Tektronix PPG4001
PatternPro® Programmable Pattern Generator

User Manual

077-1089-01

Tektronix

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www.tektronix.com
077-1089-01

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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]

Table of Contents

List of Figures

List of Tables

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 vii, *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 PPG4001 PatternPro® Pattern Generator gives you extensive control over operating parameters, including PRBS and user-defined patterns and jitter insertion.

The operational flexibility and pattern generation capability makes this unit suitable for use in many different applications, including creating stressed serial data patterns for receiver testing and characterization.

Features

The Tektronix PPG4001 Pattern Generators provides serial data and clock outputs with the following features:

- 4 Gb/s to 40 Gb/s operation
- Fully integrated benchtop instrument
- Adjustable data amplitude and offset
- Fast rise/fall time
  - 11 ps typical 20/80% rise/fall time
- User programmable data or built-in PRBS patterns
- Adjustable internal clock source
  - Full-rate single-ended output
  - Half-rate differential output
  - 10 kb/s resolution
  - Selectable prescaler output
- External clock input
- Trigger output
  - programmable as pattern trigger or clock/n
- Jitter insertion (option):
  - High Frequency SJ/RJ/BUJ jitter insertion (Option HFJIT)
  - Low frequency jitter insertion (Option LFJIT)
  - External modulation input
- Save up to twenty-five user patterns in nonvolatile memory
- Save up to twenty-five generator setups in nonvolatile memory

- Touch screen graphical user interface & USB TMC interfaces
- 3RU height, full-rack design

Table i: PPG4001 Product options

Option	Description
HFJIT	High frequency jitter insertion (SJ/RJ/BUJ)
LFJIT	Low frequency jitter option

Documentation

The following documentation is available:

- PPG/PED Safety & Installation Manual, printed version shipped with the product
- This PPG4001 PatternPro Pattern Generator User Manual (PDF versions only, downloadable from the Tektronix Web Site)
- Product data sheets (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 Tektronix PPG4001 Pattern Generator is 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 might 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 accessories are included with your instrument:

- Pattern generator
- Power cord
- Rack mount ears on the front of the instrument
- PPG/PED Installation & Safety instructions
- 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 listed 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 2A 250V

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 unit has 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.)

Controls and connectors

The following illustration and table describe the front panel controls and connectors.

NOTE. *The exact location and spacing of the Data Out connectors may be different depending on the output options ordered with the instrument.*

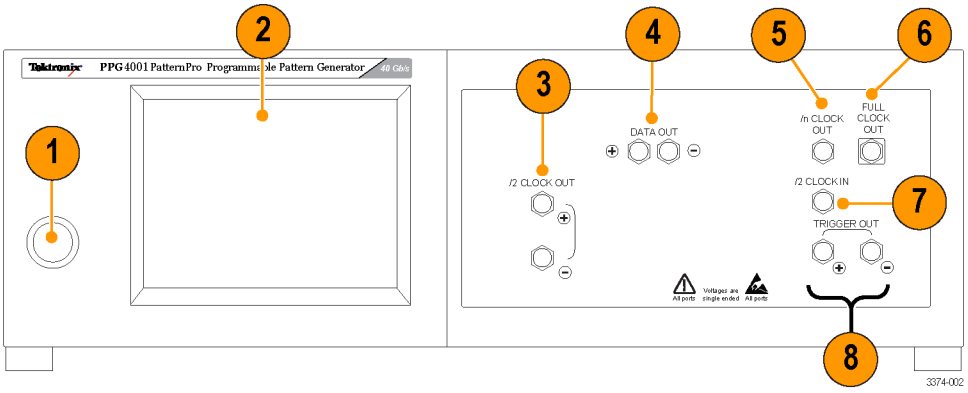


Figure 1: Front panel controls and connectors

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 lights up when the instrument is on.
2	Display	The display is a touch screen graphical user interface.
3	Half-rate (/2)CLOCK Out connectors	Differential half-rate clocks output with 2.4 mm connectors
4	DATA OUT connectors	Plus and minus Data outputs with 2.4 mm connectors
5	Divided (/n) CLOCK OUT connector	Single-ended divided clock output with 2.92 mm connector. Binary divide ratios are selected through the user interface.
6	FULL CLOCK OUT connector	Single-ended full-rate clock output with 2.4 mm connector
7	Half-rate (/n) CLOCK IN connector	Half-rate clock input with a 2.4 mm connector, AC coupled. Used to supply an external half-rate clock signal.
8	Trigger Out	SMA Differential Trigger Output. Levels swing from –500 mV to 0 V. Can be used single ended.

The following illustration and table describe the rear panel connectors.

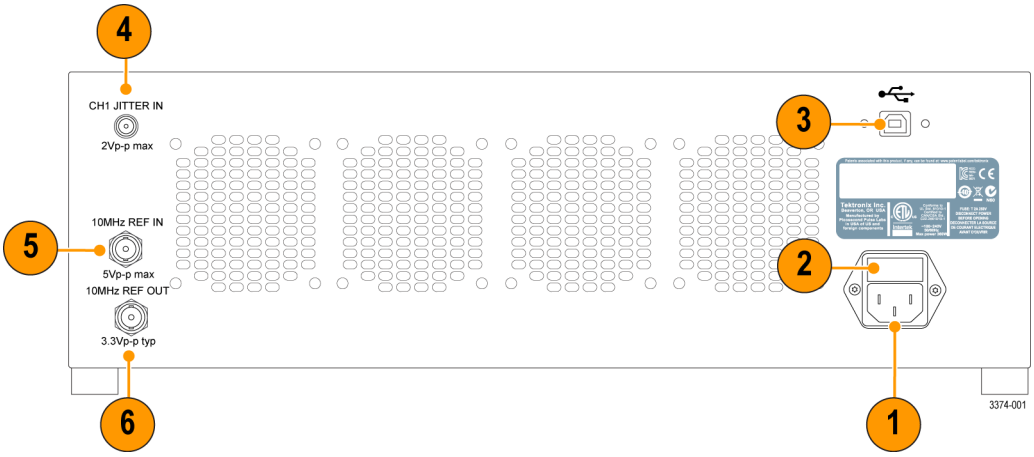


Figure 2: Rear panel connectors

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.
4	JITTER IN	SMA input for external jitter insertion (Option HFJIT)
5	10 MHz REF IN	BNC input for external frequency reference
6	10 MHz REF OUT	BNC output for buffered version of the frequency reference (internal or external)

Functional verification

Instrument setup

A typical setup for verifying the pattern generator operation is shown in the following figure. The diagram uses only the + side of all differential connections, the - side can be tested in the same manner. Use a Tektronix DSA8300 Digital Serial Analyzer Sampling Oscilloscope or similar for functional verification.

