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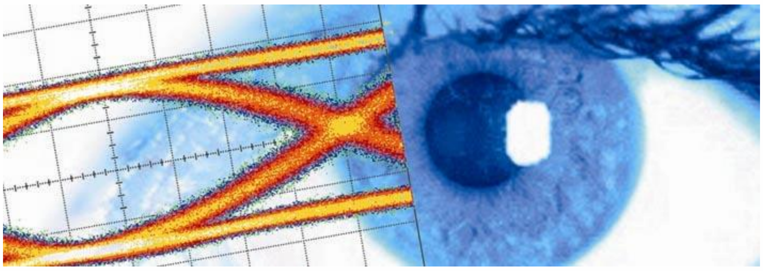
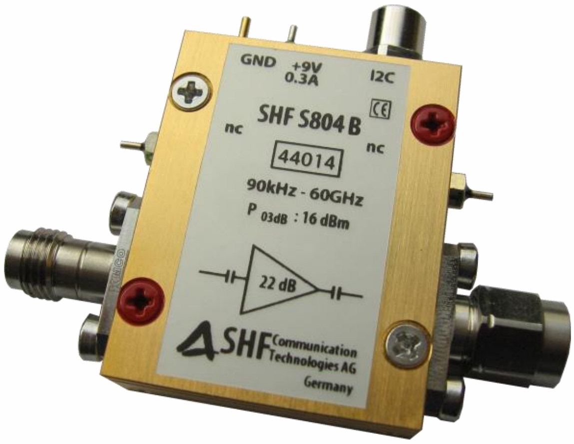


Datasheet

SHF S804 B

Linear Broadband Amplifier



Description

The SHF S804 B ultra-linear broadband amplifier is the RoHS compliant successor of the popular SHF S804 A. The SHF S804 B is well suited as a receiver amplifier for high speed NRZ and PAM-4 applications. Additionally, the 12 dBm (2.5 V) P1dB of the amplifier also makes it well suited as a linear driver for high speed EA modulators, as well as VCSELs and DFB lasers where the drive requirement is lower than that typically required for MZ modulators.

The S804 B is a two-stage amplifier design, using proprietary monolithic microwave integrated circuits (MMICs) inside special carriers to achieve ultra-wide bandwidth and low noise performance. An internal voltage regulation protects the amplifier against accidental reverse voltage connection and makes it robust against line voltage ripple.

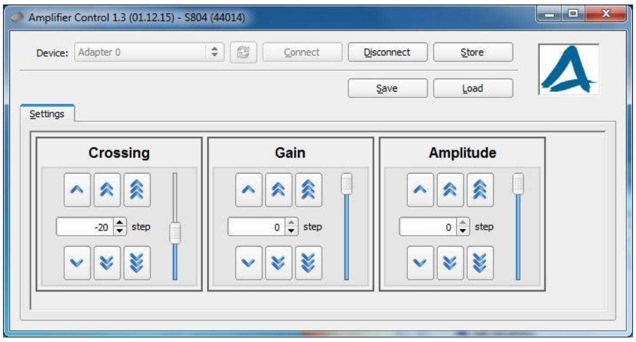
Ease of Use

Upon delivery, the amplifier is already pre-set to deliver maximum gain, maximum output amplitude and nominally 50% crossing.

These settings can be modified in an easy to use graphical user interface, as shown below. For connecting the amplifier to the computer, the USB to I2C converter cable, as well as the required software are included with each amplifier with no extra charge.

Once new settings are stored on the device the amplifier will remember the settings until further changes are made. There is no need to connect a computer to the device unless gain, maximum amplitude or crossing adjustments are to be made.

The software is available for download at www.shf-communication.com/software .



GUI of the SHF amplifier control software

Available Options

01: DC return on input (max. ±1.75 V, max. 35 mA)[1]

02: Built-in bias tee on input (max. ±9 V, max. 220 mA)[1]

03: DC return on output (max. ±1.75 V, max. 35 mA)[1]

04: Built-in bias tee on output (max. ±8 V, max. 220 mA)[1]

MP: Matches the phase of two amplifiers

QHS: Quad Heat Sink, four amplifiers on one heatsink

[1] The options 01 & 02 or 03 & 04 cannot be combined.
If an option is chosen, the maximum gain and the maximum output power might be reduced by up to 1 dB. The low frequency 3 dB Point might be increased up to 100 kHz. The DC resistance of an bias tee is about 3 Ω.

Specifications – SHF S804 B

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Absolute Maximum Ratings						
Maximum RF Input Power in Operation	dBm V	$P_{in\ max}$			4 1	 peak to peak voltage
Maximum RF Input Power without Power Supply	dBm V	$P_{in\ max}$			10 2	 peak to peak voltage
DC Voltage at RF Input	V				±9	
DC Voltage at RF Output	V				±8	
Supply Voltage	V		8		12	0.3 A, reverse voltage protected
Case Temperature[2]	T_{case}	°C	10	40	50	
Electrical Characteristics (At 40°C case temperature, unless otherwise specified)						
High Frequency 3 dB Point	GHz	f_{HIGH}	60			
Low Frequency 3 dB Point	kHz	f_{LOW}			90	
Gain	dB	S_{21}	21	22		non-inverting measured at P_{in}=-27 dBm
Max. Gain Reduction	dB		2.5	3	4	Control via software interface
Output Power at 1 dB Compression	dBm V	P_{01dB}	12 2.5	13 2.8		10 MHz…25 GHz peak to peak voltage
Output Power at 2 dB Compression	dBm V	P_{02dB}	15 3.5	15.5 3.8		10 MHz…25GHz peak to peak voltage
Output Power at 3 dB Compression	dBm V	P_{03dB}	16 4.0	16.5 4.2		10 MHz…25 GHz peak to peak voltage
Max. RF Input for Linear Operation	dBm V	$P_{in\ lin}$			-10 0.20	I.e. Pout ≤ P01dB peak to peak voltage
Crossing Control Range	%		-4		4	Control via software interface
Input Reflection	dB	S_{11}		-10 -5	-9 -3	< 35 GHz < 60 GHz
Output Reflection	dB	S_{22}		-11 -5	-10 -3	< 50 GHz < 60 GHz

[2] If operated with heat sink (part of the delivery) at room temperature there is no need for additional cooling.

