

PED3200/PED4000 Series Programmable Error Detector User Manual



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Tektronix

**PED3200/PED4000 Series
Programmable Error Detector
User Manual**

Revision A

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- Worldwide, visit www.tektronix.com to find contacts in your area.

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Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. (See page vi, *Service safety summary*.)

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Do not use the provided power cord for other products.

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, make sure that the product is properly grounded.

Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

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

The measuring terminals on this product are not rated for connection to mains or Category II, III, or IV circuits.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

Use proper fuse. Use only the fuse type and rating specified for this product.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product.

Provide proper ventilation. Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation.

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

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.*

Symbols and 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.



When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbol(s) may appear on the product:



CAUTION
Refer to Manual



Protective Ground
(Earth) Terminal

Preface

The Tektronix PED3200/PED4000 Series Error Detectors are instruments that accept a clock and an NRZ data stream. Given the contents of the expected data (PRBS or programmable user data), they can count errors and report the bit error ratio. They include various features to assist in setting the sampling point and synchronizing the incoming pattern to the internal reference pattern.

Features

The Tektronix error detectors provide the following features:

- 3 Gb/s to 32 Gb/s operation (PED3200 series)
- 3 Gb/s to 40 Gb/s operation (PED4000 series)
- Fully integrated bench-top instrument
- AC or DC coupled differential data inputs (can be used single-ended)
 - Available with 1 or 2 input channels
 - Independent data on each channel
 - User-defined patterns or built-in PRBS patterns
- Full rate AC coupled clock input (can be used single-ended)
- Auto adjustment or manual adjustment of data to clock phase
- Auto synchronization to input pattern
- Touch screen graphical user interface (GUI) and USB TMC interfaces
- 3RU height, full-rack design

Table i: Model number description

Model number	Maximum data rate	Differential channels
PED3201	32	1
PED3202	32	2
PED4001	40	1
PED4002	40	2

Documentation

The following documentation is available:

- PPG/PED Safety & Installation Manual, printed version shipped with the product
- This PED3200/PED4000 Series Error Detector User Manual (PDF versions only, downloadable from the Tektronix Web Site)
- Product datasheets (PDF versions only, downloadable from the Tektronix Web Site)
- Declassification & Security instructions (PDF versions only, downloadable from the Tektronix Web Site)

Check the Tektronix Web Site for additional product documentation at www.Tektronix.com.

Getting Started

Installation

The error detector was carefully inspected electrically and mechanically before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that may have occurred during transit (there may be a protective film over the display, which can be removed). Report damage to the shipping agent immediately. Save the original packing carton for possible future shipment.

Accessories The following items are included with your instrument:

- PPG/PED Installation & Safety instructions
- Error detector
- Power cord
- Accessories as ordered

Power requirements



CAUTION. *Operating the instrument on an incorrect line voltage can cause damage, possibly voiding the warranty. To avoid this, operate the instrument with the correct line voltage.*

The instrument operates from a single-phase line voltage shown in the following table. Line voltage and line frequency are automatically sensed; there are no switches to set. Check to ensure the operating voltage in your area is compatible.

Table 1: Power requirements

Item	Description
Voltage	100 V to 240 V
Frequency	50 Hz to 60 Hz
Power	360 W, maximum
Power fuse	T 2 A 250 V

The power cord supplied with the instrument contains a separate ground for use with grounded outlets. When proper connections are made, the instrument chassis is connected to power line ground through the ground wire in the power cord providing protection against electric shock.

Ventilation The instrument has four fans in the rear, as well as cooling vents on the bottom and side panels to keep it from overheating.



CAUTION. *Inadequate ventilation can damage the instrument; to avoid damaging the instrument, observe the following precautions:*

Do not block the cooling vents.

Do not position any devices adjacent to the instrument that force air (heated or unheated) into or onto the instrument surfaces or cooling vents. This additional airflow could compromise performance.

When rack mounting the instrument, ensure there is adequate airflow around the instrument rear, sides and bottom to ensure proper cooling. Adequate airflow enables air temperatures within approximately one inch of the instrument surfaces to remain within specified limits under all operating conditions.

Environmental considerations The following table describes the maximum operating environmental ratings for your instrument.

Table 2: Maximum operating environmental considerations

Feature	Description
Temperature	40 °C (104 °F)
Humidity	80% for temperatures up to 31 °C (88 °F) decreasing linearly to 50% at 40 °C (104 °F)
Altitude	2000 m (6562 ft.)

Front panel controls and connectors

The following illustration and table describe the front panel controls and connectors of the PED3200/PED4000 Series Error Detectors. The PED3201/PED4001 are single channel instruments; the PED3202/PED4002 are two-channel instruments.

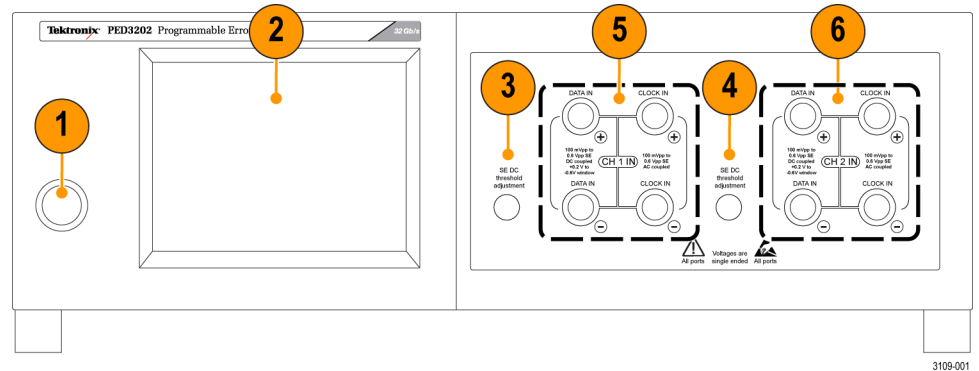


Figure 1: Front panel controls and connectors

Table 3: Front panel controls and connectors

Item	Description
1 On/off switch	Push this button to turn the instrument on and off. The green indicator inside the button is on when the instrument is on.
2 Display	The display is a touch screen graphical user interface.
3 Channel 1 Threshold output voltage (DC coupled instruments only)	This is an SMA connector that provides the threshold output voltage for channel 1.
4 Channel 2 Threshold output voltage (DC coupled instruments only)	This is an SMA connector that provides the threshold output voltage for channel 2. (PED3202/PED4002)
5 Channel 1 Input connectors	Data and clock input connectors for channel 1, 2.4 mm differential inputs.
6 Channel 2 input connectors	Data and clock input connectors for channel 2, 2.4 mm differential inputs. (PED3202/PED4002)

If using a single-ended test configuration, terminate all unused data and clock inputs into $50\ \Omega$ to either ground or to an appropriate DC level. Both the data and clock inputs are ESD sensitive so it is advised to exercise appropriate precautions.

Rear panel connectors

The following illustration and table describe the rear panel controls and connectors of the PED3200/4000 Series Error Detectors.

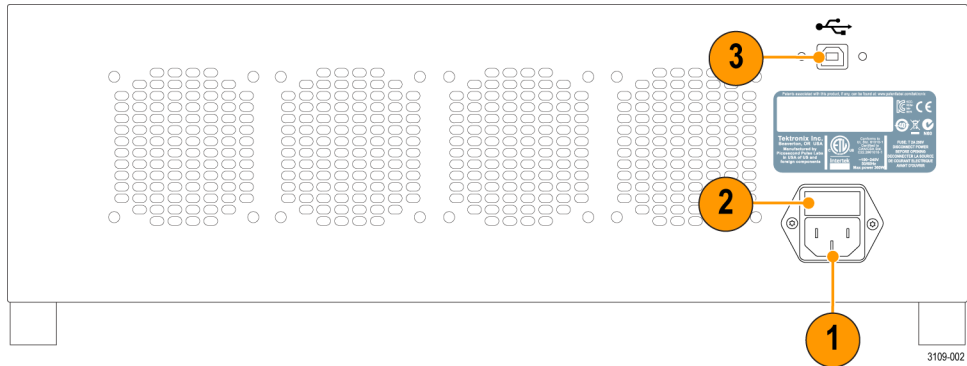


Figure 2: Rear panel connectors

Table 4: Rear panel connectors

Item	Description	
1	AC line receptacle	Connect the appropriate power cord here.
2	Fuse holder	Line fuse, 5 x 20 mm, 2 A, 250 V SLO BLO
3	USB Connection	Connect the USB cable here to control the instrument from an external computer.