CAUTION. *Damage to the pattern generator and/or associated equipment can occur if the input and output voltage ratings are exceeded. Check the input and output voltage ratings for your equipment. The following illustration shows electrical attenuators where voltage ratings are commonly exceeded.*

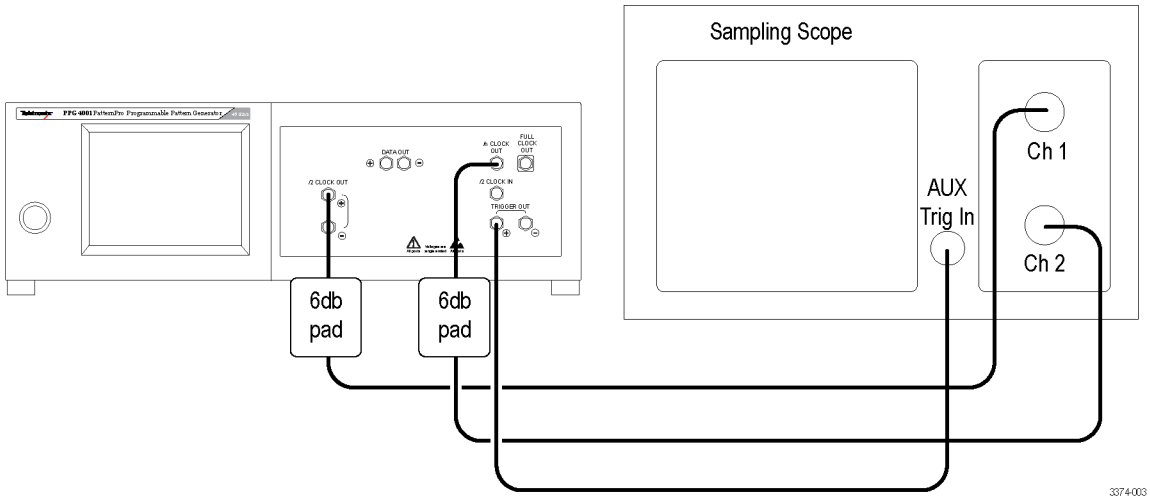


Figure 3: Verification setup

Power on and verify instrument operation

The following steps assume the unit is connected as shown in the verification setup.

NOTE. *Note: The generator is internally temperature compensated for timing and output level continuously and automatically. Internal timing calibration will also take place whenever the frequency is set (either manually or through remote programming). Setting the frequency (or resetting the frequency to its current value) is recommended after an initial 20-minute warm-up, or if a significant change in ambient temperature has occurred during operation.*

1. Push front panel on/off switch.
   - The green light on the switch turns on.
   - The instrument goes through the start-up sequence.
   - The Main menu displays on the touch screen.
2. Select **UTILITY** by touching the on-screen button.
3. Select **SAVE**.
4. Select **RECALL DEFAULTS** (The instrument loads all the default settings.)
5. Select **BACK**.
6. Select **MAIN**.
7. Turn **OUTPUT ON**.
8. Use the **AUTO SCALE** function on the sampling oscilloscope to identify and display signals.
9. Adjust the sampling oscilloscope voltage, timing and display settings as needed.
   - Channel 1 shows a square wave at the default clock rate.
   - Channel 2 shows PRBS data with pattern trigger.
   - The output should be similar to the following figure (the displayed data pattern may differ).

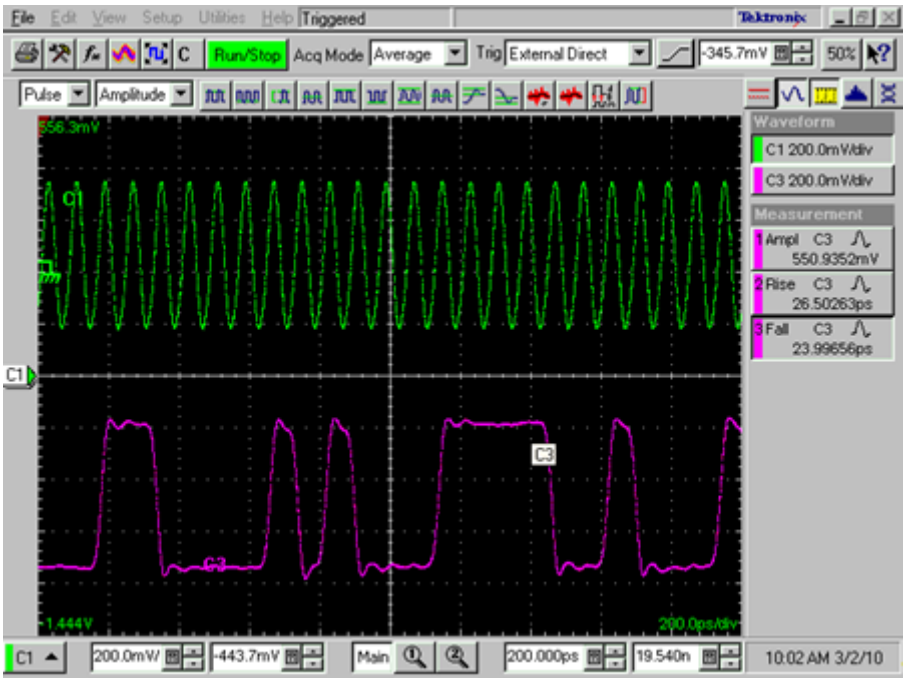


Figure 4: Clock (top) and data (bottom) waveforms

Verify the eye diagram

1. Select **UTILITY**.
2. Select **TRIGGER**.
3. Select **TRIGGER TYPE = CLK/N**.
4. Set **N DIVISOR** to **64**.
5. Turn off the display on the oscilloscope channel 1 (clock signal).

6. Adjust the sampling oscilloscope amplitude, timing and display as needed. Output should be similar to the following figure.

