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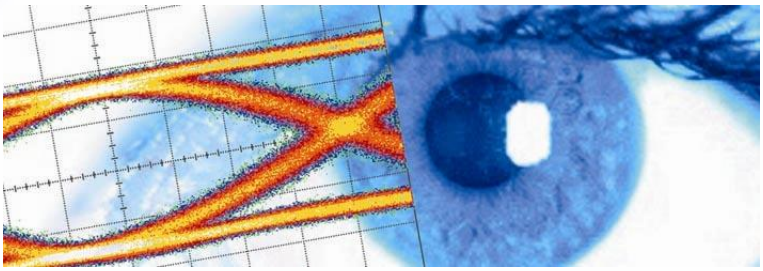
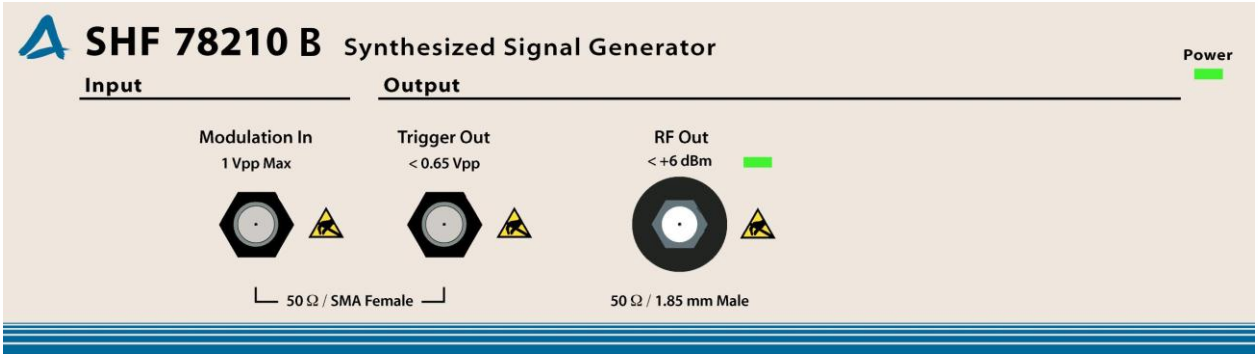


# Datasheet

# SHF 78210 B

## Synthesized Signal Generator



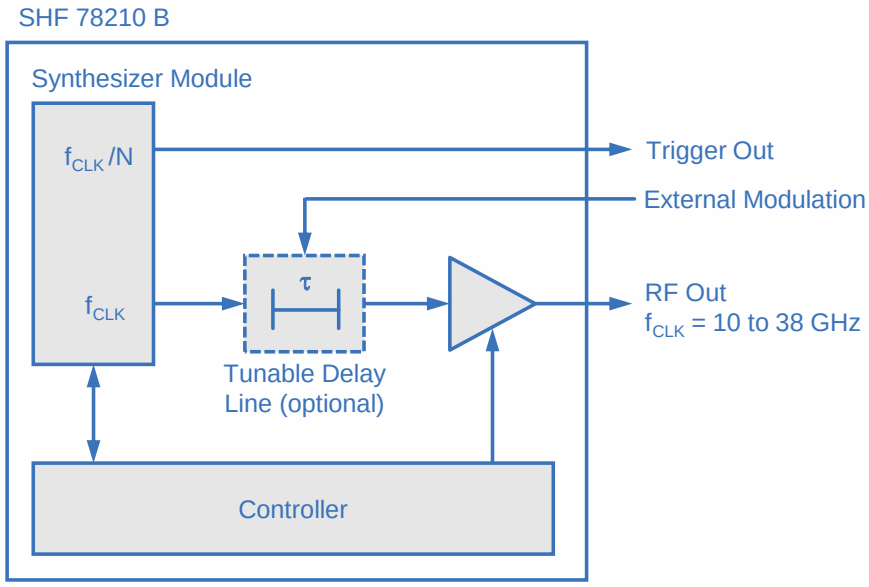
# Description

The Synthesized Signal Generator SHF 78210 B was developed to provide our BERT system customers with a suitable internal clock source for their 100G Ethernet test applications, at reasonable cost. With a frequency range from 10 GHz to 38 GHz all bit rates of interest are covered. The output power can be varied between -3 dBm and +4 dBm in 0.1 dB steps.

For trigger purposes, the SHF 78210 B provides a trigger signal at a quarter or half of the RF output frequency.

Optionally, jitter injection functionality can be added to the signal generator module. Arbitrary jitter types may be applied to the clock signal using an external signal source, enabling various test scenarios such as serial data protocol compliance testing.

