 data rates and Mask setup parameters

Parameter	E1, both	E2	E3	E4	DS1, both	DS2	DS3, both	STM-1E
Mask Symbol	– – –	– – –	– – –	Yes	– – –	– – –	– – –	Yes
Mask Time Base Adj	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mask Offset Adj	Yes	Yes	Yes	– – –	– – –	– – –	– – –	– – –
Mask Margin ##%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

ANSI T1.102 Data Rates and Selections

The next figure shows how to access Test menu selections and Setup menu parameters that are valid for ANSI T1.102 data rates. (Table 7 lists the tests with brief descriptions, and Table 8 lists the setup parameters with brief descriptions.)

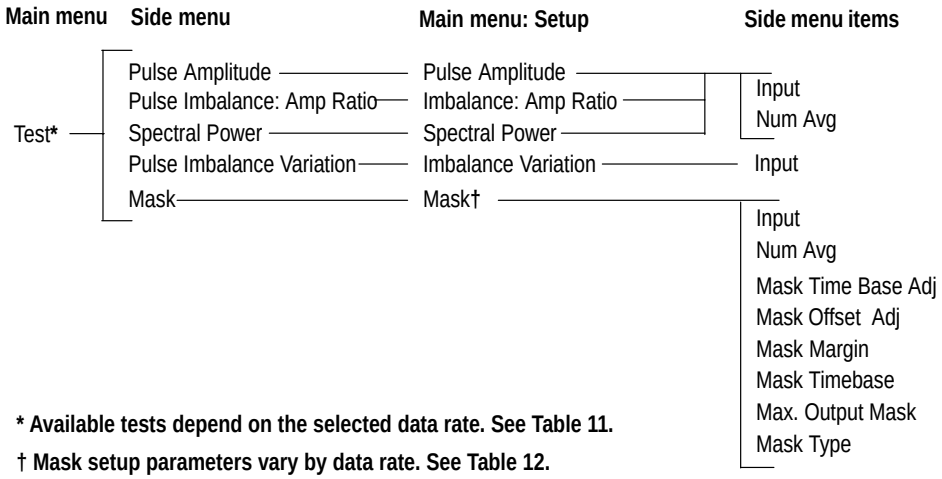


Table 11 lists the ANSI T1.102 data rate selections and shows the tests that are valid for each.

Table 11: ANSI T1.102 data rates and tests

Test	DS1	DS1A	DS1C	DS2	DS3	DS4NA	STS-1	STS-3
Pulse Amplitude	Yes	Yes	Yes	Yes	Yes	– – –	– – –	– – –
Pulse Imbalance: Variation	Yes	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Pulse Imbalance: Amp Ratio	– – –	Yes	Yes	Yes	Yes	– – –	– – –	– – –
Spectral Power	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mask	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 12 lists Mask setup parameters for each ANSI T1.102 data rate.

Table 12: ANSI T1.102 data rates and Mask setup parameters

Parameter	DS1	DS1A	DS1C	DS2	DS3	DS4NA	STS-1	STS-3
Mask Time Base Adj	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mask Offset Adj	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mask Margin ##%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mask Timebase	– – –	– – –	– – –	– – –	Yes	– – –	– – –	– – –

Table 12: ANSI T1.102 data rates and Mask setup parameters (Cont.)

Parameter	DS1	DS1A	DS1C	DS2	DS3	DS4NA	STS-1	STS-3
Max. Output Mask	– – –	– – –	– – –	– – –	– – –	Yes	– – –	Yes
Mask Type	– – –	– – –	– – –	– – –	– – –	– – –	Yes	– – –

Taking Measurements

When the measurement is set up, you can acquire data from the communications signal. To do so, follow these steps:

1. If you are saving data to a log file on a floppy disk, be sure to insert a blank, DOS-formatted floppy disk into the floppy disk drive on the oscilloscope.
2. Press Control (main). Table 13 lists selections in the Control menu.

Table 13: Control menu selections

Selection	Description
Mode	
Single	Performs measurements on a single acquisition and stops
Free Run	Repeatedly acquires the signal and takes measurements
Start	The application starts to take measurements from the signal
Continue	When paused, the application continues taking measurements
Pause	The application pauses and resumes when you press Continue or stops when you press Stop
Stop	The application stops taking measurements
Reset All	Resets all result values to zero
On Error*	
Stop	The application stops taking measurements when an error is found
Pause	The application pauses until you press Continue to resume or press Stop; while paused, you can analyze the error
Log and Continue	If the data log file is enabled, the application saves the error to it and continues to take measurements

*** When operating in Free Run mode only.**

3. Press Mode (side) to select Single or Free Run acquisition mode.
4. Press Start (side).

***NOTE**. Do not change oscilloscope settings while a measurement is being taken. Doing so can cause an invalid measurement.*

Saving the Results to a Data Log File

You can save the measurement results in a data log file. The next figure shows the selections in the Logging menu, and Table 14 lists the selections with a brief description of each.

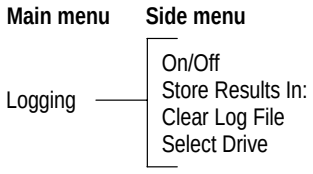


Table 14: Logging menu selections

Selection	Description
On/Off	Enables or disables the data log file; when enabled, stores the measurement results in a .CSV file that you can view on a personal computer
Store Results In:	Allows you to enter a name for the .CSV file; the extension must be .CSV
Clear Log File	Clears the data log file; you must disable the log file before you can clear its contents
Select Drive	Selects the drive on which the .CSV file will be stored; if you select the hard disk drive, the file will be stored in the hd0:/APP/TDSCPM1/TEMP directory

***NOTE**. If the disk is full or not present, the application displays an error message and stops taking measurements.*

Data Log File Format

The data log file consists of one header row and rows of logged information.

The header row of the log file contains the application name, the version number of the application, and the date and time on which the file was created.

The remaining rows contain information for the measurements. The information is in the following order: standard, data rate, bit rate, test name, result value, result unit, result remark, and date and time.

NOTE. *If you are using a GPIB program to execute the application, such as in automated test environments, you can add your own annotation through the logAnnotate GPIB command. You can add information consisting of up to 32 characters; the custom information will appear after the date and time in the rows of logged data.*

Importing a Data Log File to a Personal Computer

You can import the data log file (.CSV file) into a spreadsheet, database, or data analysis program on your personal computer for further analysis.

If you saved the data log file on the hard disk drive, you need to copy it to a floppy disk. To do so, follow these steps:

1. Insert a blank, DOS-formatted floppy disk into the floppy disk drive of the oscilloscope.
2. Copy the .CSV file from the hard disk drive to the floppy disk. For details on how to do this, refer to step 4 on page 26 in the *Tutorial* section.

To import a data log file to a personal computer, follow these steps:

1. Insert the floppy disk into the floppy disk drive on your personal computer.
2. Copy the .CSV file.
3. Open the file using a spreadsheet, database, or data analysis program.

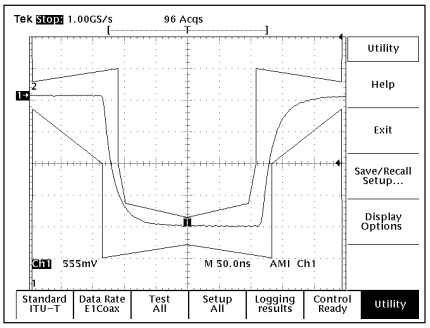
If you take different measurements and store them in one data log file, you can group the measurements by sorting them on a personal computer. Figure 4 on the next page shows an example of the .CSV file viewed in a spreadsheet program.

Viewing Data

The application displays the selected pulse-mask pattern with the communications waveform for visual analysis and can display the results from selected measurements as numeric values in a Results readout. You can also log the data to a RESULTS.CSV file for viewing with a spreadsheet, database, or data analysis program on a personal computer.

Figure 4 shows an example of the various ways to view the measurement data.

