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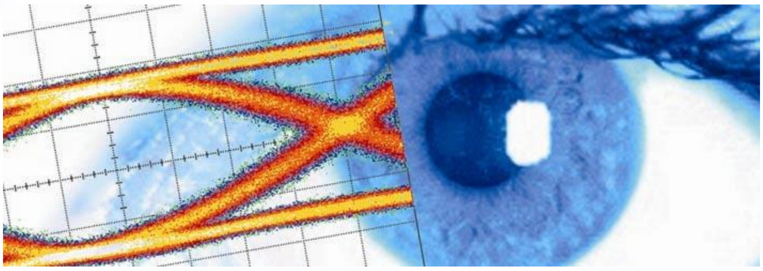


Datasheet

SHF 78120 A

Synthesized Clock Generator

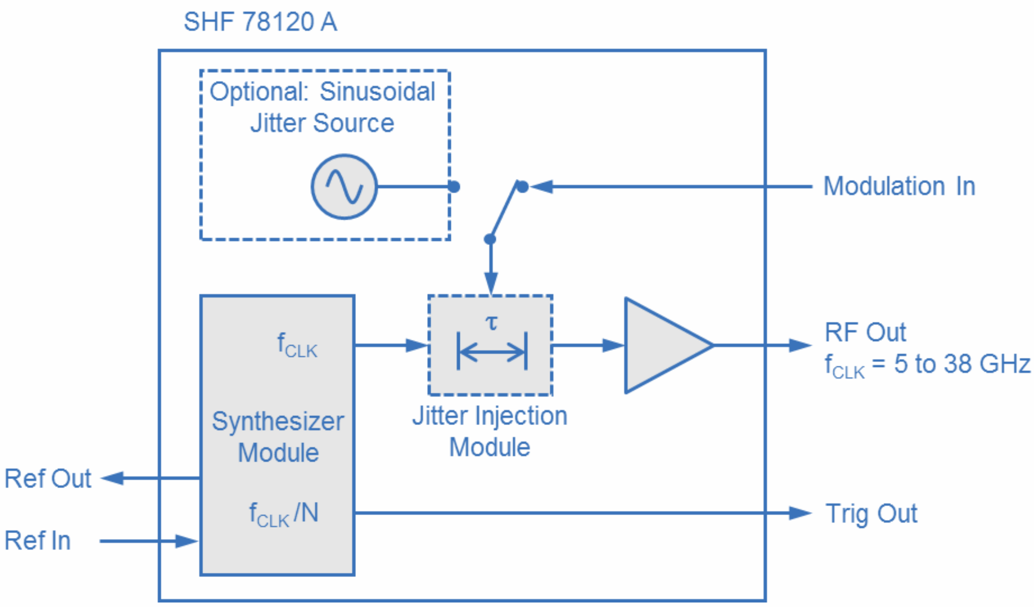
Description

The Synthesized Clock Generator SHF 78120 A is designed to provide our BERT customers with a standalone compact clock source featuring a wide frequency coverage **from 5 to 38 GHz**, high output power up to **+8 dBm**, low jitter and low harmonic levels. In combination with the SHF 12124 A Bit Pattern Generator and the SHF 11125 A Error Analyzer, it provides a compact and affordable high-speed test solution.

The **jitter injection functionality** is integrated for jitter stress test applications. 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. An optional internal jitter source provides sinusoidal jitter from 10 to 400 MHz with variable jitter amplitude.

An additional **trigger output** provides a trigger signal whose frequency can be switched to a quarter or half the output frequency. The trigger remains jitter-free even if jitter injection is used.