# Block Diagram




# Features

- Output clock frequency ranges from $f_{CLK}$ = 10 to 38 GHz
- Output power adjustable from -3 to +4 dBm in 0.1 dB steps with an accuracy better than 0.1 dB
- Computer controlled
- Integrates seamlessly in the SHF BERT system hardware and software environment
- Operated using the BERT Control Center GUI running on a PC

# Options

- Option J1: Jitter Injection

  Enables injection of arbitrary jitter types by applying an external modulation signal up to 1 GHz bandwidth with a maximum jitter amplitude of 90 ps peak-to-peak. A jitter-free trigger signal is available for measurement and calibration purposes.

- Option T2 or T4: Trigger Frequency, refer to Table 1

  The trigger signal is derived from the clock signal whose frequency is divided by an integer N depending on the chosen trigger option and the frequency range. Refer to Table 1 to determine the value of N.

  Note that the trigger remains jitter-free even if jitter injection is enabled.

**Table 1: Value of the trigger frequency divider N**

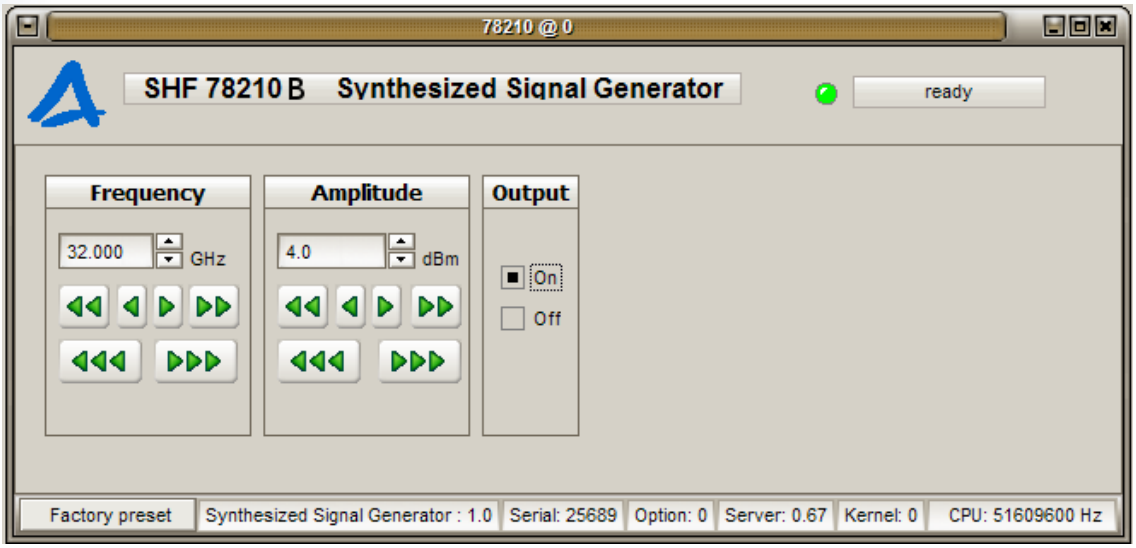
| Clock Frequency Range | Option T2 | Option T4 |
|---|---|---|
| 10 – 18.75 GHz | N=1 | N=2 |
| 18.75 – 38 GHz | N=2 | N=4 |

# Specifications – SHF 78210 B

| Parameter | Unit | Min. | Typ. | Max. | Comment |
|---|---|---|---|---|---|
| **Clock Output (RF Out)** | | | | | |
| Operating Frequency | GHz | 10 | | 38 | $f_{CLK}$ |
| Frequency Resolution | MHz | | 1 | | |
| Output Power Level | dBm | -3 | | +4 | 1.85 mm (V) male |
| Spurious Signals | dBc | | | -20 | |
| SSB Phase Noise | dBc/Hz | | tbd | | |
| Intrinsic Jitter (RMS) | fs | | | 400 | Scope measurement not deconvoluted |
| **Trigger Out** | | | | | |
| Frequency (Option T2) | GHz | 10 | | 16 | Refer to Table 1 |
| Frequency (Option T4) | GHz | 5 | | 8 | Refer to Table 1 |
| Output Amplitude | mVpp | 300 | | 650 | SMA female |
| **Jitter Injection (Option J1)** | | | | | |
| Modulation Bandwidth | MHz | 0.1 | | 1000 | |
| External Modulation Amplitude | mVpp | 0 | | 1000 | SMA female |
| Jitter Amplitude | ps | 0 | | 90 | Peak-to-peak |