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Rise Time/Fall Time	ps	t_r/t_f			7 12	20%...80%, 2 V ≤ Vout ≤ 3 V Deconvoluted [3, 4] Full Setup [3]
Jitter	fs	J_{RMS}		400 500	520 600	2 V ≤ Vout ≤ 3 V Deconvoluted [3, 4] Full Setup [3]
Group Delay Ripple	ps				±50	40 MHz…40 GHz, 160 MHz aperture
Power Consumption	W			2		9 V supply voltage
Mechanical Characteristics						
Input Connector						1.85 mm (V) female[5]
Output Connector						1.85 mm (V) male[5]

Output Amplitude Adjustment

The Output Amplitude can be adjusted by the GUI. The maximum possible reduction depends on the output amplitude itself, i.e. a minimum input power of -6 dBm is required to achieve a output power reduction of at least 1 dB. Higher output power levels will result in an extended output power reduction range.

[3] Measured with the following setup: SHF 613 A DAC -> DUT (SHF S804 B) -> Agilent 86100A with 70 GHz sampling head and precision time base.

[4] Calculation based on typical results of setup without DUT :

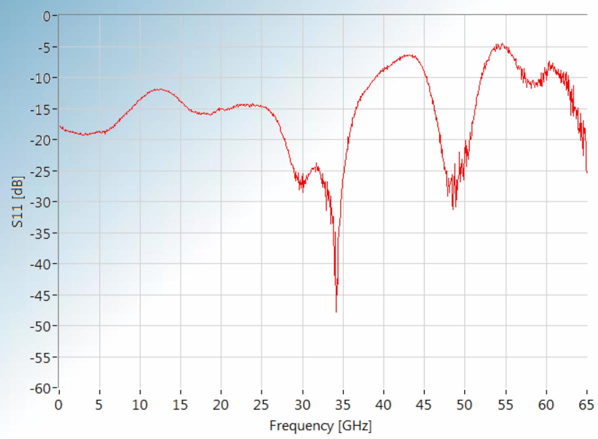
$$t_r/t_{f\ deconvoluted} = \sqrt{(t_r/t_{f\ full\ setup})^2 - (t_r/t_{f\ setup\ w/o\ DUT})^2} = \sqrt{(t_r/t_{f\ full\ setup})^2 - 11\ ps^2}$$

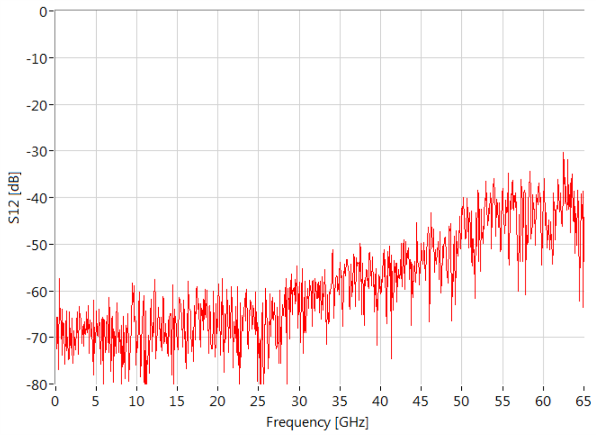
$$J_{RMS\ deconvoluted} = \sqrt{(J_{RMS\ full\ setup})^2 - (J_{RMS\ setup\ w/o\ DUT})^2} = \sqrt{(J_{RMS\ full\ setup})^2 - 300\ fs^2}$$

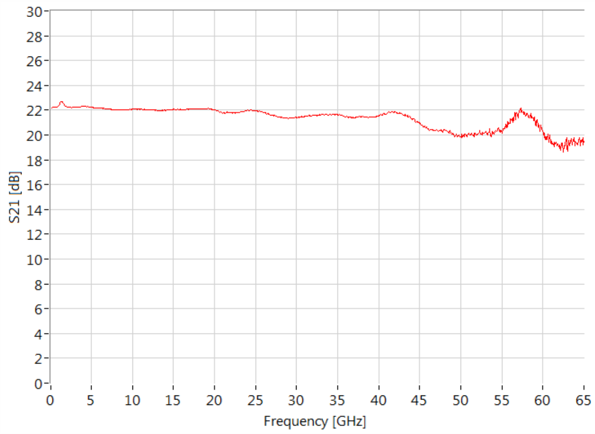
[5] Other gender configurations are available on request.

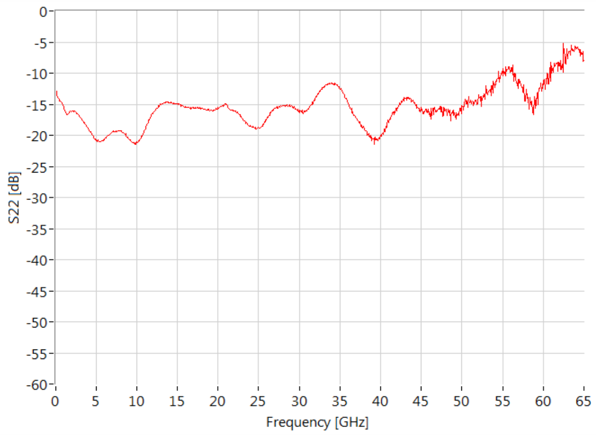
Other connector types, e.g. 2.92mm (K) or Mini-SMP (GPPO®) connectors, are also available but may impact the bandwidth and reflection characteristic.