Functional verification

Instrument setup

A typical setup for verifying the error detector operation is shown in the following illustrations. One diagram shows the connections for DC coupled instruments and the second diagram shows the connections for the AC coupled instruments. The diagrams use only the '+' side of all differential connections; the '-' side can be tested in the same manner.

You will need the following equipment to complete the functional checks:

- Programmable Pulse Pattern Generator. A Tektronix PPG3000 or PPG3200 series instrument is recommended.
- PED3200/PED4000 Series Error Detector
- High-speed cable assemblies. If using differential signals, the input cables should be phase matched.
- 50 Ω terminations should be used for all unused data and clock inputs.
- Electrical attenuator(s)



CAUTION. *Damage to the error detector and/or associated equipment can occur if the input and output ratings for your equipment are exceeded. To avoid possible damage, check the input and output voltage ratings for your equipment. The following figure shows an electrical attenuator where voltage ratings are commonly exceeded. Follow all ESD precautions when using the error detector to avoid damage.*

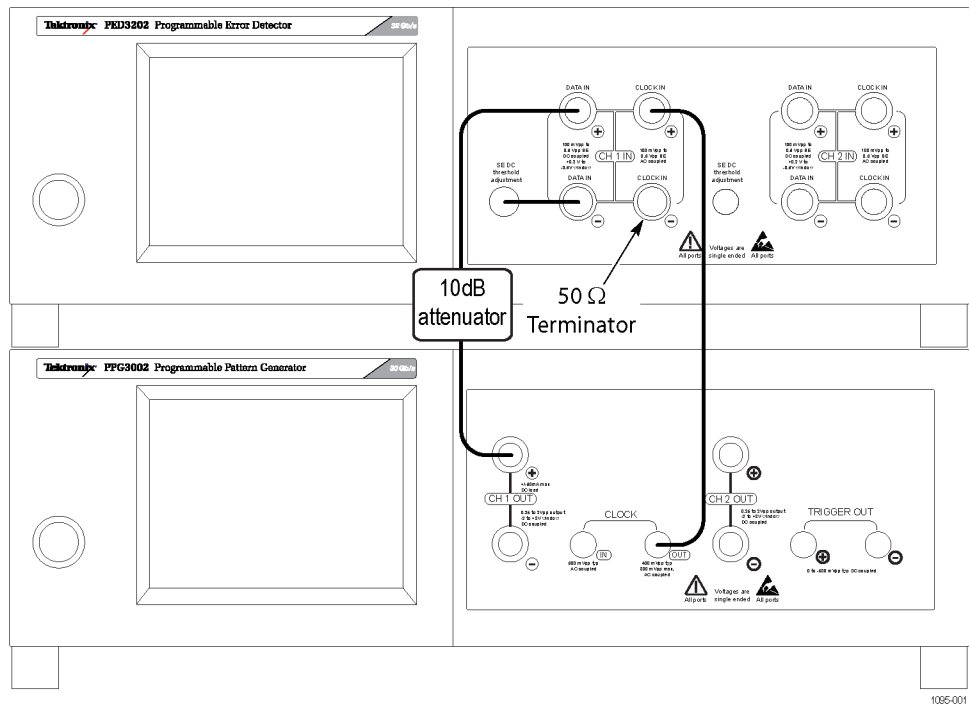


Figure 3: Verification setup, DC coupled instruments

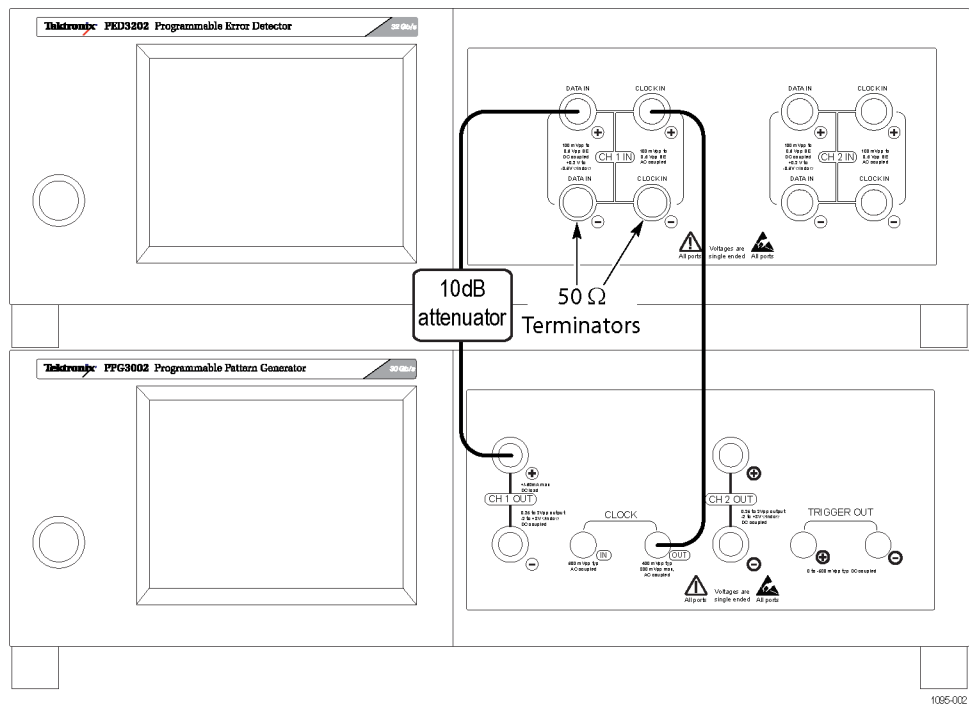


Figure 4: Verification setup, AC coupled instruments

Power on and verify instrument operation

The following steps assume that the instrument is connected as shown in one of the verification setups shown in previous illustrations.

NOTE. For DC coupled instruments connect the SE DC threshold adjustment output to the inverting data input. (See Figure 3 on page 6.)

The error detector should either be connected to the pattern generator in a differential or single-ended configuration. The user should be careful not to exceed 1 V_{p-p} differential amplitude into the error detector and to stay within the allowed input voltage window.

PPG3000 series programmable pattern generator setup

Complete the following steps to set up the pattern generator.

1. Push the on/off switch to turn the instrument on.
The light in the on/off switch turns on and the instrument goes through the startup sequence. The main menu displays on the touch screen.
2. Select **UTILITY** by touching the on-screen button.
3. Select **SAVE SETUP**.
4. Select **DEFAULTS**. The instrument loads all of the default settings.
5. Select **BACK**.
6. Select **MAIN**.
7. Adjust **OUTPUT** of Channel 1 to 400 mV_{p-p}, taking into account the attenuator value. Note that the default output voltage offset for the pattern generator is 0 mV.
8. Turn **OUTPUT ON** for Channel 1.

Error detector setup

Complete the following steps to set up the error detector.

1. Push the on/off switch to turn the instrument on.
The light in the on/off switch turns on and the instrument goes through the startup sequence. The main menu displays on the touch screen.
2. Select **PATTERN** by touching the on-screen button.
3. Select **PRBS7** (default setting for the pattern generator).
4. Select **SAMPLE**.
5. Select **AUTO ALIGN**.
6. Select **MEASURE**.

7. Confirm that SYNC STATUS is **SYNCED**.
8. Select **START**.
9. The display will show that the bit counting starts and error counting begins.

NOTE. *The clock and data will remain aligned as long as there is a stable phase relationship between the pattern source and the error detector. The error detector does not include clock recovery.*

Input and output descriptions

RF connector interface

RF connectors All front panel RF connections are 2.4 mm (K type) or SMA.

Connector torque specifications

Recommended:	7-10 in-lbs (0.791-1.130 N-m)
Maximum:	15 in-lb (1.695 N-m)

Data input and /Data input

These are the primary inputs to the unit. The data input is a DC-coupled ground referenced CML input. The inputs can be used single-ended or differentially; unused inputs should be terminated.

Clock input and /Clock input

The clock input is a differential AC-coupled ground referenced input. Unused inputs should be terminated.

