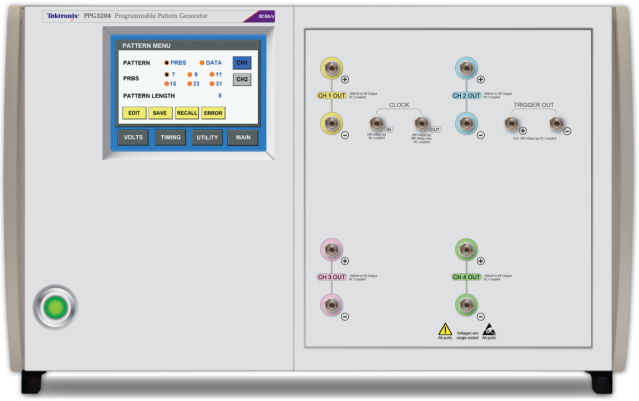
30 Gb/s and 32 Gb/s Programmable Pattern Generator

PPG Series Datasheet



The Tektronix PPG3000 series programmable pattern generators provide up to four channels of stressed pattern generation for high-speed Datacom testing.

Key performance specifications

- Low inherent jitter (typ Rj <300 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 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 60 ps_{p-p} with modulation rates up to 2.5 Gb/s (with Option HFJIT)
- 35% to 65% programmable crossing point (PPG3000 series)

Key features

- Available with 1, 2, or 4 output channels of 30 Gb/s 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

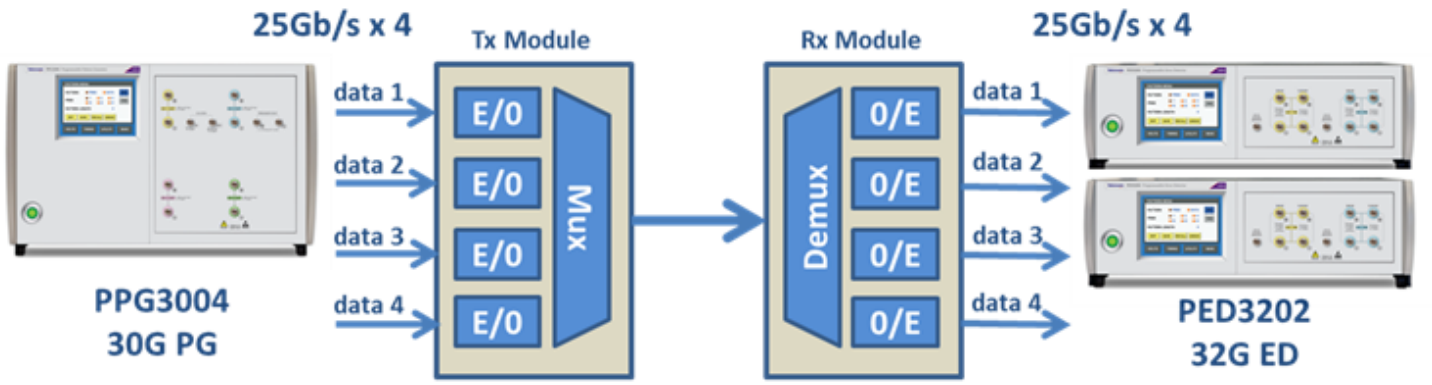
Applications

- 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

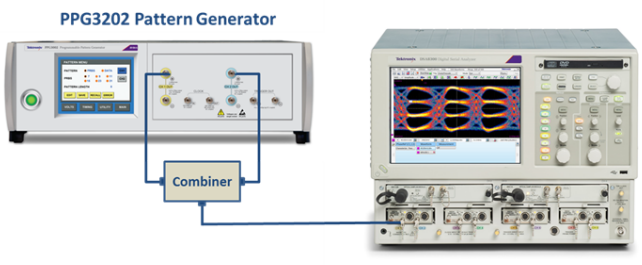
Product description

The Tektronix PPG 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.

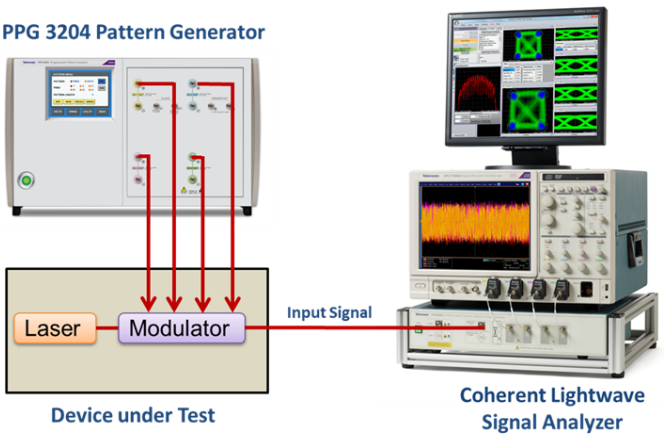
Data rate may be programmed over a broad range of values. (32 Gb/s version shown) Output may be either built-in PRBS patterns or programmed user data patterns.