Pulse-mask pattern with communications waveform



Results readout

RESULTS	Value	Remarks
Pulse Amplitude	2.3050V	
Pulse Symmetry(Amp Ratio)	1.0132	PASS
Pulse Symmetry(PW Ratio)	998.53m	PASS
Zero Level	−25.000mV	Too high
Mask		PASS

tdscpm1 Version 1.0.0 1999–11–22 “11:54:16”

ANSI	DS1A	2048000.0	Mask		FAIL(Limit)	1999–11–22 “11:54:16”
ANSI	DS1A	2048000.0	Pulse Amplitude	2.97 V	PASS	1999–11–22 “11:55:03”
ANSI	DS1A	2048000.0	Pulse Imbalance (Amp Ratio)	1.0957	Too high	1999–11–22 “11:55:33”
ANSI	DS1A	2048000.0	Spectral Power (Fundamental)	–7.0245 dBm	Too low	1999–11–22 “11:56:01”
ANSI	DS1A	2048000.0	Spectral Power (2nd Harmonic)	–29.683 dBm	PASS	1999–11–22 “11:56:01”
ANSI	DS1A	2048000.0	Mask		PASS	1999–11–22 “11:59:03”

RESULTS.CSV file viewed in a spreadsheet program on a personal computer

Figure 4: Example of a pulse-mask pattern with a communications waveform, the Results readout, and a RESULTS.CSV file

To view parts of the pulse-mask pattern and communications waveform that are obscured by the Results readout, push the CLEAR MENU button. To return to the application, push the SHIFT and then the APPLICATION front-panel menu buttons.

The next figure shows how to make the Results readout visible or invisible.

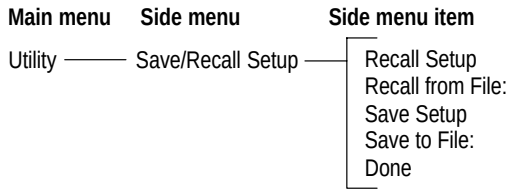
Main menu	Side menu	Side menu item
Utility	Display Options	Dialog Box: On/Off

NOTE. *The Results readout does not have to be visible to save measurements to a data log file. The application can save the measurement results to a data log file while the oscilloscope displays the pulse-mask pattern, the communications waveform, and takes measurements.*

Saving and Recalling Setups

You can use the Save/Recall Setup menu to save and recall application setups. The TDSCPM1 application Save/Recall function is totally independent of the primary oscilloscope Save/Recall function stored in nonvolatile RAM.

The next figure shows how to access the Save/Recall Setup menu.



***NOTE**. Press Utility (main) → Save/Recall Setup (side) to access the menu items that you can use to save and to recall setup files.*

Saving a Setup

To save the application setup to the file displayed in the Save to File: menu item, press Save Setup (side).

To create a new file in which to save the application setup, follow these steps:

1. Press Save to File: (side).
2. Use the direction arrows and Delete Char (side) to clear the existing file name or part of the file name.
3. Use the General Purpose (GP) knob to select each character in the file name. Press Enter Char (side) after selecting each character.

   The file name can be up to eight characters long excluding the extension. The application automatically appends a .ini extension to the name.
4. Press OK Accept (side) to save the file name.
5. Press Save Setup (side) to store the application setup in the file just created.
6. Press Done (side).

Application setups are always saved in the APPS/TDSCPM1/TEMP directory (accessed through the File Utilities menu) on the oscilloscope. Once you have saved a setup, you must recall it to use it again.

Recalling a Setup

To recall the application settings from the Default setup file or from a saved setup file, follow these steps:

1. Press Recall from File: (side) until the desired setup file name displays.

NOTE. *When you start the application, it recalls the Default setup file regardless of which setup file was last used.*

2. Press Recall Setup (side).
3. Press Done (side).

Exiting the Application

To exit the application, press Utility (main) → Exit (side). To confirm, press OK (side).

When you exit the application, the oscilloscope setup is restored that was present before you started the application.

Tutorial

This tutorial teaches you how to setup, take measurements, and view the results on the display or from a data log file. In addition, it teaches you how to stop and return to the tutorial.

Before you begin the tutorial, you need to do the following tasks:

- Connect to a communication signal
- Set up the oscilloscope
- Start the application

NOTE. *This tutorial uses a standard communication signal from the Tektronix Quick Start 7 board. Your results may match those shown in this section if you connect your TDS oscilloscope to the same type of signal from a different source.*

Further operating information is located in the *Operating Basics* section.

Connecting to a Communications Signal

Connect a P6139A probe between the E1 COAX communications signal on the SUT (the tutorial uses the Quick Start 7 board) and CH 1 on your Tektronix oscilloscope as described in *Connecting to a System Under Test* on page 4.

Be sure to power on the SUT.

Setting Up the Oscilloscope

To set up the oscilloscope, follow these steps:

1. Press SETUP → Recall Factory Setup (main) → OK Confirm Factory Init (side) to set the oscilloscope to the default factory settings.
2. Press the VERTICAL MENU → Ch 1 Coupling Impedance (main) → DC (side) → Ω and select 50.
3. Press WAVEFORM OFF as often as necessary to remove all waveforms from the display.

Starting the Application

To perform these lessons, the TDSCPM1 application must be installed on the oscilloscope. See *Installation* on page 3.

To start the application, follow these steps:

1. Press SETUP → Select Application (main).
2. Use the general purpose (GP) knob to select hd0:, and press SELECT. See Figure 5.

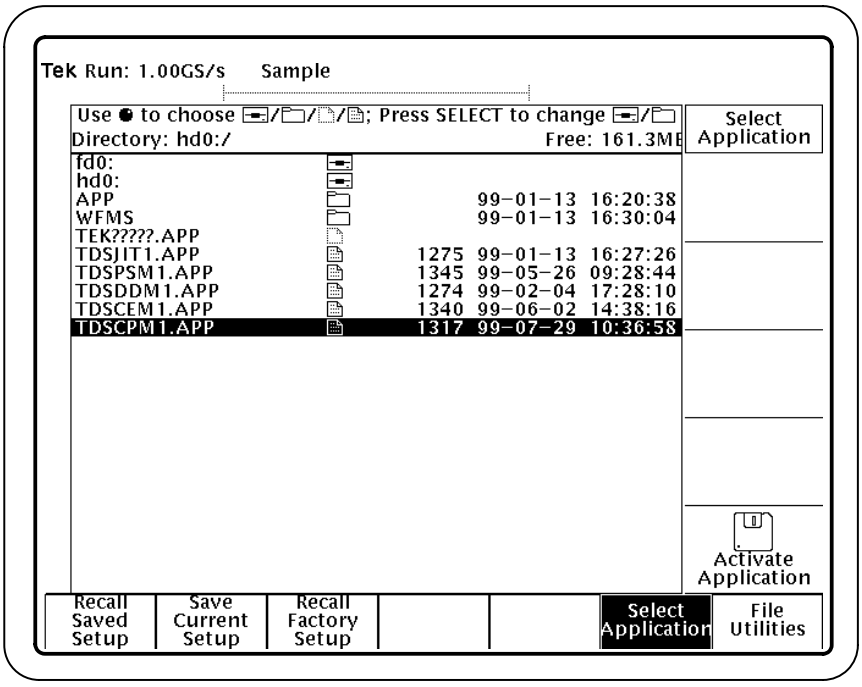


Figure 5: Starting the application

3. Use the GP knob to select the TDSCPM1.APP file and press Activate Application (side).

The application starts up and displays as shown in Figure 6.

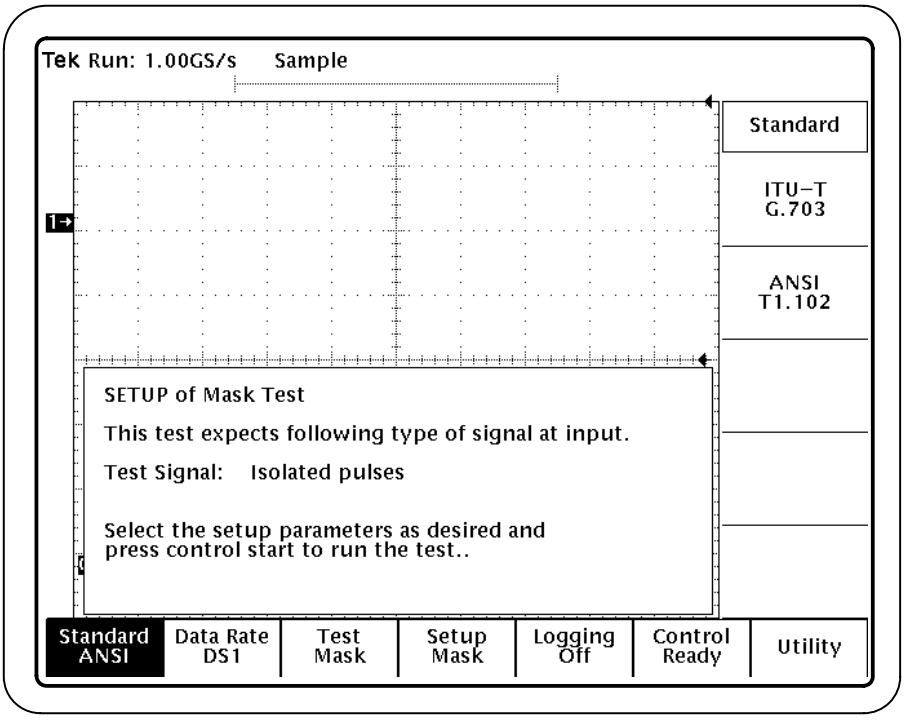


Figure 6: TDSCPM1 application initial display

Taking Measurements

In this lesson, you will learn how to use the TDSCPM1 application to take measurements from a standard communications signal and view its pulse-shaped mask pattern.

