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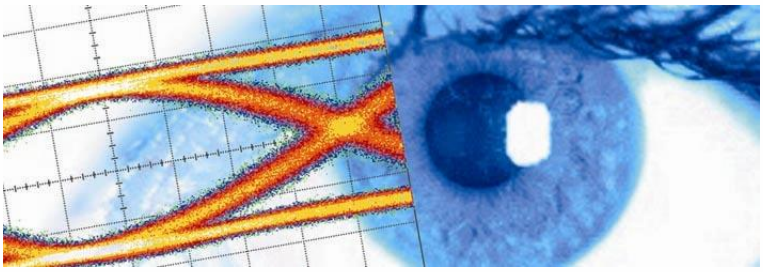
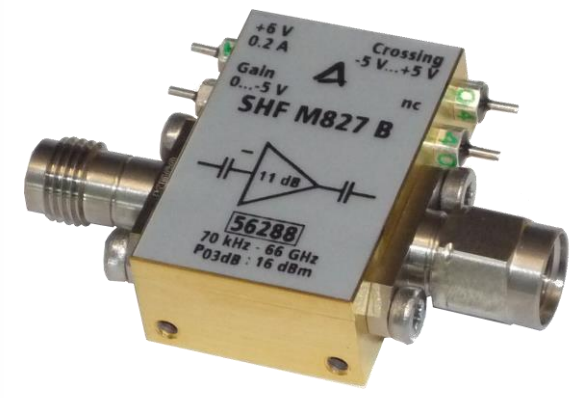
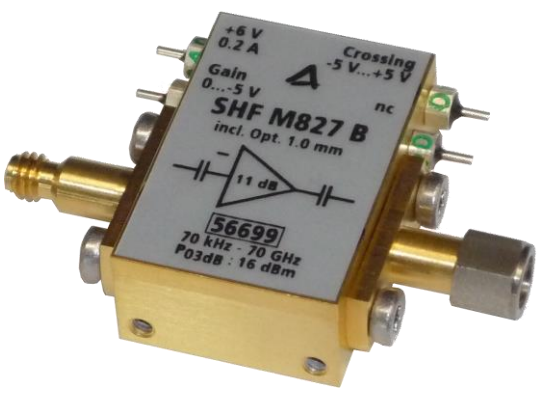


Datasheet

SHF M827 B

Ultra-Broadband Amplifier





Description

The SHF M827 B is a RoHS compliant ultra-broadband RF amplifier with a small footprint and a bandwidth of more than 66 GHz. The Option 1.0 mm offers a guaranteed 3 dB bandwidth of 70 GHz.

A single stage amplifier design is employed using our monolithic microwave integrated circuit (MMIC) inside special carriers to achieve the ultra-wide bandwidth and the low noise performance.

This extreme bandwidth offers the capability to amplify binary signals of more than 100 Gbps while the perfect linearity enables this amplifier to drive modulators and lasers for PAM, optical QAM, OFDM and analog signals.

Ease of Use

Only a single 6 V supply is needed for operation.

Upon delivery, the amplifier is already set to deliver maximum gain and 50% crossing. For operation under these conditions the appropriate pins can be left floating. However, in case gain and crossing shall be modified, this can be done just by applying another bias.

Applications

- Optical Communications
- High-Speed Pulse Experiments
- Satellite Communications
- Research and Development
- Antenna Measurements
- Data Transmission

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. 200 mA)[1]

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

04: Built-in bias tee on output (max. ±9 V, max. 200 mA) [1]

MP: Matches the phase of two amplifiers

1.0 mm: 1.0 mm connectors, guaranteed amplifier bandwidth 70 GHz

[1] Only one of the options 01 - 04 is available.
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 75 kHz. The DC resistance of an bias tee is about 6 Ω.

Specifications - SHF M827 B

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Absolute Maximum Ratings						
Maximum RF Input	dBm V	$P_{in\ max}$			10 2	peak to peak voltage
DC Voltage at RF Input	V				±9	AC coupled input
DC Voltage at RF Output	V				±9	AC coupled output
Positive Supply Voltage	V		5.8	6	7.0	typ. 0.2 A[2], reverse voltage protected
Gain Control Voltage	V		-6	-5…0	+6	will not exceed 0.02 A
Crossing Control Voltage	V		-6	-5…+5	+6	will not exceed 0.02 A
Case Temperature	T_{case}	°C	10	30	50	

[2] At startup the amplifier draws significantly more current.

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Electrical Characteristics (At 30°C case temperature, unless otherwise specified)						
High Frequency 3 dB Point	GHz	f_{HIGH}	66			
High Frequency 3 dB Point	GHz	f_{HIGH}	70			Option 1.0 mm
Low Frequency 3 dB Point	kHz	f_{LOW}			70	
Gain	dB	S_{21}	10	11		inverting measured at P_{in}=-20 dBm @ 500 MHz
Output Power at 1 dB Compression	dBm V	P_{01dB}	11.5 2.2	12 2.5		10 MHz…30 GHz peak to peak voltage
Output Power at 2 dB Compression	dBm V	P_{02dB}	14 3.2	15 3.5		10 MHz…30 GHz peak to peak voltage
Output Power at 3 dB Compression	dBm V	P_{03dB}	15.5 3.7	16 4		10 MHz…30 GHz peak to peak voltage
Input Reflection	dB	S_{11}			-9 -3	< 35 GHz < 65 GHz
Output Reflection	dB	S_{22}			-10 -5	< 30 GHz < 65 GHz
Rise Time/Fall Time	ps	t_r/t_f			 6 10	20%...80% Deconvoluted [3, 4] Full Setup [3]
Jitter	fs	J_{RMS}		350 450	500 600	Deconvoluted [3, 4] Full Setup [3]
Group Delay Ripple	ps				±50	500 MHz…40 GHz, 160 MHz aperture
Power Consumption	W			0.8		V_{DD} = 6 V / I_{DD} = 0.14A

[3] Measured with SHF 613 A DAC (at full scale) -> DUT (SHF M827 B) -> Agilent 86100C with 70 GHz sampling head & precision time base.