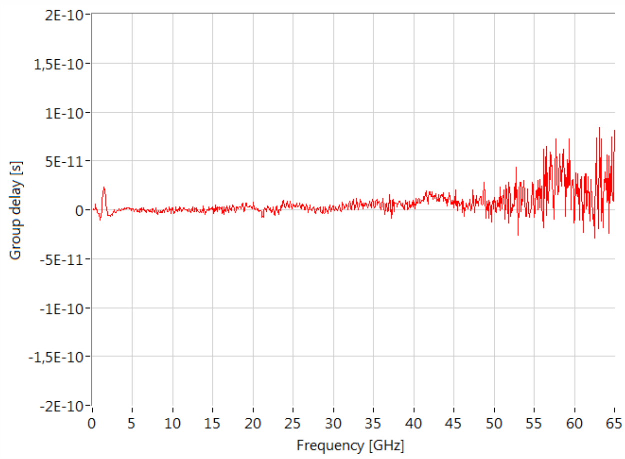
Typical S-Parameters, Group Delay and Phase Response

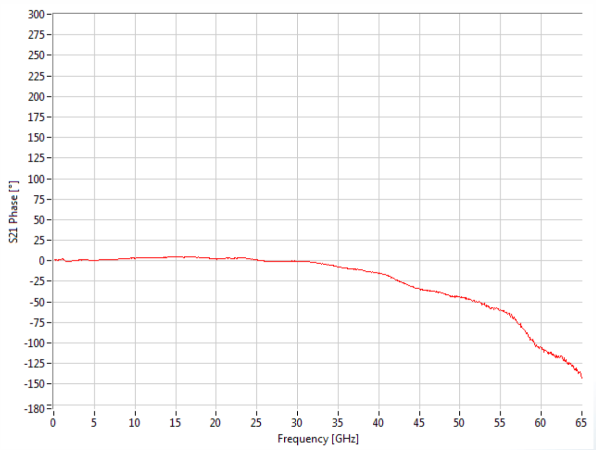








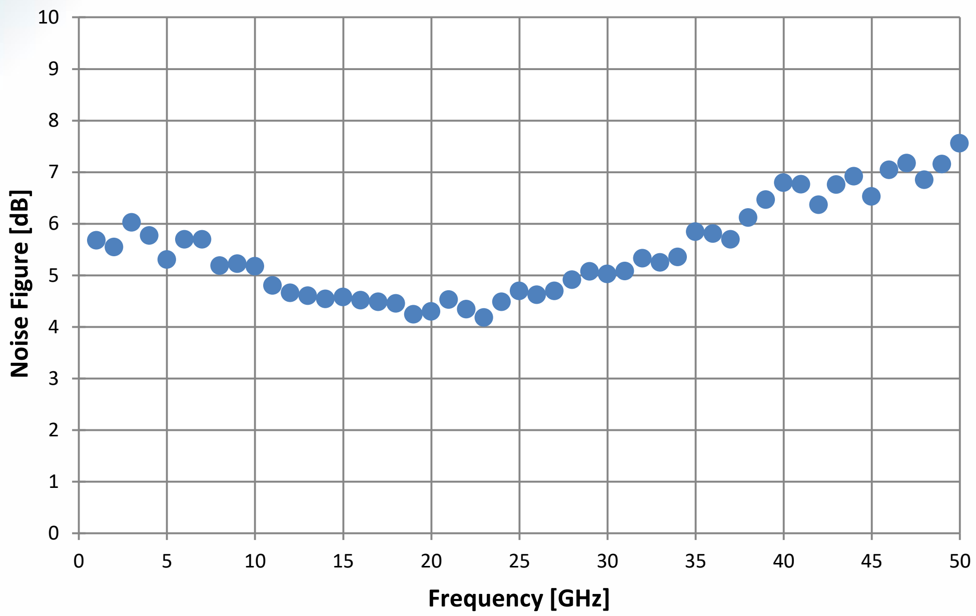




Aperture of group delay measurement: 160 MHz

Typical Noise Figure

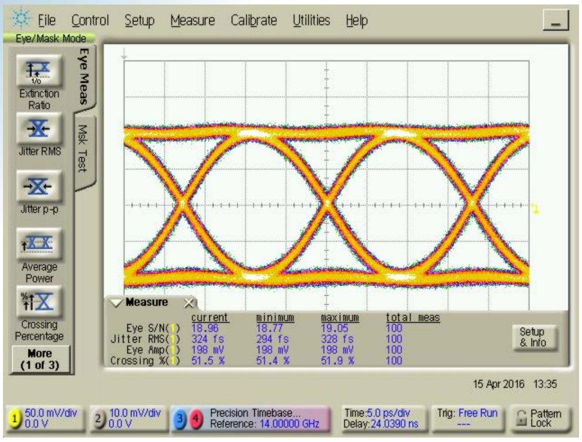
The measurement had been performed using a FSW85 Spectrum Analyzer by Rhode & Schwarz. The noise figure defines the degradation of the signal-to-noise ratio when the signal passes the amplifier. An ideal amplifier would amplify the noise at its input along with the signal. However, a real amplifier adds some extra noise from its own components and degrades the signal-to-noise ratio. Please note that this applies to small signals only. When the amplifier is used close to or in its saturation region additional non-linear effects will impact the signal-to-noise ratio and the signal waveform.



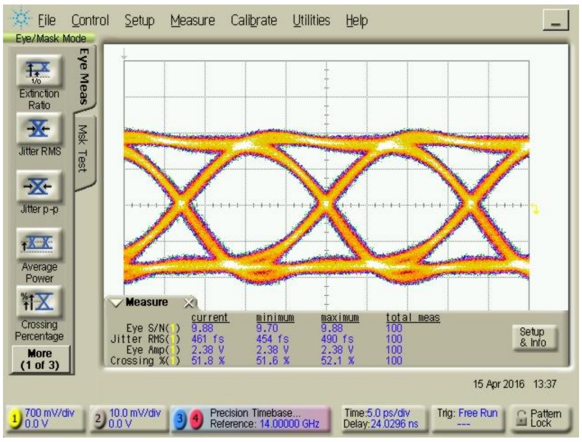
Typical Binary Waveforms

Measurements had been performed using a SHF 613 A DAC and an Agilent 86100C DCA with Precision Time Base Module (86107A) and 70 GHz Sampling Head (86118A). The measurement at ~2.4 V will be part of the inspection report delivered with each particular device.