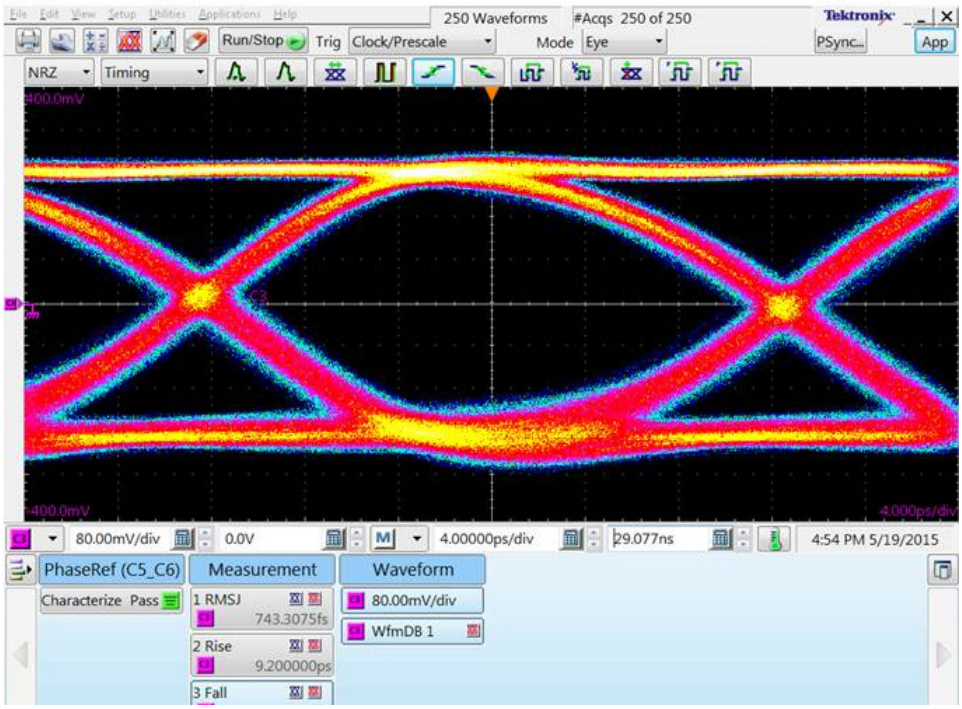


Figure 5: Typical eye diagram example

Check other settings

Access the remaining menus to experiment with other settings.

Input and output descriptions

Overview

RF connectors

Data and Clock front panel RF connectors are 2.4 mm. All other front panel RF connections are SMA.

Connector torque specifications

Minimum:	2 in-lbs (0.226 N-m)
Recommended:	7-10 in-lbs (0.791-1.130 N-m)
Maximum:	15 in-lb (1.695 N-m)

NOTE. *Please note the special termination instructions.*

Data out and /Data out

These are the primary outputs from the unit. The outputs can be used single-ended or differentially. Data pattern and timing can be controlled manually or remotely.

Trig out and /Trig out

These differential outputs provide a timing reference for viewing the data signals. The output amplitudes are fixed. Trigger options are PATTERN or CLOCK/N.

When using a pattern trigger, the trigger corresponds to the beginning of a pattern. The pattern trigger mode can be used with user-defined or PRBS data. For the CLOCK/N trigger mode, the clock frequency is reduced by a factor of N where the value N is required to be a multiple of 64.

Full-clock out

The clock output reflects the data rate; there is one full clock cycle per bit of data. The clock output is AC coupled and the amplitude is fixed. The internal clock actually operates over a range of 20 GHz to 40 GHz. When data rates <20 Gb/s are used, the internal clock will operate at a multiple of the data rate and bit-stretching is used to produce data at the specified rate.

/2 clock out

The /2 clock output reflects one half of the data rate; there is one full clock cycle per two bits of data. The clock output is AC coupled and the amplitude is fixed. The internal clock actually operates over a range of 20 GHz to 40 GHz. When data rates <20 Gb/s are used, the internal clock will operate at a multiple of the data rate and bit-stretching is used to produce data at the specified rate. The user interface will indicate the /2 clock rate for this case. A built-in clock divider can be used to divide the internal clock before it is sent to the /n clock output (divisors of 1,2,4,8,16).

/2 Clk in

This is the input used to supply an external clock. Clock frequency is restricted to a range of 10 GHz to 20 GHz.

Functional block diagram

The basic functional blocks are shown in the following figure.

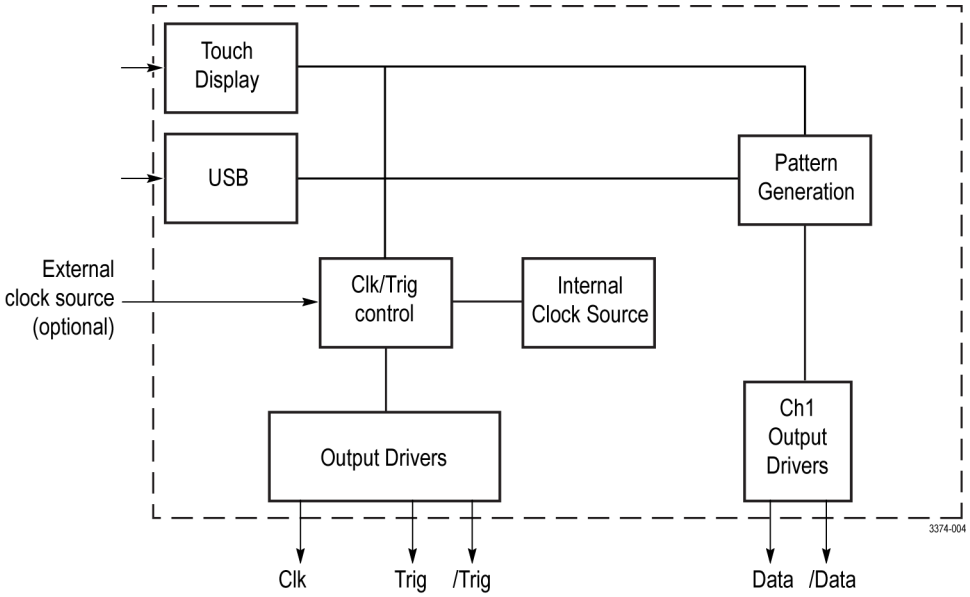


Figure 6: Block diagram

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.

The following table gives a listing of where to find various parameters within the menu structure.