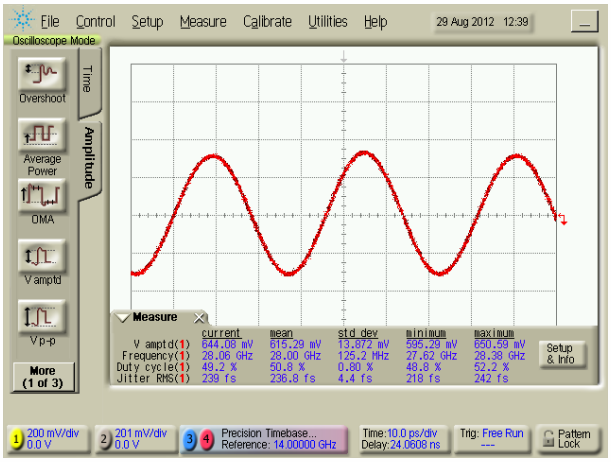
| General | | | | | |
|---|---|---|---|---|---|
| Weight | kg | | 3.3 | | |
| Dimensions | mm | | 59x213x 450 | | w/o Front Panel Connector |
| Power Consumption | W | | 12 | | |
| Operating Temperature | °C | 10 | | 35 | |

# Graphical User Interface

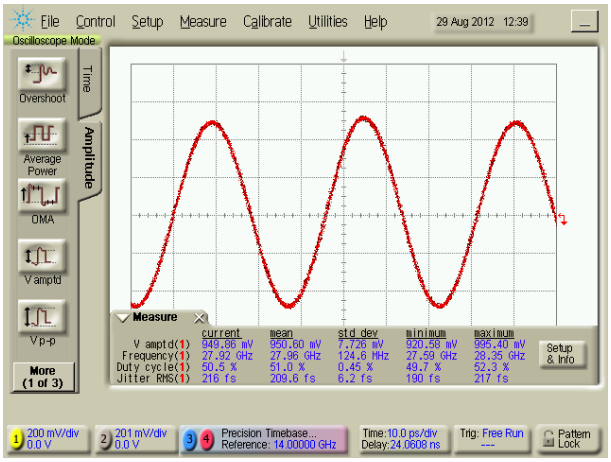



# Typical Output Signal Waveforms

**Clock Signal at $f_{CLK}$ = 28 GHz**

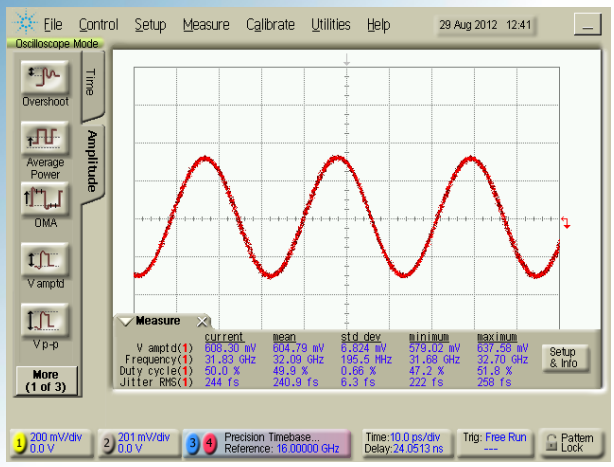



**$P_{out}$ = 0 dBm**

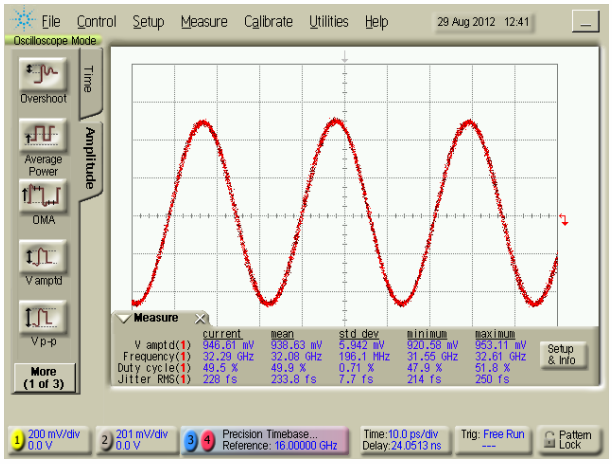



**$P_{out}$ = +4 dBm**

**Clock Signal at $f_{CLK}$ = 32 GHz**




**$P_{out}$ = 0 dBm**




**$P_{out}$ = +4 dBm**

# Jitter Injection Option

The SHF 78210 B jitter injection feature is designed to apply arbitrary jitter modulation to the high-speed clock signal. Jitter is injected by connecting a signal source such as an arbitrary waveform generator to the external modulation input. Internally, the time delay of a tunable delay line is modulated. The maximum jitter amplitude is 90 ps peak-to-peak with a modulation bandwidth of up to 1 GHz. As an example, the jitter amplitude of 90 ps corresponds to a relative jitter amplitude of 2.5 unit intervals (UI) at a bitrate of 28 Gbit/s.