Eye Amplitude: Input ~200 mV ⇒ Output ~2.4 V

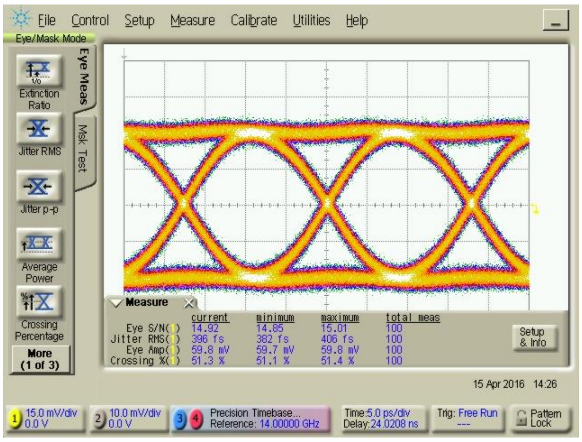


Input Signal @ 56 Gbps

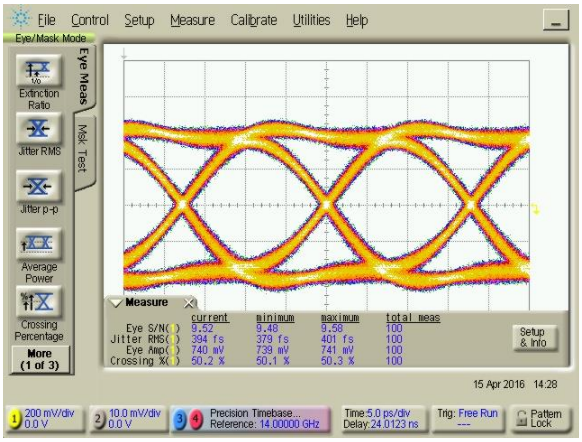


Output Signal @ 56 Gbps

Eye Amplitude: Input ~60 mV ⇒ Output ~740 mV



Input Signal @ 56 Gbps

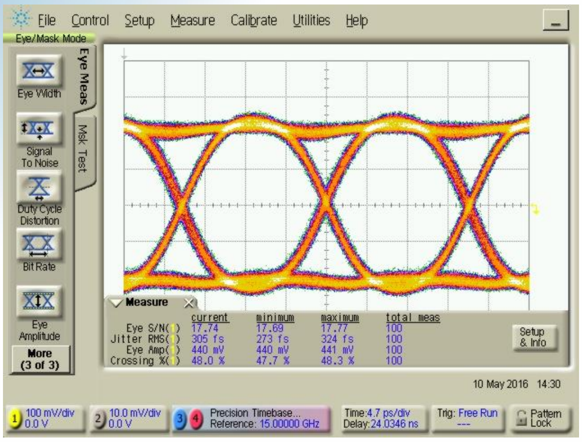


Output Signal @ 56 Gbps

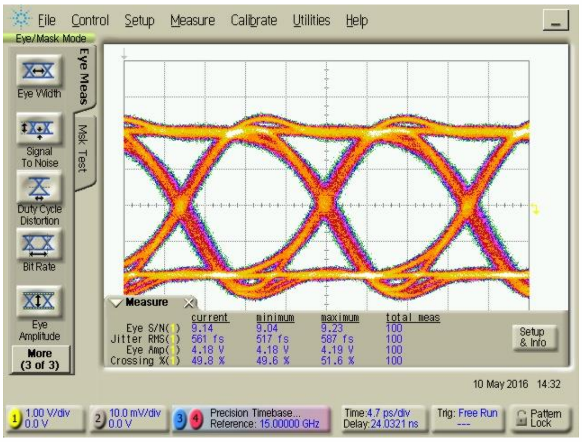
Typical Binary Waveforms

Measurements had been performed using a SHF 603 A MUX and an Agilent 86100C DCA with Precision Time Base Module (86107A) and 70 GHz Sampling Head (86118A).

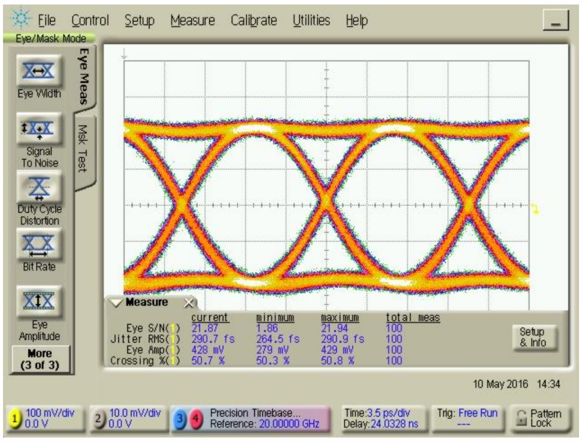
Eye Amplitude: Input ~440 mV ⇒ Output ~3.8 V



