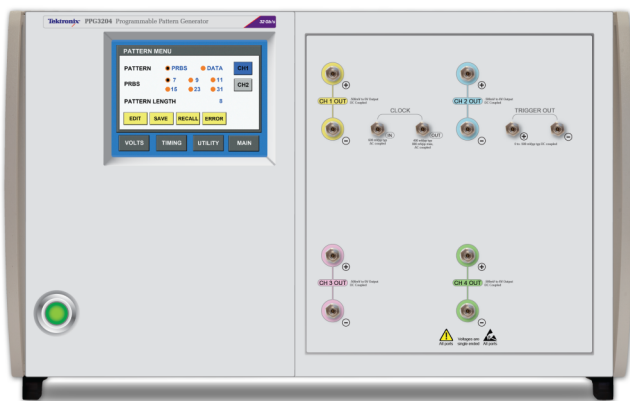# 16 Gb/s, 30 Gb/s, and 32 Gb/s PatternPro® Pattern Generator

PPG1600, PPG3000, and PPG3200 Series Datasheet

The Tektronix PatternPro® series programmable pattern generators provide up to four channels of stressed pattern generation for high-speed Datacom testing.

Key performance specifications

- Low inherent jitter (typical RJ <250 fs)

- 8 ps typical 20% to 80% rise/fall times (PPG3200 fixed output models)

- 12 ps typical 20% to 80% rise/fall times (PPG3200 with Option ADJ)

- Variable output amplitude:
  - 300 mV to 1.0 V for PPG3200 with Option ADJ
  - 250 mV to 2.0 V for PPG1600 and PPG3000 series

- Low frequency, high amplitude jitter insertion range of 10 Hz to 10 MHz at up to 5000 UI (PPG3200 series with Option LFJIT)

- BUJ amplitudes up to 50 ps_{p-p} with modulation rates up to 2.5 Gb/s (with Option HFJIT)

- 35% to 65% programmable crossing point (PPG1600 & PPG3000 series)

Key features

- Available with 1, 2, or 4 output channels of 16, 30, or 32 Gb/s (independent data on all channels)

- Provides full end-to-end multi-channel BER test solution when paired with the PED series error detector

- Jitter insertion options include BUJ, SJ, RJ, and PJ

- Aligned data on multi-channel units

- Full rate built-in adjustable clock source

- DC coupled differential data outputs

- Programmable output amplitude, offset, and crossing point

- PRBS and user defined patterns

- Adjustable channel phase delay

- Front panel touch screen GUI or USB computer control

Applications

- Multi-channel 25 Gb/s testing for 100 G Ethernet

- DQPSK and DP-QPSK testing

- CFP2 and CFP4 testing

- Multi-level signal testing

- Semiconductor and component testing

Product description

The Tektronix PatternPro® line of high-performance pattern generators offer single and multi-channel configurations capable of data rates up to 32 Gb/s. With optional jitter insertion, the PPG line offers a flexible, cost effective and easy to use test solution supporting high speed applications such as 100 Gigabit Ethernet, 32G Fibre channel, PAM4, DP-QPSK testing, and a broad range of receiver test applications. The single unit multi-channel configurations provide aligned, pattern-independent data outputs that support testing of crosstalk immunity and multi-channel functionality. The PPG line can be paired with the Tektronix PED line of Error Detector products to provide a complete BER test capability.