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

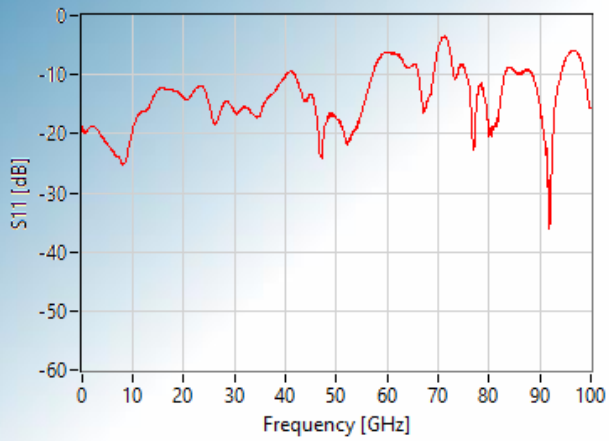
$$t_{r\ deconvoluted} = \sqrt{(t_{r\ full\ \ setup})^2 - (t_{r\ setup\ w/o\ DUT})^2} = \sqrt{(t_{r\ full\ \ setup})^2 - (7\ ps)^2}$$

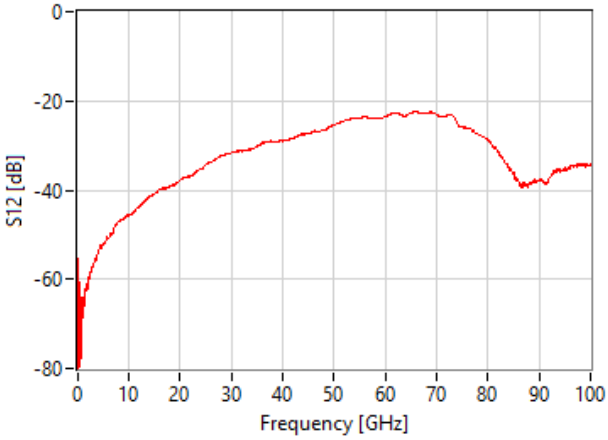
$$J_{RMS\ deconvoluted} = \sqrt{(J_{RMS\ full\ setup})^2 - (J_{RMS\ setup\ w/o\ DUT})^2} = \sqrt{(J_{RMS\ full\ \ setup})^2 - (300\ fs)^2}$$

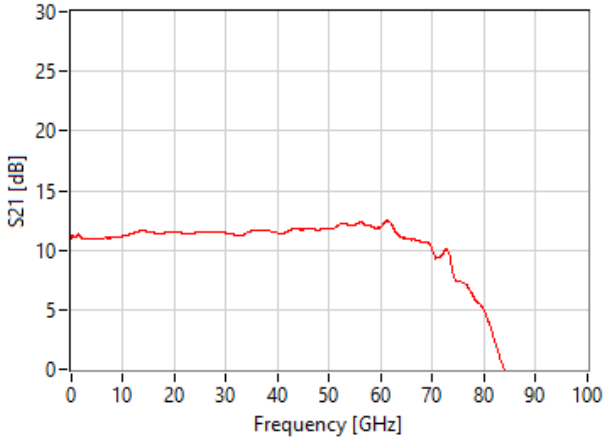
Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Mechanical Characteristics						
Input Connector	Ω			50		1.85 mm (V) female [5] 1.0 mm female (Option 1.0 mm) [5]
Output Connector	Ω			50		1.85 mm (V) male [5] 1.0 mm male (Option 1.0 mm) [5]
Dimensions	mm					please see pages 14 to 16
Weight	g			20 52		without heatsink with heatsink

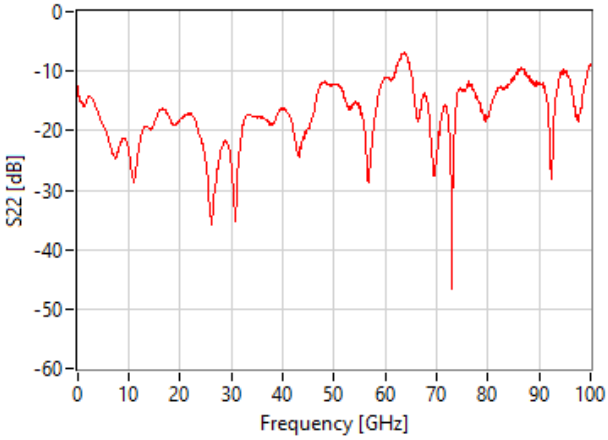
[5] Other gender configurations are available on request.

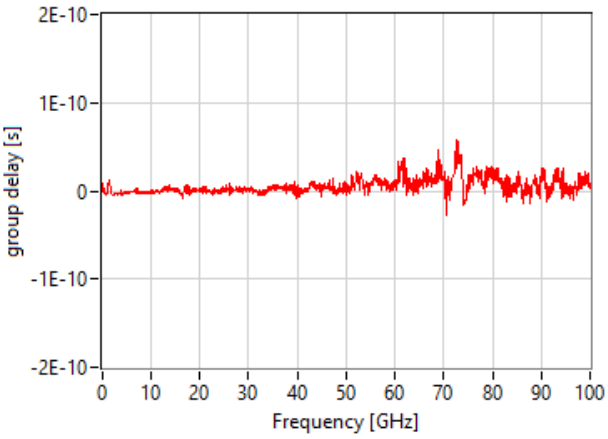
Typical S-Parameters, Group Delay and Phase Response

