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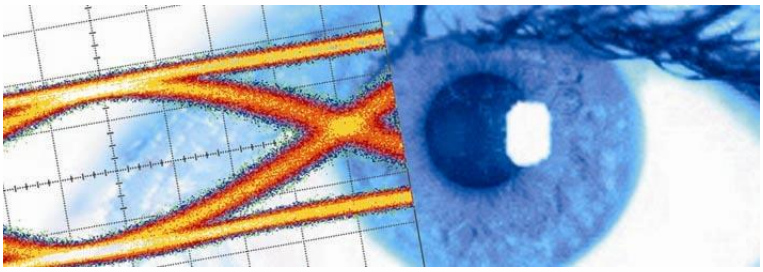


Datasheet

SHF 12124 A

Compact Dual-Channel 32 Gbps Bit Pattern Generator

Description

The SHF 12124 A is a dual-channel 32 Gbps bit pattern generator. It features two differential data outputs with individual 4-Tap pre-emphasis capabilities, 2 UI skew control and duty cycle adjustment. Digital bit sequences such as standard pseudo-random bit sequences (PRBS) or short user defined bit patterns are generated by the unit at the data outputs. Many applications in research, product development as well as production tests require these data streams for testing electrical/optical components or testing signal integrity in high speed digital data communication. A wide range of operating bit rates from 5 to 32 Gbps is covered.

The operating bit rate is determined by a clock signal from an external clock source which is not part of the pattern generator. The generator operates at full clock, i.e. a 32 GHz clock signal is required for 32 Gbps operation.

For trigger purposes two clock output signals (clock/2 and clock/16) are provided on the rear panel of the instrument.

Its compact size allows placement very close to the probe tips for on-wafer measurements.

Features

- Two differential output channels
- 5 to 32 Gbps operation, ‘gap-free’
- Output amplitude control (maximum 400 mV single ended)
- 4-Tap-FIR pre-emphasis individually adjustable for both channels
- Skew control over two UI with 1/32 UI resolution for each output
- PRBS 2^7-1, 2^{11}-1, 2^{15}-1, 2^{23}-1, 2^{31}-1
- 16 Bit user programmable pattern
- Two clock outputs (input clock divided-by-2 and 16) for trigger purposes
- Built-in frequency counter for input clock
- USB port to control the generator
- Low power consumption: < 4 W
- Compact size: 91 mm (W) x 54 mm (H) x 124 mm (D)

Applications

- Research, Development, Production Tests
- On-Wafer Testing
- CEI-28G
- 100G Ethernet
- Infiniband
- Fibre Channel ®
- High Speed Serial
- Backplane Applications

Specifications – SHF 12124 A

Parameter	Symbol	Unit	Min.	Typ.	Max.	Comment
Data Outputs						
Minimum Bit Rate		Gbps			5	
Maximum Bit Rate		Gbps	32	33		
Maximum Output Level (Eye Amplitude)	V_{out}	mV	350	430	500	adjustable by up to -6 dB, AC coupled, no pre-emphasis applied
Jitter (RMS)	J_{RMS}	fs		450	600	measured at 32 Gbps on scope display[1]
Jitter (PP)	J_{PP}	ps		2.7	4	measured at 32 Gbps on scope display[2]
Crossing		%	47	50	53	
Duty Cycle		%	47	50	53	of two consecutive eyes, can be adjusted using BCC
Skew Control		UI	-1		+1	adjustable in 1/32UI-steps
Connector Type		Ω		50		2.92 mm (K) female
Rise/Fall Time	t_r/t_f	ps		14	15	20%...80% on scope display

[1] Measured with Agilent 86100A with 70 GHz sampling head and precision time base triggered by Clk or Clk/2 output, using PRBS 2^{31}-1

[2] Measured with Agilent 86100A with 70 GHz sampling head and precision time base triggered by Clk or Clk/2 output, using PRBS 2^{31}-1

Clock						
Connector Type Clock Input Clock/2 Output Clock/16 Output		Ω		50		 2.92 mm (K) female 2.92 mm (K) female 2.92 mm (K) female
Clock Input Frequency	f_{in_clock}	GHz	5		32	
Input Level	V_{in_clock}	mV_{pp}	600		1000	AC coupled
Output Level Clock/2 Clock/16	V_{out_clock}	mV_{pp}	 350 550	 400 600	 600 750	 AC coupled AC coupled
Output Frequency Clock/2 Clock/16	f_{out_clock}	 GHz GHz	 2.5 0.3125		 16 2	 half of input frequency input frequency/16

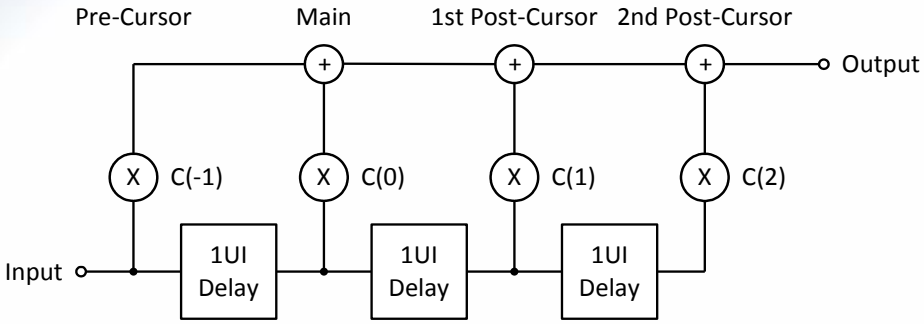
Pattern						
Output Pattern						ITU-T (CCITT) conform PRBS patterns at a length of 2^7-1, 2^{11}-1, 2^{15}-1, 2^{23}-1 & 2^{31}-1 plus user defined pattern
User Pattern Memory Size for Data Outputs		bit			16	
Clock Output Pattern						Output can be set to transmit a clock pattern clock/2, clock/4, clock/8, clock/16

General						
Supply Voltage	Vee	V	4.75	5	5.25	+5V switching power supply is included
Power Consumption	P_{tot}	W			4	
Height	H	mm		54		
Width	W	mm		91		
Depth	D	mm		124		
Weight	m	g			500	
Case Temperature	T_{case}	°C			45	