Block Diagram



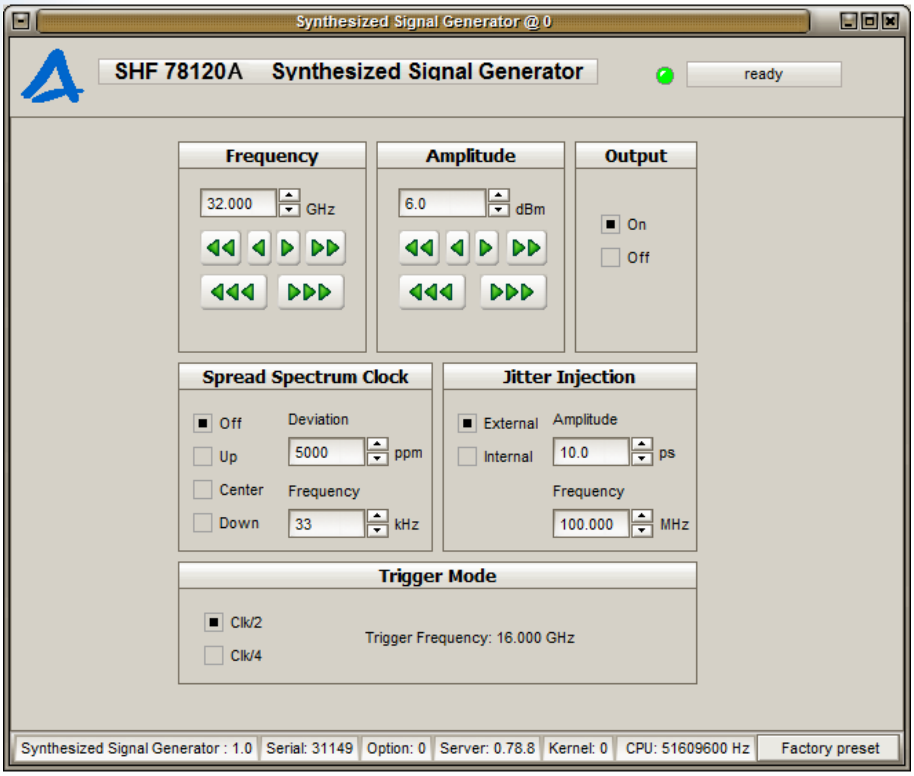
Features

- Output clock frequency ranges from f_{CLK} = 5 to 38 GHz with 1 MHz resolution
- Output power adjustable from -10 to +8 dBm with 0.1 dB resolution
- External jitter modulation
- Supports three spread-spectrum clocking (SSC) modes
- 10 MHz reference input and output for phase locking to other instruments
- Remote programming interface for automated measurements
- Ethernet connection
- Compact size and low power consumption

Ease of Use

The SHF 78120 A is controlled over a standard Ethernet connection by an external computer (not part of the delivery). Every system comes along with the intuitive, easy to use BERT Control Center software (BCC). The BCC provides the user friendly interface for changing the device parameters.

Additionally, the instrument may be programmed remotely over the Ethernet connection for automated tests and measurements. Please refer to the *SHF BERT Programming Manual*.



