SHF
Signal Generation & Analysis

SHF has always pioneered the market for high-speed bit pattern generators (BPGs) or pulse pattern generators (PPGs). Now that PAM4 is the mainstream, SHF's remote head architecture provides the most flexible approach for 400G, 800G and 1.6T applications.

SHF 12106 A BPG with remote head

Remote Head Concept

The BPG is the base instrument for data generation. By simply extending the BPG with a small, lightweight, and field-replaceable remote head, different line rates and modulation schemes can be achieved. This makes the approach highly flexible and future-proof, as new remote heads released by SHF will continue to be compatible.

The SHF BPG and the SHF remote head are more than just two separate modules connected together. The complementary software package unifies them into virtually one instrument.

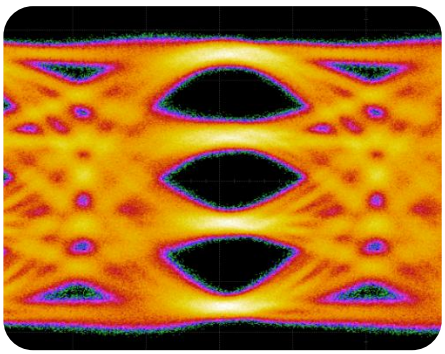
A few example configurations are outlined in the table below.

Basis Model	Remote Head	Available Options
SHF 12106 A **Pattern Generator**	---	Up to 4 NRZ channels per unit[1] (SHF 12106 A) Up to 64 Gbps per channel Built-in PRBS patterns and 8 Gbit user pattern per channel
	SHF C603 B **2:1 MUX**	Up to 128 Gbps per channel Built-in PRBS patterns and 16 Gbit user pattern per channel
	SHF C911 A **4-Bit DAC**	PAM4, PAM8 or PAM16 Up to 64 GBaud Built-in PRBS and PAM patterns (e.g., PRBS31Q) plus 8 GSamples/s user pattern per channel
	SHF 616 C **PAM-MUX**	Up to 128 GBaud PAM4 (256 Gbps) Built-in PRBS and PAM patterns (e.g., PRBS31Q) plus 8 GSamples/s user pattern per channel

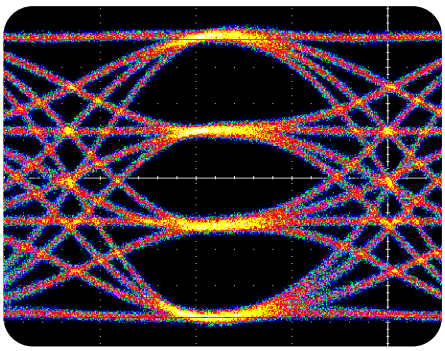
[1] Synchronization of multiple SHF 12106 A BPGs possible

BPG vs. AWG

High-speed signals are often generated by AWGs, but for NRZ or PAM data our BPG approach has significant advantages because parameters can be adjusted on the fly without waiting for the memory to be loaded. Very long patterns (e.g., PRBS 2^{31}-1 or PRBS31Q) can be generated instantly. Further, the remote heads can be placed very close to the DUT. The low weight even allows them to be placed on a wafer prober.



100 GBaud (200 Gbps)
from a *SHF 616 C* PAM-MUX



50 GBaud (100 Gbps)
from a *SHF C911 A* DAC

Clocked vs. Clock-Less Pre-Emphasis

The "classic" approach to pre-emphasis uses a DAC or an AWG with a vertical resolution higher than the signal payload requires. An example of such a "clocked" approach would be our SHF BPG extended with an SHF DAC.

While this remains a viable option, SHF adds a “clock-less” pre-emphasis method. This technique utilizes analog filters instead of individually weighted bits. The frequency response of these FIR filters can be automatically adjusted for optimal channel compensation.

The left image shows an 80 GBaud (160 Gbps) PAM4 signal degraded by a DUT.
The right image shows the same signal improved by equalization by the SHF C684 A FIR-Filter.

NRZ & PAM Error Analysis

The SHF 11104 A Error Analyzer (EA) or Error Detector (ED) can perform BER measurements on both binary and PAM4 signals. Using a three-pass approach, the instrument automatically searches to determine the optimal timing and threshold for the three PAM4 eyes. During the measurement, it successively samples and measures the three individual bit error ratios of each eye opening. While this three-pass measurement is taking place, the software calculates the total bit error ratio (BER).

SHF 11104 A EA extended with a SHF 11220 A PAM-Sampler

The SHF 11104 A Error Analyzer as a single instrument is capable to perform such BER measurement. Extended with a remote head, the upper baud rate limit is raised.

Base Model	Remote Head	Available Options
SHF 11104 A **Error Analyzer**	---	Up to 64 Gbps NRZ per channel Up to 32 GBaud PAM4 (64 Gbps) per channel
	SHF 11221 A **1:2 DEMUX**	Up to 128 Gbps NRZ per channel
	SHF 11220 A **PAM-Sampler**	Up to 58 GBaud PAM4 (116 Gbps) per channel

Find out more about our pattern generation and error analysis instruments by scanning the QR Code below.

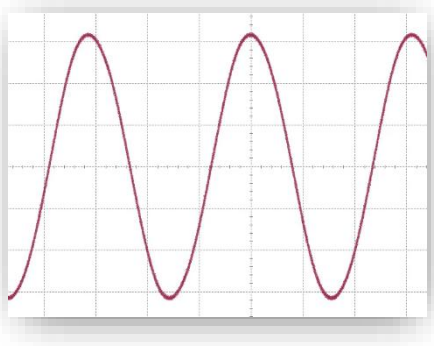
Synthesized Signal Generation

NEW: Up to 80 GHz
➲ Excellent harmonics suppression & phase noise

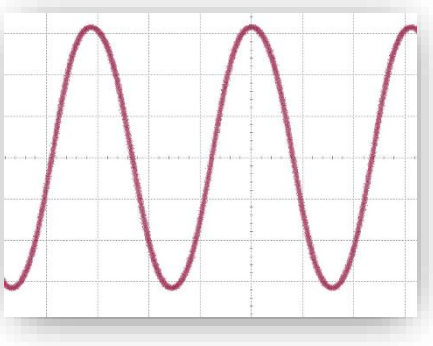
In digital high-speed test and measurement set ups with or without afore outlined SHF BPGs and EAs, a perfect clock signal is crucial for the generation of low jitter reference test signals. An SHF Synthesized Signal Generator (Synthesizer) used as a clock source can operate over several decades of frequency.

P/N	Description
SHF 78124 A | 32 Synthesizer	Output signals from 1… 32.8 GHz
SHF 78124 A | 64 Synthesizer	Output signals from 1… 64.0 GHz
SHF 78125 A | 67 Synthesizer	Output signals from 1… 67.0 GHz
SHF 78125 A | 80 Synthesizer	Output signals from 1… 80.0 GHz

In contrast to other high-speed signal generators SHF synthesizers focus on the generation of CW signals only which enables us to offer the most cost-effective solutions in this frequency range. The high purity and fidelity could be achieved by waiving potentially not required components and capabilities (like e.g., signal modulation or complex signal sweeps).



20 GHz from a SHF 78125 A



60 GHz from a SHF 78125 A

If other frequencies, more outputs or phase shifts are required, there is a wide variety of matching clock distributions, phase shifters, frequency dividers & multipliers to provide the signal exactly as needed in the setup. Find out more about these modules and our synthesizers by scanning the QR Code below.