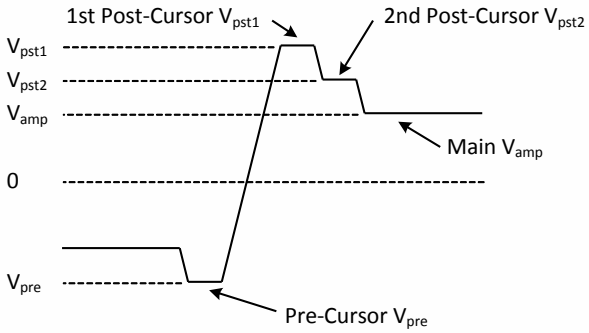
Pre-Emphasis Terms and Definitions

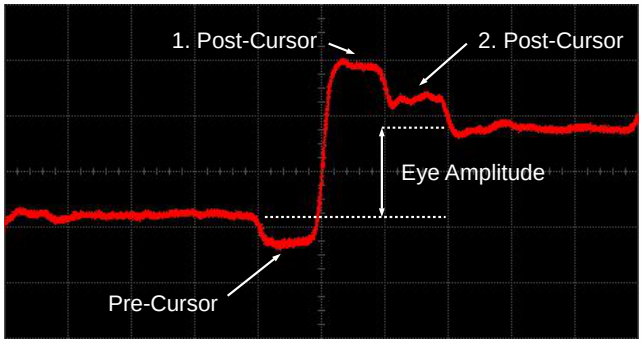
Pre-emphasis based on a finite impulse response (FIR) filter is a way to compensate for high frequency losses in a transmission path. It helps to reduce the inter-symbol interference when the filter coefficients can be set adequately to compensate the imperfections of the channel's impulse response. The basic idea is to boost the high-frequency components while leaving the low frequency components in their original state.

The SHF12124A features a 4-Tap FIR filter structure for each channel as depicted in the following picture.



The structure can be used very flexible. Up to four taps can be used and each one is individually controllable. Polarity inversion allows to add or substract the tap from the main signal. Depending on the weight of the taps different configurations as pre- and post-cursors are possible. The most common configuration is probably the use of one pre- and two post-cursors. As depicted in the following picture.





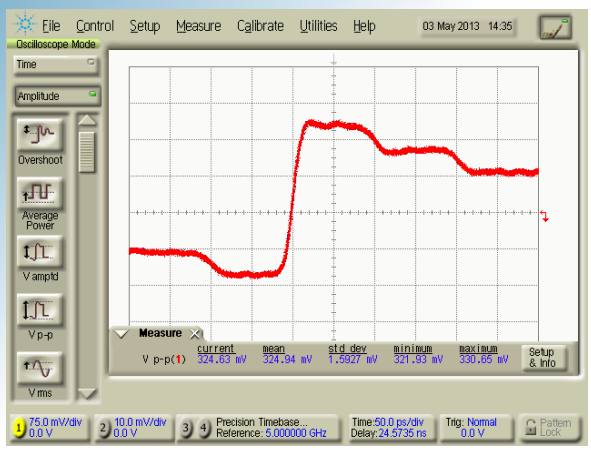
The ratio of the individual taps to the final eye amplitude is given by the following equations:

$$R_{pre}[dB] = 20 \cdot log\left(\frac{|V_{pre}|}{V_{amp}}\right)$$

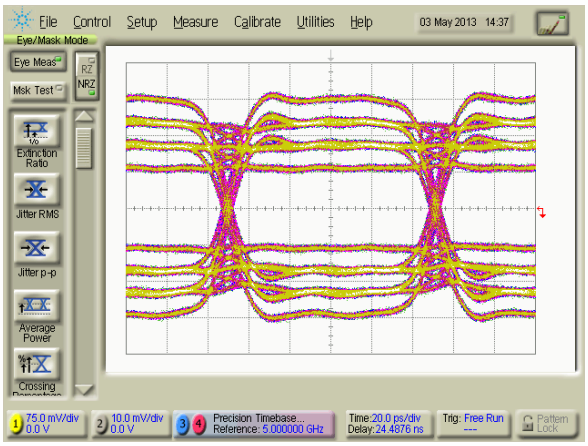
$$R_{pst1}[dB] = 20 \cdot log\left(\frac{|V_{pst1}|}{V_{amp}}\right)$$

$$R_{pst2}[dB] = 20 \cdot log\left(\frac{|V_{pst2}|}{V_{amp}}\right)$$

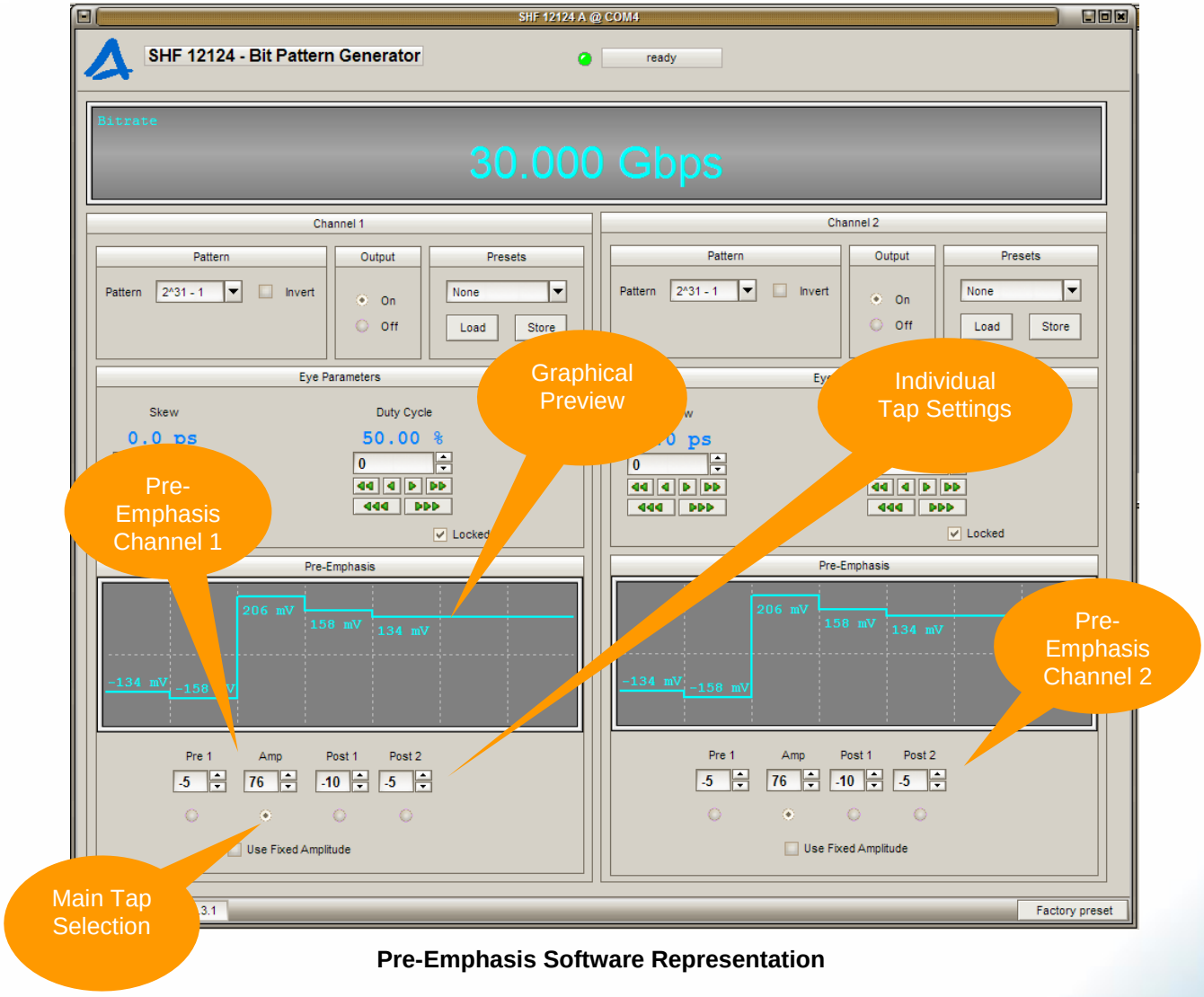
The following pictures show how pre- and post-cursor appear in the waveform or eye diagram of the signal.