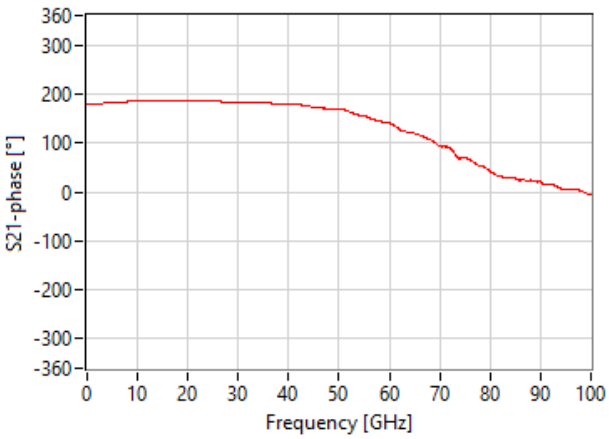








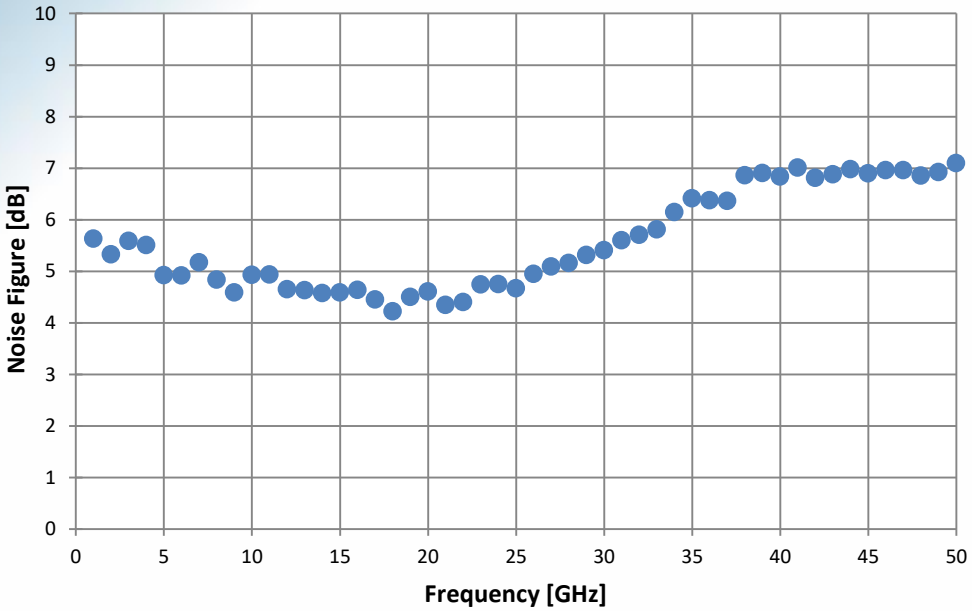




Aperture of group delay measurement: 160 MHz

Typical Noise Figure

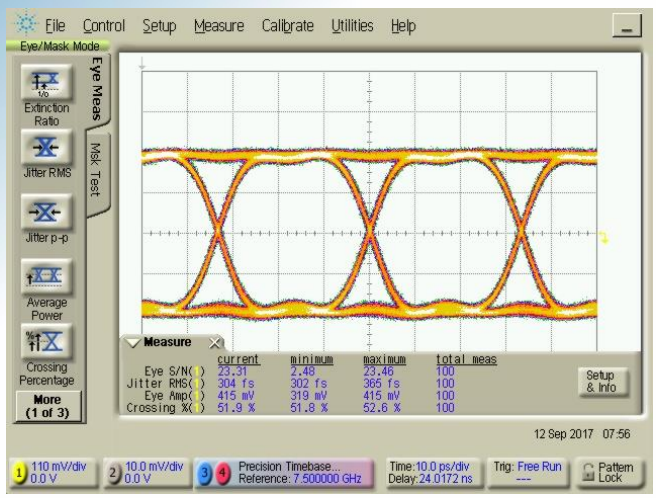
The measurement had been performed using a Spectum Analyzer Rhode & Schwarz FSW85.



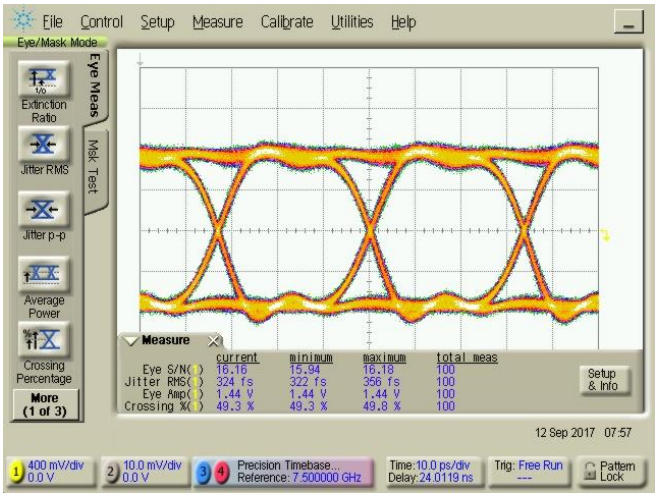
Typical Binary Eye Diagrams

All measurements up to 56 Gbps had been performed using a SHF613 A DAC in binary mode and an Agilent 86100C DCA with Precision Time Base Module (86107A) and 70 GHz Sampling Head (86118A).

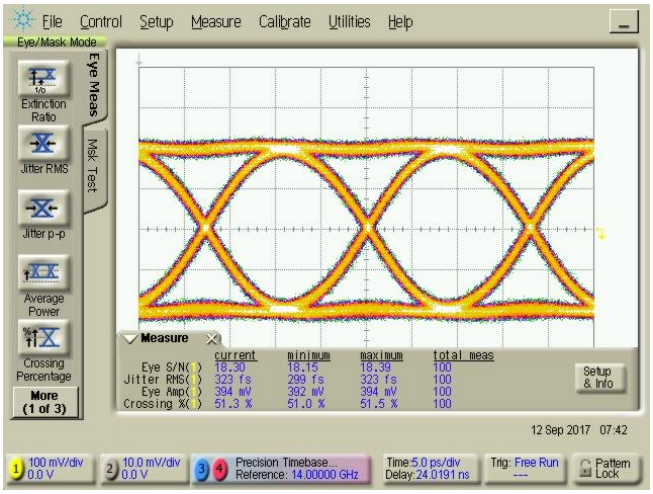
Faster input signals had been taken from a SHF 603 A multiplexer. These will not be part of the inspection report delivered with each particular device.



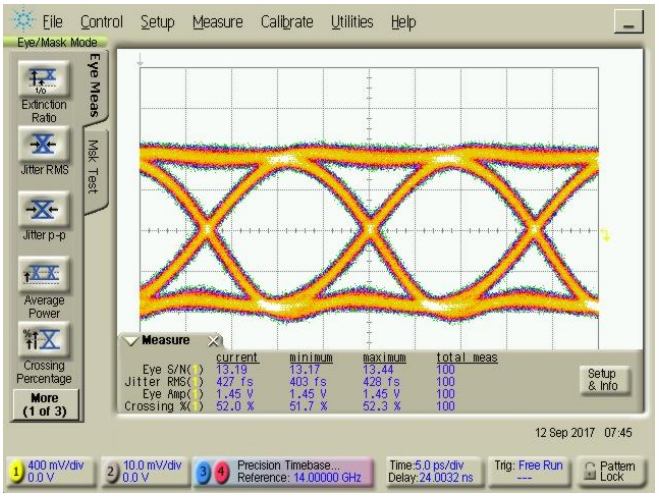
Input Signal @ 30 Gbps, Eye amp: 415 mV



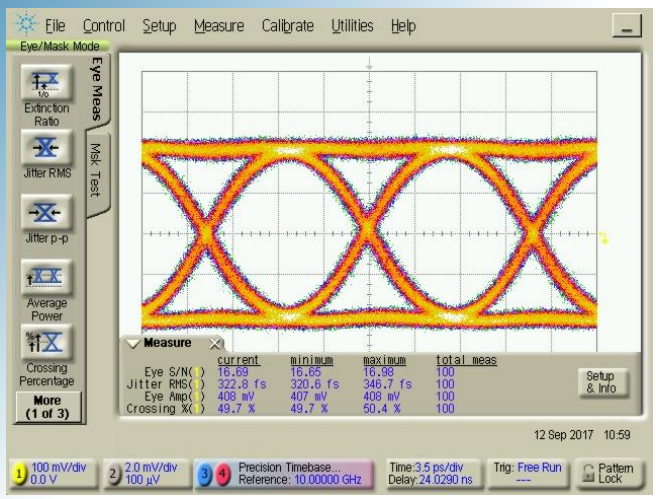
Output Signal @ 30 Gbps, Eye amp: 1.44 V