To become familiar with communications pulse measurements, follow these steps:

1. Press Standard (main) → ITU-T G.703 (side).

Figure 7 shows the Standard menu with the ITU-T G.703 standard selected.

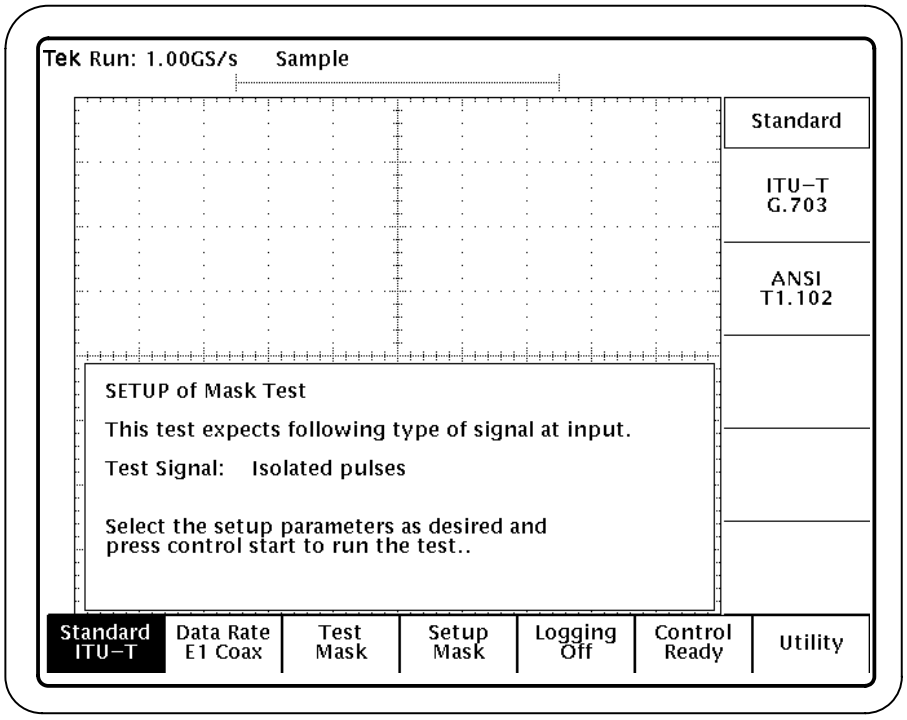


Figure 7: ITU-T G.703 standard and E1 Coax data rate selected

2. To take the measurement, press Control (main) → Start (side).

The Control menu (main) displays Control Sequencing while the application is executing. When the Control menu displays Control Ready, the application has completed the calculations.

NOTE*. The TDSCPM1 application properly aligns the pulse-diagram of the communications signal over the selected pulse-shaped mask pattern.*

3. Wait for the calculations to complete. Figure 8 shows the mask pattern, the E1 2.048 Mb/s Coax Pair pulse-diagram, and the measurement Results readout.

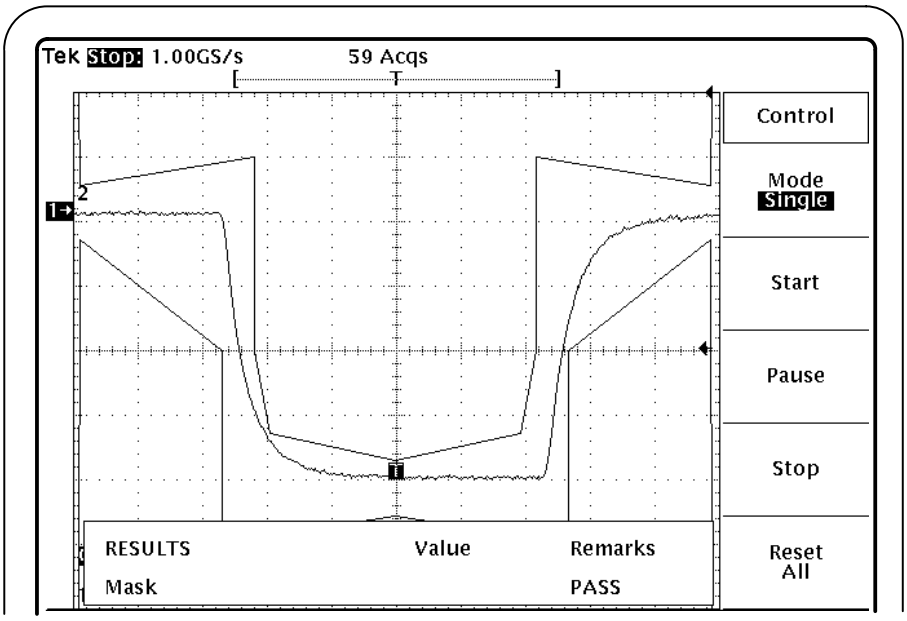


Figure 8: An E1 2.048 Mb/s Coax Pair pulse-mask pattern, communications waveform, and Results readout

Saving the Results to a Data Log File

To save the measurement results to a data log file, follow these steps:

1. Press Logging (main) → On (side). Figure 9 shows the Logging menu.

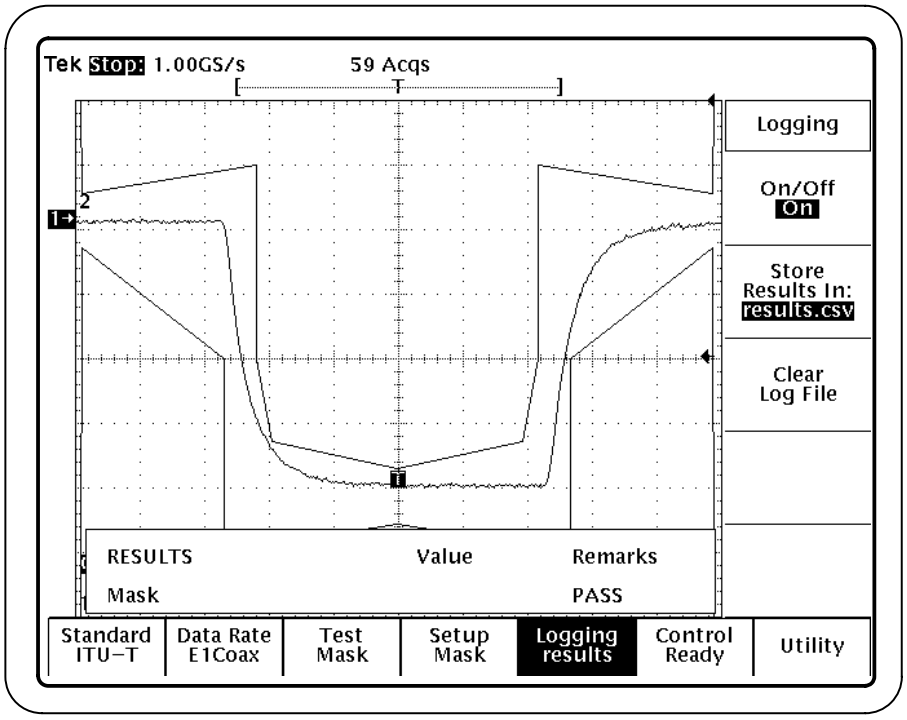


Figure 9: Logging menu

2. To log the results to a .CSV file, press Control (main) → Start (side).

The “comma separated variable” file format (.CSV) is compatible with many spreadsheet, database, and data analysis programs on a personal computer.