10 Gbps – One Pre- & Two Post-Cursors



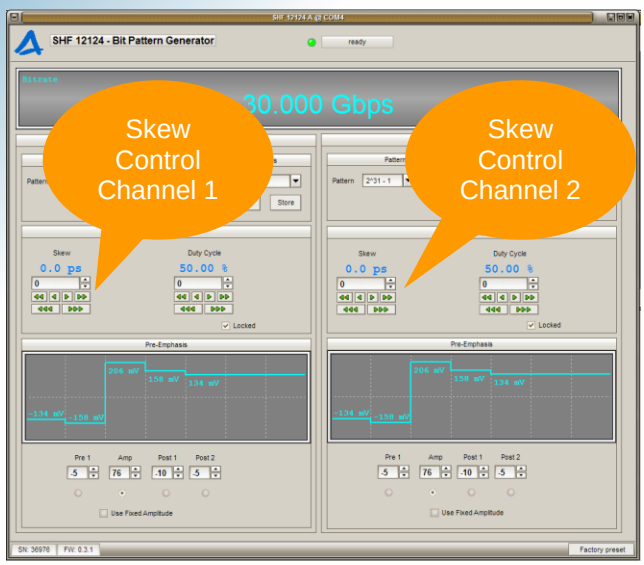
10 Gbps – One Pre- & Two Post-Cursors



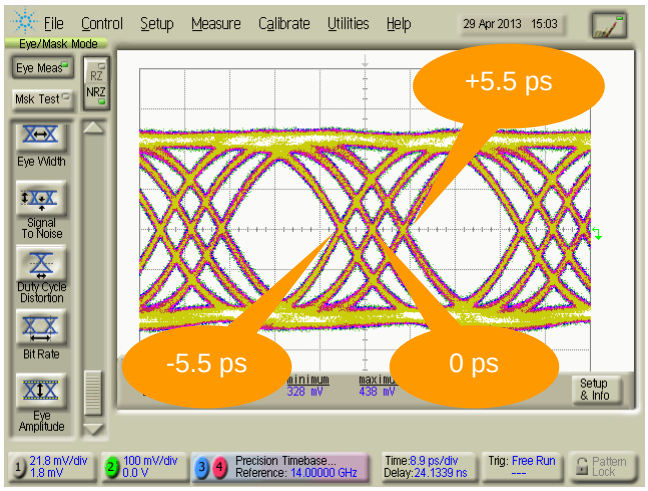
Pre-Emphasis Software Representation

Skew Control Function

The skew control function allows adjusting the channel timing relative to each other. As a result, timing delays between the two output channels can be compensated. The skew can be controlled in steps of 1/32 UI. The maximum skew range is 2 UI, i.e. two eye lengths. Since the built-in phase rotator is optimized for operation between 25 Gbps and 30 Gbps step accuracy might degrade at lower and higher bitrates.



