# Tektronix®

PED3200/PED4000 Series
Programmable Error Detector

User Manual

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Programmable Error Detector

User Manual

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For product information, sales, service, and technical support:
- In North America, call 1-800-833-9200.
- Worldwide, visit www.tek.com to find contacts in your area.

## Warranty

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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[W2 – 15AUG04]

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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 includes 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

- 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

- Differential full-rate or half-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.
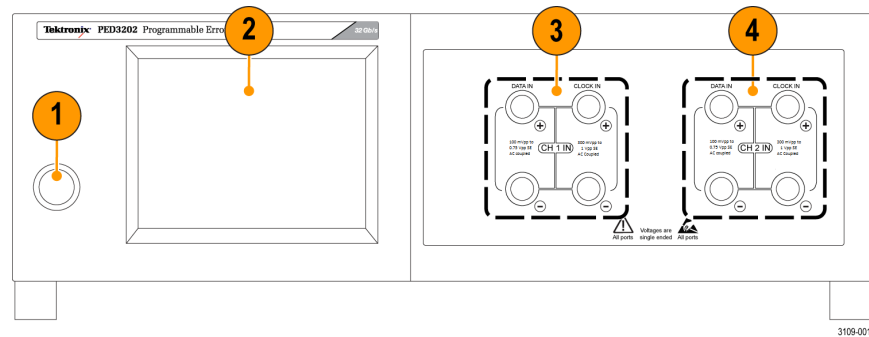


**Figure 1: Front panel controls and connectors**

**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 Input connectors | Data and clock input connectors for channel 1, 2.4 mm differential inputs. |
| 4 | Channel 2 input connectors | Data and clock input connectors for channel 2, 2.4 mm differential inputs. (PED3202PED4002) |

If using a single-ended test configuration, terminate all unused data and clock inputs into 50 Ω to ground. 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.
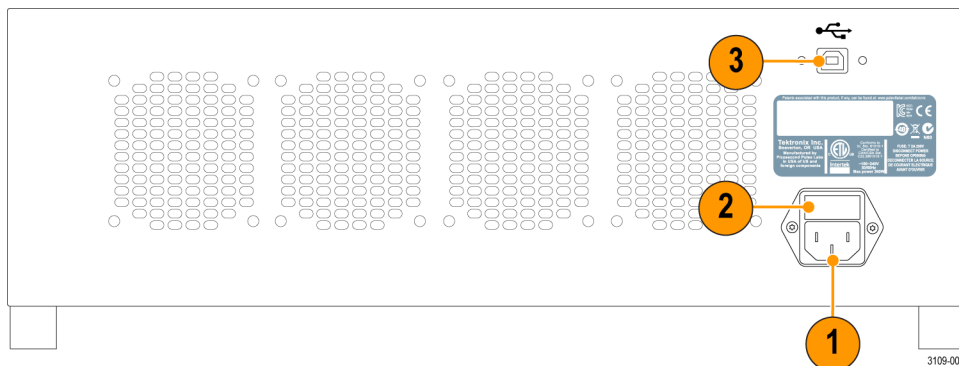