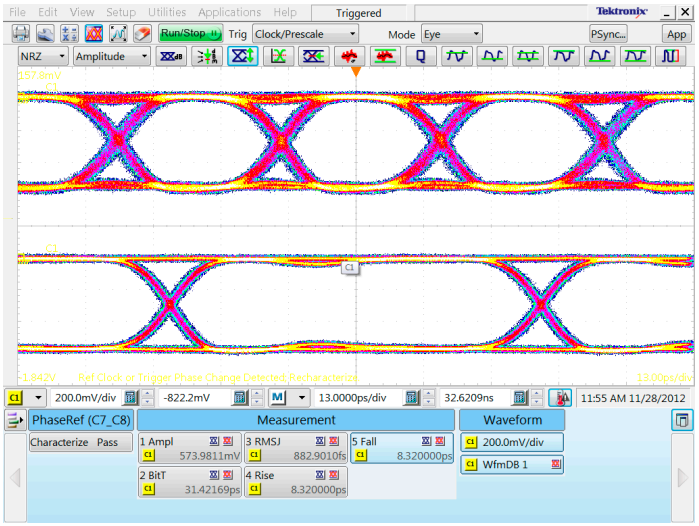
100G Ethernet four lane end-to-end test using PPG3000 series pattern generator and PED3200 series error detector



PPG3202 2-channel PG unit configured with external combiner for PAM4 signal operation

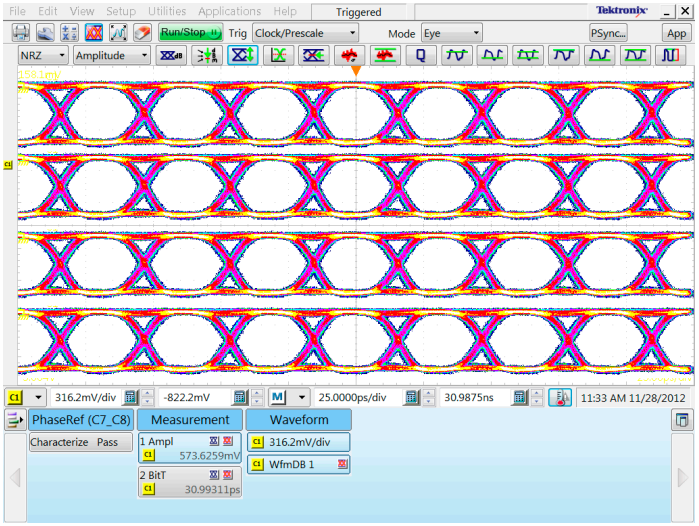


PPG3204 4-channel PG unit configured for DP-QPSK testing with Tektronix Coherent Lightwave Signal Analyzer