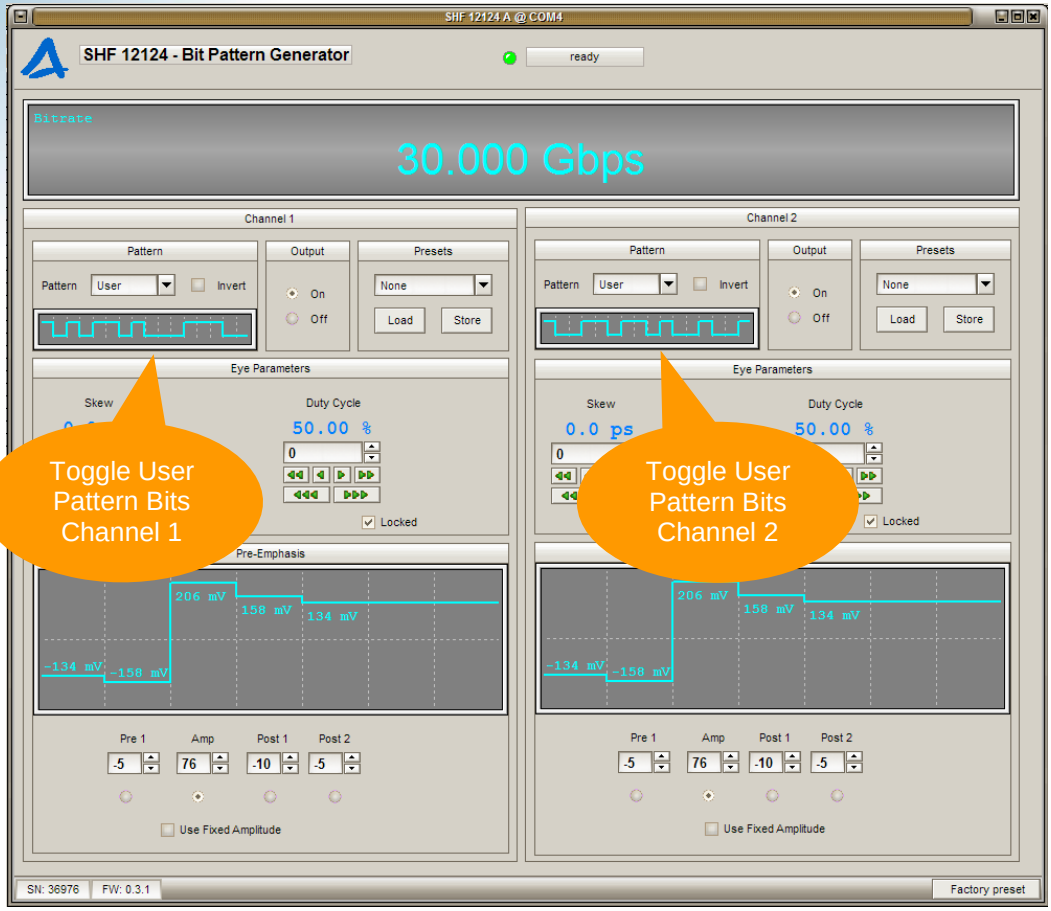
Skew Control Software Representation



Skew Control Eye Diagram Representation

User Pattern Function

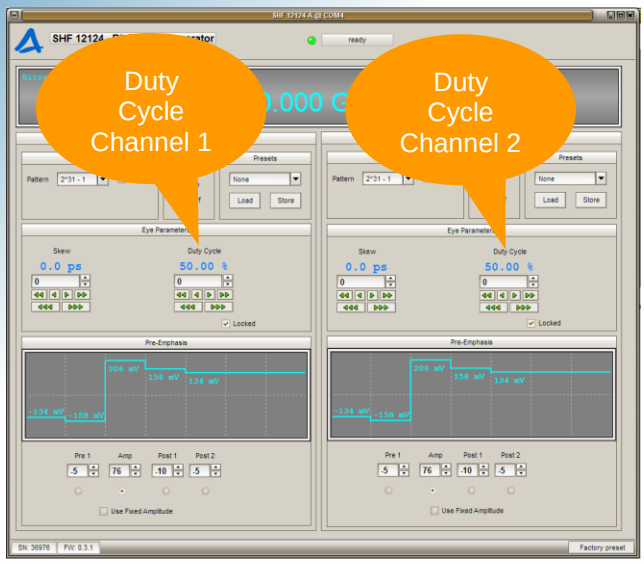
Besides the five pseudo-random bit sequences and the clock patterns a 16-Bit user pattern can be transmitted from each output. The user pattern can be set using a graphical representation in the user interface.



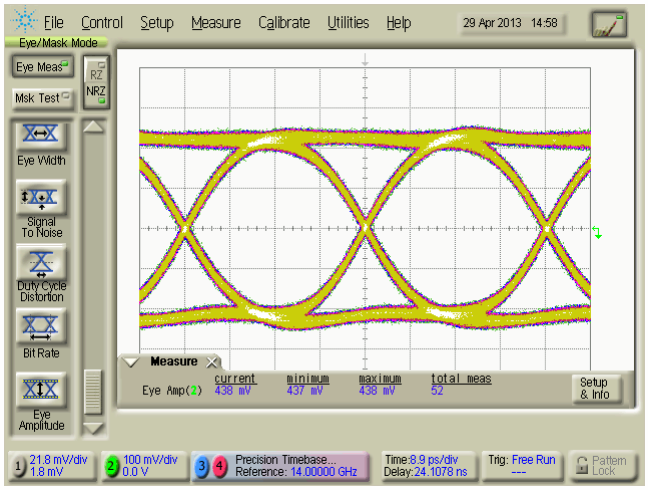
User Pattern Software Representation

Duty Cycle Control Function

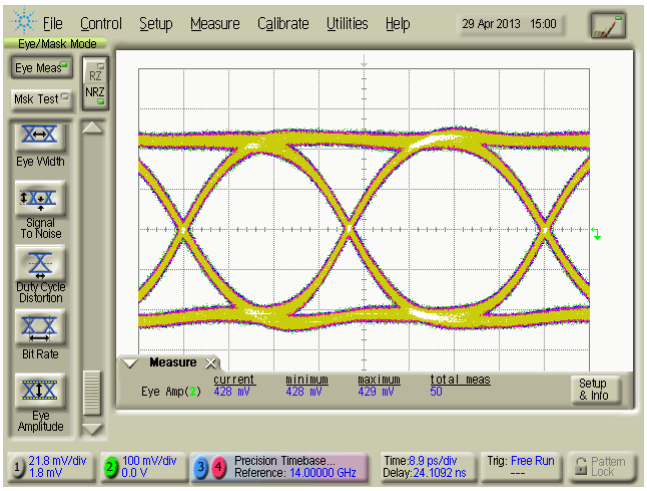
The duty cycle control function allows adjusting the length of consecutive eyes with a range of approximately +/-5% and with a 0.33% resolution.



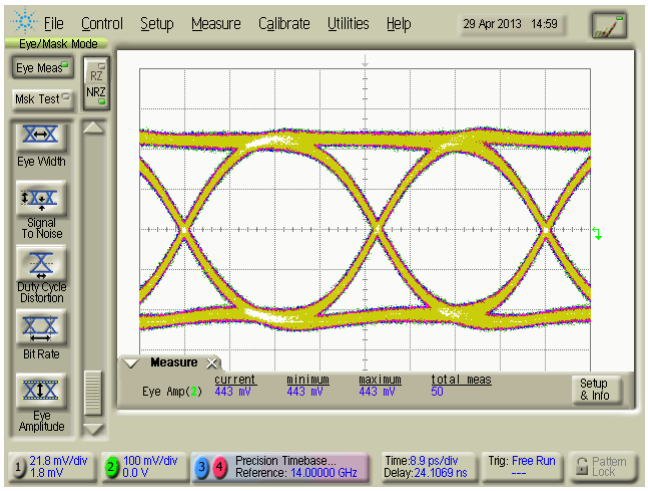
Duty Cycle Control Software Representation