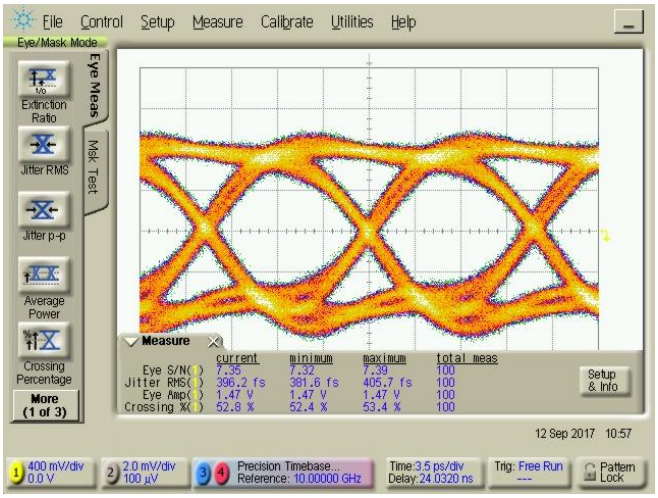
Input Signal @ 56 Gbps, Eye amp: 394 mV



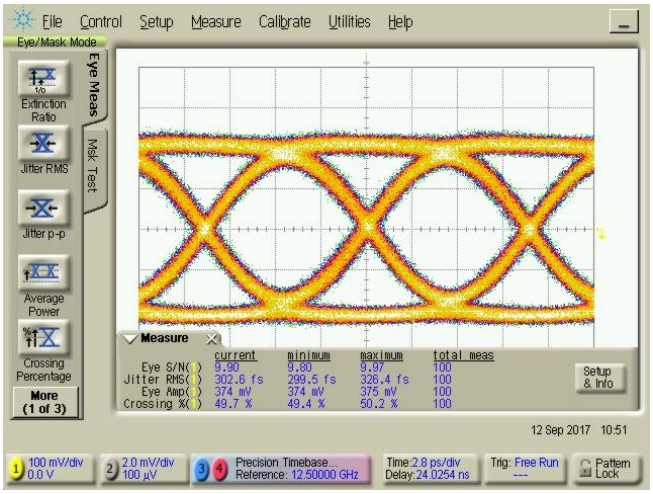
Output Signal @ 56 Gbps, Eye amp: 1.45 V



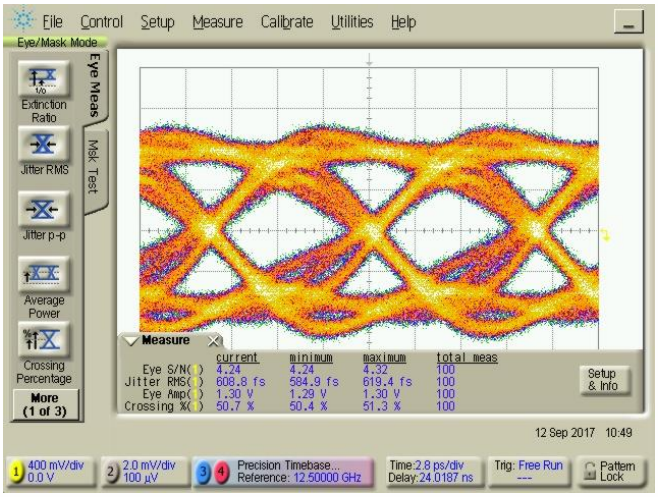
Input Signal @ 80 Gbps, Eye amp: 408 mV



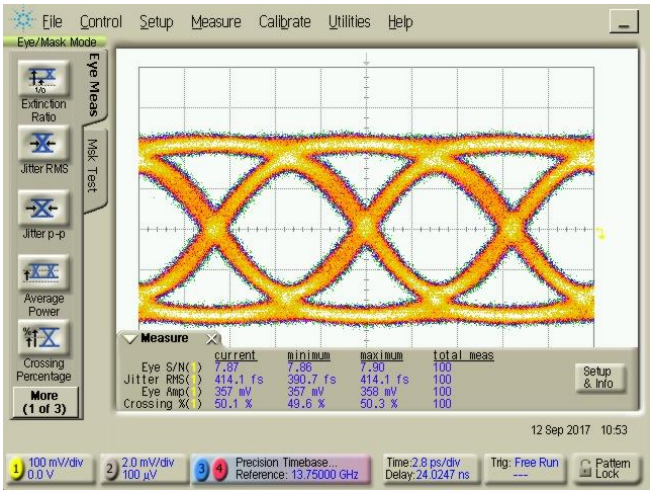
Output Signal @ 80 Gbps, Eye amp: 1.47 V



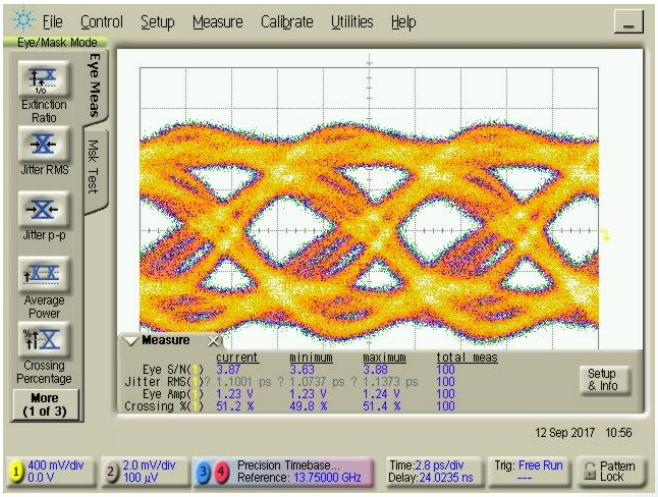
Input Signal @ 100 Gbps, Eye amp: 374 mV