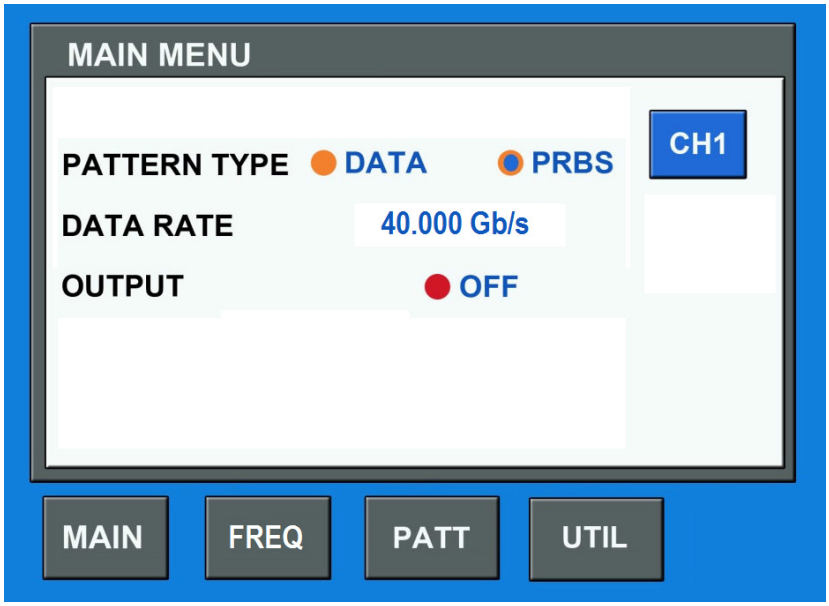


Figure 7: GUI Main menu

Table 5: GUI menu parameter locations

Parameter	Found in menu(s)
10 MHz Ref (int / ext)	UTILITY
Data Rate	MAIN, TIMING
External Clock Enable	TIMING [EXTFREQ]
Internal Clock Rate	TIMING
Jitter Enable	TIMING [JITTER]
Output Clock Rate	TIMING
Pattern Length	PATTERN
Pattern Type	MAIN, PATTERN
Pattern (user defined)	PATTERN [DATA]
PRBS Length	PATTERN
Output ON / OFF	MAIN, VOLTS
Recall Pattern	PATTERN [SAVE] [RECALL]

Table 5: GUI menu parameter locations (cont.)

Parameter	Found in menu(s)
Recall Setup	UTILITY [SAVE] [RECALL]
Save Pattern	PATTERN [SAVE] [STORE]
Save Setup	UTILITY [SAVE] [STORE]
Trigger Options	UTILITY [TRIGGER]

Jitter insertion (optional feature)

The pattern generator can be ordered with a built-in jitter insertion options. (See page 19, *Jitter insertion*.)

Jitter sources

Built-in high-frequency sinusoidal modulation source (Option HFJIT)

- Programmable frequency from 5 kHz to 100 MHz
- Programmable amplitude up to 50 ps_{P-P}

Built-in bounded uncorrelated jitter (BUJ, included in Option HFJIT)

- Programmable amplitude up to 50 ps_{P-P}
- Programmable modulation data rates from 100 Mb/s to 2.5 Gb/s
- Full suite of programmable PRBS sequences
- Low-pass filter values 25/50/100 MHz

Built-in random noise modulation source (Option HFJIT)

- Programmable amplitude up to 5 ps_{RMS}

Built-in low-frequency sinusoidal modulation source (Option LFJIT)

- SJ programmable frequency from 10 Hz to 10 MHz, from 5000 UI_{P-P} to 2 UI_{P-P}

External modulation source

- Amplitude up to 50 ps_{P-P} from 5 kHz to 100 MHz

External modulation input (Jitter in)

- 5 V_{P-P} maximum input
- Frequency range: DC to 100 MHz
- Any waveform (or random)
- Total jitter of the instrument (external plus built-in jitter) must not exceed the above specifications for *External modulation source*.

Specifications

Data outputs

Voltage amplitude

Each positive and negative differential output is independently programmable.

Single-ended. 300 mV to 1.0 V

Differential. 600 mV to 2.0 V

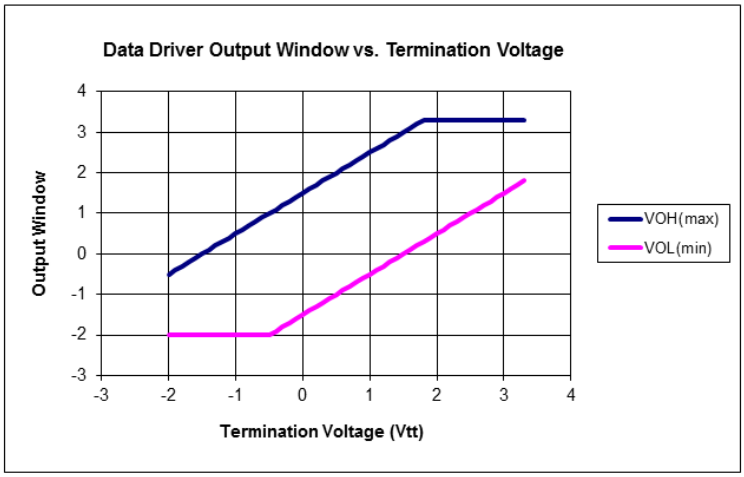
Offset window

-2 V to +3.3 V, programmable/adjustable

Termination voltage range

-2.0 V to +3.3 V window. Programmable/adjustable. Applied by user via 50 Ω.

This setting is used in cases where the load being driven is terminated at a level other than zero volts. The effect of termination voltage on the output voltage is shown in the following figure. To ensure proper operation, never load the output with a termination voltage less than Voh minus 3 V.



Rise/fall time

Scope bandwidth can impact the measured signal rise time.

20 to 80%. 11 ps, typical

10 to 90%. 16 ps, typical

Data output jitter

Measured at 40 Gb/s with 2^{11}-1 PRBS at 500 mV_{p-p}, single ended

Total jitter (1E-12). 7 ps_{p-p}, typical

Random jitter. 200 fs, RMS, typical

Connector type

2.4 mm

Output impedance

50 Ω. Single-ended

100 Ω. Differential

Clock outputs

Full rate clock output

AC coupled, single-ended

Frequency. 20 GHz to 40 GHz

Amplitude. 500 mV_{p-p}, typical

Connector type. 2.4 mm

Half-rate clock output

AC coupled, differential

Amplitude. 400 mV_{p-p}, typical

Connector type. 2.4 mm

/n clock output

AC coupled, single ended

Programmable divider. n = 2, 4, 8, 16

Amplitude. 500 mV_{p-p}, typical

Connector type. 2.4 mm

Trigger output

Programmed as pattern trigger or clock/n (with n = multiples of 128)

Amplitude. -500 mV to 0 V, DC coupled

Connector type. SMA

Data patterns

Pattern type

Data (from memory) or PRBS

Data rate

Programmable/adjustable

Range. 4 Gb/s to 40 Gb/s

Resolution. 10 kb/s

Accuracy. ±5 ppm

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 = $X^{31} + X^{28} + 1$

Data pattern depth

Range. 2 to 4,194,304 bits

Resolution. 1 bit

Programmable error insertion

Error insertion can be enabled with either single bit error insertion or at a programmable rate.

Single bit errors. Yes

Programmable bit errors. 10^{-3} to 10^{-15} BER

Jitter insertion

High frequency jitter insertion option

Add-on option for the instrument. Sum of external, internal sine, internal noise, and BUJ. Exceeding the range can generate errors.

Total modulation range. 50 ps_{p-p}

Built-in sine source

Programmable from either the front panel touch screen or remote control.

Frequency range. 5 kHz to 100 MHz

Amplitude range. 0 to 50 ps_{p-p}

Accuracy. ±10%, typical

Built-in random noise source

Programmable from either the front panel touch screen or remote control.