Data rate may be programmed over a broad range of values. (32 Gb/s version shown) Output may be either built-in PRBS patterns or programmed user data patterns.
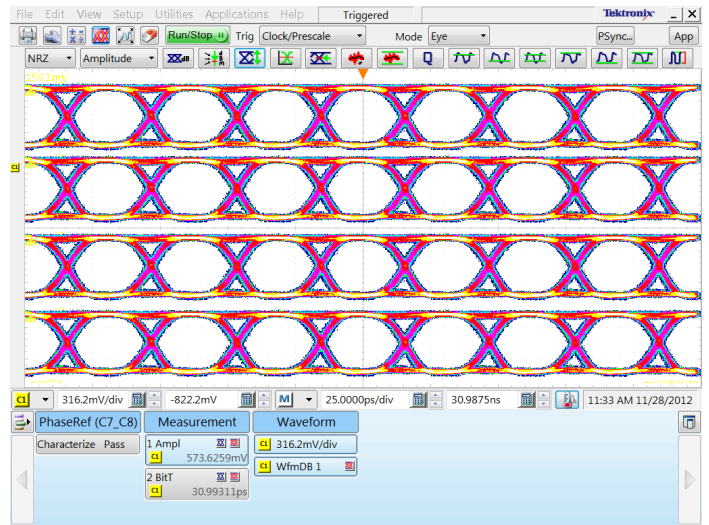
Datasheet
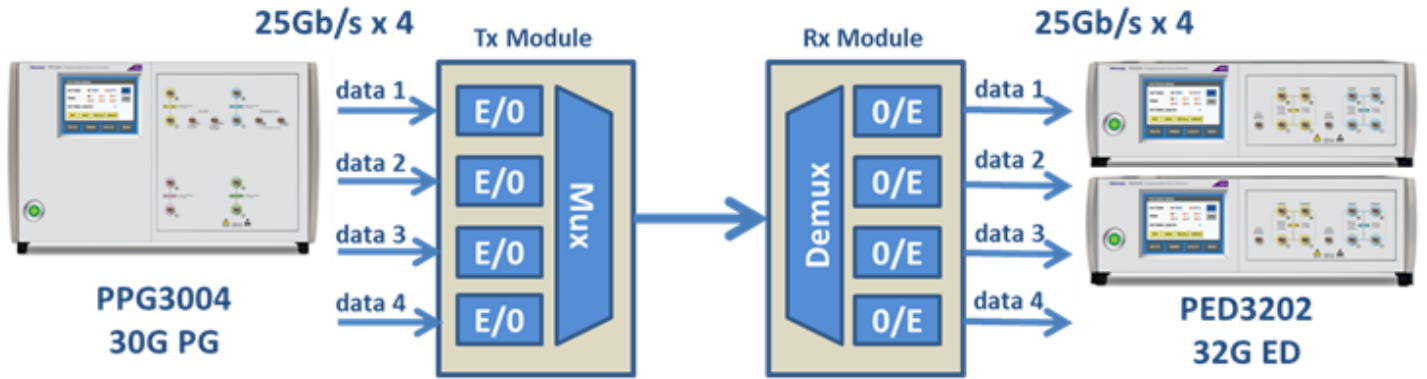
100G Ethernet four lane end-to-end test using PPG3000 series pattern generator and PED3200 series error detector
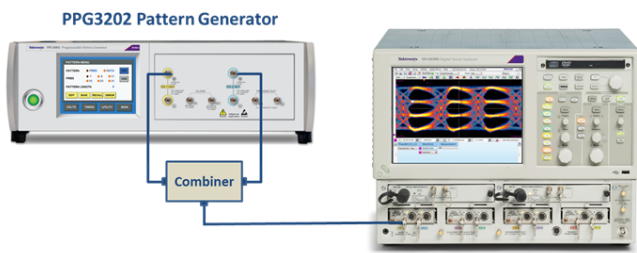
PPG3202 2-channel PG unit configured with external combiner for PAM4 signal operation
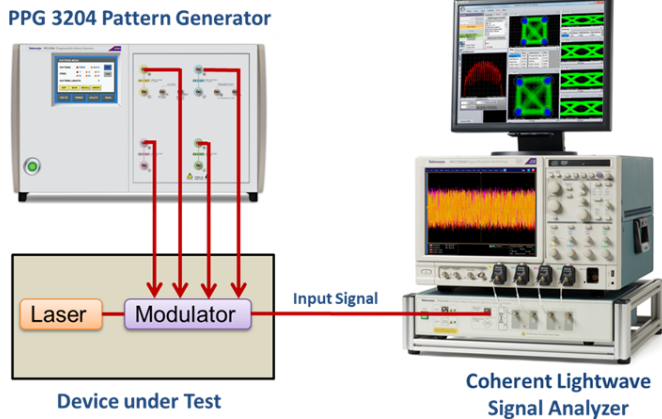
PPG3204 4-channel PG unit configured for DP-QPSK testing with Tektronix Coherent Lightwave Signal Analyzer

Four channel independent output data at 32 Gb/s
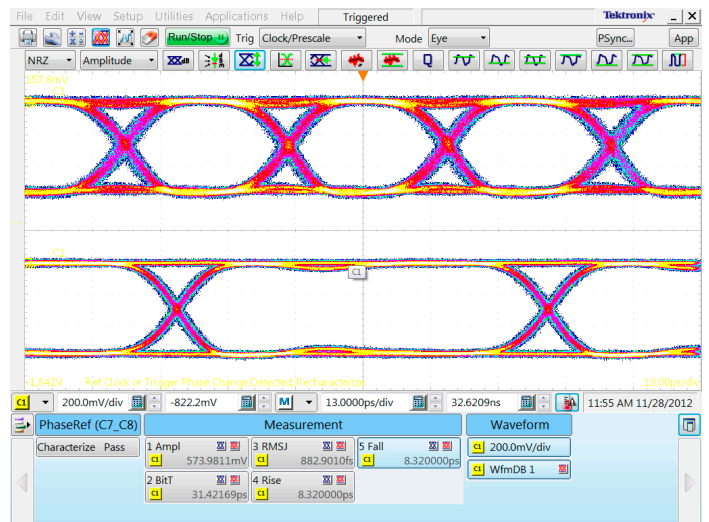
32 Gb/s and 14 Gb/s programmed data rates

Independently programmable output channels allow comprehensive multi-lane testing. Data output has an adjustable skew/delay range of 100 ps (channel independent). (32 Gb/s version shown.)