Threshold output (DC coupled instruments only)

The threshold output produces a DC voltage with 50 ohm source impedance that can be connected to either the (+) or (-) data input to provide a threshold voltage to the unused side when driving data single-ended. The threshold voltage is programmable.

Functional block diagram

Basic functional blocks are shown in the following figure.

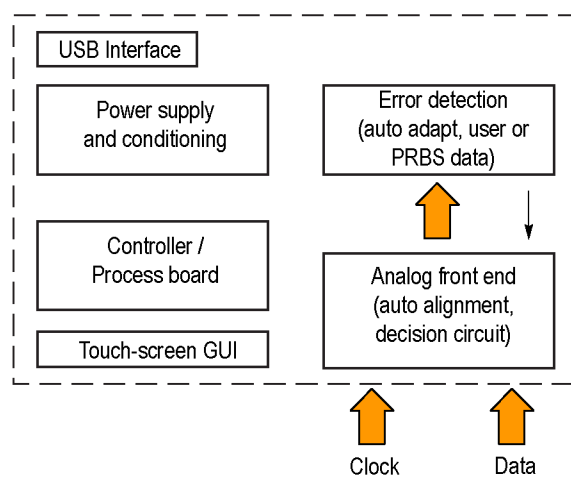


Figure 5: Block diagram

Key terminology

Sampling point The sampling point is where in the eye the sample is taken, on both the time and the voltage axis. The threshold output may be used to adjust the sample point voltage level for single-ended applications.

Synchronization Synchronization is the process of aligning the internal error detector pattern with the incoming data stream. The sync process may be initiated in several ways:

- The user enters a SYNC command.
- The user enters a CENTER DELAY command.
- The user enters a AUTO ALIGN command.

Graphical user interface (GUI) touch screen

This unit is equipped with touch screen controls. All manual settings are accessed through this user interface. An example of the GUI is shown in the following figure.

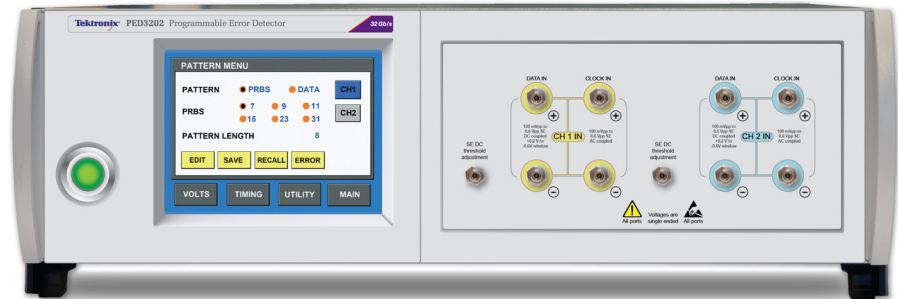


Figure 6: PED3200 instrument with graphical user interface

The following table lists where to find various parameters within the menu structure.

Table 5: GUI menu parameter locations

Parameter	Location
SYNC STATUS	MEASURE
BER	MEASURE
BIT COUNT	MEASURE
ERROR COUNT	MEASURE
EYE EDGE BER THRESHOLD	SAMPLE
CENTER DELAY	SAMPLE
CENTER OFFSET	SAMPLE (AC-coupled instruments only)
CENTER THRESHOUT	SAMPLE (DC-coupled instruments only)
AUTO ALIGN	SAMPLE
THRESHOLD OUTPUT	SAMPLE
SYNC BER THRESHOLD	SYNC
PATTERN TYPE	PATTERN
PRBS	PATTERN
Firmware version	UTILITY

Graphical user interface command set overview

Clock delay This parameter controls a delay applied to the clock signal relative to the data signal. This allows adjustment of the sampling point. The clock delay can set manually or automatically by CENTER DELAY. Numerically, mid-range of the clock delay is zero, and a more positive delay equals a longer delay.

Center delay This operation centers the clock delay relative to the data. It requires that the pattern and data input are all such that a BER lower than the EYE EDGE BER THRESHOLD can be found. If not, CENTER DELAY will fail. The CENTER DELAY operation works by finding the two ends of the eye (as determined by the Eye Edge BER Threshold) and choosing the midpoint.

Center threshout This operation centers the vertical sampling point relative to the data. It can only be used in a single-ended configuration, and the threshold output must be connected to either the (+) or (-) data input. It requires that the pattern and data input are all such that a BER lower than the EYE EDGE BER THRESHOLD can be found. If not, CENTER THRESHOUT will fail. Similar to CENTER DELAY, this operation works by finding the two ends of the eye (as determined by the Eye Edge BER Threshold) and choosing the midpoint.

Auto align This operation centers both the vertical sampling point and the clock delay relative to the data. It can only be used in a single-ended configuration, and the threshold output must be connected to either the (+) or (-) data input. It is essentially the one-touch combination of both the Center Delay and Center Threshout operations.

Eye edge BER threshold For use during CENTER DELAY, CENTER THRESHOLD, and AUTO ALIGN; this parameter specifies the BER that defines the edge of the data eye. For these operations to succeed, the error detector must be able to find settings that result in a BER lower than this threshold (the residual BER of the system must be lower than this threshold). Lower thresholds will give more accurate centering but also increase alignment time.

Sync BER threshold This parameter sets the maximum BER value for the pattern to be considered synchronized. For synchronization to succeed, the residual BER of the system must be lower than this threshold. For most patterns the default value of 10^{-3} works well.

Product specifications

All specifications apply to all models unless noted otherwise.

Data input

There is a true and a complement output for each channel. Specifications apply to each output individually.

Data rate **Range (PED3200).** 3 Gb/s to 32 Gb/s
Range (PED4000). 4 Gb/s to 40 Gb/s

DC coupled input option Ground referenced CML like input. AC coupled data input permitted within allowed voltage window.

Differential amplitude. 25 mV to 1.0 V_{p-p}

Single-ended amplitude. 25 mV to 750 mV_{p-p}

Voltage window. -0.6 V to +0.2 V

Termination voltage. 0.0 V

Input impedance. 50 Ω

Connector. 2.4 mm

AC coupled input option AC coupled input with broadband bias tees featuring a 3 dB bandwidth of 10 kHz to >50 GHz.

Differential amplitude. 6 mV to 1.0 V_{p-p}

Single-ended amplitude. 6 mV to 750 mV_{p-p}

Termination voltage. 0.0 V

Input impedance. 50 Ω

Connector. 2.4 mm

ESD sensitivity 250 V, Human body model (HBM)

Threshold output

Output voltage DC voltage terminated 50 Ω to ground
Range. -0.5 V to 0.125 V

Sampling point set points

Eye edge BER threshold **Range.** 1e-1 to 1e-11
Resolution. 1e-1

Sync BER threshold **Range.** 1e-1 to 1e-8
Resolution. 1e-1

Full rate clock input option

Amplitude AC coupled, full rate
Differential range. 300 mV_{P-P} to 1.0 V_{P-P}
Single-ended range. 300 mV_{P-P} to 1.0 V_{P-P}
Connector. 2.4 mm

Clock to data phase adjustment 100 ps (-50 ps to +50 ps)

ESD sensitivity 1000 V, Human body model (HBM)

Half rate clock input option

Amplitude AC coupled, half rate
Differential range. 300 mV_{P-P} to 1.0 V_{P-P}
Single-ended range. 300 mV_{P-P} to 1.0 V_{P-P}
Connector. 2.4 mm

Clock to data phase adjustment 100 ps (-50 ps to +50 ps)

ESD sensitivity 1000 V, Human body model (HBM)

Data patterns

Pattern type Data (from memory) or PRBS.
Length and type are individually settable on each channel.

PRBS pattern lengths

- 2⁷-1 bits.** Polynomial = $X^7 + X^6 + 1$
- 2⁹-1 bits.** Polynomial = $X^9 + X^5 + 1$
- 2¹¹-1 bits.** Polynomial = $X^{11} + X^9 + 1$
- 2¹⁵-1 bits.** Polynomial = $X^{15} + X^{14} + 1$
- 2²³-1 bits.** Polynomial = $X^{23} + X^{18} + 1$
- 2³¹-1 bits.** Polynomial = $X^{31} + X^{28} + 1$

User-defined pattern depth

Number of channels	Single bit pattern resolution
1 channel	4 Mbit
2 channel	2 Mbit

Mechanical

Front panel width (with mounting tabs) 48.3 cm (19.0 in)

Height 13.3 cm (5.25 in)

Width 45.1 cm (17.75 in)

Depth (rack mount) 34.3 cm (13.5 in)

Weight (1 channel) 11.1 kg (24.5 lbs)

Operating temperature 0 °C to 40 °C (32 °F to 104 °F)

Programming the instrument

Remote programming

USB interface All automated programming is accomplished through a USB TMC interface.