Graphical User Interface

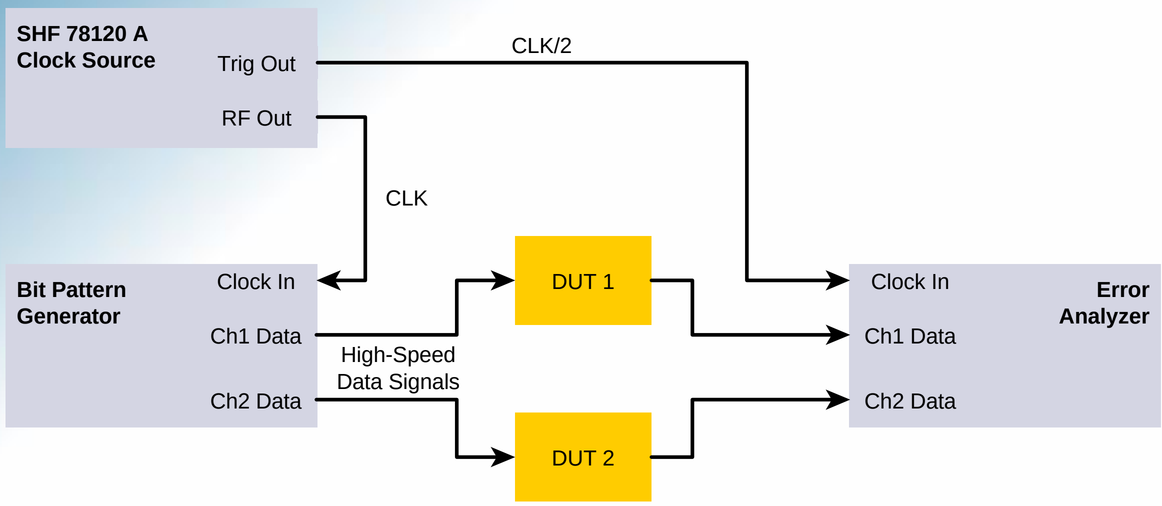
Options

Option ISJ: Internal Sinusoidal Jitter Source

Several data communication standards require jitter tolerance and jitter transfer testing for sinusoidal jitter over a specified jitter frequency range. The optional internal sinusoidal jitter source allows stress tests for jitter frequencies ranging from 10 to 400 MHz. Jitter amplitudes up to 70 ps may be generated. The jitter amplitude is calibrated depending on the jitter frequency and on the clock frequency.

It is enabled using the BCC GUI setting for internal jitter injection.

Applications



Typical Multi-Channel Test Setup

Specifications – SHF 78120 A

Parameter	Symbol	Unit	Min.	Typ.	Max.	Comment
Clock Output (RF Out)						
Operating Frequency	f_{CLK}	GHz	5		38	
Frequency Resolution		MHz		1		
Frequency Accuracy					10^{-5}	Using internal reference
Frequency Stability			10^{-6}		10^{-5}	Ambient temperature 21°C
Frequency Stability Aging		ppm			<1	
Output Power Level	P_{out}	dBm	-10		+8	
Output Power Resolution		dB			0.1	
Output Power Accuracy		dB			1	
Spurious Signals		dBc			-20	
Phase Noise		dBc/Hz		tbd		
Jitter (RMS)	J_{RMS}	fs			400	On scope display (not deconvolved)[1]
Connector						2.92 mm (K) female

[1] Measured with Agilent 86100A, 70 GHz sampling head and precision time base triggered by clock signal from RF Out.

Parameter	Symbol	Unit	Min.	Typ.	Max.	Comment
Trigger Out						
Frequency		GHz	1.25		19	
Output Amplitude		mVpp	400		700	
Connector						2.92 mm (K) female

***Option ISJ*: Internal Sinusoidal Jitter Injection**						
Jitter Frequency		MHz	10		400	
Jitter Amplitude		ps	0		70	

External Jitter Injection						
Modulation Bandwidth		MHz	0.1		1000	
Modulation Amplitude		mVpp	0		1200	Maximum corresponds to 70 ps jitter.
Jitter Amplitude		ps	0		70	Peak-to-peak
Connector						2.92 mm (K) female

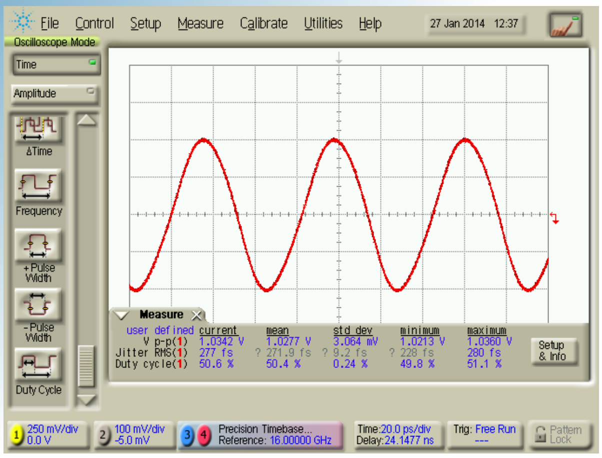
Spread Spectrum Clocking						
Modulation Frequency		Hz	10		100 k	
Deviation		ppm	0		20,000	Up/down/center

Ref In						
Reference Frequency	f_{ref}	MHz		10		
Amplitude		Vpp			3.3	
Connector						SMA female