**Figure 2: Rear panel connectors**

**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 illustration. The diagram uses 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 ratings for your equipment are exceeded. To avoid possible damage, check the input 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.*
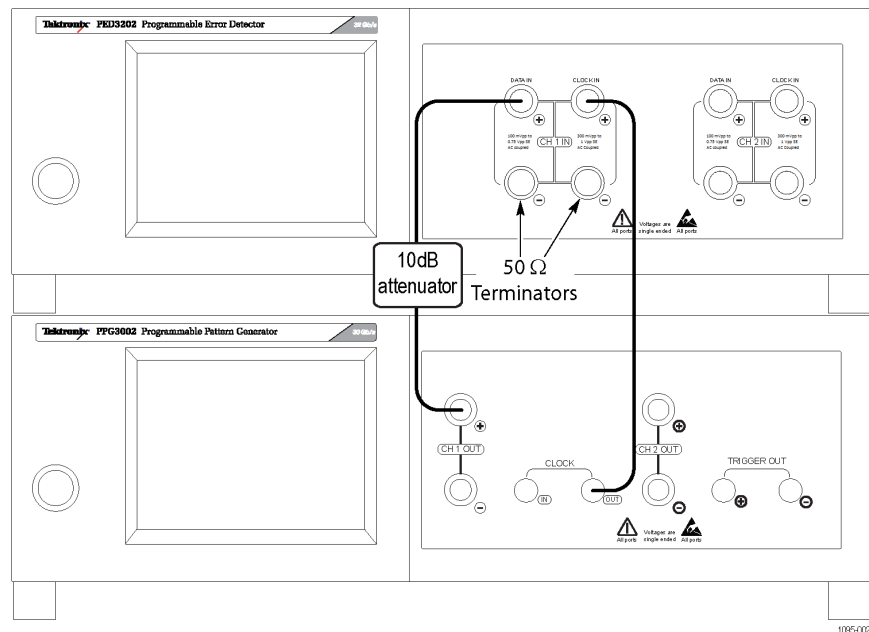
**Figure 3: Verification setup**

# Power on and verify instrument operation

The following steps assume that the instrument is connected as shown in the previous figure (See Figure 3.).

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.

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*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.*

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# Input descriptions

## RF connector interface

**RF connectors**    All front panel RF connections are 2.4 mm.

**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 AC coupled. 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.

**Functional block diagram**    Basic functional blocks are shown in the following figure.
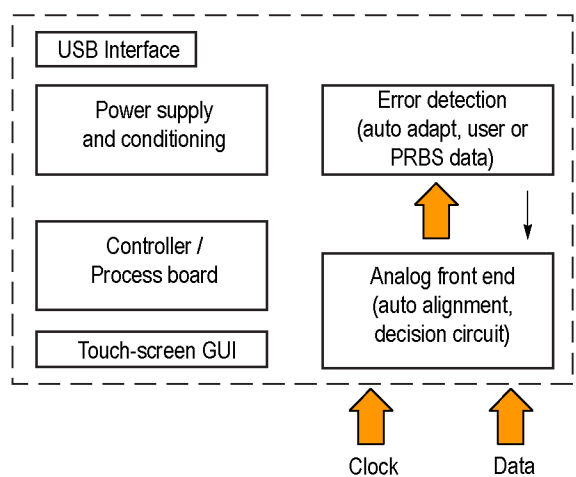


**Figure 4: Block diagram**

# Key terminology

**Sampling point**    The sampling point is where in the eye the sample is taken, on both the time and the voltage axis.

**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 5: 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 |
| AUTO ALIGN | 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 be 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 offset**  This operation centers the vertical sampling point 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 OFFSET 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 is essentially the one-touch combination of both the Center Delay and Center Offset operations.

**Eye edge BER threshold**  For use during CENTER DELAY, CENTER OFFSET, 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

**Data input**  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 m$V_{p-p}$

**Termination voltage.**  0.0 V

**Input impedance.**  50 $\Omega$

**Connector.**  2.4 mm

**ESD sensitivity**  250 V, Human body model (HBM)

## 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 m$V_{P-P}$ 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**   **$2^7$-1 bits.**   Polynomial = $X^7 + X^6 + 1$

**$2^9$-1 bits.**   Polynomial = $X^9 + X^5 + 1$

**$2^{11}$-1 bits.**   Polynomial = $X^{11} + X^9 + 1$

**$2^{15}$-1 bits.**   Polynomial = $X^{15} + X^{14} + 1$

**$2^{23}$-1 bits.**   Polynomial = $X^{23} + X^{18} + 1$

**$2^{31}$-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[?]

- :SENSe[1|3]:EYE:OCENTer[?]