Duty Cycle Control Set to 50%



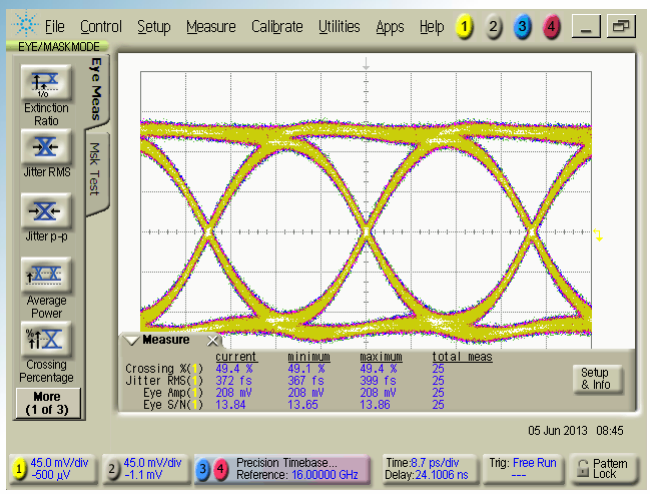
Duty Cycle Control Set to less than 50%



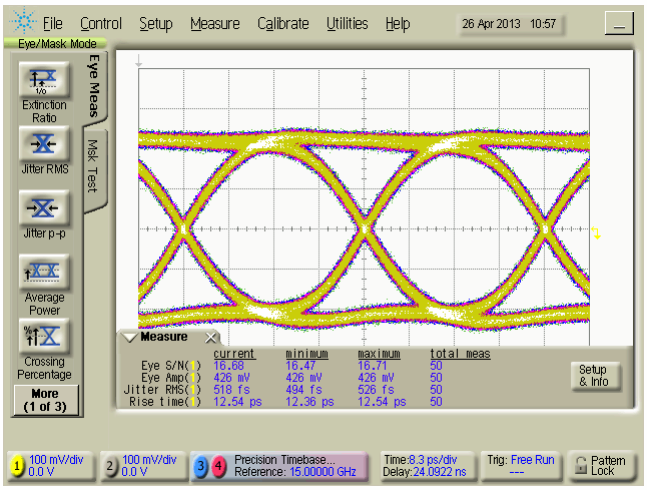
Duty Cycle Control Set to more than 50%

Typical Output Waveforms

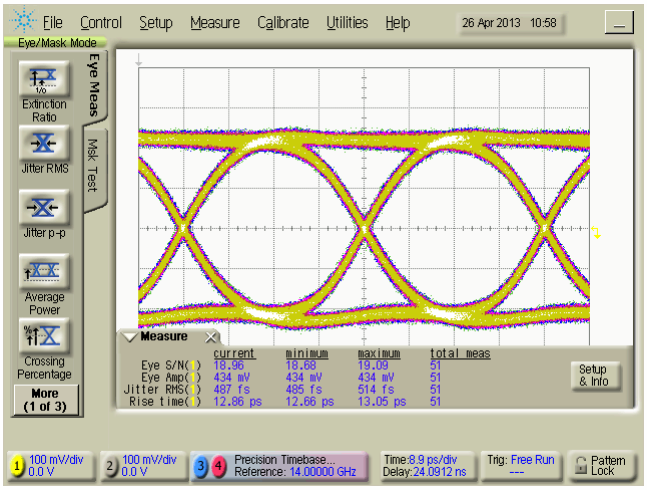
Data Output Signals (Pre-Emphasis completely deactivated)



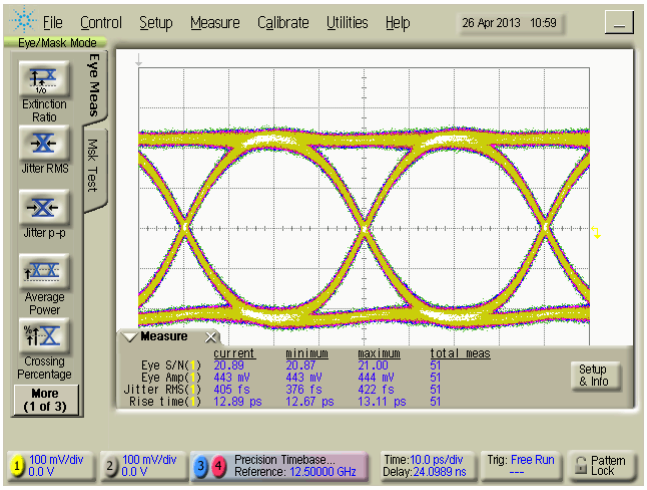
32 Gbps output eye at maximum output level



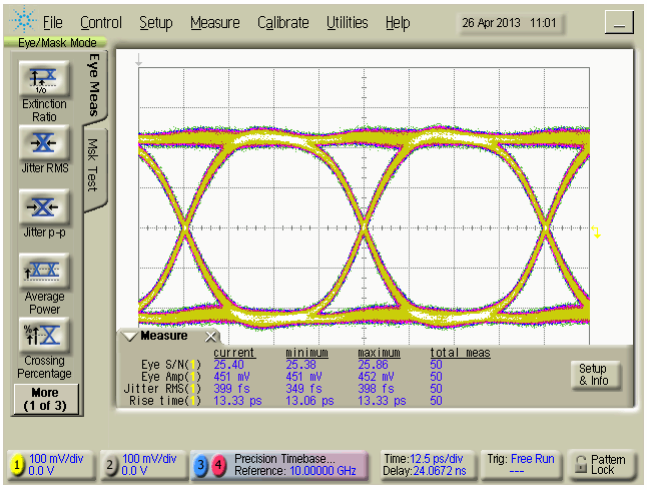
30 Gbps output eye at maximum output level



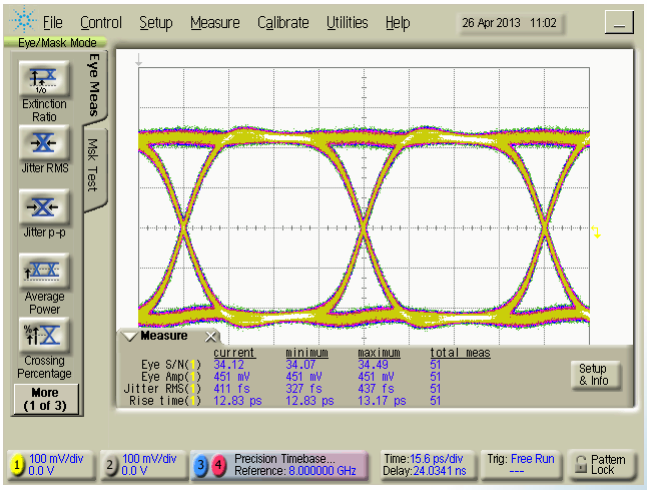
28 Gbps output eye at maximum output level



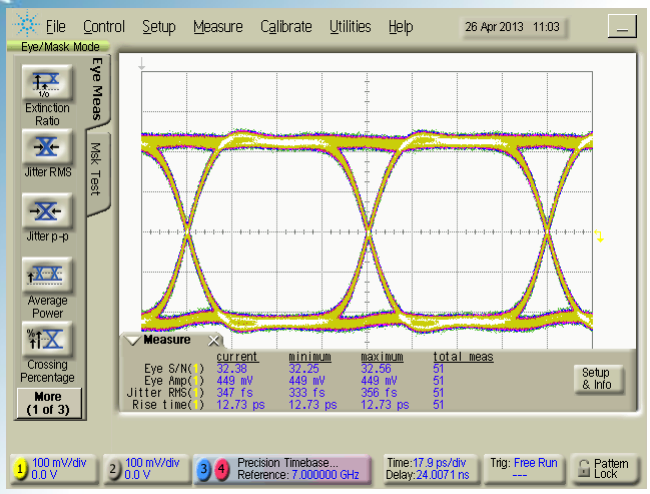
25 Gbps output eye at maximum output level