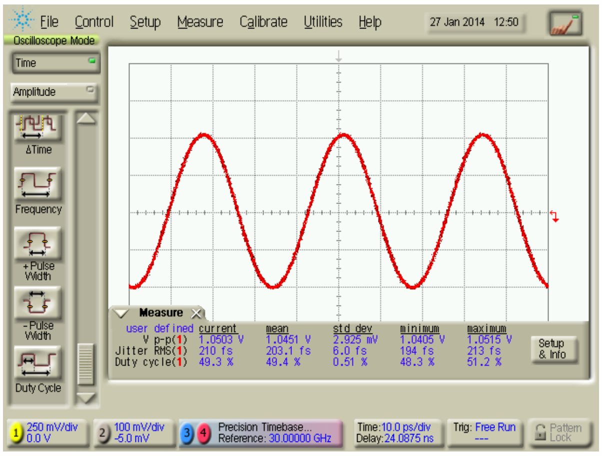
Ref Out						
Reference Frequency		MHz		10		
Amplitude		Vpp	tbd	0.8		
Connector						SMA female

General						
Power Consumption		W			25	+12V switching power supply is included
Weight		Kg				
Operating Temperature		°C	10		35	Ambient temperature

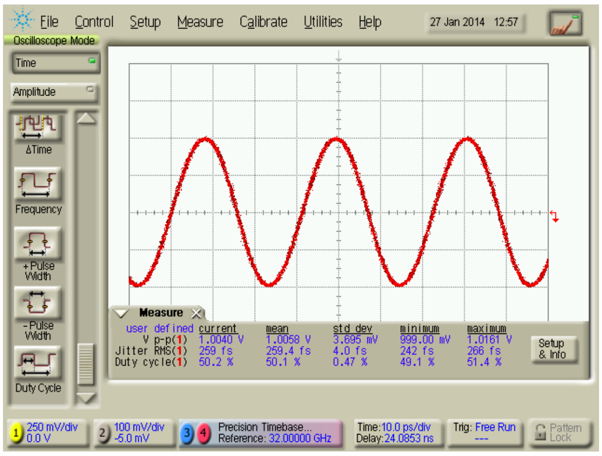
Typical Output Signal Waveforms



Clock Signal at f_{CLK} = 16 GHz, P_{out} = +4 dBm



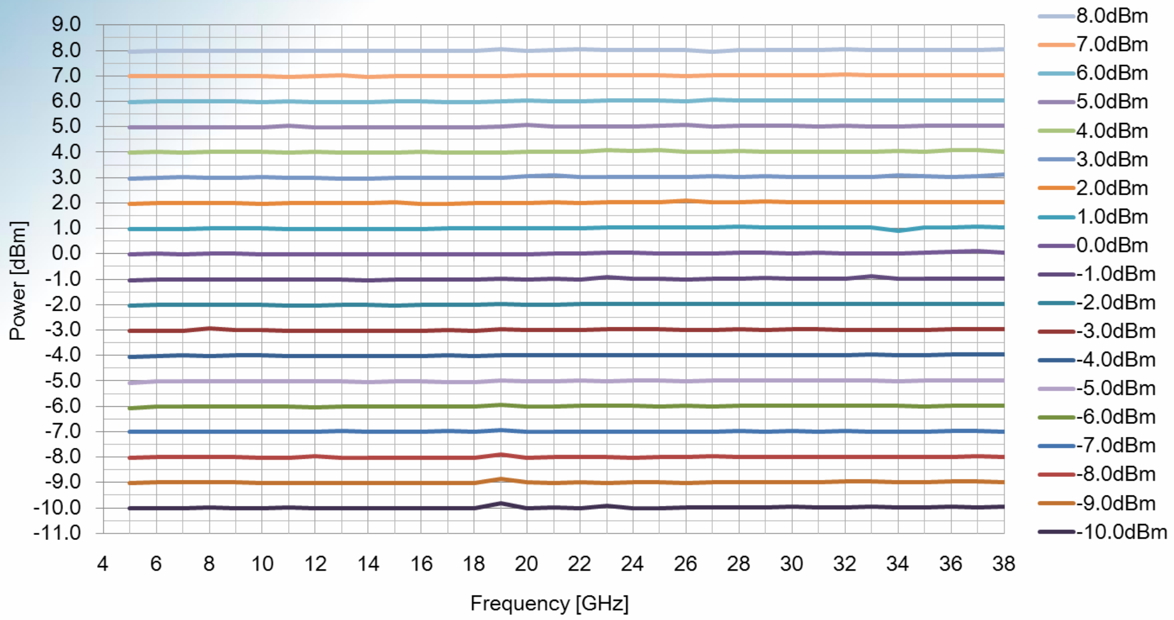
Clock Signal at f_{CLK} = 30 GHz, P_{out} = +4 dBm