Output Signal @ 100 Gbps, Eye amp: 1.3 V



Input Signal @ 110 Gbps, Eye amp: 357 mV

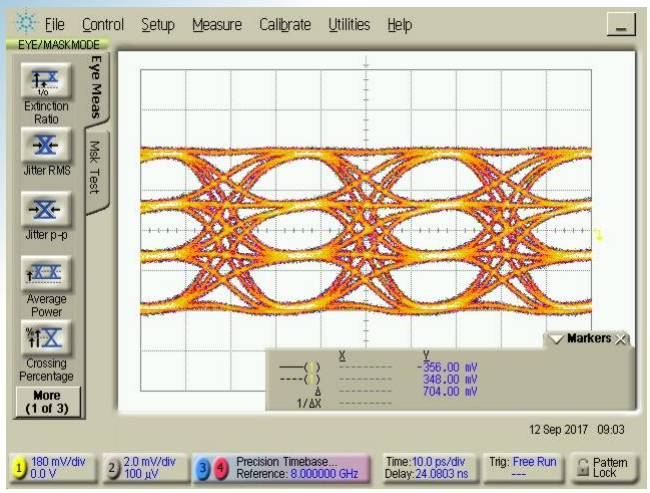


Output Signal @ 110 Gbps, Eye amp: 1.23 V

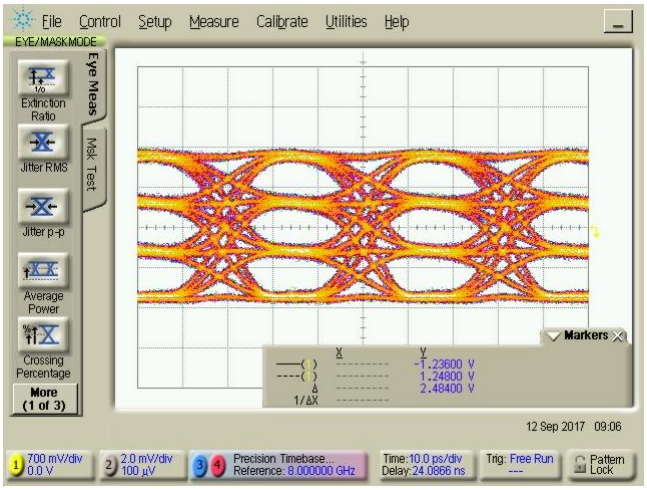
Typical 4-Level Eye Diagrams at 32 and 56 GBaud

The 32 GBaud measurements had been performed using a SHF 611 C DAC and an Agilent 86100C DCA with Precision Time Base Module (86107A) and 70 GHz Sampling Head (86118A). Faster input signals had been taken from a SHF 613 A DAC.

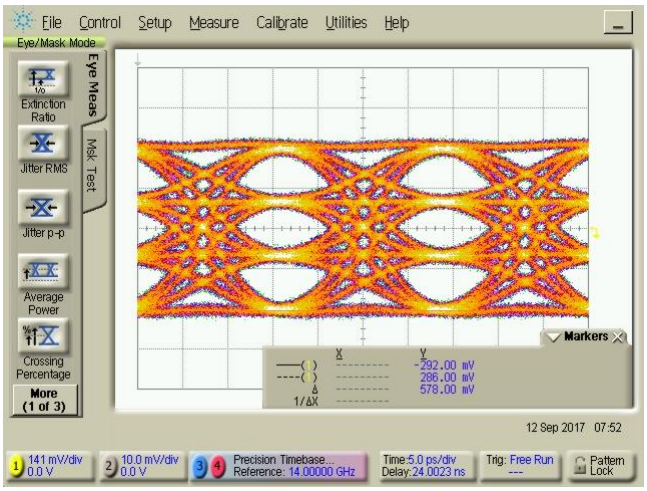
The measurement at 56 GBaud will be part of the inspection report delivered with each particular device.



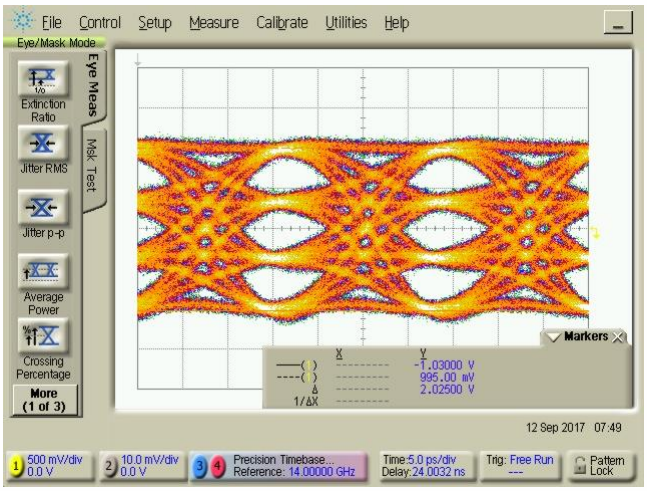
Input Signal @ 32 GBaud, ~700 mVpp



Output Signal @ 32 GBaud, ~2.5 Vpp



Input Signal @ 56 GBaud, ~580 mVpp

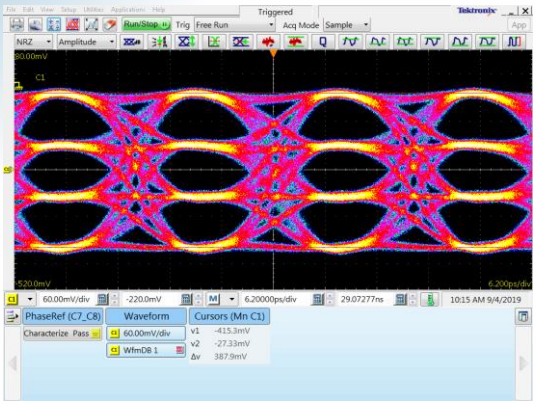


Output Signal @ 56 GBaud, ~2.0 Vpp

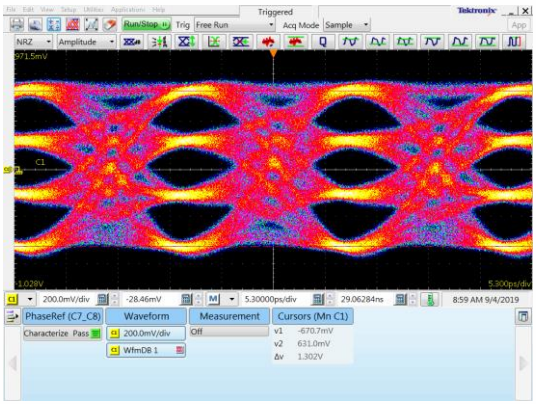
Typical 4-Level Eye Diagrams at 60, 80 and 90 GBaud

The measurements below had been performed using a SHF 12104 A Bit Pattern Generator (PRBS 2^{31}-1), a SHF 616 A PAM-MUX and a Tektronix DSA 8300 Digital Serial Analyzer (DSA) with Phase Reference Module (82A04B-60G), 70 GHz Sampling Module (80E11), 60 mm semi-rigid cable between M827 B and Sampling Module. The Amplifier was measured with 10 dB Attenuator between the output and the Sampling Module.