**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.

The SENSe and INPut subsystems apply as follows:

| | |
|---|---|
| SENSe1 | Data Input, Channel 1 |
| INPut1 | |
| SENSe2 | Clock Input, Channel 1 |
| INPut2 | |
| SENSe3 | Data Input, Channel 2 |
| INPut3 | |
| SENSe4 | Clock Input, Channel 2 |
| INPut4 | |

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]? | &lt;numeric&gt; | n/a | query total # of errors since the start of the gate period | (See page 22.) |
|         :ERATio[:ALL][:FULL][:TOTAL]? | &lt;numeric&gt; | n/a | query total error ratio since the start of the gate period | (See page 22.) |
|     :SENSe[2\|4]:BCOunt? | &lt;numeric&gt; | 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[?] | &lt;numeric&gt; | 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 | &lt;string&gt; | n/a | store pattern data in system memory | (See page 23.) |
|         :STATe | &lt;string&gt; | n/a | store instrument settings in system memory | (See page 24.) |
|     :LOAD | | | | |
|         :PDATa | &lt;string&gt; | n/a | recall pattern data from system memory | (See page 24.) |
|         :STATe | &lt;string&gt; | n/a | recall instrument settings from system memory | (See page 25.) |
|     :MOVE | | | | |
|         :PDATa | &lt;string&gt;, &lt;string&gt; | n/a | rename existing pattern data file in system memory | (See page 25.) |
|         :STATe | &lt;string&gt;, &lt;string&gt; | 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.) |
| **SYSTEM Subsystem** | | | | |
| :SYSTem:ERRor[:NEXT]? | none | n/a | query error queue | (See page 38.) |

# 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 *Center Clock Delay* and *Auto Align* processes. |
| Range Coupling | None |
| Default | 0 |
| Description | 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.<br><br>[2|4] specifies the port. 2 = channel 1 clock, 4 = channel 2 clock. |
| Example | Set Ch1 delay to 23 ps<br><br>`:INP2:DEL 23.0ps`<br><br>Set Ch2 delay to -17 ps (= 17 ps advance)<br><br>`:input4:delay -17ps` |

## :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 | Set Ch1 data input polarity to inverted<br><br>`:INP2:POL INV` |

## :MMEMory:STORe:PDATa

| Form | Set |
|---|---|
| Parameters | String |
| Value Coupling | None |
| Range Coupling | None |
| Default | N/A |
| Description | 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.<br><br>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. |
| Example | Store the pattern data in system memory.<br><br>`:MMEM:STOR:PDAT "PATT1011"` |

## :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.<br><br>`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.<br><br>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".<br><br>`: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?` |

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## :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 offset value. |
| Range Coupling | None |
| Default | N/A |
| Description | Initiates the "auto align" process or queries the process status. This centers the clock delay setting and the voltage, relative to the eye edges. |
| | For the command form: |
| | 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. |
| | The query form returns status of the last "auto align" process to be initiated: |
| | 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. |
| | This is an overlapped command. Allowed concurrent commands include: |
| | :SENSE[1\|3]: EYE:ALIG:AUTO ABORT |
| | :SENSE[1\|3]: EYE:ALIG:AUTO? |
| | 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. |
| 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 | Initiates the *center offset* process or queries the process status. |
| | For the command form: |
| | SENS[1\|3]:EYE:OCEN ONCE begins the *center offset* process |
| | SENS[1\|3]: EYE:OCEN ABORT stops the *center offset* process. If the process is not in progress, it has no effect. |
| | The query form returns status of the last *center offset* process to be initiated: |
| | 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. |
| | This is an overlapped command. Allowed concurrent commands include: |
| | :SENSE[1\|3]: EYE:OCEN ABORT |
| | :SENSE[1\|3]: EYE:OCEN? |
| | The *center offset* 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. |
| Example | Initiate the "center offset" process for channel 1. |
| | `:SENS1:EYE:OCEN ONCE` |

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

| Form | Set & Query |
|---|---|
| Parameters | Numeric |
| Value Coupling | None |
| Range Coupling | None |
| Default | 0.0 |
| Description | Programs the data offset voltage. |
| | 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. |
| Example | Set the channel 1 offset to -125 mV. |
| | `:SENS1:EYE:OFFS -0.125` |