Clock Signal at f_{CLK} = 32 GHz, P_{out} = +4 dBm

Output Amplitude

The following diagram shows typical amplitude measurement results using a power meter directly on the RF Out port for power settings from -10 to +8 dBm.



External Jitter Injection

For additional flexibility, arbitrary jitter modulation may be applied 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. The maximum jitter amplitude is 70 ps peak-to-peak with a modulation bandwidth of up to 1 GHz. As an example, the jitter amplitude of 70 ps corresponds to a relative jitter amplitude of 2.2 unit intervals (UI) at a bit rate of 32 Gbit/s.

The jitter amplitude is calibrated using the Trig Out trigger signal of the SHF 78120 A which remains jitter-free even if jitter injection is used.

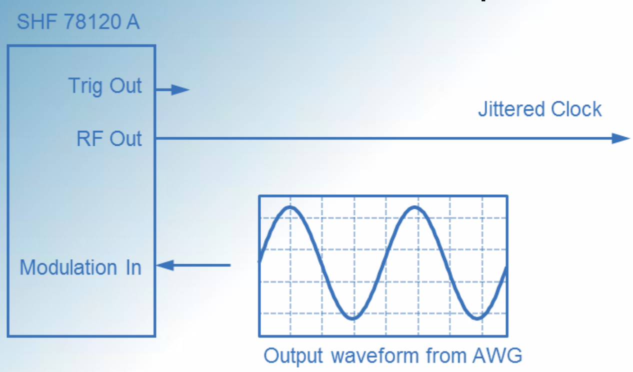
In combination with an SHF Bit Pattern Generator and an Error Analyzer, the SHF 78120 A enables a complete test solution for jitter tolerance tests as required by many telecommunication standards such as 100G Ethernet and 40 GBit/s OTN, FibreChannel, InfiniBand®, PCI Express®, and Serial ATA. For further details please refer to the SHF application note „Jitter Injection using the Multi- Channel BPG“, available online at www.shf.de.

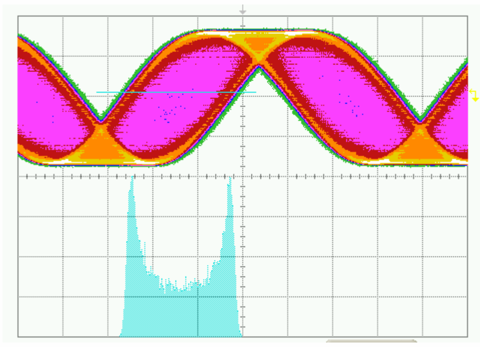
Typical Jittered Signal Waveforms

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 78120 A.

® *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).