Amplitude range. 0 to 5_{RMS}

Accuracy. ±10%, typical

Built-in BUJ source

Programmable from either the front panel touch screen or remote control.

Amplitude range. 0 to 50 ps_{p-p}

Modulation data rates. 100 Mb/s to 2.5 Gb/s

PRBS sequences. 7,9,11,15,23,31

Filter values. 25/50/100 MHz filters

External modulation input

DC coupled, 3 dB bandwidths

Frequency range. DC to 100 MHz

Amplitude range. 0 to 50 ps_{p-p}

Maximum input. 5 V_{p-p}

Low frequency jitter insertion (Option LFJIT)

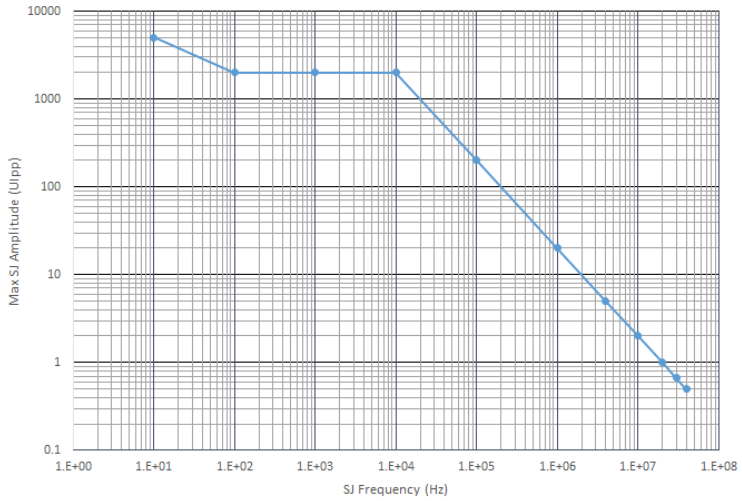
Add-on option

The specifications below apply when the data rate equals the internal clock rate frequency of 20 to 40 GHz. For each frequency octave below, the internal clock rate, the specifications below will be reduced by half. Thus when the data rate is 10 to 19.99999 Gb/s, the values below will be divided by 2. When the data rate is 5 to 9.99999 Gb/s, the values will be divided by 4.

SJ modulation range curve points.

Parameter	Value
10 Hz f_{mod}	5000 UI_{p-p}
100 Hz f_{mod}	2000 UI_{p-p}
1 kHz f_{mod}	2000 UI_{p-p}
10 kHz f_{mod}	2000 UI_{p-p}
100 kHz f_{mod}	200 UI_{p-p}
1 MHz f_{mod}	20 UI_{p-p}

Parameter	Value
4 MHz f_{mod}	5 UI_{p-p}
10 MHz f_{mod}	2 UI_{p-p}
20 MHz f_{mod}	1 UI_{p-p}
30 MHz f_{mod}	0.67 UI_{p-p}
40 MHz f_{mod}	0.5 UI_{p-p}



Trigger system

Trigger waveform

Pattern mode. 1 pattern per trigger for pattern length = multiple of 128
128 patterns per trigger for other pattern lengths

Clock/n mode. 128 through (2^{32} - 128), n = any multiple of 128 in that range

Duty cycle. 50%, for either Pattern or Clock/n

High level

0 V, typical

Low level

-500 mV, typical

Output impedance

50 Ω, DC-coupled

Connector type

SMA

Clock inputs

Frequency range 10 GHz to 20 GHz, half rate

Input signal 500 mV_{p-p}, typical, AC coupled

Maximum input signal 800 mV_{p-p}

Input impedance 50 Ω, AC-coupled

Reference clock

Input frequency range 10 MHz

Input signal 1 V_{p-p}, typical, 50% duty square wave

Maximum input signal 5 V_{p-p}, ±10 V DC, Damage threshold

Input impedance 50 Ω, AC-coupled

Output signal 1.2 V_{p-p}, typical, Square wave

10 MHz reference input/output Yes, BNC connector

Data error insertion

Error insertion types Single or rate-based

Error insertion rate

Range. 1 x 10^{-3} to 10^{-15} BER

Resolution. 3 digits

Control interfaces

Front panel touchscreen GUI	Yes, edit all instrument settings
Computer programmable interface	USB TMC, program all instrument settings

Physical characteristics

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)	35.1 cm (13.8 in)
Weight	11.1 kg (24.5 lbs)
Operating temperature	0 °C to 40 °C (32 °F to 104 °F)

Remote programming

USB interface

All automated programming is accomplished through a USB TMC interface.

Command information

Sequential vs. overlapped

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.

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.

Channel numbers

The PPG4001 pattern generator is currently available as a single-channel unit (Channel 1) Commands for non-existent channels are not valid.

Common commands

Summary

Command	Description
*IDN?	Read Instrument's Identification string
*RST	Reset instrument to default settings

Reference

***IDN?** Read the instrument's identification string.

The returned string has the following format:

"`Tektronix Inc.,Model code,SN,FWREV`" Where:

- Model code = 12604
- SN = serial number
- FWREV = firmware revision

***RST** Resets the instrument to default settings. This sets all parameters to their default values, including output enable, pattern length, and pattern data.

Regular commands

Summary

The following table provides a summary of the remote control commands.

Command	Parameters	Default	Description	
DIGITAL subsystem				
:DIGital				
:PATTern				
:LENGth	<numeric>	8	set/query Pattern Length	(See page 31.)
:TYPE	DATA | PRBS	PRBS	set/query Pattern type	(See page 31.)
:PLENgth	<numeric>	7	set/query PRBS length	(See page 32.)
:DATA	<numeric>, <numeric>, <arbitrary block>	1000…	set/query Pattern Data	(See page 33.)
:HDATa	<numeric>, <numeric>, <arbitrary block>	1000…	set/query Pattern Data in hexadecimal character format	(See page 34.)
:SERRor	none	n/a	insert a single error into the data output	(See page 35.)
:ERATe	<numeric>	1e-3	inserts error into the data output at the specified rate	(See page 35.)
:ERATe:STATe	OFF | ON	OFF	enable error rate injection into the data output	(See page 35.)
Memory subsystem				
:STORe				
:PDATa	<string>	n/a	store pattern data in system memory	(See page 36.)
:STATe	<string>	n/a	store instrument settings in system memory	(See page 36.)
:LOAD				
:PDATa	<string>	n/a	recall pattern data from system memory	(See page 36.)
:STATe	<string>	n/a	recall instrument settings from system memory	(See page 37.)