3. After the measurement completes, press Control (main) → Start (side) to log more data to the RESULTS.CSV file. There are now two rows of data in the RESULTS.CSV file.

4. To copy the RESULTS.CSV file to a floppy disk to view on a personal computer, follow these steps:

a. Insert a blank, DOS-formatted floppy disk into the floppy disk drive on the oscilloscope.

b. Press SAVE/RECALL SETUP → File Utilities (main).

c. Use the GP knob to highlight hd0:, and press SELECT.

d. Use the GP knob to highlight APP, and press SELECT.

e. Use the GP knob to highlight TDSCPM1, and press SELECT.

f. Use the GP knob to highlight TEMP, and press SELECT.

Figure 10 shows the RESULTS.CSV file and the path to it.

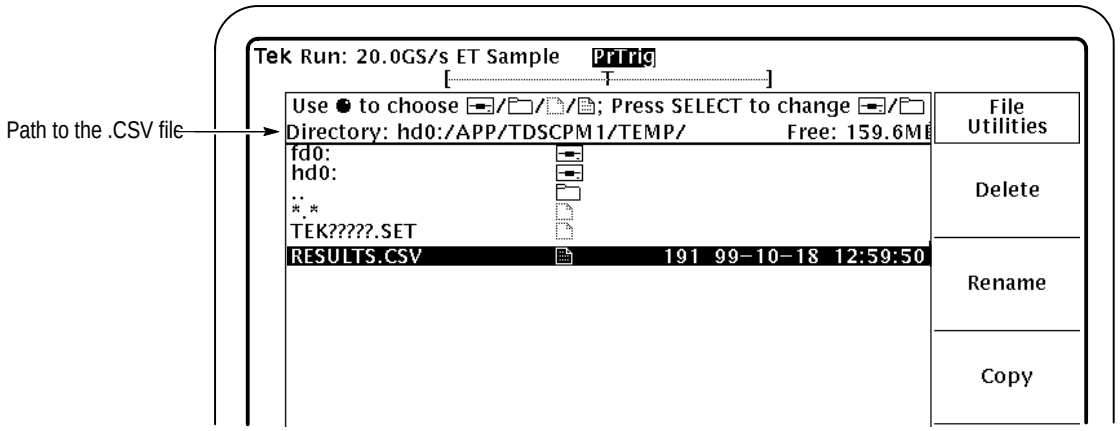


Figure 10: Path to the RESULTS.CSV file on the hard drive

g. Use the GP knob to highlight RESULTS.CSV, and press Copy (side).

h. Use the GP knob to highlight fd0:, and press Copy RESULTS.CSV to selected directory (side). Figure 11 shows this side menu item.

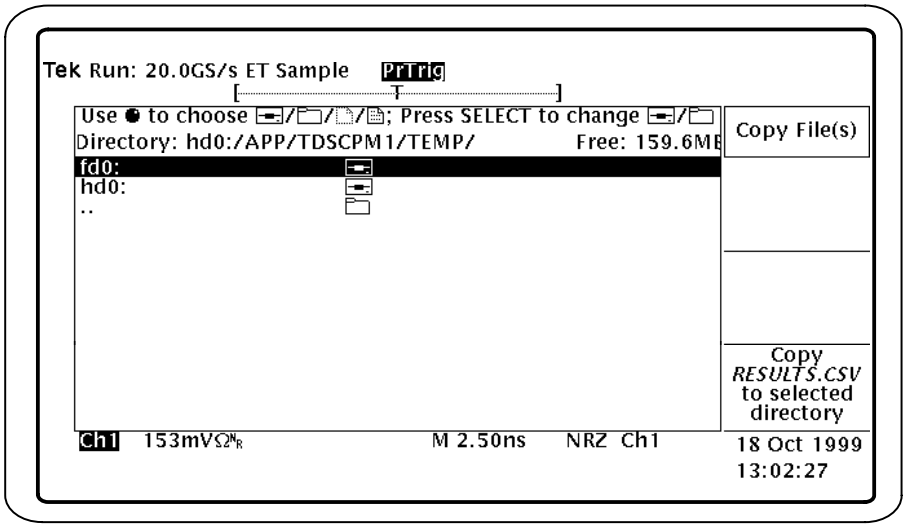


Figure 11: Copying the RESULTS.CSV file to a floppy disk

5. To return to the application, push the SHIFT and then the APPLICATION front-panel menu buttons.

6. Eject and remove the floppy disk from the floppy disk drive.

Viewing the RESULTS.CSV File (Data Log)

You can import the RESULTS.CSV file to a DOS-based personal computer and then view the data log file with a spreadsheet, database, or data analysis program. Figure 12 shows an example of how the RESULTS.CSV file might look in a spreadsheet program on a personal computer.

tdscpm1	Version 1.0.0	1999–11–22 “11:54:16”				
ANSI	DS1A	2048000.0	Mask		FAIL(Limit)	1999–11–22 “11:54:16”
ANSI	DS1A	2048000.0	Pulse Amplitude	2.97 V	PASS	1999–11–22 “11:55:03”
ANSI	DS1A	2048000.0	Pulse Imbalance (Amp Ratio)	1.0957	Too high	1999–11–22 “11:55:33”
ANSI	DS1A	2048000.0	Spectral Power (Fundamental)	–7.0245 dBm	Too low	1999–11–22 “11:56:01”
ANSI	DS1A	2048000.0	Spectral Power (2nd Harmonic)	–29.683 dBm	PASS	1999–11–22 “11:56:01”
ANSI	DS1A	2048000.0	Mask		PASS	1999–11–22 “11:59:03”

Figure 12: Data in a RESULTS.CSV file viewed in a spreadsheet program

Stopping the Tutorial

If you need more than one session to complete the tutorial lessons, you can stop the tutorial and return to it another time. To do so, you will need to save the oscilloscope setup and then the application setup.

To save the oscilloscope setup, refer to the user manual for your oscilloscope. The procedure varies between models.

To save the application setup and stop your session, refer to *Saving a Setup* on page 18 and to *Exiting the Application* on page 19.

Returning to the Tutorial

To return to the tutorial setup, you can recall the saved oscilloscope setup from the hard disk, and then restart the application.

To recall the oscilloscope setup, refer to the user manual for your oscilloscope. The procedure varies between models.

To recall the application setup, refer to *Recalling a Setup* on page 19.

GPIB Program Example

This section contains an example of a GPIB program that can execute the TDSCPM1 application.

Guidelines

Your GPIB program should comply with the following guidelines:

- Turn on the GPIB response leaders with the “HEADER OFF” command; refer to the programmer information (in online help) for your oscilloscope.
- The application startup must complete before sending additional GPIB commands to the application (see example).
- The measurements cycle must complete before data is queried (see example).
- The error variable should be checked to ensure that an error has not occurred because of a measurement command problem.

NOTE. *You should allow at least a three second delay in your program between specifying a data rate and specifying a test. If there is not enough time between data rate and test selections, the application reverts to the default test.*

Program Example

This example shows how a GPIB program might execute the application to do the following tasks:

- Start the application
- Select a data rate
- Select a test
- Enable the logger
- Take a measurement
- Check for an error
- Exit the application