Command information

Sequential vs. Overlapped Except for the following list, all commands are sequential commands. Sequential commands complete before the next is executed. This means that completion of any command can be verified by following it with any query. When the query response is received, the previous command is certain to be complete.

Non-sequential commands are called “overlapped” commands. These commands allow processing of other commands while the overlapped command is being processed. There are restrictions on what commands will be processed concurrent with the processing of an overlapped command. In general, the allowed concurrent commands are the commands necessary to monitor the status and/or completion of the overlapped command. If a disallowed command is sent during the processing of an overlapped command, it will be processed normally when the overlapped command completes. See the command description for details of these restrictions.

Overlapped Commands:

- :SENSe[1|3]:EYE:TCENter[?]
- :SENSe[1|3]:SYNC:EXECute[?]
- :SENSe[1|3]:EYE:ALIGn:AUTO[?]
- :SOURce[1|2]:VOLTage[:LEVel]:CENTer[?]

Command description notation **Long and short form.** Commands have both a long and short form. In command descriptions, the long form is the entire command while the short form is the part in capital letters. Commands must be either the exact long form or the exact short form, other combinations will create an error.

Optional commands. Some parts of commands are optional. These are enclosed by square brackets [].

Selection. Where a command can include one of two or more mutually exclusive options, the options will each be listed with a vertical bar | separating the options. If the options are integers and enclosed by square brackets indicating the choice is optional, then the first option will be assumed if none are included in the command.

Common commands

Summary

command	Description
*IDN?	Identification Query
*OPC?	Operation Complete Query
*RST	Reset Command

Reference

***IDN?** Read the instrument's identification string. The returned string has the following format: "Tektronix Inc., PED3200, SN,FWREV"

where:

- PED3200 = PED3200 series
- SN = serial number
- FWREV = firmware revision

The returned string can be up to 72 characters long.

***OPC?** The operation complete query returns the ASCII character "1" when the processing of all previous commands is complete. This can be used to ensure that previous commands are complete before issuing more commands.

***RST** Reset the instrument to default settings. This sets all parameters to their default values, including pattern length and pattern data. Any measurement in progress is stopped and sync is lost.

Command subsystems

A SENSE and an INPUT subsystem can apply to a given input port. The INPUT subsystem sets the input port parameters that condition the input signal while the SENSE subsystem sets parameters that define the expected input signal.

An OUTPUT and a SOURCE subsystem can apply to a given output port. The OUTPUT subsystem conditions the output signal after it has been generated and the SOURCE subsystem sets the signal generation parameters.

The SENSE, INPUT, OUTPUT, and SOURCE subsystems apply as follows (not all subsystems listed are used in all versions of the instrument):

SENSe1	Data Input, Channel 1
INPut1	
SENSe2	Clock Input, Channel 1
INPut2	
SENSe3	Data Input, Channel 2
INPut3	
SENSe4	Clock Input, Channel 2
INPut4	
SOURce1	Threshold Output, Channel 1
OUTPut1	
SOURce2	Threshold Output, Channel 2
OUTPut2	

The FETCH subsystem is used to read the measurement results. At the next level, it is divided by the SENSE node of the measurement.

The SYSTEM subsystem is used for instrument system level commands. This includes reading the error queue.

The MMEMORY subsystem is used for commands related to mass memory. This means saving and recalling pattern data and instrument states.

Regular commands

Command	Parameter	Default	Description	Page
FETCh Subsystems				
FETCh:				
[:SENSe[1 3]]				
:ECount[:ALL][:FULL][:TOTAL]?	<numeric>	n/a	query total # of errors since the start of the gate period	(See page 22.)
:ERATio[:ALL][:FULL][:TOTAL]?	<numeric>	n/a	query total error ratio since the start of the gate period	(See page 22.)
:SENSe[2 4]:BCOunt?	<numeric>	n/a	query total # of bits since the start of the gate period	(See page 22.)
INPut[1 3] Subsystems(not used)				
INPut[2 4] Subsystems				
:INPut[2 4]:DELay[?]	<numeric>	0	set/query clock to data delay	(See page 23.)
:INPut[2 4]:DELay[?]	NORMal INVerted	NORM	set/query data input polarity	(See page 23.)
MMEMORY Subsystem				
:MMEMory				
:STORe				
:PDATA	<string>	n/a	store pattern data in system memory	(See page 23.)
:STATe	<string>	n/a	store instrument settings in system memory	(See page 24.)
:LOAD				
:PDATA	<string>	n/a	recall pattern data from system memory	(See page 24.)
:STATe	<string>	n/a	recall instrument settings from system memory	(See page 25.)
:MOVE				
:PDATA	<string>, <string>	n/a	rename existing pattern data file in system memory	(See page 25.)
:STATe	<string>, <string>	n/a	rename existing instrument settings file in system memory	(See page 25.)

Command	Parameter	Default	Description	Page
:DELeTe				
:PDATa	<string>	n/a	delete stored pattern data file in system memory	(See page 26.)
:STATe	<string>	n/a	delete instrument settings file in system memory	(See page 26.)
:CATalog				
:PDATa	n/a	n/a	get list of stored pattern data files in system memory	(See page 26.)
:STATe	n/a	n/a	get list of instrument settings files in system memory	(See page 27.)
SENSe[1 3] Subsystems				
:SENSe[1 3]				
:EYE				
:ALIGn				
:AUTO	ONCE ABORT OK ERROR BUSY	n/a	initiate an an auto align process or query status	(See page 27.)
:OCENter	ONCE ABORT OK ERROR BUSY	n/a	initiate center offset process or query status	(See page 28.)
:OFFSet	<numeric>	0	set input offset voltage	(See page 29.)
:TCENter	ONCE ABORT OK ERROR BUSY	n/a	initiate center clock delay process or query status	(See page 28.)
:TEDGe?	<numeric>	n/a	query the eye edge positions	(See page 29.)
:THReshold[?]	<numeric>	10e-3	set/query the Eye Edge BER Threshold	(See page 30.)
:VEDGe?	<numeric>	n/a	query the voltage axis eye edge positions	(See page 31.)
:GATE				
:STATe[?]	OFF ON	OFF	set/query the accumulation state	(See page 31.)
:PATtern				
:LENGth[?]	<numeric>	8	set/query Pattern Length	(See page 32.)

Command	Parameter	Default	Description	Page
:TYPE[?]	DATA PRBS	PRBS	set/query Pattern type	(See page 32.)
:PLENgtH[?]	<numeric>	7	set/query PRBS length	(See page 33.)
:DATA[?]	<numeric>, <numeric>, <arbitrary block>	1000...	set/query Pattern Data	(See page 34.)
:HDATA[?]	<numeric>, <numeric>, <arbitrary block>	1000...	set/query Pattern Data in hexadecimal character format	(See page 35.)
:SYNC				
:EXECute[?]	ONCE ABORT OK ERROR BUSY	n/a	initiate synchronization process or query status	(See page 36.)
:STATe?	SYNC LOSS	n/a	query sync state	(See page 36.)
:THReshold[?]	<numeric>	1e-3	set/query Sync BER Threshold	(See page 37.)
:TYPE	MANUAL AUTO	MANUAL	set/query sync type	(See page 37.)
SENSe[2 4] Subsystems				
:SENSe[2 4]:FREQUency[:CS]:FIXED?	<numeric>	n/a	query clock frequency	(See page 37.)
SOURce[1 2] Subsystems				
:SOURce[1 2]:VOLTage[:LEVel]				
[:IMMediate][:AMPLitude]	<numeric>	0.0	set/query voltage of threshold output	(See page 38.)
:CENTer	ONCE ABORT OK ERROR BUSY	n/a	Initiate center threshold out process or query status	(See page 38.)
SYSTEM Subsystem				
:SYSTem:ERRor[:NEXT]?	none	n/a	query error queue	(See page 39.)

Command reference

:FETCh[:SENSe[1|3]]:ECOunt[:ALL][:FULL][:TOTal]?