PAM4 eye diagram at 28 Gb/s

32 Gb/s custom user data demonstrating programmed data skew values of 0 ps, -50 ps, and +50 ps

Specifications

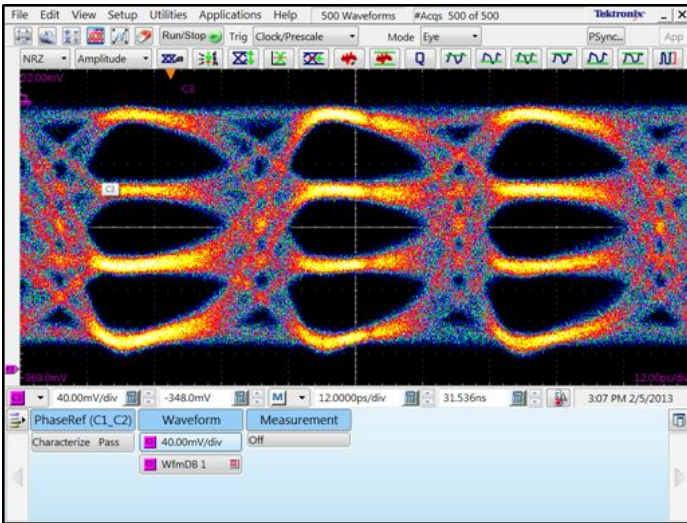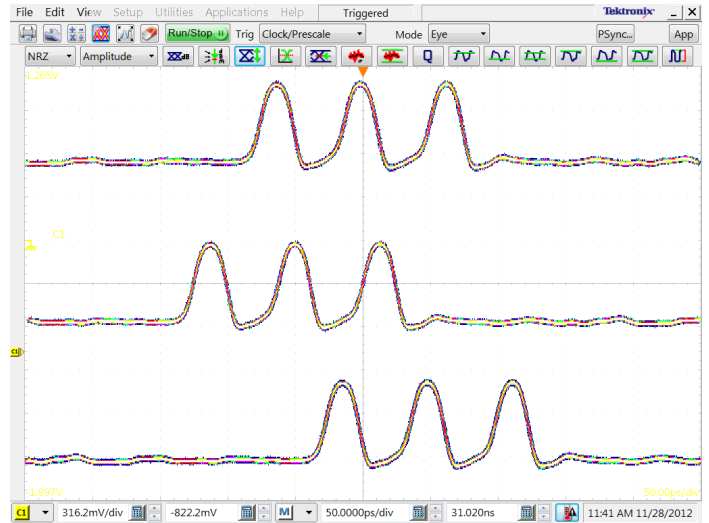All specifications apply to all models unless noted otherwise.

PPG3200 data outputs

Option FXD 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
Option FXD Rise/fall time	Scope bandwidth can impact the measured signal rise time.
20 to 80%	8 ps, typical
10 to 90 %	12 ps, typical
Option ADJ 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
Option ADJ Offset window	-2 V to +3 V, programmable/adjustable
Option ADJ 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	250 fs$_{RMS}$ RMS RJ typical
Data phase delay adjustment	Phase adjustment range of a given channel output differential pair.
Range	100 ps (±50 ps)
Resolution	100 fs
Connector type	2.4 mm

Datasheet

PPG3200 data outputs

Output impedance

50 Ω	Single-ended
100 Ω	Differential

PPG3000 & PPG1600 data outputs

Amplitude range

250 mV to 2.0 V	Single-ended
500 mV to 4.0 V	Differential. Each positive and negative differential output is independently programmable.

Offset range	–2 V to +3.0 V window. Programmable/adjustable.
Termination voltage range	-2.0 V to +3.3 V window. Programmable/adjustable. Applied by user via 50 Ω.

Crossing point — Programmable/adjustable

Range	35% to 65%, typical. Tested using 50% mark density pattern.
Resolution	1%

Rise/fall time — Scope bandwidth can impact the measured signal rise time.