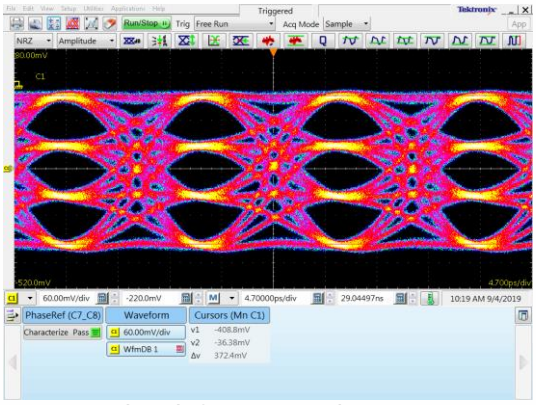
Please note that the inspection report will not show these measurements.



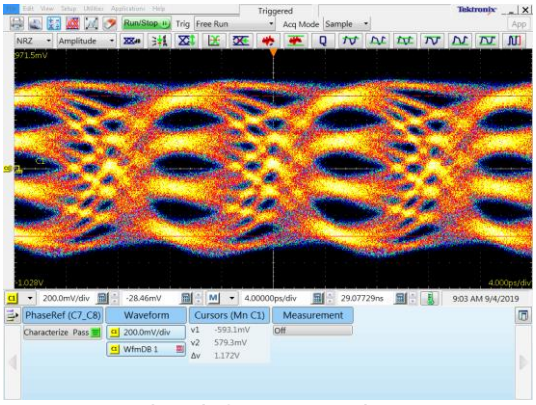
Input Signal @ 60 GBaud, ~390 mVpp



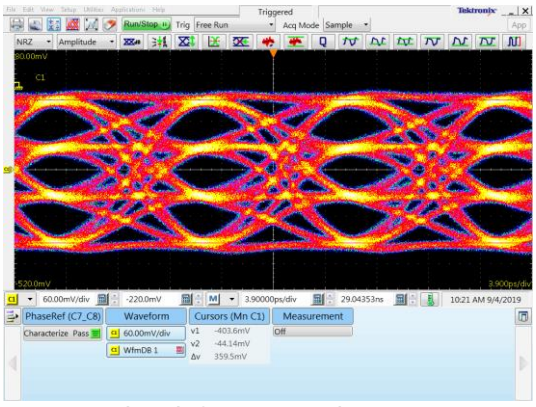
Output Signal @ 60 GBaud, ~1.3 Vpp



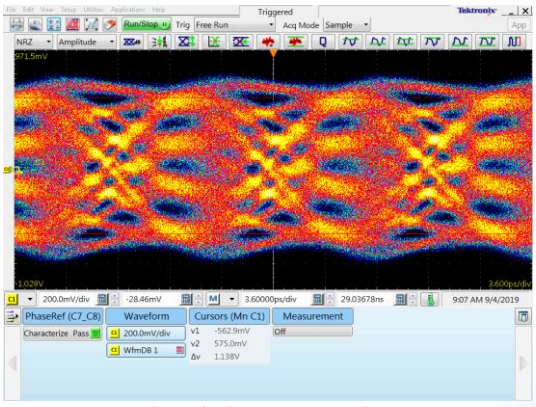
Input Signal @ 80 GBaud, ~370 mVpp



Output Signal @ 80 GBaud, ~1.2 Vpp



Input Signal @ 90 GBaud, ~360 mVpp

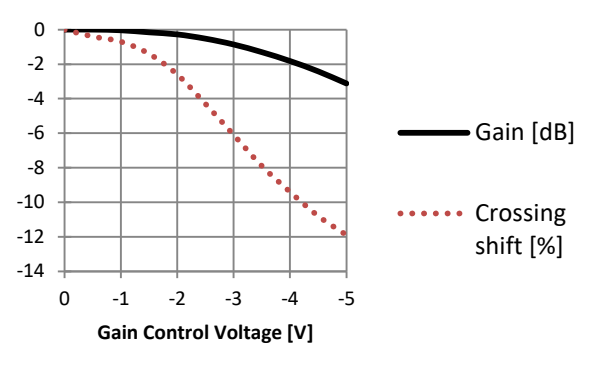


Output Signal @ 90 GBaud, ~1.1 Vpp

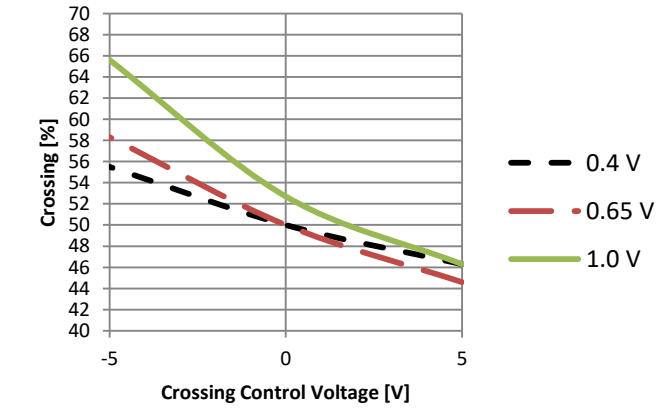
Handling Instructions

To operate the amplifier a positive supply voltage of approximately +6 V must be applied.

The gain can be adjusted by applying a voltage of 0 to -5 V. If this pin is left open, the amplifier will have maximum gain. By reducing the gain the crossing will shift. Typical characteristics are shown in the following diagram for an input voltage of 0.65 V with 50% crossing.

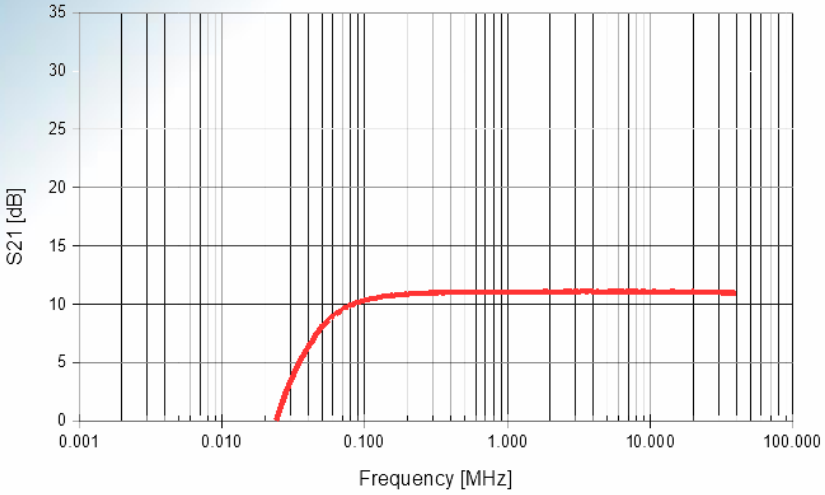


The crossing can be adjusted by applying a voltage of -5 to +5 V. If this pin is left open a crossing of approximately 50 % is achieved. The range depends on the input voltage. Typical characteristics are shown in the following diagram for input voltages of 0.4, 0.65 and 1.0 V with 50% crossing.