Form	Query
Parameters	Numeric.
Description	Queries the total number of errors accumulated since the start of the gate period. If the gate period is in progress, the measurement will be an interim measurement. If the gate period has ended, the result is retained until the start of the next gate period. If there is no valid data, the return value will be 9.91e37. (this is Not A Number, NaN, as defined by the SCPI standard)
Example	Query total errors for channel 1 :FETC:ECO? or :FETC:SENS:ECO? or :FETC:SENS1:ECO?

:FETCh[:SENSe[1|3]]:ERATio[:ALL][:FULL][:TOTal]?

Form	Query
Parameters	Numeric.
Description	Queries the bit error ratio accumulated during the current gate period. This is the ratio of the total errors and the total bit count. If the gate period is in progress, the measurement will be an interim measurement. If the gate period has ended, the result is retained until the start of the next gate period. If there is no valid data, the return value will be 9.91e37 (NaN).
Example	Query the total error ratio for channel 1 :FETC:ERAT?

:FETCh:SENSe[2|4]:BCOunt?

Form	Query
Parameters	Numeric.
Description	Queries the total bit count accumulated during the current gate period. If the gate period is in progress, the measurement will be an interim measurement. If the gate period has ended, the result is retained until the start of the next gate period. If there is no valid data, the return value will be 9.91e37 (NaN). The bit count is associated with a clock input. The [2 4] specifies which channel clock input. 2 = channel 1 clock, 4 = channel 2 clock.
Example	Query the total bit count for channel 1 :FETC:SENS2:BCO?

:INPut[2|4]:DELay[?]

Form	Set & Query
Parameters	Numeric
Value Coupling	Value is changed by <i>Center Clock Delay</i> and <i>Auto Align</i> processes.
Range Coupling	None
Default	0
Description	<p>Programs the delay of the clock signal relative to the data signal, in seconds. Larger positive values indicate more delay of the clock relative to the data. Max/min values are -50/+50 ps, resolution is 0.1 ps.</p> <p>[2 4] specifies the port. 2 = channel 1 clock, 4 = channel 2 clock.</p>
Example	<p>Set Ch1 delay to 23 ps</p> <pre>:INP2:DEL 23.0ps</pre> <p>Set Ch2 delay to -17 ps (= 17 ps advance)</p> <pre>:input4:delay -17ps</pre>

:INPut[2|4]:POLarity[?]

Form	Set & Query
Parameters	NORMal INVerted
Value Coupling	None
Range Coupling	None
Default	NORM
Description	Programs the polarity of the data input.
Example	<p>Set Ch1 data input polarity to inverted</p> <pre>:INP2:POL INV</pre>

:MMEMory:STORe:PDATa

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	<p>Store the current pattern data into the system memory. In a two-channel unit, the pattern data running on both channels is stored. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only.</p> <p>The pattern data is stored up to the current pattern length, and the pattern length is also stored. The pattern type (data/PRBS) is not stored.</p>
Example	<p>Store the pattern data in system memory.</p> <pre>:MMEM:STOR:PDAT "PATT1011"</pre>

:MMEMory:STORe:STATe

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	Store the instrument setting into the system memory. Every parameter of the instrument is stored except for pattern data, pattern length and output enable status. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only.
Example	Store the parameters in system memory. MMEM:STOR:STAT "PARAM22"

:MMEMory:LOAD:PDATa

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	Recalls the pattern data from a saved file in system memory. In a two-channel unit, the pattern data of both channels are recalled. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only. The pattern data is loaded up to the stored pattern length, and the stored pattern length is also loaded. Pattern data in memory above the stored pattern length is not altered. The pattern type (data/PRBS) is not stored or loaded.
Example	Recall the pattern data from file "PATT1011". :MMEM:LOAD:PDAT "PATT1011"

:MMEMory:LOAD:STATe

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	Recalls the instrument setting from a saved file in system memory. Every parameter of the instrument is recalled except for pattern data, pattern length, and output enable status. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only.
Example	Recall the instrument settings from file "PARAM22". :MMEM:LOAD:STAT "PARAM22"

:MMEMory:MOVE:PDATa

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	Rename the existing saved pattern data file in system memory. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only.
Example	Rename the pattern data file PATT1011 to PATT0101. :MMEM:MOVE:PDAT "PATT1011", "PATT0101"

:MMEMory:MOVE:STATe

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	Rename the existing saved instrument settings file in system memory. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only.
Example	Rename the instrument settings file PARAM22 to PARAM. :MMEM:MOVE:STAT "PARAM22", "PARAM"

:MMEMory:DELeTe:PDATa

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	Deletes an existing saved pattern data file in system memory. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only.
Example	Delete the existing pattern data file PATT0101. :MMEM:DEL:PDAT "PATT0101"

:MMEMory:DELeTe:STATe

Form	Set
Parameters	String
Value Coupling	None
Range Coupling	None
Default	N/A
Description	Deletes an existing saved instrument settings file in system memory. The name of the file can be up to 8 characters long and is not case-sensitive. Filenames must consist of alphanumeric characters only.
Example	Delete the existing instrument settings file PARAM. :MMEM:DEL:STAT "PARAM"

:MMEMory:CATalog:PDATa?

Form	Query
Parameters	None
Description	Get the list of pattern data files stored in system memory. All the filenames stored in the system memory are returned as capital letters
Example	Get the list of pattern data files stored in system memory. :MMEM:CAT:PDAT?

:MMEMory:CATalog:STATe?

Form	Query
Parameters	None
Description	Get the list of instrument settings files stored in system memory. All the filenames stored in the system memory are returned as capital letters
Example	Get the list of instrument settings files stored in system memory. :MMEM:CAT:STAT?

:SENSe[1|3]:EYE:ALIGn:AUTO[?]

Form	Set & Query
Parameters	Set: ONCE ABORT Query: OK ERROR BUSY
Value Coupling	Can change the clock delay value and the threshold output value.
Range Coupling	None
Default	N/A
Description	<p>Initiates the “auto align” process or queries the process status. This centers the clock delay setting and the voltage, relative to the eye edges. The process used for centering the voltage depends on the instrument type:</p> <p>DC: center threshold out AC option: center offset</p> <p>For the command form:</p> <p>SENS[1 3]:EYE:ALIG:AUTO ONCE begins the “auto align” process. SENS[1 3]:EYE:ALIG:AUTO ABORT stops the “auto align” process. If the process is not in progress, it has no effect.</p> <p>The query form returns status of the last “auto align” process to be initiated:</p> <p>OK means the process has successfully completed. This value is also returned if the process has not yet run since power-on. ERROR means the process has completed and was unable to successfully synchronize. BUSY means the process is still in progress.</p> <p>This is an overlapped command. Allowed concurrent commands include:</p> <p>:SENSe[1 3]:EYE:ALIG:AUTO ABORT :SENSe[1 3]:EYE:ALIG:AUTO?</p> <p>The “auto align” process can take a significant amount of time. It uses the Eye Edge BER Threshold to determine the eye edges during the process. Lower Eye Edge BER Threshold values take more time, as do data patterns (vs PRBS), especially longer data pattern lengths.</p>
Example	Initiate the “auto align” process for channel 1. :SENS1:EYE:ALIG:AUTO ONCE

:SENSe[1|3]:EYE:OCENter[?]

Form	Set & Query
Parameters	Set: ONCE ABORT Query: OK ERROR BUSY
Value Coupling	Can change the offset value.
Range Coupling	None
Default	N/A
Description	<p>Initiates the <i>center offset</i> process or queries the process status. This command is available on instruments with the AC option only. For instruments without the AC option, see the command “:SOURce[1 2]:VOLtage[:LEVel] :CENTer[?]”.</p> <p>For the command form:</p> <p> SENSe[1 3]:EYE:TCEN ONCE begins the <i>center offset</i> process</p> <p> SENSe[1 3]: EYE:TCEN ABORT stops the <i>center offset</i> process. If the process is not in progress, it has no effect.</p> <p>The query form returns status of the last <i>center offset</i> process to be initiated:</p> <p> OK means the process has successfully completed. This value is also returned if the process has not yet run since power-on.</p> <p> ERROR means the process has completed and was unable to successfully synchronize.</p> <p> BUSY means the process is still in progress.</p> <p>This is an overlapped command. Allowed concurrent commands include:</p> <p> :SENSe[1 3]: EYE:OCEN ABORT</p> <p> :SENSe[1 3]: EYE:OCEN?</p> <p>The <i>center offset</i> process can take a significant amount of time. It uses the EYE EDGE BER THRESHOLD to determine the eye edges during the process. Lower EYE EDGE BER THRESHOLD values take more time, as do data patterns (vs PRBS) and longer data pattern lengths.</p>
Example	<p>Initiate the “center offset” process for channel 1.</p> <p>:SENS1:EYE:OCEN ONCE</p>

:SENSe[1|3]:EYE:OFFSet[?]