Refer to *Appendix B: GPIB Command Syntax* for a complete list of the GPIB command syntax with the arguments, variables, and variable values.

```
   /*  C Example Program:   TDSCPM1 GPIB control                                */

/* ======================================================================
 *  This sample program is for Tektronix Java application TDSCPM1 --
 *  Communication Pulse Measurements
 *
 *  Note: In order to build the .exe correctly, copy gpib-32.obj from
 *  "C:\Program Files\National Instruments\GPIB\NI488\LangInt\C\" to
 *  the workspace.
*/

#include <string.h>
#include <stdio.h>
#include <sys/timeb.h>
#include <windows.h>
#include "C:\Program Files\National Instruments\NI-488.2\Languages\DLL Direct Entry\decl-32.h"

int start_application(/* in */ int scope);
int do_single_test(/* in */ int scope);


void main (void)
{
     char  read_buffer          [100] = "";
     char  write_buffer [100] = "";
     int          scope;
     int          status;

     /*
      * Open session with for IBIC
     */
     scope  = ibfind ("DEV2");
     status = ibpad (scope, 1);
     status = ibtmo (scope, T10s);

     /*
      * In order for this program to work correctly, the scope should be in "Header Off" state
     */
     sprintf (write_buffer, "%s", "Header Off");
     status = ibwrt (scope, write_buffer, strlen (write_buffer));


     /*
      * Start Application
     */
     if (start_application(scope)){
          printf ("Application is started up!\n");

          /*
           * Select a communication standard
          */
          sprintf (write_buffer, "%s", "Variable:value \"standard\",\"ITU-T\"");
          status = ibwrt (scope, write_buffer, strlen (write_buffer));
```

```
        /*
         * Select a DataRate
        */
        sprintf (write_buffer, "%s", "Variable:value \"dataRate\",\"E1 Coax\"");
        status = ibwrt (scope, write_buffer, strlen (write_buffer));

        /*
         * Select a Test (Pusle Amplitude)
        */
        sprintf (write_buffer, "%s", "Variable:value \"test\",\"PA\"");
        status = ibwrt (scope, write_buffer, strlen (write_buffer));

        /*
         * Turn on the logger
        */
        sprintf (write_buffer, "%s", "Variable:value \"loggerState\",\"On\"");
        status = ibwrt (scope, write_buffer, strlen (write_buffer));

        /*
         * Do a single test
        */
        if (do_single_test(scope)){
             /*
              * Query test result
             */
             sprintf (write_buffer, "%s", "Variable:value? \"resultValue\"");
             status = ibwrt (scope, write_buffer, strlen (write_buffer));
             status = ibrd  (scope, read_buffer, sizeof (read_buffer));
             if (ibcnt != 4) {                    /* It's not an empty string */
                  read_buffer [ibcnt] = 0;   /* Get rid of extra characters */
                  printf ("Pulse Amplitude: %s\n", read_buffer);
             }
             else{
                  printf ("*** Computation Error ***\n");
             }
        }
   }
   else{
        printf ("*** Fails to start Application ***\n");
        return;
   }

   /*
    * Exit application
   */
   printf ("Exit application!\n");
   sprintf (write_buffer, "%s", "Variable:value \"application\",\"exit\"");
   status = ibwrt (scope, write_buffer, strlen (write_buffer));

   /*
    * Program Ending
   */
   printf ("Program Terminating Normally\n\n");
}
```

```
/*-------------------------------------------------------------------------
 * Function: start_application
 * Argument: scope
 * Return:   1 if success, 0 otherwise
 *
 * This function starts the application and comfirms the completion of startup
*/
int start_application(/* in */ int scope)
{
     char  read_buffer          [100];
     char  write_buffer [100];
     char  app_name[30] = "\"tdscpm1\"\n";
     int          status;
     int          timer = 0;
     int          i = 0;

   /*
       * Has application already been started?
     */
     sprintf (write_buffer, "%s", "Variable:value? \"application\"");
     status = ibwrt (scope, write_buffer, strlen (write_buffer));
     status = ibrd  (scope, read_buffer, sizeof (read_buffer));
     read_buffer [ibcnt] = 0;   /* Get rid of extra characters */

     if (strcmp(app_name, read_buffer) == 0){
          return 1;                 /* Application is running, don't need to do anything */
     }

     /*
      * If application is not started up, start it and wait for application to completely
      * start up
     */

     sprintf (write_buffer, "%s", "Application:activate \"hd0:/tdscpm1.app\"");
     status = ibwrt (scope, write_buffer, strlen (write_buffer));
   printf ("Starting application, please wait...\n");
     while (strcmp(app_name, read_buffer) != 0){
          timer = timer + 2;
          if (timer > 30) {          /* The application takes about 24 seconds to start up */
               printf ("***Application start up time out***\n");
               return 0;            /* Something is wrong if CPM1 doesn't start up in 30s */
          }
          sprintf (write_buffer, "%s", "Variable:value? \"application\"");
          status = ibwrt (scope, write_buffer, strlen (write_buffer));
          status = ibrd  (scope, read_buffer, sizeof (read_buffer));
          read_buffer [ibcnt] = 0;/* Get rid of extra characters */
//        printf ("Debug Msg: App = %s\n", read_buffer);
        Sleep(2000);
     }
     /* Application start up! */

     return 1;
}
```

```
/*---------------------------------------------------------------
 * Function: do_single_test
 * Argument: scope
 * Return:   1 if success, 0 otherwise
 *
 * This function does a single measurement and checks error status
*/
int do_single_test(/* in */ int scope)
{
     char  read_buffer          [100];
     char  write_buffer [100];
     char  state[10]          = "\"Ready\"\n";
     int          status;
     int          timer = 0;
     int          i = 0;

     /*
      *  Start measurement
      */
   printf ("Do a single test...\n");
     sprintf (write_buffer, "%s", "Variable:value \"sequencerState\",\"Sequencing\"");
     status = ibwrt (scope, write_buffer, strlen (write_buffer));
   do{
          timer = timer + 2;
          if (timer > 60) {    /* Assuming a single test takes less than 60 seconds */
               printf ("***Test time out***\n");
               return 0;         /* Something is wrong if sequencerState does not come back
                                    * to Ready */
          }
          sprintf (write_buffer, "%s", "Variable:value? \"sequencerState\"");
          status = ibwrt (scope, write_buffer, strlen (write_buffer));
          status = ibrd  (scope, read_buffer, sizeof (read_buffer));
          read_buffer [ibcnt] = 0;        /* Get rid of extra characters */
        Sleep(2000);
     }while (strcmp(state, read_buffer) != 0);

     /*
      *  Though sequencerState Back to Ready, need to check the error variable
      *  to make no error occur during measurement
     */
     sprintf (write_buffer, "%s", "Variable:value? \"error\"");
     status = ibwrt (scope, write_buffer, strlen (write_buffer));
     status = ibrd  (scope, read_buffer, sizeof (read_buffer));
     if (ibcnt != 4){                                /* error string is not empty */
          read_buffer [ibcnt] = 0;        /* Get rid of extra characters */
          printf ("*** Error: %s ***\n", read_buffer);
          return 0;
     }

     return 1;
}
```

Reference

Menu Structure

Figure 13 shows the relationship of the application-specific menus. Available tests depend on the selected standard and data rate. Refer to Table 9 on page 12 and Table 11 on page 13 for more information.