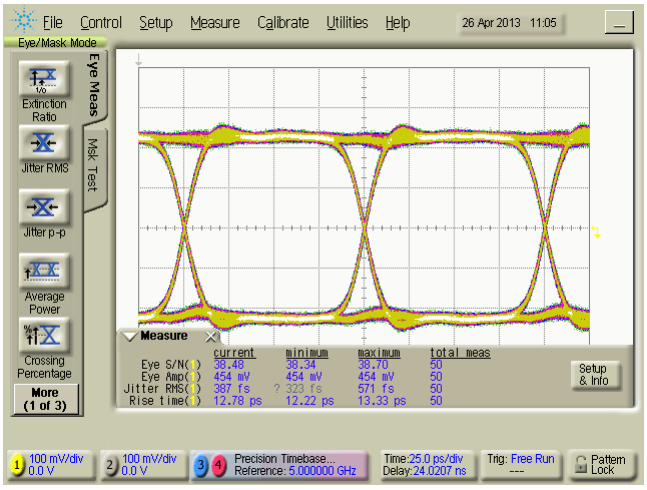
20 Gbps output eye at maximum output level



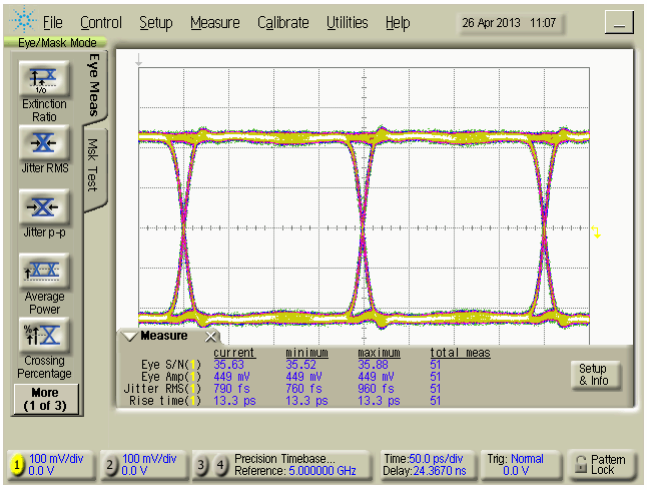
16 Gbps output eye at maximum output level



14 Gbps output eye at maximum output level

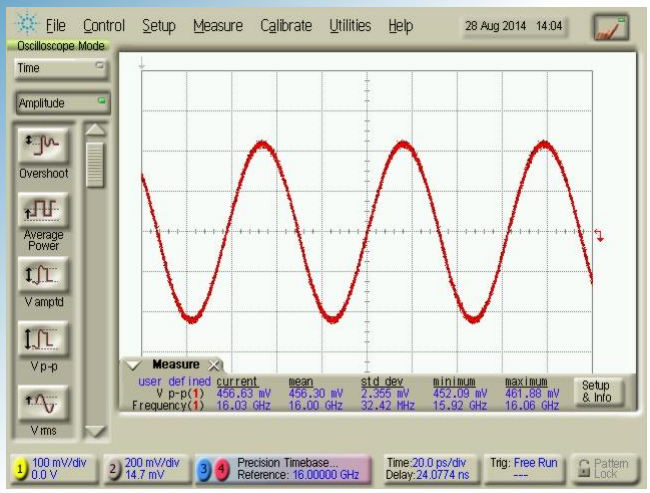


10 Gbps output eye at maximum output level

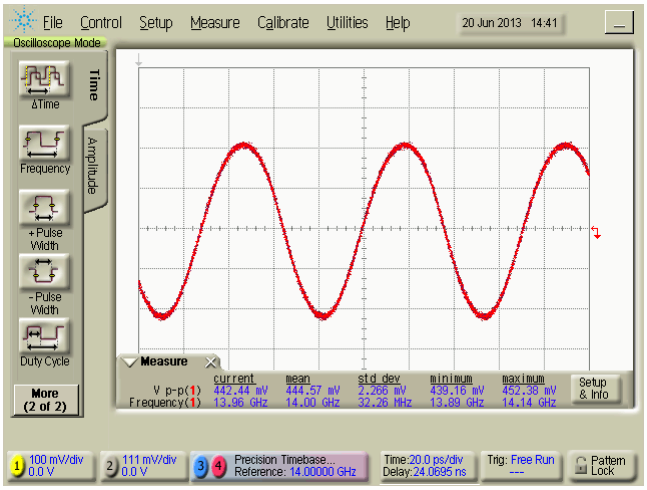


5 Gbps output eye at maximum output level

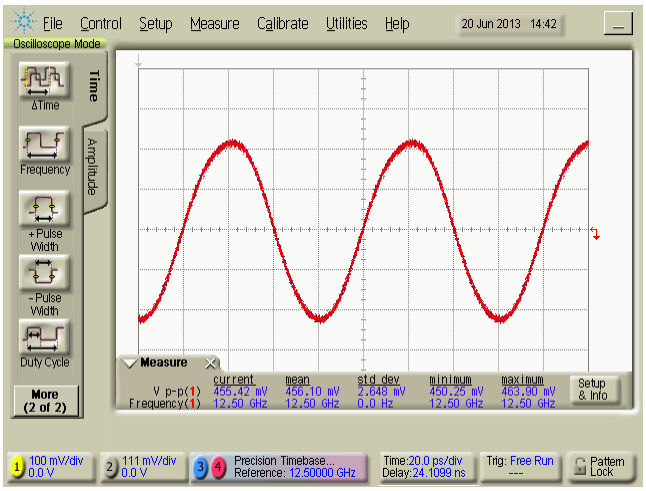
Clock/2 Output Signals



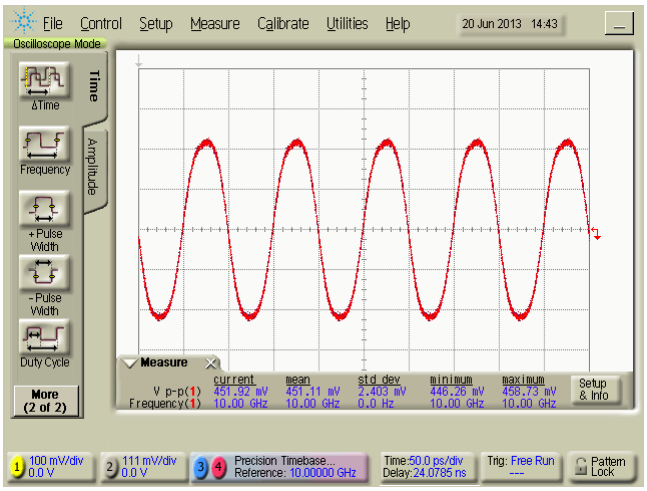
Clock/2 output signal @ 32 Gbps data rate