Form	Set & Query
Parameters	Numeric
Value Coupling	None
Range Coupling	None
Default	0.0
Description	<p>Programs the data offset voltage. This command is available on instruments with AC option only. For instruments without the AC option, see the command “:SOURce[1 2]:VOLTage[:LEVel][:IMMediate][:AMPLitude]”.</p> <p>The default value of 0 is normally good for 50% duty input signals. See the command :SENSe[1 3]:EYE:OCENter to automatically optimize this value.</p>
Example	<p>Set the channel 1 offset to -125 mV.</p> <pre>:SENS1:EYE:OFFS -0.125</pre>

:SENSe[1|3]:EYE:TCENter[?]

Form	Set & Query
Parameters	<p>Set: ONCE ABORT</p> <p>Query: OK ERROR BUSY</p>
Value Coupling	Can change the clock delay value.
Range Coupling	None
Default	N/A
Description	<p>Initiates the <i>center clock delay</i> process or queries the process status.</p> <p>For the command form:</p> <p> :SENSe[1 3]:EYE:TCEN ONCE begins the <i>center clock delay</i> process.</p> <p> :SENSe[1 3]:EYE:TCEN ABORT stops the <i>center clock delay</i> process. If the process is not in progress, it has no effect.</p> <p>The query form returns status of the last <i>center clock delay</i> process to be initiated:</p> <p> OK means the process has successfully completed. This value is also returned if the process has not yet run since power-on.</p> <p> ERROR means the process has completed and was unable to successfully synchronize.</p> <p> BUSY means the process is still in progress.</p> <p>This is an overlapped command. Allowed concurrent commands include:</p> <p> :SENSe[1 3]:EYE:TCEN ABORT</p> <p> :SENSe[1 3]:EYE:TCEN?</p> <p>The <i>center clock delay</i> process can take a significant amount of time. It uses the EYE EDGE BER THRESHOLD to determine the eye edges during the process. Lower EYE EDGE BER THRESHOLD values take more time, as do data patterns (vs PRBS) and longer data pattern lengths.</p>
Example	<p>Initiate the “center clock delay” process for channel 1.</p> <pre>:SENS1:EYE:TCEN ONCE</pre>

:SENSe[1|3]:EYE:TEDGe?

Form	Query
Parameters	<p><edge_num></p> <p><edge_num> is numeric and specifies which edge of the eye. It is 1 for the left (first) edge, and 2 for the right (second) edge.</p> <p>The response is Numeric.</p>
Description	<p>Queries the left or right (time axis) eye edges as determined during the most recent automatic process that sets the horizontal sampling point. This includes the <i>Center Clock Delay</i> and <i>Auto Align</i> processes.</p> <p>If those processes have not been run or failed on the most recent attempt, the return value will be 9.91e37. (NaN)</p>
Example	<p>Read the second (right-side) eye edge for channel 1.</p> <pre>:SENS1:EYE:TEDG? 2</pre>

:SENSe[1|3]:EYE:THReshold[?]

Form	Set & Query
Parameters	Numeric
Value Coupling	None
Range Coupling	None
Default	N/A
Description	<p>Programs the Eye Edge BER Threshold. This is the BER value used by the instrument during automatic alignment procedures to determine the edges of the eye. The edge of the eye is defined as the point where the BER value is less than or equal to Eye Edge BER Threshold and the neighboring point is greater than the Eye Edge BER Threshold.</p> <p>Allowed values range from 10^{-7} to 10^{-2}, in decade steps. Note that higher values result in faster but possibly less accurate alignment procedures.</p>
Example	<p>Read the Eye Edge BER Threshold for channel 1.</p> <pre>:SENS1:EYE:THR?</pre>

:SENSe[1|3]:EYE:VEDGe?

Form	Query
Parameters	<p><edge_num></p> <p><edge_num> is numeric and specifies which edge of the eye. It is 1 for the bottom edge, and 2 for the top edge.</p> <p>The response is Numeric.</p>
Description	<p>Queries the bottom or top (voltage axis) eye edges as determined during the most recent automatic process that sets the vertical sampling point. This includes the <i>Center Thresh Out</i> and <i>Auto Align</i> processes.</p> <p>If those process have not been run or failed on the most recent attempt, the return value will be 9.91e37. (NaN)</p>
Example	<p>Read the top eye edge for channel 1.</p> <pre>:SENS1:EYE:VEDG? 2</pre>

:SENSe[1|3]:GATE:STATe[?]

Form	Set & Query
Parameters	OFF ON
Value Coupling	None
Range Coupling	None
Default	N/A
Description	<p>Programs the accumulation state, equivalent to starting/stopping measurement on the GUI. Accumulation can be started only while the instrument is synchronized. If the command to start accumulation is sent while the instrument is not synchronized, accumulation will not start and an error will be generated.</p> <p>Related commands:</p> <pre>:SENS[1 3]:SYNC:STATe?</pre> <pre>:SYSTem:ERRor[:NEXT]?</pre>
Example	<p>Start accumulation on ch 1.</p> <pre>:SENS1:GATE:STAT ON</pre> <p>Stop accumulation on ch 1.</p> <pre>:SENS1:GATE:STAT OFF</pre>

:SENSe[1|3]:PATTern:LENGth[?]

Form	Set & Query
Parameters	Numeric
Value Coupling	None
Range Coupling	None
Default	8
Description	<p>Programs the Pattern Length. This value is only relevant if the pattern type is DATA.</p> <p>For a single channel instrument, the length can be any integer from 2 through 4,194,304. In a two channel instrument, the maximum pattern length per channel is 2,097,152</p>
Example	<p>Set Ch1 pattern length to 56.</p> <pre>:SENS1:PATT:LENG 56</pre> <p>Set Ch2 pattern length to 500.</p> <pre>:SENSE3:PATTERN:LENGTH 500</pre> <p>Query Ch 1 pattern length.</p> <pre>:SENS1:PATT:LENG?</pre>

:SENSe[1|3]:PATTern:TYPE[?]

Form	Set & Query
Parameters	DATA PRBS
Value Coupling	None
Range Coupling	None
Default	PRBS
Description	Programs the Pattern Type.
Example	<p>Set the Ch 1 pattern type to PRBS.</p> <pre>:SENS1:PATT:TYPE PRBS</pre> <p>Query Ch 1 pattern type.</p> <pre>:SENS1:PATT:TYPE?</pre>

:SENSe[1|3]:PATTern:PLENght[?]

Form	Set & Query
Parameters	7 9 11 15 23 31
Value Coupling	None
Range Coupling	None
Default	7
Description	Programs the Pattern PRBS Length. PRBS Length is specified as 2^N-1 , where N is the specified value. This value is only relevant if the pattern type is PRBS.
Example	Set the Ch 1 PRBS length to (2^7-1) . :SENSe1:PATT:PLEN 7 Query Ch1 PRBS length. :SENSe1:PATT:PLEN?

:SENSe[1|3]:PATTern:DATA[?]