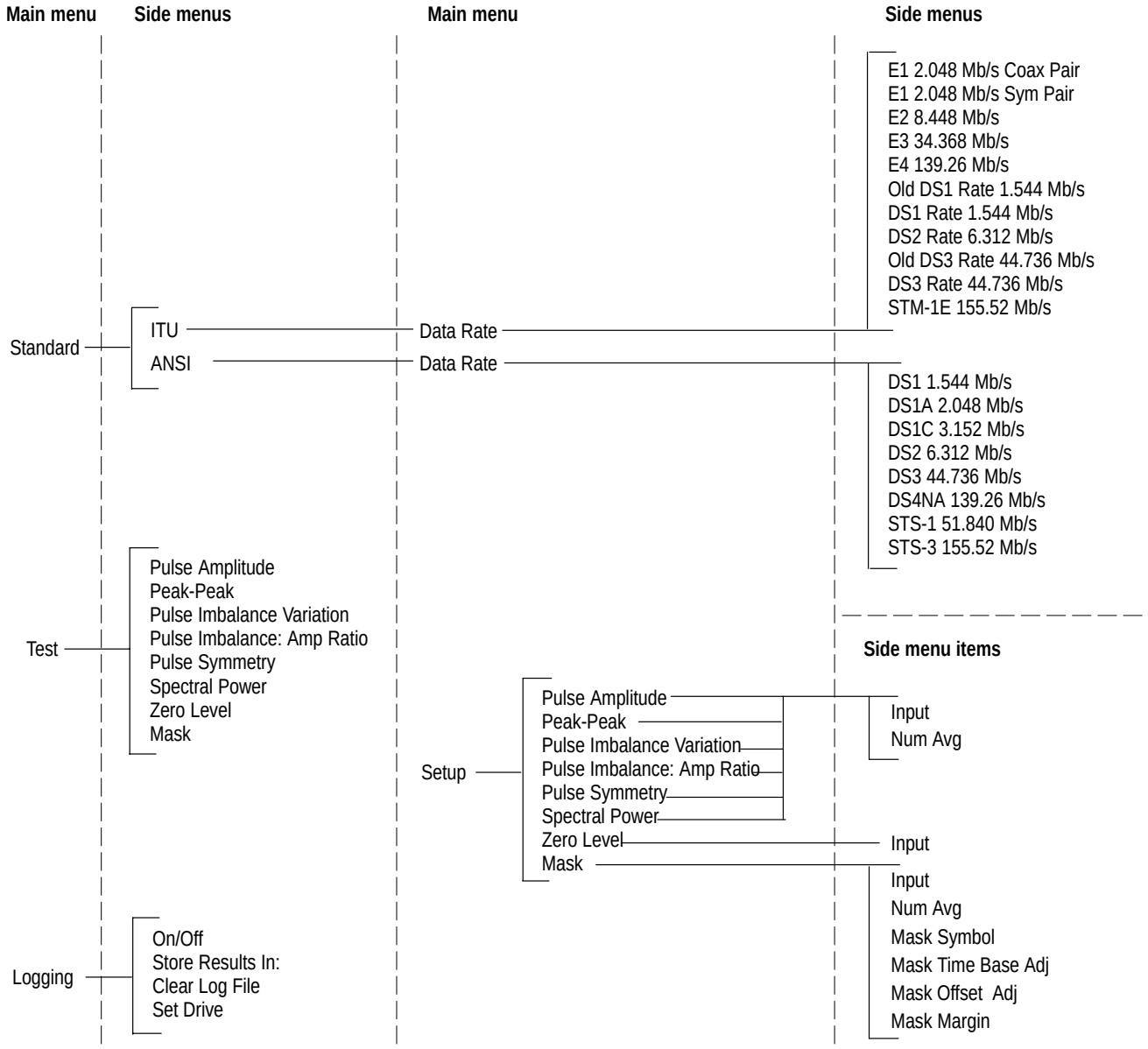


Figure 13: Application-specific menu structure

Figure 14 shows the structure of the Control and Utility menus.

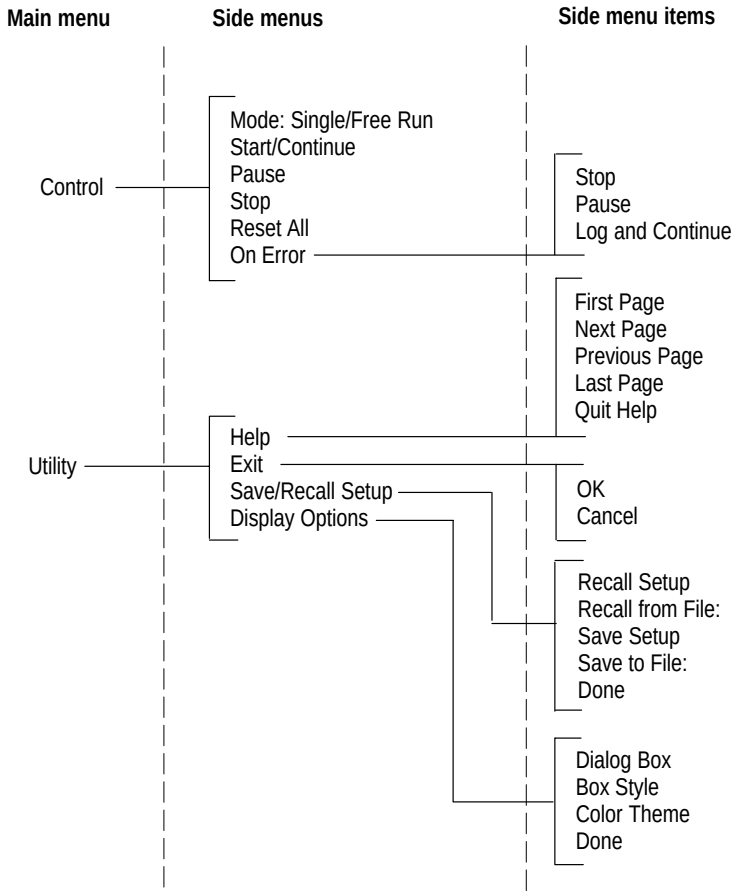


Figure 14: Control and Utility menus structures

Parameters Reference

This section describes the TDSCPM1 application parameters. You should refer to the user manual for your oscilloscope for operating details for each front-panel menu button.

Refer to *Appendix B: GPIB Command Syntax* for a complete list of the GPIB command syntax with the arguments, variables and variable values that correspond to the TDSCPM1 parameters.

Standard Menu

The selections for the Standard menu are as follows:

- ITU-T G.703
- ANSI T1.102

Data Rate Menu

For the ITU-T G.703 standard, the data rate selections are as follows:

- E1 2.048 Mb/s Coax Pair
- E1 2.048 Mb/s Sym Pair
- E2 8.448 Mb/s
- E3 34.368 Mb/s
- E4 139.26 Mb/s
- Old DS1 Rate 1.544 Mb/s
- DS1 Rate 1.544 Mb/s
- DS2 Rate 6.312 Mb/s
- Old DS3 Rate 44.736 Mb/s
- DS3 Rate 44.736 Mb/s
- STM-1E 155.52 Mb/s

The application takes measurements based on these data rates as they are defined in the *ITU-T Recommendation G.704, General Aspects of Digital Transmission Systems, ITU-T G.703* document. Table 5 on page 9 lists the location of the data rate definitions in the standard.

For the ANSI T1.102 standard, the data rate selections are as follows:

- DSI 1.544 Mb/s
- DSIA 2.048 Mb/s
- DS1C 3.152 Mb/s
- DS2 6.312 Mb/s
- DS3 44.736 Mb/s
- DS4NA 139.26 Mb/s
- STS-1 51.840 Mb/s
- STS-3 155.52 Mb/s

The application takes measurements based on these data rates as they are defined in the *American National Standard for Telecommunications – Digital Hierarchy – Electrical Interfaces, ANSI T1.102-1993* document. Table 6 on page 9 lists the location of the data rate definitions in the standard.

Test Menu

For the ITU-T G.703 data rates, the test selections are as follows:

- Pulse Amplitude (only for AMI signals)
- Peak-Peak (only for CMI signals)
- Pulse Imbalance Variation
- Pulse Imbalance Amp Ratio
- Pulse Symmetry
- Zero Level
- Spectral Power
- Mask

NOTE. *Available tests depend on the selected standard and data rate. Table 9 on page 12 lists test selections for ITU-T G.703 data rates and Table 11 on page 13 lists test selections for ANSI T1.102 data rates.*

For the ANSI T1.102 data rates, the test selections are as follows:

- Pulse Amplitude
- Pulse Imbalance Variation
- Pulse Imbalance Amp Ratio
- Spectral Power
- Mask

Setup Menu

Table 15 lists the parameters for the Setup menu, the selections available, and the default settings.

Table 15: Setup menu parameters

Parameter	Selections	Default setting
Input	Ch1, Ch2, Ch3, Ch4	Ch1
Num Avg	2 through 10,000	16
Mask Symbol	Binary 0, Binary 1	Binary 0
Mask Time Base Adj	Yes, No	No
Mask Offset Adj	Yes, No	No
Mask Margin ##.#	-50.0 to 50.0, refer to Table 19	0.0
Mask Time Base	Full Mask, Time Details	Full Mask
Max Output Mask	Yes, No	No
Mask Type	Pulse, Eye	Pulse

For the ITU-T G.703 data rates, the setup parameter selections are as follows:

- Input
- Num Avg
- Mask Symbol
- Mask Time Base Adj
- Mask Offset Adj
- Mask Margin ##.#

NOTE. *Setup parameters vary by data rate for the Mask test. Table 10 on page 12 lists Mask setup parameters for ITU-T G.703* data rates and *Table 12 on page 13 lists Mask setup parameters for ANSI T1.102 data rates.*

For the ANSI T1.102 data rates, the setup parameter selections are as follows:

- Input
- Num Avg
- Mask Timebase Adj
- Mask Offset Adj
- Mask Margin ##.#
- Mask Time Base
- Max. Output Mask
- Mask Type

Logging Menu

Table 16 lists the parameters for the Logging menu, the selections available, and the default settings.

Table 16: Logging menu parameters

Parameter	Selections	Default setting
On/Off	On, Off	Off
Store Results In:	RESULTS.CSV or new file name	RESULTS.CSV
Clear Log File	None	
Select Drive	hd0, fd0	hd0

Control Menu

Table 17 lists the parameters for the Control menu and the selections available.