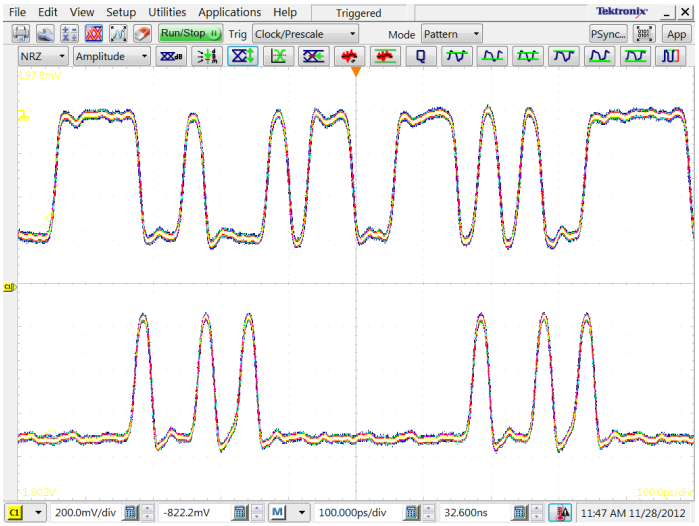


32 Gb/s and 14 Gb/s programmed data rates

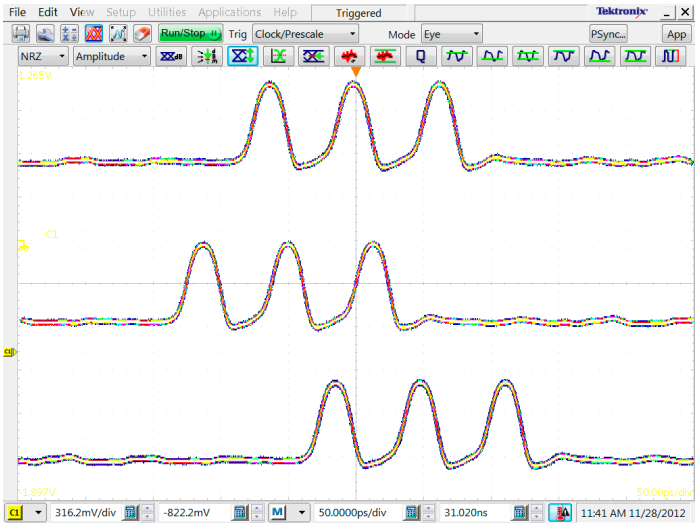
Independently programmable output channels allow comprehensive multi-lane testing. Data output has an adjustable skew/delay range of 100 ps (channel independent). (32 Gb/s version shown.)



Four channel independent output data at 32 Gb/s



Built-in PRBS and programmed user data



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	900 fs_{RMS}, typical. Tested using 2^7-1 PRBS.
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

PPG3200 data outputs

Output impedance	
50 Ω	Single-ended
100 Ω	Differential

PPG3000 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 +3.3 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	900 fs_{RMS}, typical. Tested using 2^7-1 PRBS.
Data phase delay adjustment	Phase adjustment range of a given channel output differential pair.
Range	100 ps (±50 ps)
Resolution	100 fs
Connector type	2.92 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 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 = $X^{15} + X^{14} + 1$

Data patterns

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

Pattern output bit shift range	±(2^{30} – 1) bits. Shifts the data pattern; independent per channel.
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

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	< 300 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) 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 (PPG3200 series)

Range	Value
≤10 MHz f_{mod}	0 to 150 ps_{p-p}
>10 MHz to 100 MHz f_{mod}	0 to 60 ps_{p-p}

Total modulation range (PPG3000 series)

Range	Value
5 kHz to 100 MHz f_{mod}	0 to 150 ps_{p-p}

Built-in sine source

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

Parameter	Value
Frequency range	5 kHz to 100 MHz
Amplitude range (PPG3200 series)	
5 kHz to ≤10 MHz f_{mod}	0 to 150 ps_{p-p}
>10 MHz to 100 MHz f_{mod}	0 to 150 ps_{p-p}
Amplitude range (PPG3000 series)	0 to 150 ps_{p-p}
Accuracy	±10% typical

Jitter insertion

Built-in random noise source — Programmable from either the front panel touch screen or remote control.

- **Amplitude range (PPG3200 series)** — 0 to 5 ps
- **Amplitude range (PPG3000 series)** — 0 to 12.5 ps
- **Crest factor** — <10
- **Accuracy** — ±10% typical

Built-in BUJ source — Programmable from either the front panel touch screen or remote control.

- **Amplitude range** — 0 to 60 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, 1 V_{p-p} Input equals modulation of 150 ps_{p-p}.

Parameter	Value
Frequency range	DC to 100 MHz
Amplitude range	
≤10 MHz f_{mod}	0 to 150 ps_{p-p}
>10 MHz to 100 MHz f_{mod}	0 to 60 ps_{p-p}
Maximum input	5 V_{p-p}

Low frequency jitter insertion (Option LFJIT) — Add-on option for the PPG3200 series.

- **SJ modulation range curve paths** — .

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, patterns 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

Trigger system

Output impedance	50 Ω, DC-coupled
Connector type	SMA

Clock inputs

Frequency range	15 GHz to 30 GHz, (PPG3000 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
10 MHz reference input/output	Yes, BNC connector

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

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	± (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 TMS, 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)
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

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

PPG3201 LFJIT	Low frequency jitter option for PPG3201
PPG3202 LFJIT	Low frequency jitter option for PPG3202
PPG3204 LFJIT	Low frequency jitter option for PPG3204
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 ADJ	Adjustable output option for PPG3201
PPG3202 ADJ	Adjustable output option for PPG3202
PPG3204 ADJ	Adjustable output option for PPG32014
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

CE

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.

ASEAN / Australasia (65) 6356 3900
Belgium 00800 2255 4835*
Central East Europe and the Baltics +41 52 675 3777
Finland +41 52 675 3777
Hong Kong 400 820 5835
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* European toll-free number. If not accessible, call: +41 52 675 3777

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