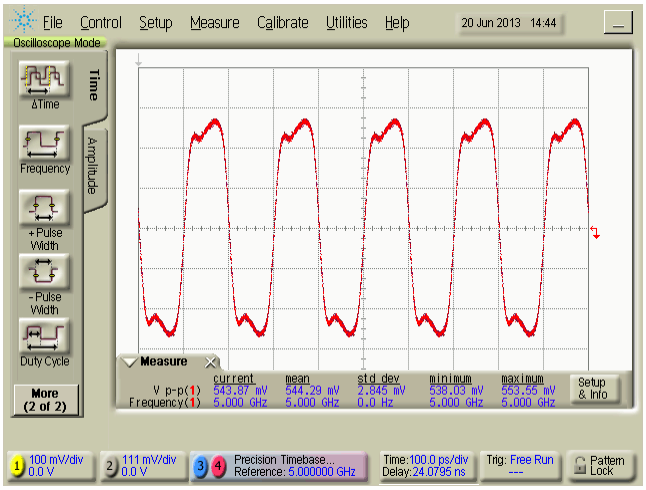
Clock/2 output signal @ 28 Gbps data rate



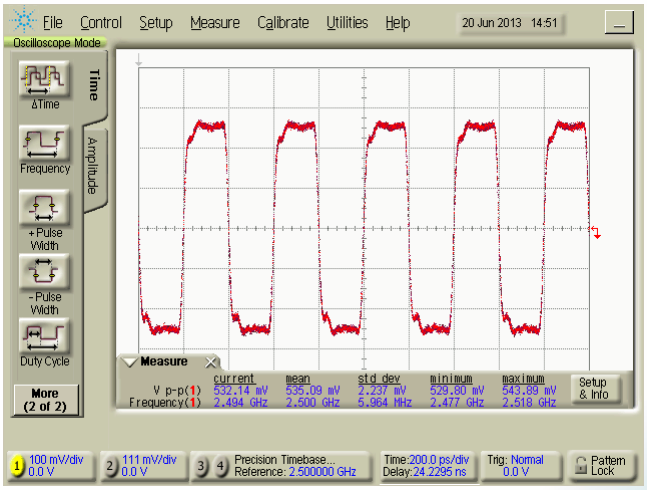
Clock/2 output signal @ 25 Gbps data rate



Clock/2 output signal @ 20 Gbps data rate

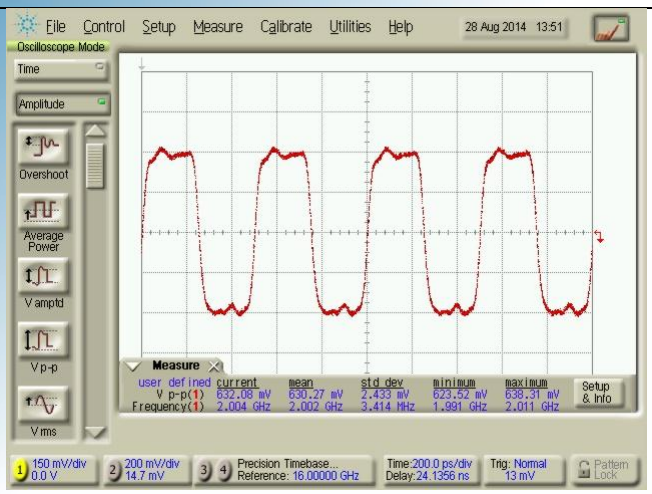


Clock/2 output signal @ 10 Gbps data rate

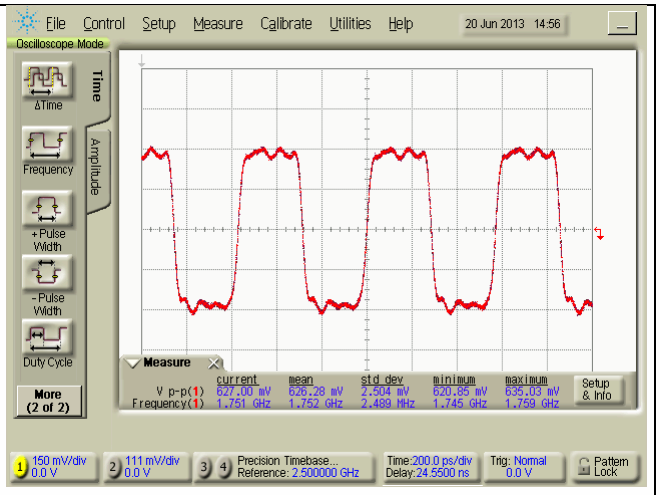


Clock/2 output signal @ 5 Gbps data rate

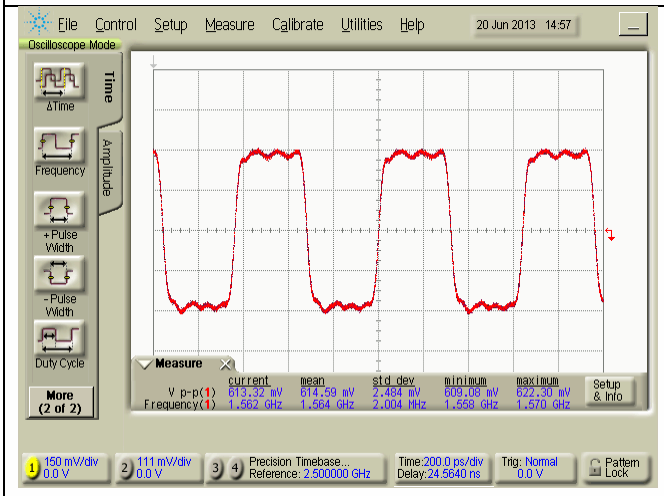
Clock/16 Output Signals



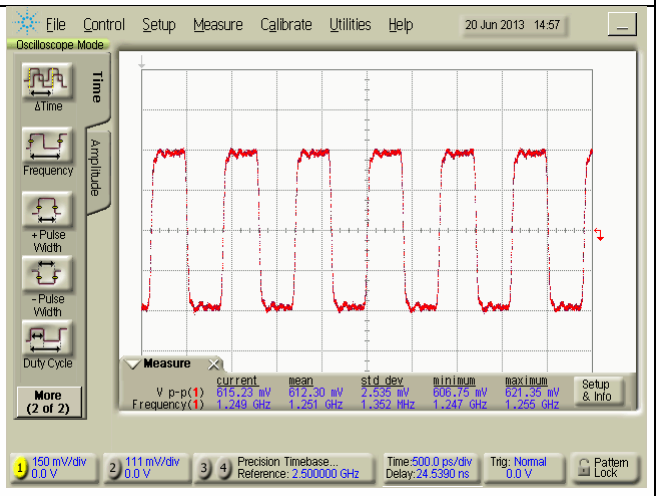
Clock/16 output signal @ 32 Gbps data rate