Sine Wave on Modulation Input



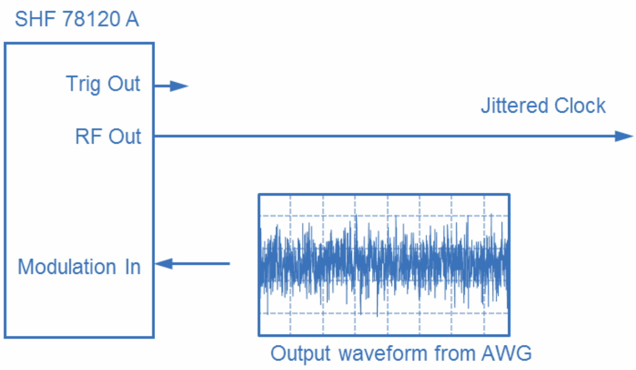


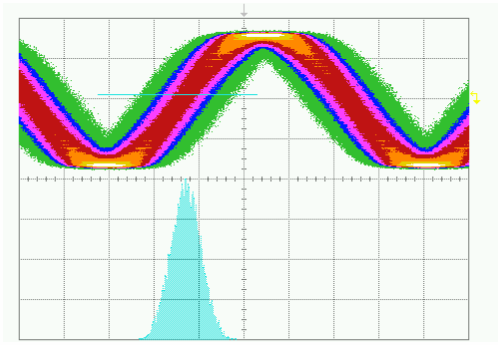
Sinusoidal jitter on 28 GHz clock, jitter amplitude 11 ps peak-to-peak.

AWG Setting

Waveform	Sine wave
Frequency	100 kHz
Amplitude	70 mVpp

Gaussian-Distributed Noise on Modulation Input



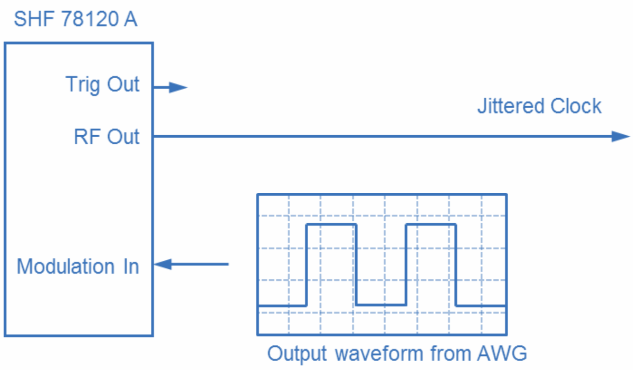


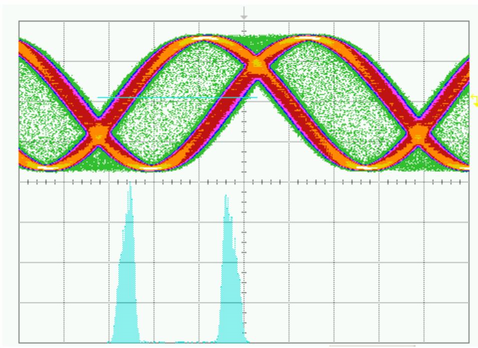
Random jitter on 28 GHz clock, jitter amplitude 1.7 ps rms.

AWG Setting

Waveform	Noise
Amplitude	70 mVpp

Square Waveform on Modulation Input





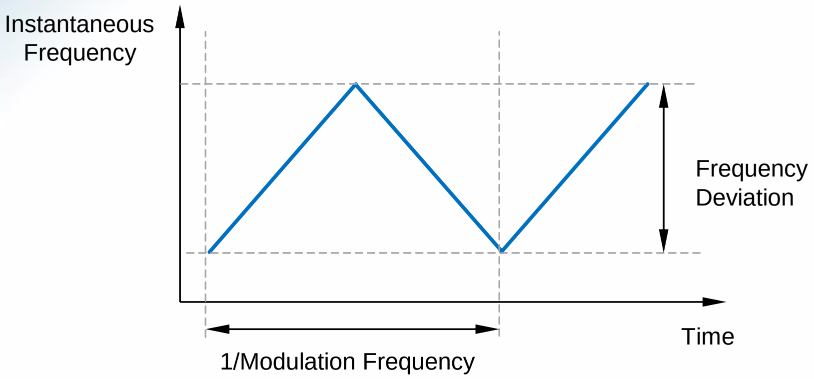
Peak-to-peak jitter on 28 GHz clock, jitter amplitude 11 ps peak-to-peak.