Table 17: Control menu parameters

Parameters	Selections	Default setting
Mode	Single, Free Run	Single
Start (or Continue)	None	
Pause	None	
Stop	None	
Reset All	None	
On Error*	Stop, Pause, Log and Continue	Pause

*** When operating in Free Run mode only.**

Utility Menus

Table 18 lists each utility menu, the parameters, the selections available and default settings.

Table 18: Utility menus and parameters

Utility menu	Parameters	Selections	Default setting
Help	Refer to Figure 14 on page 36.	None	
Exit	Refer to Figure 14 on page 36.	None	
Save/Recall Setup	Recall Setup	None	
	Recall from File:	Default, or saved setup files	Default
	Save Setup	None	
	Save to File:	setup1.ini, or new file name	setup1.ini
Display Options	Dialog Box	On, Off	On
	Box Style	Opaque, Transparent	Opaque
	Color Theme	Based on the TDS oscilloscope color selections	TDS Default

Appendices

Appendix A: Measurement Algorithms

The TDSCPM1 application displays a standard pulse-mask pattern behind the communications signal being acquired. The application also takes measurements from the communication signal.

Oscilloscope Setup Guidelines

For all measurements, use the following guidelines to set up the oscilloscope:

1. The vertical scale for the communication signal must be set so that the pulse does not exceed the vertical range of the TDS oscilloscope.
2. The input power level must be less than 250 μW.

Test Methodology

The application performs the measurement according to the following algorithm:

1. Imports the communications signal.
2. Performs the measurement.
3. Uses the results in the Results readout, or saves the results to a data log file.

Measurements

All communications signal measurements are based on the power level, the voltage level, or the time locations of edges within each acquisition. Pulse-mask patterns are defined in the Standard and the Data Rate menus.

Pulse Parameters

The application tests characteristics of communications signals to see if they meet the value or fall within a range of values expected for certain parameters as defined in the ITU-T G.703 or ANSI T1.102 standards.

Pulse Amplitude

The Pulse Amplitude test measures the amplitude of isolated positive and negative pulses. This test is performed on standards which uses AMI line coding.

The application calculates the measurement using the following equation:

$PA = Avg\ (PA_{Isolated\ +1}, Abs(PA_{Isolated\ -\ 1}))$

Where: *PA* is the amplitude of the pulse

Avg is the average of the two input parameters determined by adding the inputs and dividing it by two

$PA_{Isolated\ +1}$ is the result of the Measure → High measurement on the oscilloscope of the Isolated +1 signal

$PA_{Isolated\ -\ 1}$ is the result of the Measure → Low measurement on the oscilloscope of the Isolated -1 signal

$Abs\ (PA_{Isolated\ -\ 1})$ is the absolute value of its input parameter

Peak-Peak

The Peak-to-Peak test measures the amplitude of isolated positive and negative edges. This test is performed on standards which uses CMI line coding.

The application calculates the measurement using the following equation:

PP = Result of the Measure → PK2PK measurement on the oscilloscope

Where: *PP* is the peak-to-peak amplitude of the pulse

Pulse Imbalance Variation

The Pulse Imbalance Variation measurement is the maximum variation of the pulse amplitude and pulse widths based on an All 1 signal. The application assumes that the signal is an All 1s data stream but does not attempt to validate this.

The application calculates the measurement using the following equations:

PIV(PK2PK Amplitude) = Absolute Average (pkpkPositiveAmplitude, pkpkNegativeAmplitude)

PIV(PK2PK Pulse Width) = Absolute Average (pkpkPositivePW, pkpkNegativePW)

Where: *Absolute Average* returns the average of its input ignoring the sign

pkpkPositiveAmplitude is the Peak-to-Peak vertical histogram variation of the Positive 1 of an AMI 17 consecutive 1s signal

pkpkNegativeAmplitude is the Peak-to-Peak vertical histogram variation of the Negative 1 of an AMI 17 consecutive 1s signal

pkpkPositivePW is the Peak-to-Peak horizontal histogram variation of the Positive 1 of an AMI 17 consecutive 1s signal

pkpkNegativePW is the Peak-to-Peak horizontal histogram variation of the Negative 1 of an AMI 17 consecutive 1s signal

Pulse Imbalance Amp Ratio

The Pulse Imbalance Amp Ratio measurement is the ratio of positive and negative isolated pulses.

The application calculates the measurement using the following equation:

PulseImbalance Amp ratio = meanPPA/meanNPA

Where: *meanPPA* is the mean value of the vertical histogram placed on the positive isolated pulse

meanNPA is the mean value of the vertical histogram placed on the negative isolated pulse

Pulse Symmetry

The Pulse Symmetry measurement is the amplitude and width symmetry of AMI signals between positive and negative pulses.

The application calculates the measurement using the following equation:

PulseSymmetry(Amp Ratio) = meanPPA/meanNPA

PulseSymmetry(PW Ratio) = meanPositivePW/meanNegativePW

Where: *meanPPA* is the mean value of the vertical histogram placed on the positive isolated pulse

meanNPA is the mean value of the vertical histogram placed on the negative isolated pulse

meanPositivePW is the positive width of Isolated plus 1 signal

meanNegativePW is the negative width of Isolated minus 1 signal

Zero Level

The Zero Level measurement verifies if the maximum and minimum values of a logical zero (no pulse) signal is within the expected limits for the signal.

The application calculates the measurement using the following equation:

ZeroLevel = Average(ZeroLevelMax, ZeroLevelMin)

Where: *ZeroLevelMax* is equal to the average of Max1 and Max2

ZerolevelMin is equal to the average of Min1 and Min2

Average is the average of the two input parameters determined by adding the inputs and dividing it by two

Max1 is equal to Mean1 + PeakPeak1/2

Min1 is equal to Mean1 - PeakPeak1/2

Max2 is equal to Mean2 + PeakPeak2/2

Min2 is equal to Mean2 -PeakPeak2/2

Mean1 is the mean value of a vertical histogram placed on an Isolated + 1 pulse

PeakPeak1 is the peak-to-peak value of a vertical histogram placed on an Isolated + 1 pulse

Mean2 is the mean value of a vertical histogram placed on an Isolated -1 pulse

PeakPeak2 is the peak-to-peak value of a vertical histogram placed on an Isolated -1 pulse

Spectral Power

The Spectral Power measurement determines whether a communications signal is within the spectral power limits set by the ITU-T G.703 or ANSI T1.102 standards. To calculate the spectral power, the application uses the FFT function of the oscilloscope to convert a time domain signal into a frequency domain signal.

The application calculates the measurement using the following equation:

$$W = \frac{1}{\Omega N^2} \sum_{k=0}^{N-1} X_k^2$$

Where: *W* is the power of the spectrum

Ω is the characteristic impedance of the signal being measured, and not the 50Ω of the oscilloscope input; the adapter provides the proper termination and voltage translation so the application displays the voltage level as if the input of the oscilloscope was 75/100/110/120 Ω

N is the number of waveform samples

For the spectral display, the oscilloscope uses the following equation:

$$A\ \sqrt{2}\ \frac{X_k}{N}$$

Where: *A* is the window adjustment scalar and the $\sqrt{2}$ accounts for both the + and - frequencies; A equals 1 for a rectangular window

This means (ignoring A for the moment) that the oscilloscope calculates the spectral power using the following equation:

$$W\ =\ \frac{1}{\Omega N^2}\sum_{k=0}^{\frac{N}{2-1}} X_k^2$$

Narrow Band

The application measures transmitted power in two, 3 kHz ± 1 kHz frequency bands. The center frequencies of the two bands are half the bit rate (fundamental) and the bit rate (2nd harmonic). The power at the fundamental must fall within a specified range. The power in the second harmonic must be lower than the fundamental by a specified amount or more. The measurements are made using an All 1s signal.

For narrow-band power measurements, you must use a window to correct the power calculation.

The application uses a Hanning window which results in multiplying the power by a factor of 2/3rds as shown in the following equation:

$$W\ =\ \frac{2}{3\Omega}\sum_{k=L}^{M} X_k^2$$

Where: *L* equals the floor(N((f_{center} - f_{width}) ÷ (2 - 1))) ÷ f_s

M equals the floor(N((f_{center} + f_{width}) ÷ (2 + 1))) ÷ f_s

Wide Band

The application measures the total power below a designated bandwidth. The bandwidth limit is between 3 to 4 times the bit rate.