The specifications of the external signal source are given in the table below for sinusoidal jitter injection. Depending on the user's jitter injection requirements, an arbitrary waveform generator may be used for maximum flexibility of the available jitter types. Several examples of jittered clock waveforms using an arbitrary waveform generator are shown in the next section.

**Recommended Minimum Specifications of the External Signal Source Required for Injection of Sinusoidal Jitter**

| Parameter | Unit | Min. | Typ. | Max. |
|---|---|---|---|---|
| Frequency Range | MHz | 0.1 | | 1000 |
| Amplitude | mVpp | 0 | | 1000 |
| Connector Type | | | SMA | |

For jitter calibration purposes, the trigger signal of the SHF 78210 B remains jitter-free even if jitter injection is applied to the RF out signal.

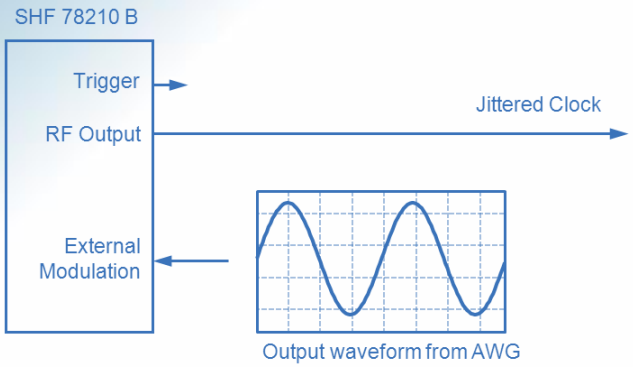
In combination with the SHF bit pattern generator series 1210X A, the SHF 78210 B including the jitter injection feature enables a complete test solution for jitter tolerance tests as required by many telecommunication standards such as 100G Ethernet and 40 GBit/s OTN, FibreChannel, InfiniBand®, PCI Express®, and Serial ATA. For further details please refer to the SHF application note „Jitter Injection using the Multi- Channel BPG", available online at www.shf.de.

® *InfiniBand* is a registered trademark of the InfiniBand Trade Association. *PCI Express* is a registered trademark of Peripheral Component Interconnect Special Interest Group (PCI-SIG).

# Typical Jittered Signal Waveforms

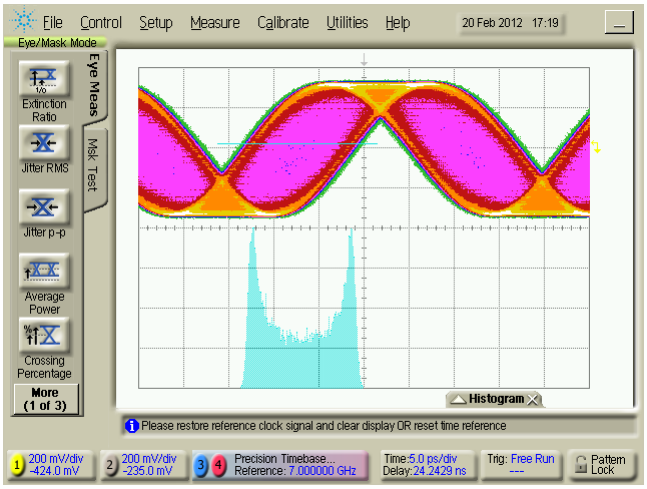
The external modulation input can be driven by a function generator such as the Agilent 332XX family of function / arbitrary waveform generators (AWG). The waveform characteristics of the AWG determine the jitter type of the SHF 78210 B.