Command	Parameters	Default	Description	
:MOVE				
:PDATa	<string>, <string>	n/a	rename existing pattern data file in system memory	(See page 37.)
:STATe	<string>, <string>	n/a	rename existing instrument settings file in system memory	(See page 37.)
:DELete				
:PDATa	<string>	n/a	delete stored pattern data file in system memory	(See page 38.)
:STATe	<string>	n/a	delete instrument settings file in system memory	(See page 38.)
:CATalog				
:PDATa	n/a	n/a	get list of stored pattern data files in system memory	(See page 38.)
:STATe	n/a	n/a	get list of instrument settings files in system memory	(See page 39.)
Output subsystem				
:OUTPut0				
:SOURce	PERiodic | BITStream	BITS	set/query trigger out event	(See page 39.)
:DIVider	<numeric>	128	set/query trigger divider	(See page 39.)
:OUTPut				
:POLarity	NORMal | INVerted	NORM	set/query data output polarity	(See page 40.)
[:STATe]	OFF | ON	OFF	set/query data output enable/disable status	(See page 40.)
:OUTPut				
:CLOCk:DIVider	<numeric>	varies	programs the clock divider output for the internal clock	(See page 40.)
Sense subsystem				
:SENSe:ROSCillator				
:SOURce	INTernal | EXTernal	INT	set/query 10 MHz reference source	(See page 41.)

Command	Parameters	Default	Description	
Source subsystem				
[:SOURce]				
:FREQuency[:CW|:FIXed]	<numeric>	30 GHz	set/query clock frequency	(See page 41.)
PM [:HF]				
:[:STATe]	OFF | ON	OFF	set/query overall jitter insertion enable/disable status	(See page 41.)
:INTernal1[:DEViation]	<numeric>	0 ps	set/query internal HF sine jitter amplitude	(See page 42.)
:INTernal1:FREQuency	<numeric>	1 MHz	set/query internal HF sine jitter frequency	(See page 42.)
:INTernal1:STATe	OFF | ON	OFF	set/query internal HF sine jitter enable/disable status	(See page 42.)
:INTernal2[:DEViation]	<numeric>	0 ps	set/query internal random jitter amplitude	(See page 43.)
:INTernal2:STATe	OFF | ON	OFF	set/query internal random jitter enable/disable status	(See page 43.)
:INTernal4:CALibration	GAUSsian | CEI	GAUS	set/query BUJ amplitude cal	(See page 43.)
:INTernal4[:DEViation]	<numeric>	0 ps	set/query internal HF BUJ jitter amplitude	(See page 44.)
INTernal4:FILTer	<numeric>	100 MHz	set/query internal HF BUJ generator filter bandwidth	(See page 45.)
:INTernal4:FREQuency	<numeric>	2 GHz	set/query internal HF BUJ generator clock frequency	(See page 45.)
:INTernal4:PLENgth	<numeric>	31	set/query internal HF BUJ generator PRBS length	(See page 45.)
:INTernal4:STATe	OFF | ON	OFF	set/query internal HF BUJ jitter enable/disable status	(See page 46.)

Command	Parameters	Default	Description	
:PM:LF				
[:INTernal3][:DEViation]	<numeric>	0 UI	set/query internal LF sine jitter amplitude	(See page 45.)
[:INTernal3]:FREQuency	<numeric>	10 kHz	set/query internal LF sine jitter frequency	(See page 46.)
[:INTernal3]:STATe	OFF | ON	OFF	set/query internal LF sine jitter enable/disable status	(See page 46.)
:VOLTage#[:POS|:NEG][:LEVel][:IMMediate]				
[:AMPLitude]	<numeric>	500 mV	set/query data amplitude	(See page 46.)
:OFFSet	<numeric>	0 V	set/query data offset	(See page 47.)
:TERMination	<numeric>	0 V	set/query data term	(See page 47.)
:VOLTage#[:LEVel][:IMMediate]				
:LINK		OFF	Enable/disable Linking	(See page 47.)
System subsystem				
:SYSTem:ERRor[:NEXT]?	none	n/a	query error queue	(See page 48.)
Trigger subsystem				
:TRIGger				
:SOURce	IMMediate | EXTernal	IMM	set/query clock source	(See page 48.)
:LOCK	none	n/a	initiate lock to external clock	(See page 49.)

Reference

:DIGital: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. The length can be any integer from 2 through 4,194,304.

Example	Set pattern length to 56
	`:DIG:PATT:LENG 56`
	Query pattern length
	`:DIG:PATT:LENG?`

:DIGital:PATTern:TYPE

Form	Set & Query
Parameters	DATA | PRBS
Value Coupling	None
Range Coupling	None
Default	PRBS
Description	Programs the Pattern Type.

Example	Set the pattern type to PRBS
	`:DIG:PATT:TYPE PRBS`
	Query pattern type
	`:DIG:PATT:TYPE?`

:DIGital: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 PRBS length to (2^7-1)
	`:DIG:PATT:PLEN 7`
	Query PRBS length
	`:DIG:PATT:PLEN?`

:DIGital: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 > is 4,194,304. 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 ≤ (<max address> + 1).

Example	`:DIG: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
	Thus, bits 1 through 16 in the channel 1 pattern data memory will be set to 0100000101010010.
	`:DIG:PATT:DATA? 1,8`
	This query reads 8 bits of pattern data starting from address 1. Given the above pattern data memory contents, the response would be "#1801000001".

:DIGital: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. The bit count can be any number 1 – 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 ≤ (<max address> + 1).

Example	`:DIG: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
	Thus, bits 1 through 16 in the channel 1 pattern data memory will be set to 0100000101010010.
	`:DIG:PATT:HDAT? 1,8`
	This query reads 8 bits of 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.

:DIGital:PATTern:SERRor

Form	Set
Parameters	None
Value Coupling	None
Range Coupling	None
Default	n/a
Description	Inserts a single error into the data output. Error insertion works for either data patterns or PRBS patterns. If there is no pattern currently being output, for instance if the outputs are disabled, the command has no effect.
Example	Insert one error into the data output. `:DIG:PATT:SERROR`

:DIGital:PATTern:ERATe

Form	Set & Query
Parameters	Numeric
Value Coupling	None
Range Coupling	None
Default	1e-3
Description	Insert errors into the data output at the specified rate. Error rate insertion works for either data patterns or PRBS patterns when error rate is enabled.
Example	Insert 2E-12 error rate into the data output. `:DIG:PATT:ERAT 2e-12`

:DIGital:PATTern:ERATe:STATe

Form	Set & Query
Parameters	OFF | ON
Value Coupling	None
Range Coupling	None
Default	OFF
Description	Enables insertion of errors into the data output at a rate specified by the :DIGital:PATTern:ERATe command.
Example	Enable error insertion rate into the data output. `:DIG:PATT:ERAT:STAT ON`

: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. The pattern length and all pattern data up to the pattern length are stored. The filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
Example	Store the pattern data in system memory. `: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 filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
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. The pattern length and all data up to the pattern length are recalled. Pattern memory addresses above the pattern length are not changed. The filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
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 filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
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 filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
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 filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
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 filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
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 filename can be up to 8 characters long and is not case-sensitive. Filenames must consist of only alphanumeric characters.
Example	Delete the existing instrument settings file PARAM. `:MMEM:DEL:STAT "PARAM"`

:MMEMory:CATalog:PDATa?