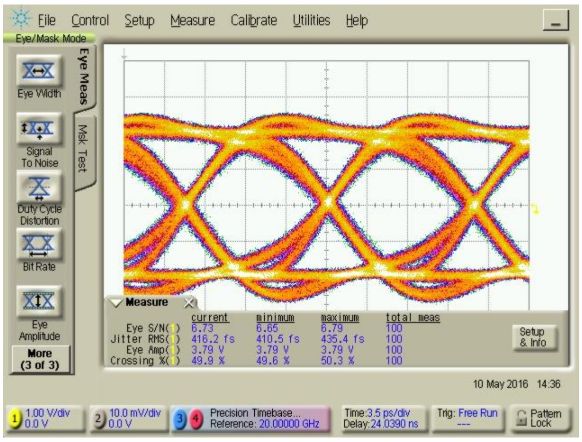
Input Signal @ 60 Gbps



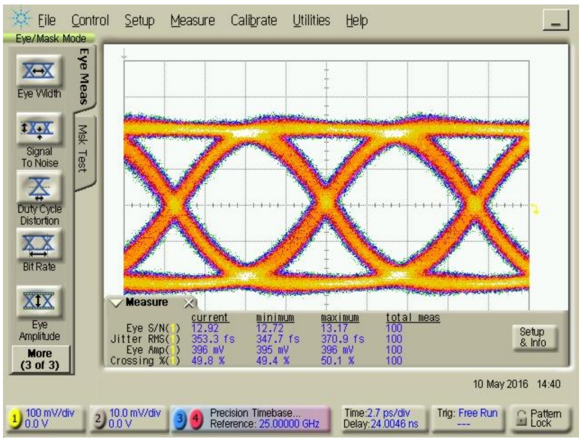
Output Signal @ 60 Gbps



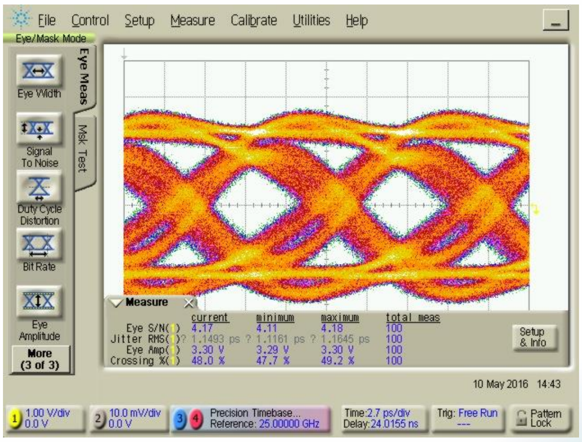
Input Signal @ 80 Gbps



Output Signal @ 80 Gbps



Input Signal @ 100 Gbps

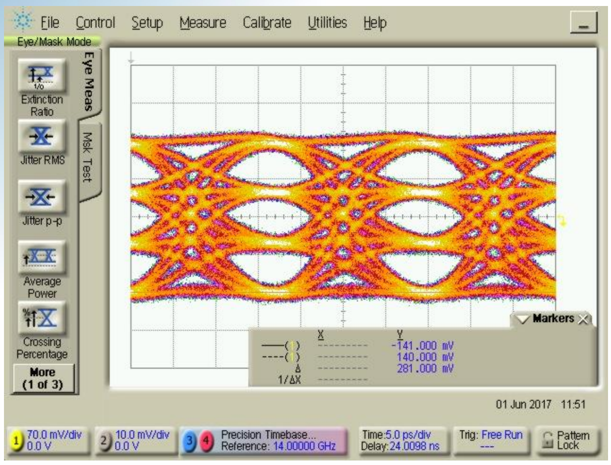


Output Signal @ 100 Gbps

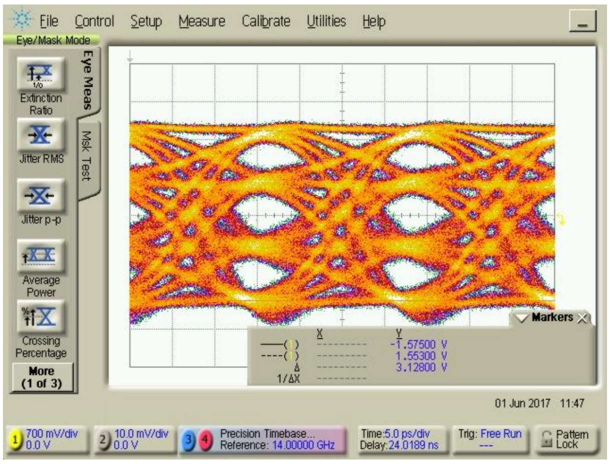
Typical 4-Level Waveforms

Measurements had been performed using a SHF 613 A DAC and an Agilent 86100C DCA with Precision Time Base Module (86107A) and 70 GHz Sampling Head (86118A). The measurement at ~2.4 V will be part of the inspection report delivered with each particular device.