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

| Form | Set & Query |
|---|---|
| Parameters | Set: ONCE \| ABORT |
| | Query: OK \| ERROR \| BUSY |
| Value Coupling | Can change the clock delay value. |
| Range Coupling | None |
| Default | N/A |
| Description | Initiates the *center clock delay* process or queries the process status. |
| | For the command form: |
| | SENS[1\|3]:EYE:TCEN ONCE begins the *center clock delay* process. |
| | SENS[1\|3]: EYE:TCEN ABORT stops the *center clock delay* process. If the process is not in progress, it has no effect. |
| | The query form returns status of the last *center clock delay* process to be initiated: |
| | 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. |
| | This is an overlapped command. Allowed concurrent commands include: |
| | :SENSE[1\|3]: EYE:TCEN ABORT |
| | :SENSE[1\|3]: EYE:TCEN? |
| | The *center clock delay* 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. |
| Example | Initiate the "center clock delay" process for channel 1. |
| | `:SENS1:EYE:TCEN ONCE` |

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

| | |
|---|---|
| Form | Query |
| Parameters | <edge_num> |
| | <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. |
| | The response is Numeric. |
| Description | 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 *Center Clock Delay* and *Auto Align* processes. |
| | If those processes have not been run or failed on the most recent attempt, the return value will be 9.91e37. (NaN) |
| Example | Read the second (right-side) eye edge for channel 1. |
| | `:SENS1:EYE:TEDG? 2` |

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

| | |
|---|---|
| Form | Set & Query |
| Parameters | Numeric |
| Value Coupling | None |
| Range Coupling | None |
| Default | N/A |
| Description | 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. |
| | 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. |
| Example | Read the Eye Edge BER Threshold for channel 1. |
| | `:SENS1:EYE:THR?` |

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

| Form | Query |
|---|---|
| Parameters | <edge_num> |
| | <edge_num> is numeric and specifies which edge of the eye. It is 1 for the bottom edge, and 2 for the top edge. |
| | The response is Numeric. |
| Description | 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 *Center Offset* and `Auto Align` processes. |
| | If those process have not been run or failed on the most recent attempt, the return value will be 9.91e37. (NaN) |
| Example | Read the top eye edge for channel 1. |
| | `:SENS1:EYE:VEDG? 2` |

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

| Form | Set & Query |
|---|---|
| Parameters | OFF \| ON |
| Value Coupling | None |
| Range Coupling | None |
| Default | N/A |
| Description | 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. |
| | Related commands: |
| | :SENS[1\|3]:SYNC:STATe? |
| | :SYSTem:ERRor[:NEXT]? |
| Example | Start accumulation on ch 1. |
| | `:SENS1:GATE:STAT ON` |
| | Stop accumulation on ch 1. |
| | `:SENS1:GATE:STAT OFF` |

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

| Form | Set & Query |
|---|---|
| Parameters | Numeric |
| Value Coupling | None |
| Range Coupling | None |
| Default | 8 |
| Description | Programs the Pattern Length. This value is only relevant if the pattern type is DATA. |
| | 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 |
| Example | Set Ch1 pattern length to 56. |
| | `:SENS1:PATT:LENG 56` |
| | Set Ch2 pattern length to 500. |
| | `:SENSE3:PATTERN:LENGTH 500` |
| | Query Ch 1 pattern length. |
| | `:SENS1:PATT:LENG?` |

# :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 | Set the Ch 1 pattern type to PRBS. |
| | `:SENS1:PATT:TYPE PRBS` |
| | Query Ch 1 pattern type. |
| | `:SENS1:PATT:TYPE?` |

## :SENSe[1|3]:PATTern:PLENgth[?]

| 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).<br>`:SENS1:PATT:PLEN 7` |
| | Query Ch1 PRBS length.<br>`:SENS1:PATT:PLEN?` |

Command reference

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

| Form | Set & Query |
|---|---|
| Parameters | <start address>, <bit count>, <data> |
| | <start address> > is numeric, and is the bit number in pattern data memory of the first bit to write. |
| | <bit count> is the number of bits to write into pattern data memory. |
| | <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. |
| Value Coupling | None |
| Range Coupling | None |
| Default | Default data is a 1 in position 1, all other bits are 0. |
| Description | 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. |
| | (<start address> + <bit count>) must be ≤ (<start address> + 1) |
| Example | `:SENS1:PATT:DATA 1,16,#2160100000101010010` |
| | This command does the following: |
| |     Starts loading the Ch 1 data into bit location 1. |
| |     Specifies that 16 bits of data will be loaded. |
| |     In the <data>: |
| |         #: 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. |
| | Bits 1 through 16 in the channel 1 pattern data memory will be set to 0100000101010010. |
| | `:SENS1:PATT:DATA? 1,8` |
| | 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" |