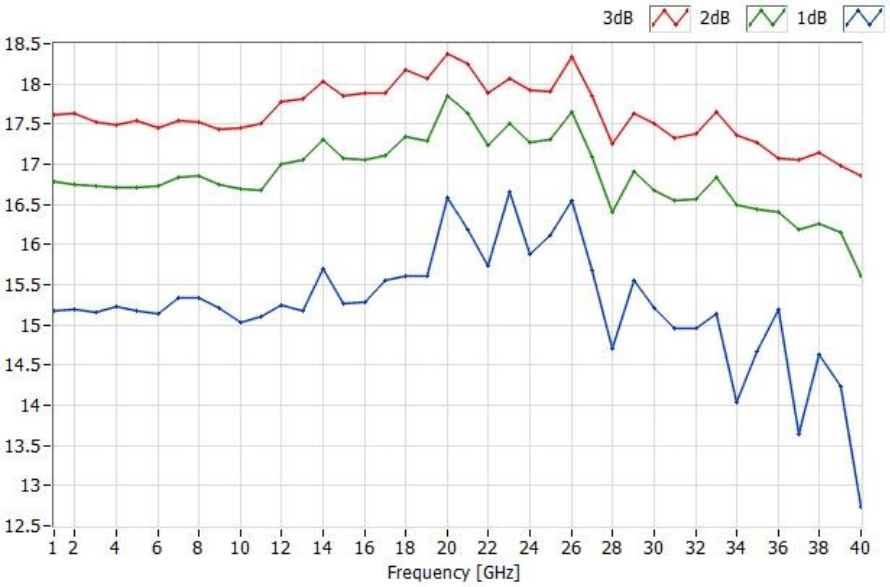


Note: If both functions are used the effect of the gain control will decrease up to -1 dB. This is the typical characteristic of a single stage amplifier.

Typical Low Frequency Response (<40 MHz)