Eye Amplitude: Input ~280 mV ⇒ Output ~3.1 V

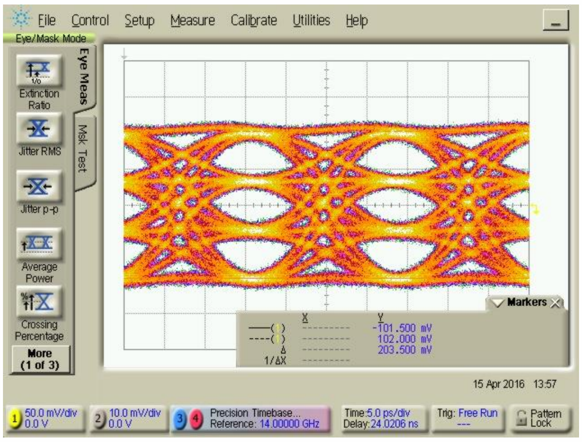


Input Signal @ 56 GBaud

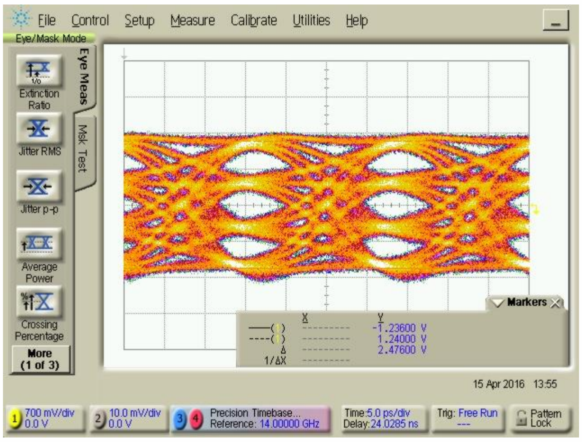


Output Signal @ 56 GBaud

Eye Amplitude: Input ~200 mV ⇒ Output ~2.5 V

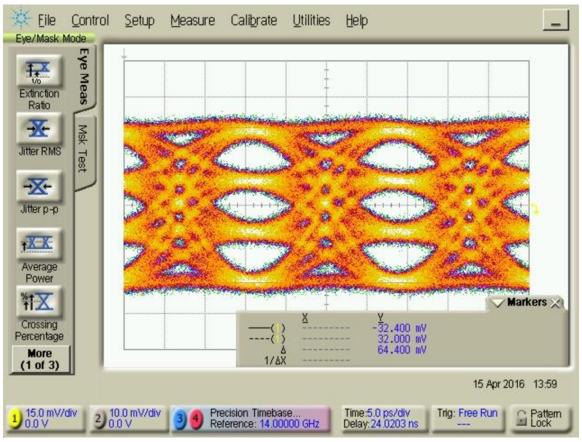


Input Signal @ 56 GBaud

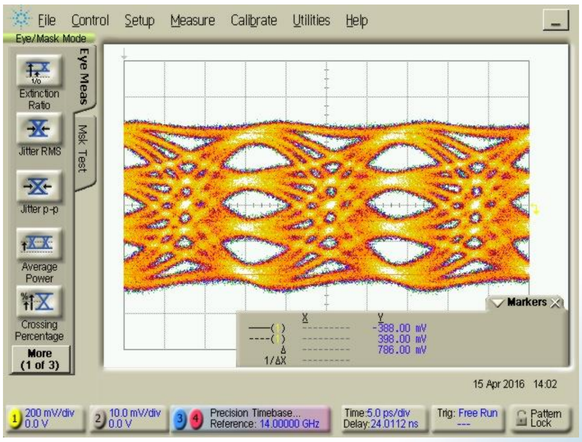


Output Signal @ 56 GBaud

Eye Amplitude: Input ~65 mV ⇒ Output ~800 mV

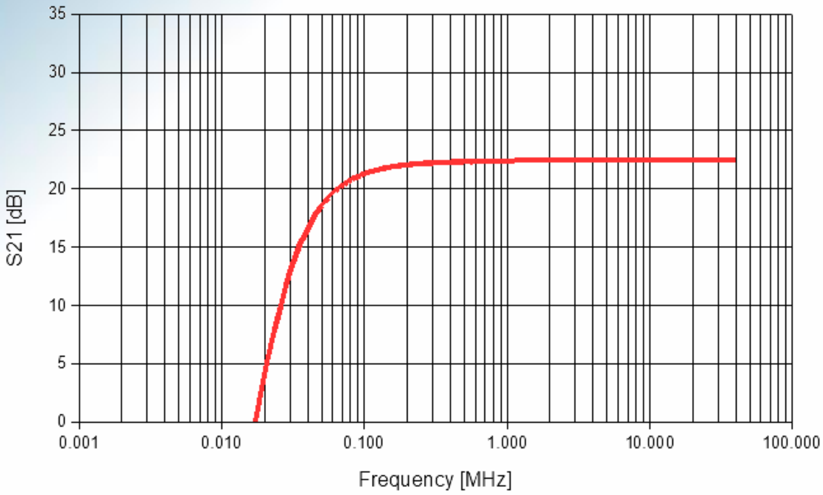


Input Signal @ 56 GBaud

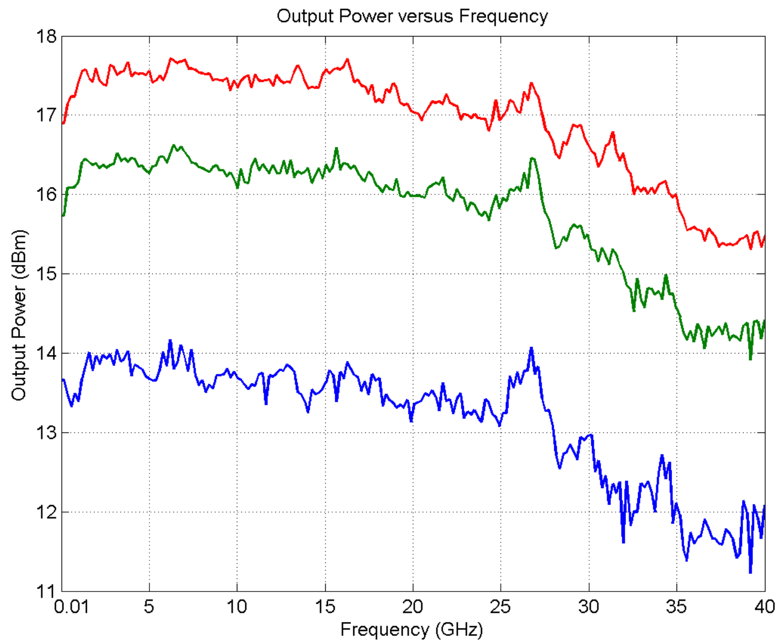


Output Signal @ 56 GBaud

Typical Low Frequency Response (<40 MHz)