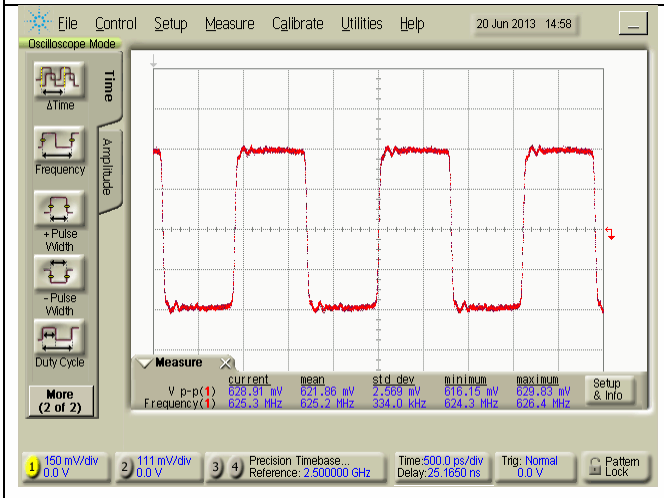
Clock/16 output signal @ 28 Gbps data rate



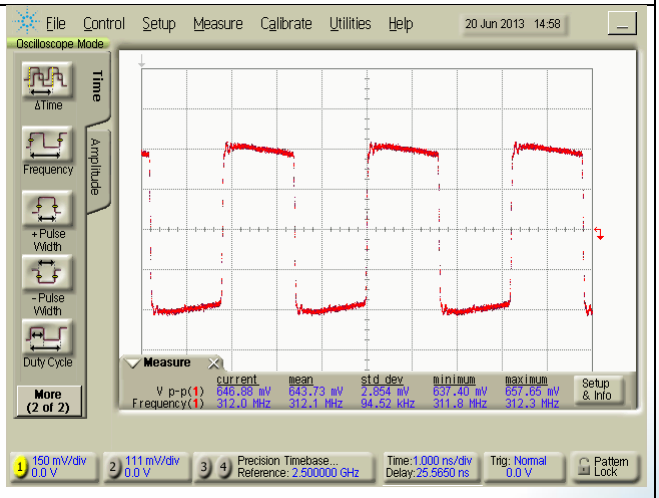
Clock/16 output signal @ 25 Gbps data rate



Clock/16 output signal @ 20 Gbps data rate

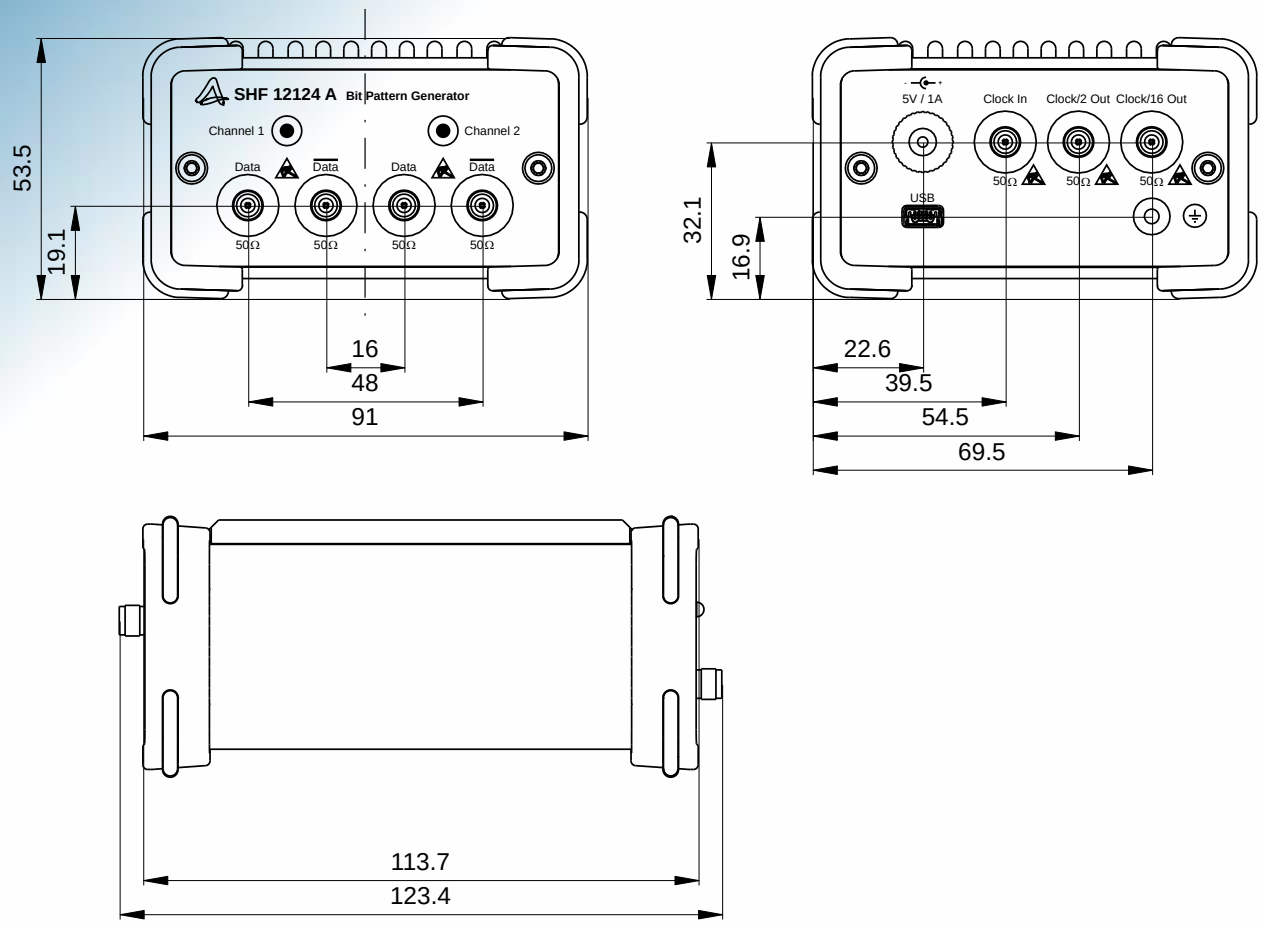


Clock/16 output signal @ 10 Gbps data rate



Clock/16 output signal @ 5 Gbps data rate

Outline Drawing



All dimensions are specified in millimeters (mm).