Form	Query
Parameters	None
Value Coupling	None
Range Coupling	None
Default	N/A
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
Value Coupling	None
Range Coupling	None
Default	N/A
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?`

:OUTPut0:SOURce

Form	Set & Query
Parameters	PERiodic | BITStream
Value Coupling	None
Range Coupling	None
Default	PERiodic
Description	Programs the trigger out event. PERiodic means the trigger will output a signal whose frequency is the clock rate divided by N, where N is the trigger divider setting. BITStream means trigger pulses will be aligned with the pattern length.
Example	Set the trigger out event to bit stream. `:OUTP0:SOUR BITSTREAM`

:OUTPut0:DIVider

Form	Set & Query
Parameters	Numeric
Value Coupling	None
Range Coupling	None
Default	128
Description	Programs the trigger divider. This is meaningful only if the trigger output event is set to `periodic`.. For the PPG4001, valid values are multiples of 128.
Example	Set the trigger divider to 128. `:OUTP0:DIV 128`

:OUTPut:POLarity

Form	Set & Query
Parameters	NORMal | INVerted
Value Coupling	None
Range Coupling	None
Default	NORMal
Description	Programs the polarity of the channel outputs.
Example	Set for inverted output `:OUTPUT:POLARITY INV`

:OUTPut[:STATe]

Form	Set & Query
Parameters	OFF | ON
Value Coupling	None
Range Coupling	None
Default	OFF
Description	Programs the enable/disable status of the channel outputs. If the unit has optional pre-emphasis outputs, the state of the pre-emphasized output is set together with that of the standard output.
Example	Disable the output. `:OUTP OFF`

:OUTPut:CLOCk:DIVider

Form	Set & Query
Parameters	1 | 2 | 4 | 8 | 16
Value Coupling	None
Range Coupling	None
Default	Varies with model & options. The minimum allowed value is either 1 or 2.
Description	Programs the clock output divider. The input to this divider is internal clock, and the output from the divider goes to the clock output or to the divided clock output if the full rate & divided outputs are separate. The max and min valid values depend on the instrument model and options.
Example	Program clock divider for 8. `:OUTP:CLOC:DIV 8`

:SENSe:ROSCillator:SOURce

Form	Set & Query
Parameters	INTernal | EXTernal
Value Coupling	None
Range Coupling	None
Default	INT
Description	Programs the 10 MHz reference source.
Example	Set the 10 MHz reference source to use the internal reference. `:SENSE:ROSCILLATOR:SOURCE INTERNAL`

[:SOURce]:FREQuency[:CW|:FIXed]

Form	Set & Query
Parameters	Numeric [Hz]
Value Coupling	None
Range Coupling	None
Default	30e9
Description	Programs the internal clock frequency, and also selects the internal clock as clock source if it is not already selected.
Example	Set frequency to 28 GHz. `:FREQ 28e9`

[:SOURce]:PM[:HF][:STATe]

Form	Set & Query
Parameters	OFF | ON
Value Coupling	None
Range Coupling	None
Default	OFF
Description	Programs the overall channel jitter insertion enable/disable status. The HF sources are HF sine, random, and external. If enabled, the external jitter source is enabled and the internal sources are set according to their individual controls.
Example	Enable overall HF jitter insertion. `:PM ON`

[:SOURce]:PM[:HF]:INTernal1[:DEViation]

Form	Set & Query
Parameters	Numeric [S]
Value Coupling	None
Range Coupling	None
Default	0 ps
Description	Programs the peak-to-peak amplitude of the channel internal sine jitter source. Units are in seconds.
Example	Set the internal HF sine jitter source to 11 ps peak-to-peak. `:PM:INT1 11ps`

[:SOURce]:PM[:HF]:INTernal1:FREQuency

Form	Set & Query
Parameters	Numeric [Hz]
Value Coupling	None
Range Coupling	None
Default	1 MHz
Description	Programs the frequency of the channel internal HF sine jitter source. Units are Hz.
Example	Set sinusoidal jitter frequency to 1.3 MHz. `:PM:INT1:FREQ 1.3MHz`

[:SOURce]:PM[:HF]:INTernal1:STATe

Form	Set & Query
Parameters	OFF | ON
Value Coupling	None
Range Coupling	None
Default	OFF
Description	Programs the channel internal HF sine jitter source enable/disable status. Both this setting and [:SOURce]:PM[:HF][:STATe] for a given channel must be on for HF sine jitter to be applied.
Example	Enable the internal HF sine jitter source. `:PM:INTERNAL1:STATE ON`

[:SOURce]:PM[:HF]:INTernal2[:DEViation]

Form	Set & Query
Parameters	Numeric [S]
Value Coupling	None
Range Coupling	None
Default	0 ps
Description	Programs the rms amplitude of the channel internal random jitter source. Units are in seconds.
Example	Set the internal random jitter source to 7 ps rms. `:PM:INT2 7ps`

[:SOURce]:PM[:HF]:INTernal2:STATe

Form	Set & Query
Parameters	OFF | ON
Value Coupling	None
Range Coupling	None
Default	OFF
Description	Programs the channel internal random jitter source enable/disable status. Both this setting and [:SOURce]:PM[:HF][:STATe] for a given channel must be on for random jitter to be applied.
Example	Disable the internal random jitter source. `:PM:INTERNAL2:STATE OFF`

[:SOURce]:PM[:HF]:INTernal4:CALibration

Form	Set & Query
Parameters	GAUSsian | CEI
Value Coupling	None
Range Coupling	None
Default	GAUS
Description	Programs the calibration source for the BUJ amplitude. BUJ amplitude is calibrated under two conditions; select the source closest to the current settings. The settings for each cal are given below.