Form	Set & Query
Parameters	<p><start address>, <bit count>, <data></p> <p><start address> > is numeric, and is the bit number in pattern data memory of the first bit to write.</p> <p><bit count> is the number of bits to write into pattern data memory.</p> <p><data> is an arbitrary block of program data as defined in IEEE-488.2-1992, section 7.7.6.2. It starts with a “#” character, followed by a single character representing the length of the length, then 1 to 5 characters specifying the length as a decimal number, then the program data.</p>
Value Coupling	None
Range Coupling	None
Default	Default data is a 1 in position 1, all other bits are 0.
Description	<p>Programs the pattern data memory. Each byte of pattern data is a character (0 or 1) representing one bit of pattern data. The start address can be any bit location, 1 – <max address>, <max address> is 4,194,304 for a single-channel instrument and 2,097,152 for a two-channel instrument. The bit count can be any number 1 – 1024. The entire pattern data memory is accessible for reads or writes, even outside the range of the current pattern length setting. The bit count parameter and the length of the data block must match.</p> <p>(<start address> + <bit count>) must be ≤ (<start address> + 1)</p>
Example	<p>:SENS1:PATT:DATA 1,16,#2160100000101010010</p> <p>This command does the following:</p> <ul style="list-style-type: none"> Starts loading the Ch 1 data into bit location 1. Specifies that 16 bits of data will be loaded. <p>In the <data>:</p> <ul style="list-style-type: none"> #: signifies the beginning of the block. 2: indicates that the length of the data length is two characters. 16: indicates that data length is 16 bytes. (16 ASCII characters). 0100000101010010: is the character representation of the data. <p>Bits 1 through 16 in the channel 1 pattern data memory will be set to 0100000101010010.</p> <hr/> <p>:SENS1:PATT:DATA? 1,8</p> <p>This query reads 8 bits of channel 1 pattern data starting from address 1. Given the above pattern data memory contents, the response would be "#1801000001"</p>

:SENSe[1|3]:PATTern:HDATa[?]

Form	Set & Query
Parameters	<p><start address>, <bit count>, <data></p> <p><start address> > is numeric, and is the bit number in pattern data memory of the first bit to write.</p> <p><bit count> is the number of bits to write into pattern data memory.</p> <p><data> is an arbitrary block of program data as defined in IEEE-488.2-1992, section 7.7.6.2. It starts with a “#” character, followed by a single character representing the length of the length, then 1 to 5 characters specifying the length as a decimal number, then the program data.</p>
Value Coupling	None
Range Coupling	None
Default	Default data is a 1 in position 1, all other bits are 0.
Description	<p>Programs the pattern data memory using hexadecimal character format. Each byte of pattern data is a hexadecimal character (0-9, A-F or a-f) representing four bits of pattern data. The start address can be any bit location, 1 – <max address>, <max address> is 4,194,304 for a single-channel instrument and 2,097,152 for a two-channel instrument. The bit count can be any number 1 to 4096. The entire pattern data memory is accessible for reads or writes, even outside the range of the current pattern length setting.</p> <p>The bit count parameter must be equal to 4 times the length of the data block or up to 3 bits fewer. If it is fewer, then the extra bits in the last data byte are ignored.</p> <p>(<start address> + <bit count>) must be ≤ (<start address> + 1)</p>
Example	<p>:SENSe1:PATT:HDAT 1,16,#144152</p> <p>This command does the following:</p> <ul style="list-style-type: none"> Starts loading the Ch 1 data into bit location 1. Specifies that 16 bits of data will be loaded. In the <data>: <ul style="list-style-type: none"> #: signifies the beginning of the block. 1: indicates that the length of the data length is one character. 4: indicates that data length is 4 bytes. (4 ASCII characters). 4152: is the character representation of the data. <p>Bits 1 through 16 in the channel 1 pattern data memory will be set to 0100000101010010.</p> <hr/> <p>:SENSe1:PATT:HDAT? 1,8</p> <p>This query reads 8 bits of channel 1 pattern data starting from address 1. Given the above pattern data memory contents, the response would be “#1241”</p> <p>Note that if the query requests a number of bits that is not a multiple of 4, some bits in the last byte will not be meaningful, and will be 0.</p>

:SENSe[1|3]:SYNC:EXECute[?]

Form	Set & Query
Parameters	Set: ONCE ABORT Query:OK ERROR BUSY
Value Coupling	None
Range Coupling	None
Default	N/A
Description	<p>Initiates the synchronization process or queries the process status.</p> <p>For the command form:</p> <p> SENSe[1 3]:SYNC ONCE begins the synchronization process.</p> <p> SENSe[1 3]:SYNC ABORT stops a sync process. If a sync is not in progress, it has no effect.</p> <p>The query form returns status of the last sync process to be initiated:</p> <p> OK means the process has successfully completed. This value is also returned if the process has not yet run since power-on.</p> <p> ERROR means the process has completed and was unable to successfully synchronize.</p> <p> BUSY means the process is still in progress.</p> <p>This is an overlapped command. Allowed concurrent commands include:</p> <p> :SENSe[1 3]:SYNC:EXEC ABORT</p> <p> :SENSe[1 3]:SYNC:EXEC?</p> <p>The synchronization process can take a significant amount of time in data mode. PRBS patterns synchronize quickly. Longer patterns and lower Sync BER Thresholds increase the time to synchronize.</p>
Example	<p>Initiate the sync process for channel 1.</p> <p>:SENS1:SYNC:EXEC ONCE</p>

:SENSe[1|3]:SYNC:STATe?

Form	Query
Parameters	SYNC LOSS
Description	Queries the synchronization state. The return value will be either SYNC or LOSS.
Example	<p>Query Ch2 synchronization state.</p> <p>:SENS3:SYNC:STAT?</p>

:SENSe[1|3]:SYNC:THReshold[?]

Form	Set & Query
Parameters	Numeric
Value Coupling	None
Range Coupling	None
Default	10 ⁻³
Description	<p>Programs the synchronization BER threshold. This is the maximum BER value for which a synchronization is considered successful. Also, in auto sync mode, the current BER is monitored and compared to this threshold.</p> <p>The threshold may range from 10⁻¹ to 10⁻⁸ in decade steps.</p> <p>Synchronization will succeed only if the BER of the system is less than the sync BER threshold.</p>
Example	<p>Set the ch1 synchronization threshold to 10⁻².</p> <pre>:SENS1:SYNC:THR 1e-2</pre>

:SENSe[1|3]:SYNC:TYPE[?]

Form	Set & Query
Parameters	MANUAL AUTO
Value Coupling	None
Range Coupling	None
Default	MANUAL
Description	<p>Programs the synchronization type. For auto type, the error rate is monitored and if it exceeds the sync BER Threshold, a resync is attempted. If the resync attempt fails, then sync is lost and no more automatic resync attempts are made. For manual type, the BER Threshold is not monitored so sync is maintained regardless of error rate.</p>
Example	<p>Query Ch1 sync type.</p> <pre>:SENS1:SYNC:TYPE?</pre>

:SENSe[2|4]:FREQuency[:CW]:FIXed]?

Form	Query
Parameters	Numeric
Description	<p>Queries the frequency measured at the clock input. This value is valid only if the error detector is synchronized. The return value is in Hz.</p> <p>[2 4] specifies the port. 2 = channel 1 clock, 4 = channel 2 clock. Omitting the port specifier is equivalent to specifying channel 1 clock.</p>
Example	<p>Query Ch1 frequency</p> <pre>:SENS2:FREQ?</pre>

:SOURce[1|2]:VOLTage[:LEVel][:IMMediate][:AMPLitude][?]

Form	Set & Query
Parameters	Numeric
Value Coupling	None
Range Coupling	None
Default	0.0
Description	<p>Programs the voltage of the Threshold Output. This command is not available on instruments with AC option. For those instruments, see the command “:SENSe[1 3]:EYE:OFFSet”.</p> <p>To automatically optimize this value, see the command “:SOURce[1 2]:VOLTage[:LEVel]:CENTer”.</p>
Example	<p>Set the channel 1 threshold output to -125 mV</p> <pre>: SOUR1:VOLT -0.125</pre>

:SOURce[1|2]:VOLTage[:LEVel]:CENTer[?]