### Sine Wave on Modulation Input



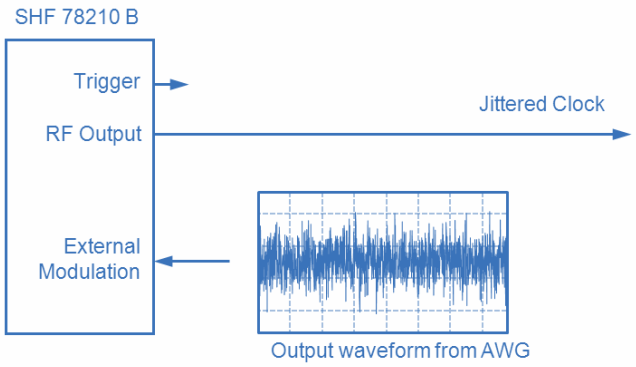

AWG Setting

| | |
|---|---|
| Waveform | Sine wave |
| Frequency | 100 kHz |
| Amplitude | 70 mVpp |



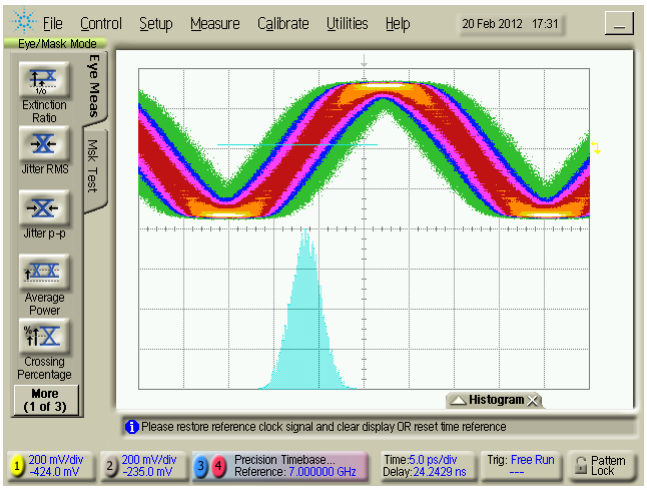

Sinusoidal jitter on 28 GHz clock,
jitter amplitude 11 ps peak-to-peak

### Gaussian-Distributed Noise on Modulation Input



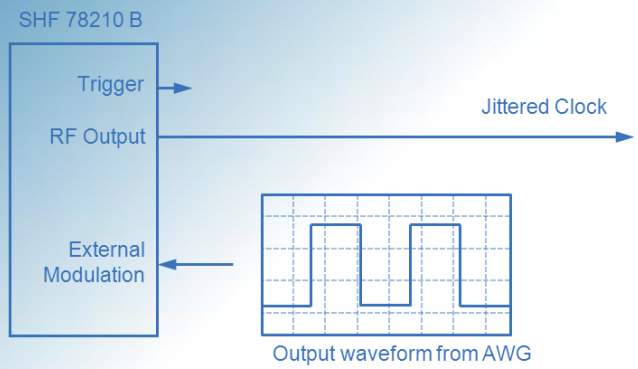

AWG Setting

| | |
|---|---|
| Waveform | Noise |
| Amplitude | 70 mVpp |

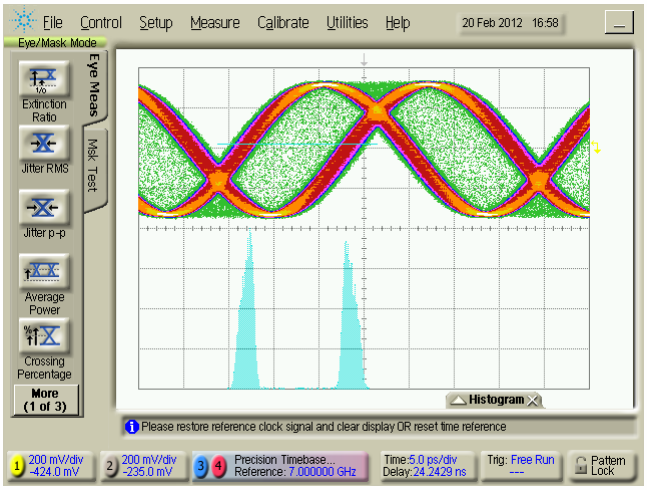



Random jitter on 28 GHz clock,
jitter amplitude 1.7 ps rms

## Square Waveform on Modulation Input




| AWG Setting | |
|---|---|
| Waveform | Square |
| Frequency | 100 kHz |
| Amplitude | 70 mVpp |




Peak-to-peak jitter on 28 GHz clock,
jitter amplitude 11 ps peak-to-peak

As an example, the following diagram shows the peak-to-peak jitter amplitude in ps versus the modulation signal amplitude in mVpp for the special case of sinusoidal jitter of 100 kHz frequency modulated onto a 28 GHz clock using a function generator of the Agilent 332XX family. Note the hatched area which indicates a relative jitter amplitude of more than 1 UI (~36 ps). The jitter measurement in this case was limited by the sampling oscilloscope which shows a completely closed eye for jitter amplitudes larger than 1 UI.