	Frequency	*Filter*	*Plength*
Gaussian	2 Gb/s	100 MHz	31
CIE	1.1 Gb/s	100 MHz	7

Example	Select the CEI calibration. `:PM:INTERNAL4:CAL CEI`

[:SOURce]:PM[:HF]:INTernal4[:DEViation]

Form	Set & Query
Parameters	Numeric [S]
Value Coupling	None
Range Coupling	None
Default	0 ps
Description	Programs the peak-to-peak amplitude of the channel internal BUJ jitter source. Units are Seconds.
Example	Set the internal BUJ random jitter source to 12 ps peak-to-peak. `:PM:INT4 12ps`

[:SOURce]:PM[:HF]:INTernal4:FILTer

Form	Set & Query
Parameters	Numeric [Hz]
Value Coupling	None
Range Coupling	None
Default	100 MHz
Description	Programs the bandwidth of the low-pass filter used to generate the BUJ jitter. Units are Hz. Valid values are 25 MHz, 50 MHz, or 100 MHz. Other values will be rounded to the nearest valid value.
Example	Set the internal BUJ low-pass filter to 50 MHz. `:PM:HF:INT4:FILTER 50MHz`

[:SOURce]:PM[:HF]:INTernal4:FREQuency

Form	Set & Query
Parameters	Numeric [Hz]
Value Coupling	None
Range Coupling	None
Default	2 GHz
Description	Programs the clock frequency of the PRBS used to generate the BUJ jitter. Units are Hz.
Example	Set clock frequency of the BUJ PRBS to 1.7 GHz. `:PM:INT4:FREQ 1.7GHz`

[:SOURce]:PM[:HF]:INTernal4:PLENgth

Form	Set & Query
Parameters	7 | 9 | 11 | 15 | 23 | 31
Value Coupling	None
Range Coupling	None
Default	31
Description	Programs the length of the PRBS used to generate the BUJ jitter. PRBS Length is specified as 2^N-1, where N is the specified value.
Example	Set PRBS Length of the channel BUJ PRBS to (2^{15}-1). `:PM:INT4:PLEN 15`

[:SOURce]:PM[:HF]:INTernal4:STATe

Form	Set & Query
Parameters	OFF | ON
Value Coupling	None
Range Coupling	None
Default	OFF
Description	Programs the channel internal BUJ jitter source enable/disable status. Both this setting and [:SOURce]:PM[:HF][:STATe] for a given channel must be on for BUJ jitter to be applied.
Example	Disable the internal BUJ jitter source. `:PM:INTERNAL4:STATE OFF`

[:SOURce]:PM:LF[:INTernal3][:DEViation]

Form	Set & Query
Parameters	Numeric [UI]
Value Coupling	None
Range Coupling	LF Sine Jitter Frequency
Default	0 UI
Description	Programs the peak-to-peak amplitude of the internal LF sine jitter source. Units are UI. Maximum allowed value depends on LF Sine Jitter Frequency. LF jitter is common to all channels.
Example	Set the internal LF sine jitter source to 2.5 UI peak-to-peak. `:PM:LF:INT3 2.5`

[:SOURce]:PM:LF[:INTernal3]:FREQuency

Form	Set & Query
Parameters	Numeric [Hz]
Value Coupling	None
Range Coupling	LF Sine Jitter Amplitude
Default	10 kHz
Description	Programs the frequency of the internal LF sine jitter source. Units are Hz. Allowed range depends on LF Sine Jitter Amplitude. LF jitter is common to all channels.
Example	Set the LF sinusoidal jitter frequency to 7.3 kHz. `:PM:LF:INT3:FREQ 7300`

[:SOURce]:PM:LF[:INTernal3]:STATe

Form	Set & Query
Parameters	OFF | ON
Value Coupling	None
Range Coupling	None
Default	OFF
Description	Programs the internal LF sine jitter source enable/disable status. LF jitter is common to all channels.
Example	Enable the internal LF sine jitter source. `:PM:LF:INTERNAL3:STATE ON`

[:SOURce]:VOLTage[:POS|:NEG][:LEVel][:IMMediate]:[:AMPLitude]

Form	Set & Query
Parameters	Numeric [V]
Value Coupling	N/A
Range Coupling	Offset
Default	500 mV
Description	Programs the amplitude of the output signal for the positive or negative data outputs.

Example	Set positive data amplitude to 1 V.
	`:VOLT:POS 1V`
	Query the positive data amplitude.
	`:VOLT:POS?`

[:SOURce]:VOLTage[:POS|:NEG][:LEVel][:IMMediate]:OFFSet

Form	Set & Query
Parameters	Numeric [V]
Value Coupling	N/A
Range Coupling	Amplitude
Default	0 V
Description	Programs the offset of the output signal for the positive or negative data outputs.

Example	Set negative data offset to –0.5 V.
	`:VOLT:NEG:OFFS –0.5V`
	Query the negative data offset.
	`:VOLT:NEG:OFFS?`

[:SOURce]:VOLTage[:POS|:NEG][:LEVel][:IMMediate]:TERMination

Form	Set & Query
Parameters	Numeric [V]
Value Coupling	Offset
Range Coupling	Amplitude, Offset
Default	0 V
Description	Programs the user-supplied external termination voltage for the positive or negative data outputs.

Example	Set positive term voltage to –1.0 V.
	`:VOLT:POS:TERM –1.0V`
	Query the positive voltage..
	`:VOLT:POS:TERM?`

[:SOURce]:VOLTage[:LEVel][:IMMediate]:LINK

Form	Set & Query
Parameters	Numeric [V]
Value Coupling	Offset
Range Coupling	Amplitude, Offset
Default	0 V
Description	When linking is on, the true & complement values for amplitude, offset, and termination of the channels are coupled together.

Example	Disable linking between data out and data out complement.
	`:VOLT1:LINK OFF`
	Query the linking between data out and data out complement.
	`:VOLT:LINK?`

:SYSTem:ERRor[:NEXT]?

Form	Query
Parameters	None
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 may 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?`

:TRIGger:SOURce

Form	Set and Query
Parameters	IMMediate | EXTernal
Value Coupling	N/A
Range Coupling	N/A
Default	IMMediate
Description	Programs the clock source. IMMediate means the internal clock source provides the clock. Clock frequency is set by the [:SOURce]:FREQuency[:CW|:FIXed] command. EXTernal means the signal at the Ext Clock connector provides the clock source. Clock frequency is equal to the frequency of the external signal. After changing to external clock source the generator must be locked to the clock. If external clock source is in use, the generator must be re-locked to the clock after any interruption or change in frequency of the clock. The lock process must be successfully completed for the generator to function properly. See the :TRIGger:LOCK command. (See page 49, *:TRIGger:LOCK*.)
Example	Set the clock source to internal. `:TRIG:SOUR IMM`

:TRIGger:LOCK

Form	Set
Parameters	None
Value Coupling	N/A
Range Coupling	N/A
Default	N/A
Description	Initiates the process of locking the generator to the external clock. After changing to external clock source the generator must be locked to the clock. If external clock source is in use, the generator must be re-locked to the clock after any interruption or change in frequency of the clock. The lock process must be successfully completed for the generator to function properly.
Example	Lock the generator to the external clock. `:TRIG:LOCK`

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

Mfr. Compliance Contact.
Tektronix, Inc. PO Box 500, MS 19-045
Beaverton, OR 97077, USA
www.tek.com

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.

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

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).

Index