AWG Setting

Waveform	Square
Frequency	100 kHz
Amplitude	70 mVpp

Spread Spectrum Clocking

To meet the regulatory demands of electromagnetic interference several high-speed bus systems use a spread spectrum clocking (SSC) method. When SSC is enabled, the instantaneous frequency of the clock signal varies periodically with time by a small amount, i.e. the clock signal is frequency-modulated. The figure below illustrates the SSC frequency modulation with a triangular shape.



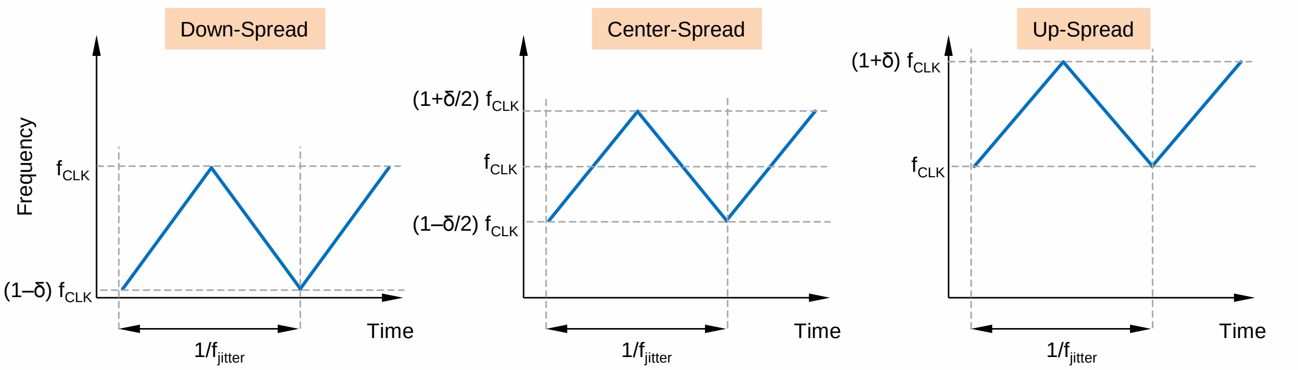
The principle of SSC is the periodic frequency modulation of a clock signal.

The key SSC parameters are the following:

- f_{CLK} original clock frequency without SSC
- δ relative frequency deviation (often given in percent or ppm, parts per million)
- f_{jitter} modulation frequency.

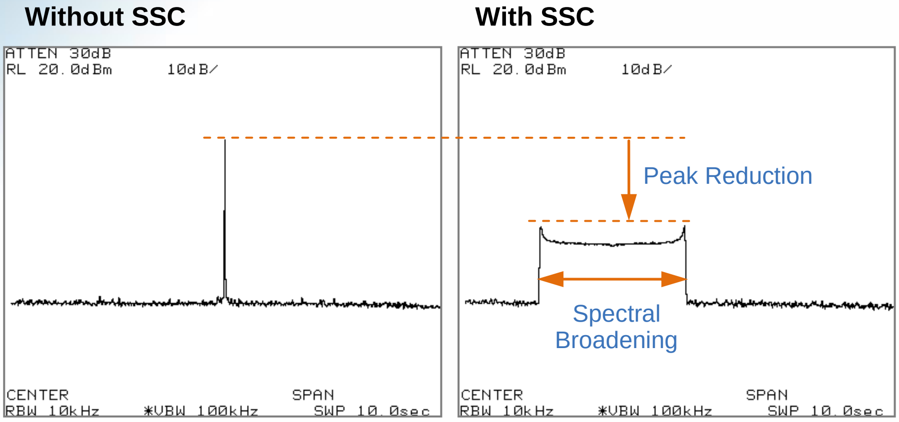
The parameters are directly accessible in the BERT Control Center software GUI or through remote programming.

Depending on the relative position of the clock frequency and the frequency deviation, SSC can be classified into three types: down, center, and up-spread. The figure below illustrates the three configurations.