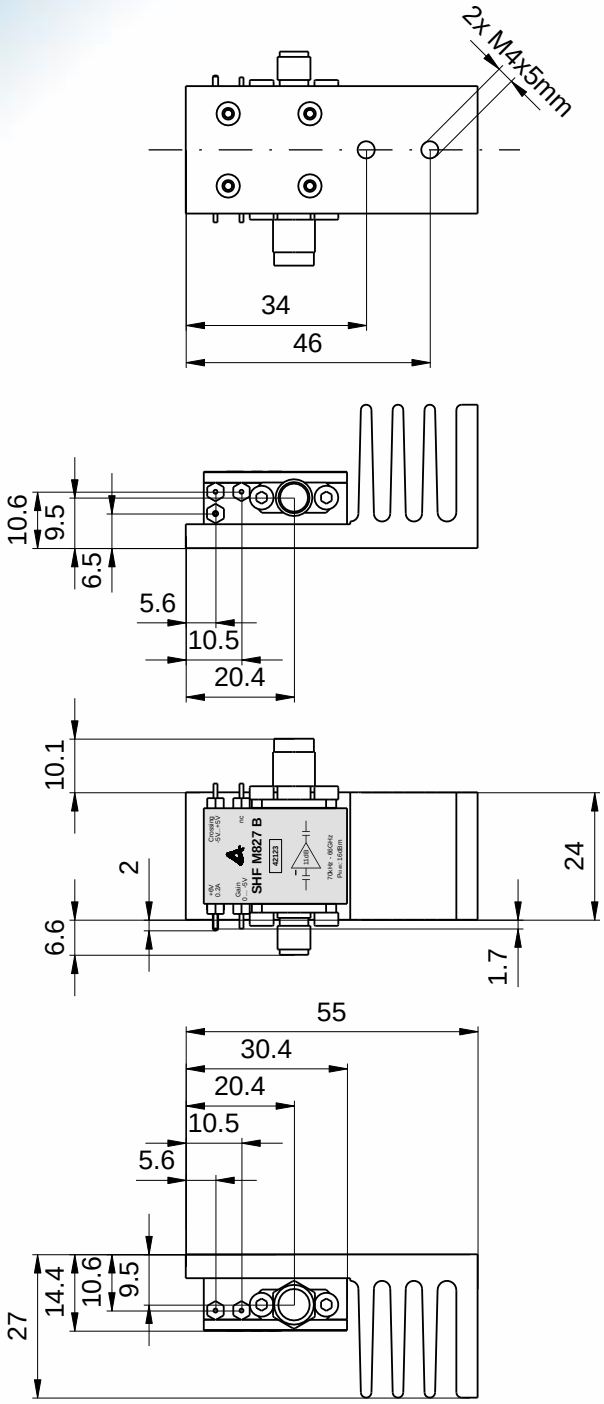


Typical Saturation power



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

Mechanical Drawing with Heat Sink

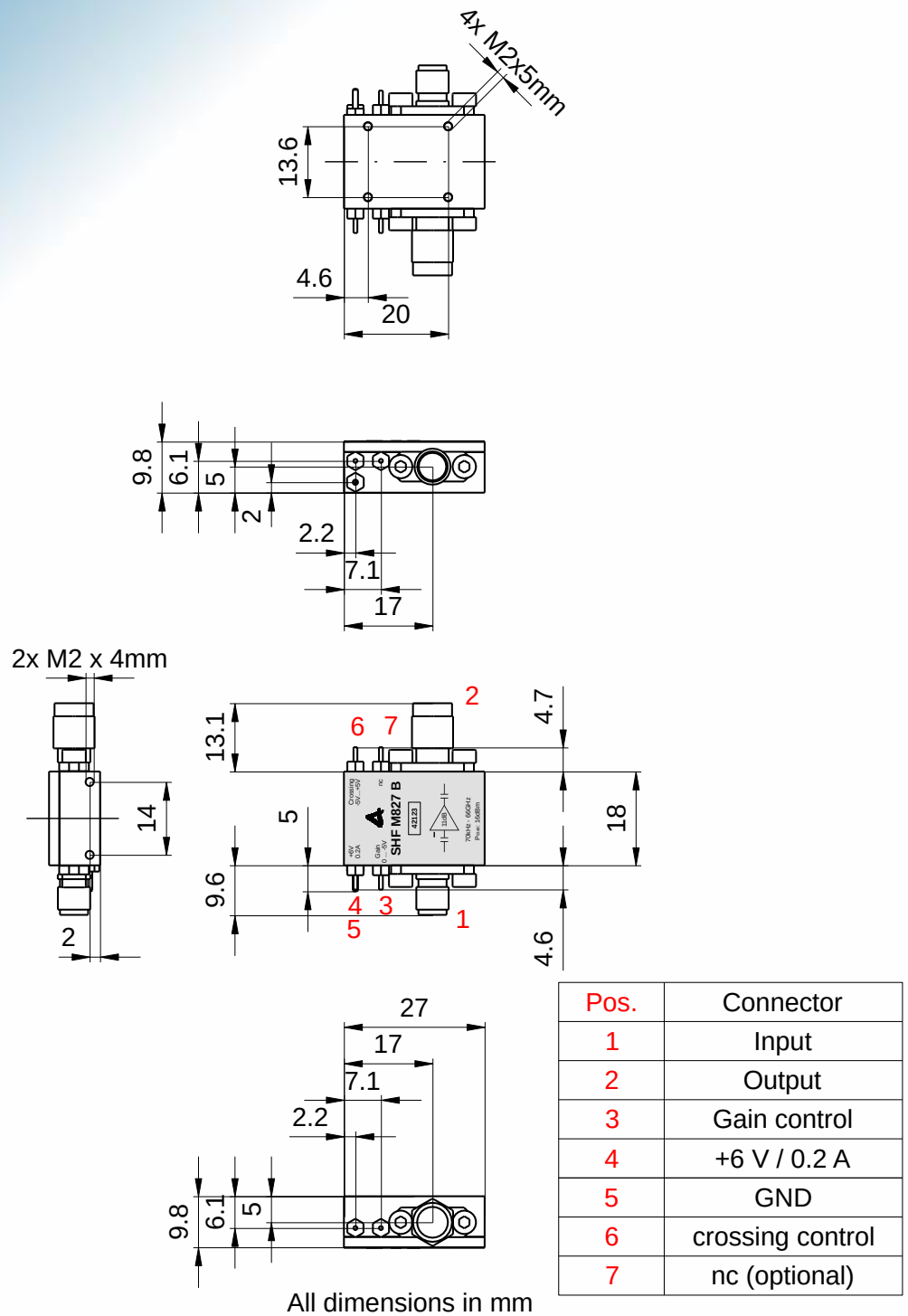


All dimensions in mm

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

For permanent mounting remove the heat sink from the amplifier. In order to separate the heat sink from the amplifier, remove the four screws on the heat sink.

Mechanical Drawing without Heat Sink

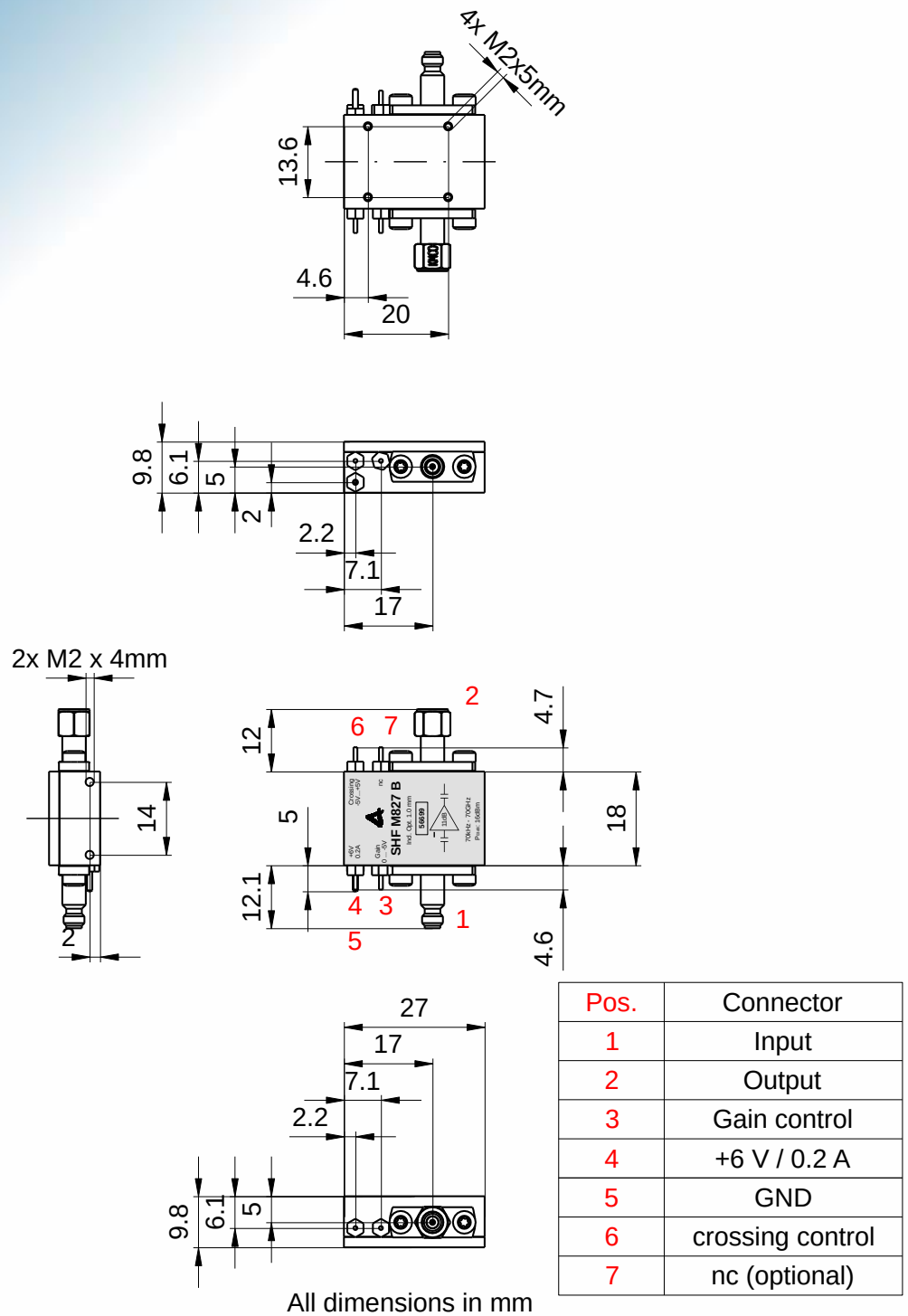


Pos.	Connector
1	Input
2	Output
3	Gain control
4	+6 V / 0.2 A
5	GND
6	crossing control
7	nc (optional)

All dimensions in mm

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

Mechanical Drawing without Heat Sink Option 1.0 mm



Pos.	Connector
1	Input
2	Output
3	Gain control
4	+6 V / 0.2 A
5	GND
6	crossing control
7	nc (optional)

All dimensions in mm

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

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 5.8…7.0 V, 0.2 A DC power supply and can be connected to the supply feed-through filter via an ON / OFF switch.

   In case 6 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/ 1.85mm attenuators)!
5. An input signal of about 1.6 V_{pp} will produce saturated output swing of about 4 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 2 V_{pp} equivalent to 10 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. The ground pin requires significantly more heat as it is connected to the solid housing.