For wide band measurements, the range of k should not include DC and the next bin (such as, start at k=2) and should end at the index that equates to the specified upper frequency limit.

For wide-band signals (such as other than All 1s), the application uses a Rectangular window which results in the following equation:

$$W = \frac{1}{\Omega}\sum_{k=2}^{M} X_k^2$$

Mask

The Mask measurement checks the communications signal to see if it conforms to corresponding mask parameters. This application uses Option 2C on the oscilloscope to perform this test.

The application offers the following parameters that you can use to customize the Mask test.

Mask Time Base Adj. Parameter

Setting this parameter to "Yes" enables the application to find the Mask test Failure due to marginal time shift. The application performs iterative mask tests by changing the value of the Time Base Position on the oscilloscope (Measure → Mask menu). The change in the value is based on the standard and data rate selected.

Mask Offset Adj. Parameter

Setting this parameter to "Yes" enables the standard mask autoset to adjust the vertical offset so that the waveform can match the mask. The application sets the Std Mask Offset Adj of the oscilloscope to ON (Measure → Mask menu).

Mask Margin Parameter

The application uses this parameter to relax or restrict the signal space for a selected mask. A positive margin causes the signal space to be smaller and makes the Mask test harder to pass. A negative margin causes the signal space to be larger and makes the Mask test easier to pass.

Table 19 lists the upper and lower mask margins for each standard and data rate.

Table 19: Mask margin limits

Standard and data rate	Upper margin	Lower margin
ITU-T G.703		
E1 Coax	13.6%	-32.9%
E1 Sym	14.3%	-32.9%
E2	13.6%	-32.9%
E3	14.3%	-32.9%
E4 (Binary 0)	12.3%	-32.9%

Table 19: Mask margin limits (Cont.)

Standard and data rate	Upper margin	Lower margin
E4 (Binary 1)	12.3%	-32.9%
Old DS1 Rate	6.3%	-32.9%
DS1 Rate	6.3%	-32.9%
DS2 Rate	5.6%	-32.9%
Old DS3 Rate	0%	-32.9%
DS3 Rate	5.6%	-32.9%
STM-1E (Binary 0)	12.3%	-32.9%
STM-1E (Binary 1)	12.3%	-32.9%
ANSI T1.102		
DS1	6.3%	-32.9%
DS1A	6.3%	-32.9%
DS1C	8.3%	-32.9%
DS2	5.6%	-32.9%
DS3 (Time Details)	5.6%	-32.9%
DS3 (Full Mask)	5.6%	-32.9%
DS4NA	50%	-323%
STS-1 (Eye)	38.8%	-24.9%
STS-1 (Pulse)	5.6%	-32.9%
STS-3	50%	-23.4%
STS-3 (Max. Output)	50%	-50%

Mask Symbol Parameter

The Mask Symbol parameter is for the ITU-T G.703 E4 and STM-1E data rates and offers two kinds of masks: Binary 0 or Binary 1.

Mask Timebase Parameter

The Mask Timebase parameter is for the ANSI T1.102 DS3 data rate and offers two kinds of masks: Full Mask and Time Details.

Max. Output Mask Parameter

The Max. Output Mask parameter is for the ANSI T1.102 DS4NA and STS-3 data rates and offers two kinds of masks: Max Output and Standard.

Mask Type Parameter

The Mask Type parameter is for the ANSI T1.102 STS-1 data rate and offers two kinds of masks: Eye and Pulse.

Appendix B: GPIB Command Syntax

This appendix describes the GPIB command syntax that you can use in your GPIB program to do the following tasks:

- Start the TDSCPM1 application
- Recognize an active application with GPIB protocol
- Program and read application setup parameters
- Sequence measurements
- Synchronously read measurement results

NOTE. *Refer to the* GPIB Program Example *section for an example of a GPIB program and for guidelines to use while designing your GPIB program.*

To use GPIB commands with your TDS oscilloscope, refer to the programmer information in the online help of your oscilloscope.

Description. Gives the function of the command, conditions of its use, and its interactions with other commands.

Syntax. Gives the valid select and query command forms. The required arguments are listed in their proper order.

For example, in the syntax definition

```
PATH= <Ad><Ars>
```

```
the arguments <Ad> and <Ars> are required in the order indicated.
```

Arguments. The arguments to a command are defined along with their range of values.

Returns. Defines the data returned in response to a command query.

VARIABLE:VALUE TDS COMMAND

Description VARIABLE:VALUE TDS COMMAND accepts string arguments for a control or data variable and a value to which to set the argument.

Syntax VARIABLE:VALUE

```
VARIABLE:VALUE "<variable name>","<variable value>"

the arguments <variable name> and <variable value> are required
in the order indicated.
```

Arguments and Returns Table 20 lists the arguments, their function, and the query returns.

Table 20: VARIABLE:VALUE TDS COMMAND arguments and queries

Variable name	Variable value	Function	Query form
application	exit	Terminates the active application	Returns a string that corresponds to the name of the active application
boxBackground	{Transparent, Opaque}	Sets the message box background	Returns the message box background
boxVisibility	{On, Off}	Sets box visible or invisible	Returnsbox visible or invisible
colorTheme	{TDS Default, Black, Green, Mild, Purple, Steel, Tek Blue}	Sets the TDS oscilloscope color scheme	Returns the TDS oscilloscope color scheme
logAnnotate*	Any string from one to thirty two characters from A to Z and/or zero to nine	Provides custom annotation to the data log file	None
logger	{Reset}	Clears the current data log file	Returns the reset of the data log
loggerDestination	Any string from one to eight characters from A to Z and/or zero to nine	Sets the data log file name	Returns the data log file name
logDrive	{fd0, hd0}	Sets the state of the data log	Returns the state of the data log
loggerState	{On, Off}	Sets the drive used for logging	Returns the drive used for logging
recallName	Any string that uses one to eight characters from A to Z and/or zero to nine	Sets the recalled setup file name	Returns the saved setup file name
saveName	Any string from one to eight characters from A to Z and/or zero to nine	Sets setup file name	Returns the setup file name
setup	{Default, Recall, Save}	Sets the setup file name	Returns the setup file name
sequencerMode	{Free Run, Single}	Sets the sequencer mode	Returns the sequencer mode
sequencerState	{Ready, Paused, Sequencing}	Sets the state of the sequencer	Returns the state of the sequencer
standard	{ANSI, ITU–T}	Sets the communications standard	Returns the communications standard

Table 20: VARIABLE:VALUE TDS COMMAND arguments and queries (Cont.)

Variable name	Variable value	Function	Query form
dataRate	{E1 Coax, E1 Sym, E2, E3, E4, Old DS1 Rate, DS1 Rate, DS2 Rate, Old DS3 Rate, DS3 Rate, STM-1E, DS1, DS1A, DS1C, DS2, DS3, DS4NA, STS-1, STS-3}	Sets the transmission rate of the data communications signal	Returns the transmission rate of the data communications signal
source	{Ch1, Ch2, Ch3, Ch4}	Sets the channel from which input will be received	Returns the channel from which input will be received
test	{PA, PP, PIV, PIA, PS, ZL, SP, MASK}	Sets the name of the current test	Gets the name of the current test
numAvg	{2 to 10000}	Sets the averaging window size of the acquisition	Returns the averaging window size of the acquisition
maskInfo	{Binary 0, Binary 1, Eye, Pulse, Full Mask, Time Details, Yes, No}	Sets additional information for the mask	Gets additional information for the mask
maskTimeBaseAdj	{Yes, No}	Sets the timebase adjustment of the pulse-mask pattern	Returns the timebase adjustment of the pulse-mask pattern
maskOffsetAdj	{Yes, No}	Sets the mask offset adjustment of the pulse-mask pattern	Returns the mask offset adjustment of the pulse-mask pattern
maskMargin	{–50.0 to +50.0}†	Sets the margin value of a pulse-mask pattern	Returns the margin value of a pulse-mask pattern

*** Custom annotation in the data log file is only available through GPIB execution of the application.**

† Refer to Table 19 for mask margin values by data rate.

Table 21 lists the measurement results queries.

Table 21: Measurement results queries

Variable name	Function
error	Returns the error dialog box, if one exists, associated with the last measurement
resultValue	Returns the result of the last test in the Name, Value, Remarks format

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