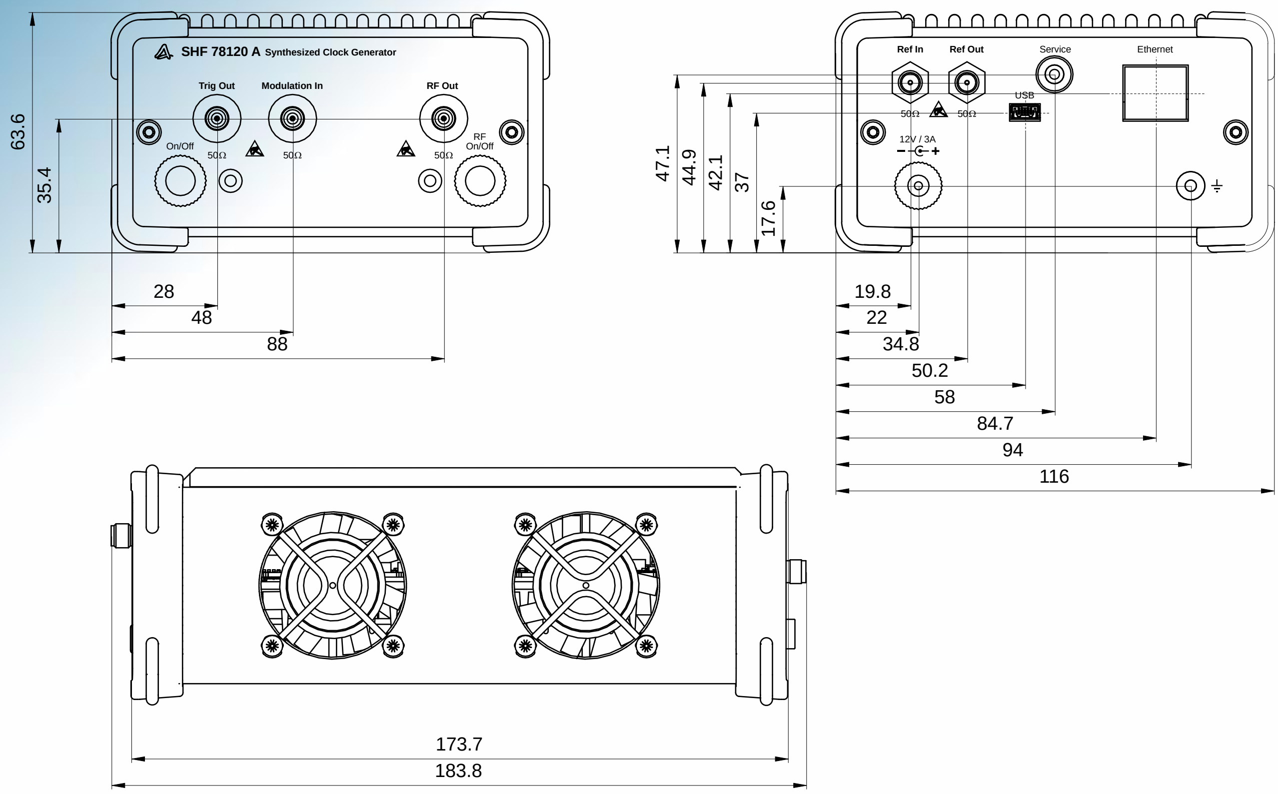
Three types of SSC.

SSC, effectively, broadens the spectral peak of a clock signal so that the maximum of the power spectral density is reduced leading to less radiated emission. This is illustrated in the following spectra measured at the output of the SHF 78120A for a 25 GHz clock with 30 kHz modulation frequency and 0.5% deviation. Note that SSC does not reduce the total signal power of the clock. Rather, it redistributes the clock's spectral components as shown in the figure below.



SHF 78120 A clock spectrum with and without SSC.

Outline Drawing



All dimensions are specified in millimeters (mm).

Input/Output Connectors

Connector Name	Description
RF Out	Clock output
Trig Out	Trigger output
Modulation In	External jitter modulation input
Ref In	External 10 MHz reference input
Ref Out	10 MHz reference output
Ethernet	Ethernet connection
Service	Service connector – **Do not connect**
USB	USB socket – **Do not connect**