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

| | |
|---|---|
| Form | Set & Query |
| Parameters | <start address>, <bit count>, <data> |
| | <start address> > is numeric, and is the bit number in pattern data memory of the first bit to write. |
| | <bit count> is the number of bits to write into pattern data memory. |
| | <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. |
| Value Coupling | None |
| Range Coupling | None |
| Default | Default data is a 1 in position 1, all other bits are 0. |
| Description | 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. |
| | 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. |
| | (<start address> + <bit count>) must be ≤ (<start address> + 1) |
| Example | `:SENS1:PATT:HDAT 1,16,#144152` |
| | This command does the following: |
| |     Starts loading the Ch 1 data into bit location 1. |
| |     Specifies that 16 bits of data will be loaded. |
| |     In the <data>: |
| |         #: 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. |
| | Bits 1 through 16 in the channel 1 pattern data memory will be set to 0100000101010010. |
| | `:SENS1:PATT:HDAT? 1,8` |
| | 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" |
| | 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. |

# :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 | Initiates the synchronization process or queries the process status. |
| | For the command form: |
| | SENS[1\|3]:SYNC ONCE begins the synchronization process. |
| | SENS[1\|3]:SYNC ABORT stops a sync process. If a sync is not in progress, it has no effect. |
| | The query form returns status of the last sync process to be initiated: |
| | 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. |
| | This is an overlapped command. Allowed concurrent commands include: |
| | :SENSE[1\|3]:SYNC:EXEC ABORT |
| | :SENSE[1\|3]:SYNC:EXEC? |
| | 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. |
| Example | Initiate the sync process for channel 1. |
| | `:SENS1:SYNC:EXEC ONCE` |

# :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 | Query Ch2 synchronization state. |
| | `:SENS3:SYNC:STAT?` |

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

| Form | Set & Query |
|---|---|
| Parameters | Numeric |
| Value Coupling | None |
| Range Coupling | None |
| Default | $10^{-3}$ |
| Description | 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.<br><br>The threshold may range from $10^{-1}$ to $10^{-8}$ in decade steps.<br><br>Synchronization will succeed only if the BER of the system is less than the sync BER threshold. |
| Example | Set the ch1 synchronization threshold to $10^{-2}$.<br><br>`:SENS1:SYNC:THR 1e-2` |

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

| Form | Set & Query |
|---|---|
| Parameters | MANUAL \| AUTO |
| Value Coupling | None |
| Range Coupling | None |
| Default | MANUAL |
| Description | 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. |
| Example | Query Ch1 sync type.<br><br>`:SENS1:SYNC:TYPE?` |

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

| Form | Query |
|---|---|
| Parameters | Numeric |
| Description | 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.<br><br>[2\|4] specifies the port. 2 = channel 1 clock, 4 = channel 2 clock. Omitting the port specifier is equivalent to specifying channel 1 clock. |
| Example | Query Ch1 frequency<br><br>`:SENS2:FREQ?` |

# :SYSTem:ERRor[:NEXT]?

| Form | Query |
|------|-------|
| Parameters | Numeric |
| Value Coupling | N/A |
| Range Coupling | N/A |
| Default | N/A |
| Description | 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. |
| | 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. |
| Example | Query the error queue |
| | `:SYST:ERR?` |

# 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.

PED3200/PED4000 Series Programmable Error Detector User Manual

# 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.**

FLUKE AUSTRALIA PTY LTD
Unit 26, 7 Amelia Avenue
Castle Hill, NSW, Australia 2154
ABN: 43 086 173 882

# 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 2014/35/EU.

■ 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**    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.

- 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**    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).

- 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.

*NOTE. 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.*

**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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