20% - 80%	17 ps, typical
10% - 90%	25 ps, typical

Data output jitter	250 fs$_{RMS}$, RJ typical
Connector type	2.92 mm

Output impedance

50 Ω	Single-ended
100 Ω	Differential

Data patterns

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

Data rate — Programmable/adjustable

Range	1.5 Gb/s to 16 Gb/s, (PPG1600 series)
	1.5 Gb/s to 30 Gb/s, (PPG3000 series)
	1.5 Gb/s to 32 Gb/s (PPG3200 series)
Resolution	10 kb/s
Accuracy	±5 ppm

PRBS pattern lengths — Independently selected on multi-channel units

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 patterns

Data pattern depth

Range	2 to 4,194,304 bits. For 1 channel generator (4 Mbits).
	2 to 2,097,152 bits. For 2 or 4 channel generators (2 Mbits/channel).
Resolution	1 bit

Clock outputs

Frequency	(Internal clock)/(n), n = 1,2,4,8, or 16 user programmable
Amplitude	Amplitude varies with frequency
	600 mV$_{p-p}$, typical; 200 mV$_{p-p}$ minimum; 1.0 V$_{p-p}$ maximum
Output impedance	50 Ω, AC-coupled
Maximum external DC voltage	±5 V
Jitter	< 200 fs$_{RMS}$ typical, measured by spectrum analyzer on 1010 pattern, phase noise integrated from 1 kHz to 1 GHz.
Connector type	2.92 mm (PPG3000 & PPG1600)
	2.4 mm (PPG3200)

Jitter insertion

High frequency jitter insertion option (Option HFJIT)	Add-on option for the instrument. Independent jitter sources on each channel. Sum of external, internal sine, and internal noise. Total range depends on modulation frequencies. 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 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 12.5 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
External modulation input	DC coupled, 3 dB bandwidths
Frequency range	DC to 100 MHz
Amplitude range	0 to 12.5 ps $_{p-p}$
Maximum input	5 V$_{p-p}$

Datasheet

Jitter insertion

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

	Parameter	Value
SJ modulation range curve points	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 Ulp-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 15 GHz to 30 GHz, (PPG3000 & PPG1600 series)

16 GHz to 32 GHz, (PPG3200 series)

Input signal 400 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	10 MHz ±10 ppm
Input signal	1 V_{p-p}, typical, 50% duty square wave
Maximum input signal	6 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
Nominal channel to channel pattern skew	< ±2 UI, Time difference between patterns on a 2 channel PPG3000 series, skew adjust and bit shift at 0.

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	
1 & 2 channel	13.3 cm (5.25 in)
4 channel	27.9 cm (11.0 in)
Width	45.1 cm (17.75 in)
Depth (rack mount)	35.1 cm (13.8 in)

Physical characteristics

Weight

1 & 2 channel	11.1 kg (24.5 lbs)
4 channel	20.4 kg (45 lbs)

Operating temperature	0 °C to 50 °C (32 °F to 122 °F)

Ordering information

Models

PPG1601	16 Gb/s programmable pattern generator, 1 channel
PPG1602	16 Gb/s programmable pattern generator, 2 channels
PPG1604	16 Gb/s programmable pattern generator, 4 channels
PPG3001	30 Gb/s programmable pattern generator, 1 channel
PPG3002	30 Gb/s programmable pattern generator, 2 channels
PPG3004	30 Gb/s programmable pattern generator, 4 channels
PPG3201	32 Gb/s programmable pattern generator, 1 channel
PPG3202	32 Gb/s programmable pattern generator, 2 channels
PPG3204	32 Gb/s programmable pattern generator, 4 channels

Options

Instrument options

PPG1601 HFJIT	High frequency jitter option for PPG1601
PPG1602 HFJIT	High frequency jitter option for PPG1602
PPG1604 HFJIT	High frequency jitter option for PPG1604
PPG3001 HFJIT	High frequency jitter option for PPG3001
PPG3002 HFJIT	High frequency jitter option for PPG3002
PPG3004 HFJIT	High frequency jitter option for PPG3004
PPG3201 HFJIT	High frequency jitter option for PPG3201
PPG3202 HFJIT	High frequency jitter option for PPG3202
PPG3204 HFJIT	High frequency jitter option for PPG3204
PPG3201 LFJIT	Low frequency jitter option for PPG3201
PPG3202 LFJIT	Low frequency jitter option for PPG3202
PPG3204 LFJIT	Low frequency jitter option for PPG3204
PPG3201 ADJ	Adjustable output option for PPG3201
PPG3202 ADJ	Adjustable output option for PPG3202
PPG3204 ADJ	Adjustable output option for PPG3204

PPG3201 FXD	Fixed output option for PPG3201
PPG3202 FXD	Fixed output option for PPG3202
PPG3204 FXD	Fixed output option for PPG3204

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

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.

Datasheet

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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