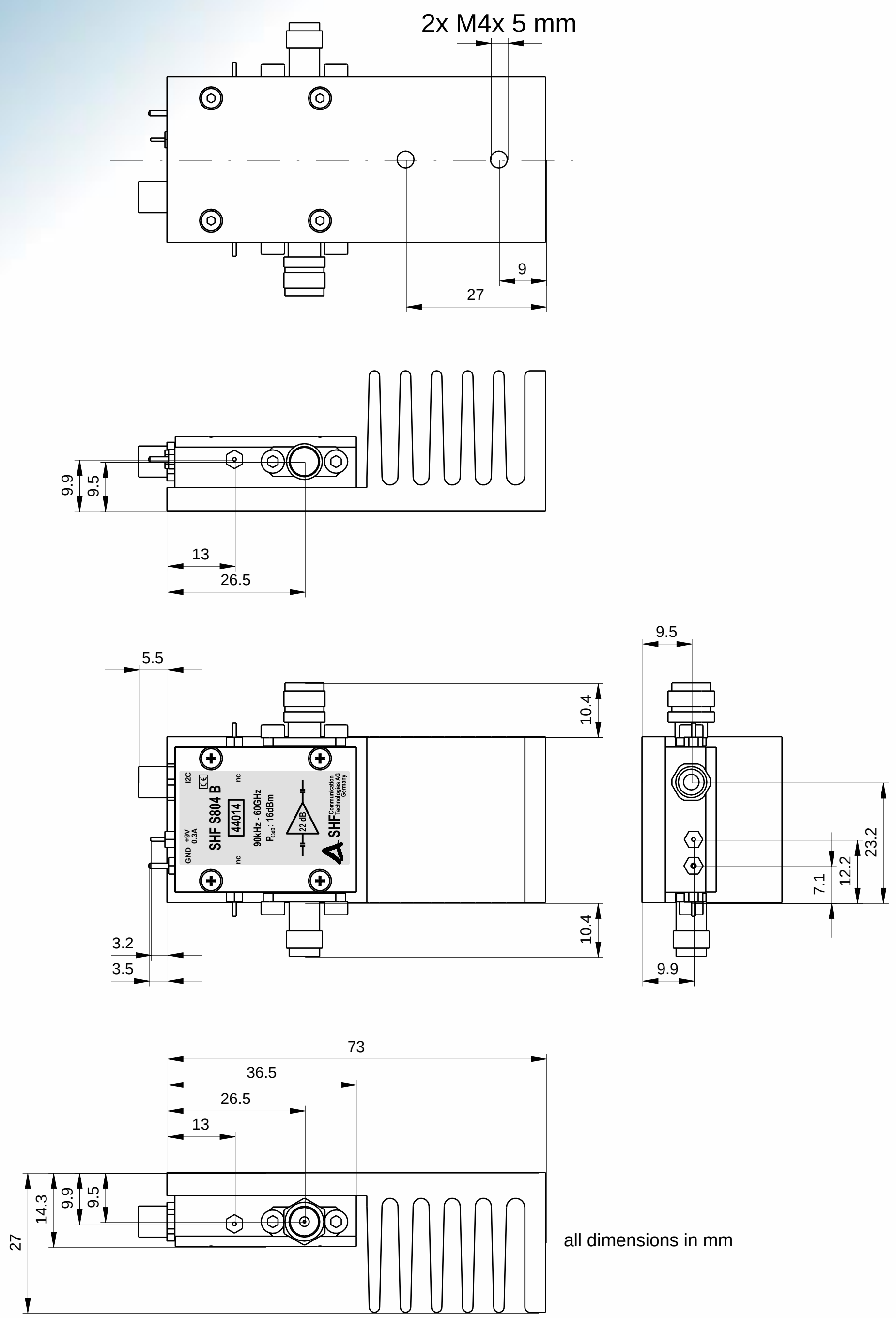


Typical Saturation power



Top (red): 3 dB compression;
Middle (green): 2 dB compression;
Bottom (blue): 1 dB compression

Mechanical Drawing with Heat Sink

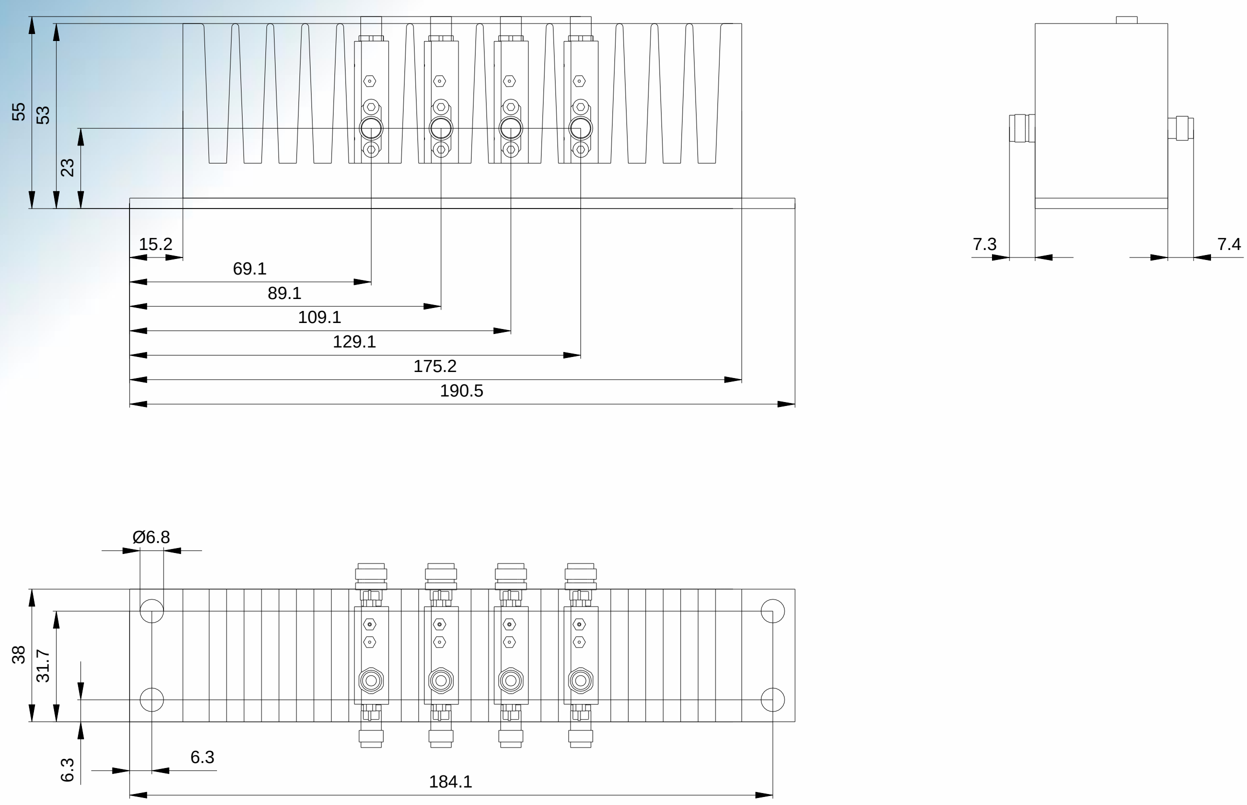


Pin assignment might change if a bias tee option is chosen.