Form	Set & Query
Parameters	<p>Set: ONCE ABORT</p> <p>Query: OK ERROR BUSY</p>
Value Coupling	Can change the Threshold Output.
Range Coupling	None
Default	n/a
Description	<p>Initiates the <i>center thresh out process</i> or queries the process status. This command is not available on instruments with the AC option. For those instruments, see the command “:SENSe[1 3]:EYE:OCENter[?]”.</p> <p>For the command form:</p> <p style="padding-left: 20px;">SOUR[1 2]:VOLT:CENT ONCE begins the “center thresh out” process.</p> <p style="padding-left: 20px;">SOUR[1 2]:VOLT:CENT ABORT stops the “center thresh out” process. If the process is not in progress, it has no effect.</p> <p>The query form returns status of the last <i>center clock delay</i> process to be initiated:</p> <p style="padding-left: 20px;">OK means the process has successfully completed. This value is also returned if the process has not yet run since power-on.</p> <p style="padding-left: 20px;">ERROR means the process has completed and was unable to successfully synchronize.</p> <p style="padding-left: 20px;">BUSY means the process is still in progress.</p> <p>This is an overlapped command. Allowed concurrent commands include:</p> <p style="padding-left: 20px;">: SOUR[1 2]:VOLT:CENT ABORT</p> <p style="padding-left: 20px;">: SOUR[1 2]:VOLT:CENT?</p> <p>The <i>center thresh out process</i> can take a significant amount of time. It uses the Eye Edge BER Threshold to determine the eye edges during the process. Lower Eye Edge BER Threshold values take more time, as do data patterns (vs PRBS), especially longer data pattern lengths.</p>
Example	<p>Initiate the “center thresh out” process for channel 1</p> <pre>: SOUR1:VOLT:CENT ONCE</pre>

:SYSTem:ERRor[:NEXT]?

Form	Query
Parameters	Numeric
Value Coupling	N/A
Range Coupling	N/A
Default	N/A
Description	<p>Queries the system error queue. Returns an integer representing the error number and a string in double quotes containing the error description. The integer and string are separated by a comma.</p> <p>The error queue can have multiple items that can be retrieved using multiple queries. If the queue is empty, the response will be: +0,"No error" If the queue receives more errors than it can hold, the extra errors will be discarded.</p>
Example	<p>Query the error queue</p> <p>:SYST:ERR?</p>

User service

This section describes high-level service information and procedures for your instrument.

Service offerings

Tektronix provides service to cover repair under warranty and other services that are designed to meet your specific service needs.

Whether providing warranty repair service or any of the other services listed below, Tektronix service technicians are well equipped to service your instruments. Services are provided at Tektronix Service Centers and on-site at your facility, depending on your location.

Warranty repair service

Tektronix warrants this product as described in the warranty statements at the front of this manual. Tektronix technicians provide warranty service at most Tektronix service locations worldwide. The Tektronix product catalog lists all service locations worldwide.

Calibration and repair service

In addition to warranty repair, Tektronix Service offers calibration and other services that provide cost-effective solutions to your service needs and quality standards compliance requirements. Tektronix instruments are supported worldwide by the leading-edge design, manufacturing, and service resources of Tektronix to provide the best possible service.

General care

Protect the instrument from adverse weather conditions. The instrument is not waterproof. Do not store or leave the instrument where the display will be exposed to direct sunlight for long periods of time.



CAUTION. *To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents.*

Preventive maintenance

Preventive maintenance mainly consists of periodic cleaning. Periodic cleaning reduces instrument breakdown and increases reliability. Clean the instrument as needed, based on the operating environment. Dirty conditions may require more frequent cleaning than computer room conditions.

Clean the flat panel display

The flat panel display is a soft plastic display and must be treated with care during cleaning.



CAUTION. *Improper cleaning agents or methods can damage the flat panel display.*

- Do not use abrasive cleaners or commercial glass cleaners to clean the display surface.
- Do not spray liquids directly on the display surface.
- Do not scrub the display with excessive force.
- Avoid getting moisture inside the instrument while cleaning the display; use only enough solution to dampen the wipe.
- Clean the flat panel display surface by gently rubbing the display with a cleanroom wipe (such as Wypall Medium Duty Wipes, #05701, available from Kimberly-Clark Corporation).
- If the display is very dirty, moisten the wipe with distilled water or a 75% isopropyl alcohol solution and gently rub the display surface. Avoid using excess force or you may damage the plastic display surface.

Clean the exterior surfaces

Clean the exterior surfaces with a dry, lint-free cloth or a soft-bristle brush. If dirt remains, use a cloth or swab dampened with a 75% isopropyl alcohol solution. A swab is useful for cleaning in narrow spaces around the controls and connectors. Do not use abrasive compounds on any part of the instrument.

To avoid damaging the instrument follow these precautions:

- Avoid getting moisture inside the instrument during external cleaning and use only enough solution to dampen the cloth or swab.
- Do not wash the front-panel power switch. Cover the switch while washing the instrument.
- Use only deionized water when cleaning. Use a 75% isopropyl alcohol solution as a cleanser and rinse with deionized water.
- Do not use chemical cleaning agents; they may damage the instrument. Avoid chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.

Battery information

The coin cell battery on the instrument computer motherboard is not a user replaceable part. The coin cell battery is not rechargeable. Under no circumstances attempt to recharge the battery.

Fuse replacement

The instrument is protected by a fuse placed in series with the power line input. The fuse is conservatively rated and should never open through the life of the instrument. A blown fuse would generally indicate a problem with the instrument which requires factory service. It is recommended that you arrange to have the instrument serviced if you experience a blown fuse.

Repack the instrument for shipment

If the instrument is to be shipped to a Tektronix service center for repair, attach a tag showing the following information:

- Name of the product owner
- Address of the owner
- Instrument serial number
- A description of the problems encountered and/or service required

When packing an instrument for shipment, use the original packaging. If it is unavailable or not fit for use, contact your Tektronix representative to obtain new packaging.

Compliance information

This section lists the EMC (electromagnetic compliance), safety, and environmental standards with which the instrument complies.

EMC compliance

EC Declaration of Conformity – EMC

Meets intent of Directive 2004/108/EC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61326-1. EMC requirements for electrical equipment for measurement, control, and laboratory use.^{1 2 3}

- CISPR 11. Radiated and conducted emissions, Group 1, Class A
- IEC 61000-4-2. Electrostatic discharge immunity
- IEC 61000-4-3. RF electromagnetic field immunity
- IEC 61000-4-4. Electrical fast transient / burst immunity
- IEC 61000-4-5. Power line surge immunity
- IEC 61000-4-6. Conducted RF immunity
- IEC 61000-4-11. Voltage dips and interruptions immunity

EN 61000-3-2. AC power line harmonic emissions

EN 61000-3-3. Voltage changes, fluctuations, and flicker

European contact.

Tektronix UK, Ltd.
Western Peninsula
Western Road
Bracknell, RG12 1RF
United Kingdom

¹ This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.

² Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.

³ For compliance with the EMC standards listed here, high quality shielded interface cables should be used.

**Australia / New Zealand
Declaration of
Conformity – EMC**

Complies with the EMC provision of the Radiocommunications Act per the following standard, in accordance with ACMA:

- CISPR 11. Radiated and Conducted Emissions, Group 1, Class A, in accordance with EN 61326-1.

Australia / New Zealand contact.

Baker & McKenzie
Level 27, AMP Centre
50 Bridge Street
Sydney NSW 2000, Australia

Safety compliance

This section lists the safety standards with which the product complies and other safety compliance information.

**EU declaration of
conformity – low voltage**

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Union:

Low Voltage Directive 2006/95/EC.

- EN 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.

**U.S. nationally recognized
testing laboratory listing**

- UL 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.

Canadian certification

- CAN/CSA-C22.2 No. 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.

Additional compliances

- IEC 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.

Equipment type

Test and measuring equipment.

Safety class

Class 1 – grounded product.

Pollution degree descriptions	<p>A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.</p> <ul style="list-style-type: none">■ Pollution degree 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.■ Pollution degree 2. Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.■ Pollution degree 3. Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.■ Pollution degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.
Pollution degree rating	Pollution degree 2 (as defined in IEC 61010-1). Rated for indoor, dry location use only.
Measurement and overvoltage category descriptions	<p>Measurement terminals on this product may be rated for measuring mains voltages from one or more of the following categories (see specific ratings marked on the product and in the manual).</p> <ul style="list-style-type: none">■ Category II. Circuits directly connected to the building wiring at utilization points (socket outlets and similar points).■ Category III. In the building wiring and distribution system.■ Category IV. At the source of the electrical supply to the building. <hr/> <p>NOTE. <i>Only mains power supply circuits have an overvoltage category rating. Only measurement circuits have a measurement category rating. Other circuits within the product do not have either rating.</i></p> <hr/>
Mains overvoltage category rating	Overvoltage category II (as defined in IEC 61010-1).

Environmental considerations

This section provides information about the environmental impact of the product.

Product end-of-life handling

Observe the following guidelines when recycling an instrument or component:

Equipment recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2012/19/EU and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Tektronix Web site (www.tektronix.com/productrecycling).

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