40 Gb/s PatternPro® Programmable Pattern Generator
PPG4001 Datasheet

The Tektronix PPG4001 PatternPro® programmable pattern generator provides stressed pattern generation for high-speed Datacom testing.

Key performance specifications

- Low inherent jitter (typical RJ 200 fs)

- 8 ps typical 20% to 80% rise/fall times

- Low frequency, high amplitude jitter insertion range of 10 Hz to 10 MHz at up to 5000 UI

- High frequency jitter insertion, including SR, RJ, and BUJ with amplitudes up to 12.5 ps (with Option HFJIT)

Key features

- DC coupled differential data outputs

- Adjustable data output skew

- Full rate and sub-rate multiple clock outputs

- Pattern trigger output

- Built-in adjustable clock source

- PRBS and user defined patterns

- Front panel touch screen GUI and USB computer control

Applications

- Semiconductor device testing

- Optical component testing

- Transceiver module testing

Product description

The Tektronix PPG4001 PatternPro® programmable pattern generator provides an unparalleled combination of industry leading performance, features, and ease of use. Design validation of today's demanding high-speed applications requires instruments that produce the highest quality signals and enable programmable controls while being simple and easy to use.

Fast rise time and low jitter are critical performance parameters and the PPG4001 delivers typical 200 fs inherent RJ with 8 ps rise time. Within seconds of powering up the instrument, a first time user can be creating high-performance programmable patterns to test a DUT. In addition, the PPG4001 offers comprehensive jitter insertion for stressed receiver testing and similar applications.

The PPG4001 may be paired with the PED4001 40 Gb/s programmable error detector to provide a complete BERT system that includes control and analysis software.
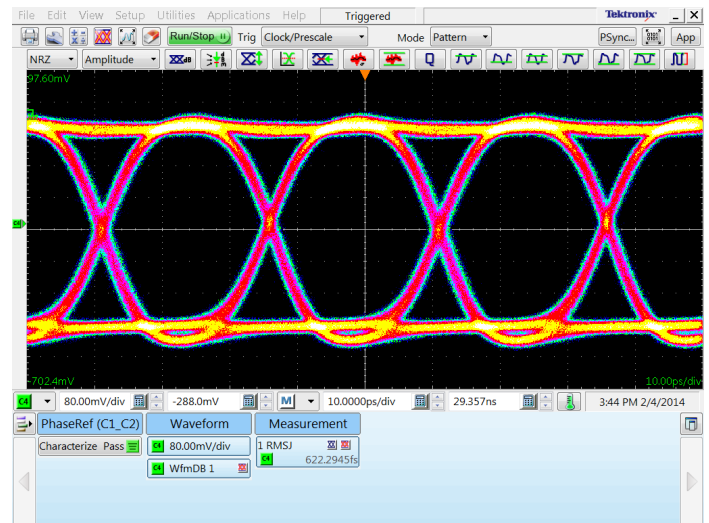
Typical 40 Gb/s eye diagram

Specifications

Data outputs

Amplitude	DC coupled. Each side of the differential pair swings from -500 mV to 0 V. Ground-referenced CML. Terminiated 50 Ω to ground.
Single-ended	500 mV, typical
Differential	1.0 V, typical
Rise/fall time	Scope bandwidth can impact the measured signal rise time.
20 to 80%	8 ps, typical
10 to 90 %	12 ps, typical
Data output jitter	Measured at 40 Gb/s with 2^{11}-1 PRBS
Total jitter (1E-12)	7 ps_{p-p}, typical
Random jitter	200 fs, RMS, typical
Data phase delay adjustment	
Range	100 ps (±50 ps)
Resolution	100 fs
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	500 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 64)
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	1.54 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

Pattern output bit shift range	$\pm(2^{30} - 1)$ bits. Shifts the data pattern

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, and internal noise. Total range depends on modulation frequencies. Exceeding the range can generate errors.
Frequency range	5 kHz to 100 MHz
Amplitude range	0 to 1.25 ps$_{p-p}$
Accuracy	±10%, typical
Total modulation range	1.25 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 12.5 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 ps
Accuracy	±10% typical

Built-in BUJ source	Programmable from either the front panel touch screen or remote control.
Amplitude range	0 to 12.5 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

Datasheet

Jitter insertion

External modulation input	DC coupled, 3 dB bandwidths, 1 V_{p-p}. Input equals modulation of 150 ps_{p-p}.
Frequency range	DC to 100 MHz
Amplitude range	0 to 12.5 ps $_{p-p}$
Maximum input	5 V_{p-p}

Low frequency jitter insertion (Option LFJIT)	Add-on option.

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}	100 UI_{p-p}
1 MHz f_{mod}	10 UI_{p-p}
2 Mz f_{mod}	1 UI_{p-p}
10 MHz f_{mod}	0.5 UIp-p

Trigger system

Trigger waveform	Pattern mode trigger is synced to channel 1 pattern.
Pattern mode	1 pattern per trigger for pattern length = multiple of 64
	64 patterns per trigger for other pattern lengths
Clock/n mode	64 through (2^{32} - 64), n= any multiple of 64 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}, ±5 V DC, Damage threshold
Input impedance	50 Ω, AC-coupled

Reference clock

Input frequency range	100 MHz ±10 ppm
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

Channel skew

Skew adjust	Relative to nominal position
Range	±50 ps
Resolution	100 fs
Pattern shift	Advance or delay. This is equivalent to unlimited shifting since this range allows shifting the longest pattern to any position.
Range	$\pm (2^{30}-1)$
Resolution	1 bit

Data error insertion

Error insertion types	Single or rate-based
Error insertion rate	
Range	1 x 10^{-3} to 1 x 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 50 °C (32 °F to 122 °F)

Ordering information

Models

PPG4001   40 Gb/s programmable pattern generator, 1 channel

Instrument options

PPG4001 LFJIT   Low frequency jitter option for the PPG4001

PPG4001 HFJIT   High frequency jitter option for the PPG4001

Power plug options

Opt. A0   North America power plug (115 V, 60 Hz)

Opt. A1   Universal Euro power plug (220 V, 50 Hz)

Opt. A2   United Kingdom power plug (240 V, 50 Hz)

Opt. A6   Japan power plug (100 V, 110/120 V, 60 Hz)

Opt. A10   China power plug (50 Hz)

Opt. A11   India power plug (50 Hz)

Opt. A99   No power cord

User manual options

Opt. L0   English manual

$C\:E$

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

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For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tektronix.com.

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