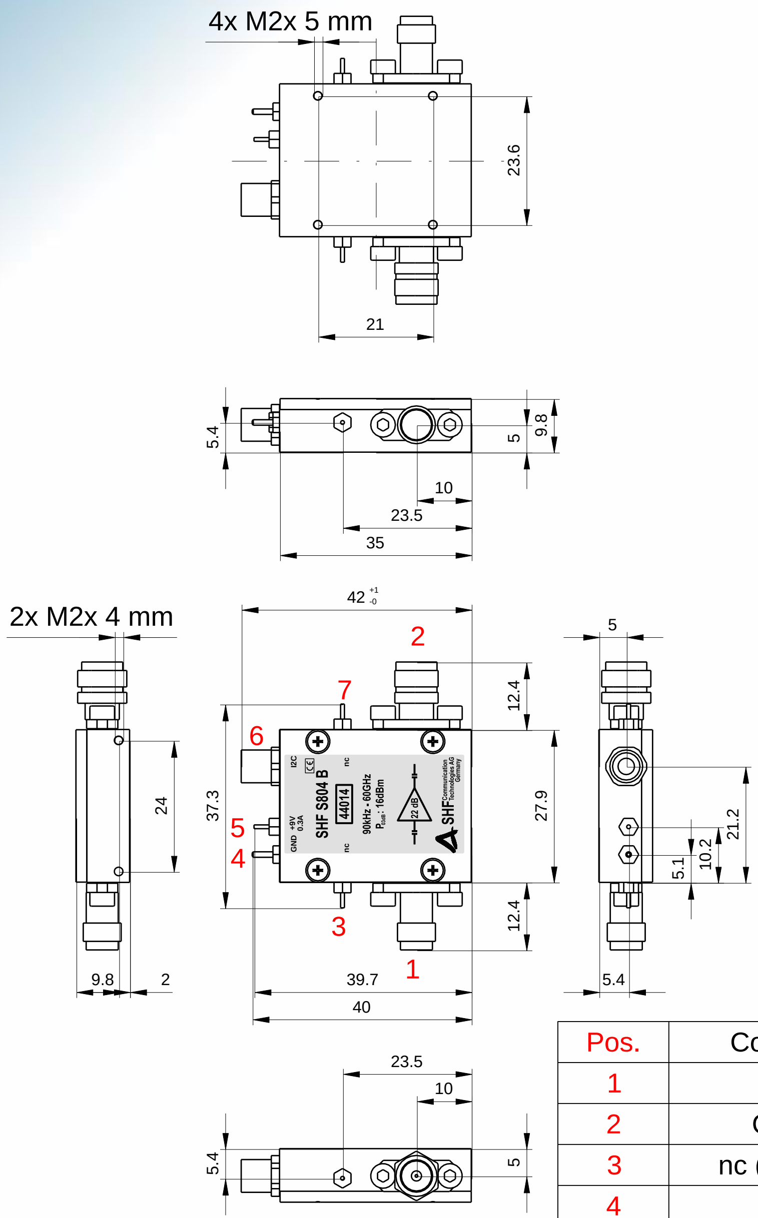
Thermal resistance of heat sink approx. 6 K/W

For permanent mounting remove the heat sink from the amplifier. In that case please ensure that adequate cooling of the amplifier is guaranteed. It is recommended to use thermal paste or a thermal gap pad for the mounting. In order to separate the heat sink from the amplifier, remove the four screws on the heat sink. Please note, thermal paste is used between the heat sink and the amplifier housing.

Mechanical Drawing with Heat Sink Option QHS



Mechanical Drawing without Heat Sink



all dimensions in mm

Pos.	Connector
1	Input
2	Output
3	nc (optional)
4	GND
5	+9 V / 0.3 A
6	I^2C
7	nc (optional)

Pin assignment might change if a bias tee option is chosen.

Please ensure that adequate cooling of the amplifier is guaranteed.

User Instructions

ATTENTION!

Electrostatic sensitive GaAs FET amplifier

1. To prevent damage through static charge build up, cables should be always discharged before connecting them to the amplifier!
2. Attach a 50 Ohm output load before supplying DC power to the amplifier!
3. The supply voltage can be taken from any regular 8 …12 V, (0.3 A @ 9V) DC power supply and can be connected to the supply feed-through filter via an ON / OFF switch.

   In case 9 V are applied to the amplifier typically 0.2 A are drawn during operation. However, the amplifier requires more current during start up. This is particularly important in case the current compliance of a very fast acting voltage source is set too tight. As this can prevent the amplifier from starting properly, please allow up to 100% overhead for your current compliance during startup.
4. Using a 3 dB or 6 dB input attenuator will result in a 6 dB or 12 dB increase of the input return loss. For minimal degradation of amplifier rise time, these attenuators should have a bandwidth specification of greater 50 GHz (V / 1.85 mm attenuators)!
5. An input signal of about 0.45 V_{pp} will produce an output swing of about 4.2 V_{pp}. Higher input voltages are leading to waveform degradation.
6. The amplifier can only be used without damage by connecting a 50 Ohm precision load to the output.
7. ATTENTION: At radio frequencies a capacitive load can be transformed to an inductive one through transmission lines! With an output stage driven into saturation this may lead to the immediate destruction of the amplifier (within a few ps)!
8. The input voltage should never be greater than 1 Vpp equivalent to 4 dBm input power.
9. For the DC-connections flexible cable 0.2…0.5 mm^2 / AWG 24…20 are recommended. A maximum soldering temperature of 260 °C for 3 seconds is recommended for the feedthrough (positive supply voltage and bias tee pin). The ground pin requires significantly more heat as it is connected to the solid housing.