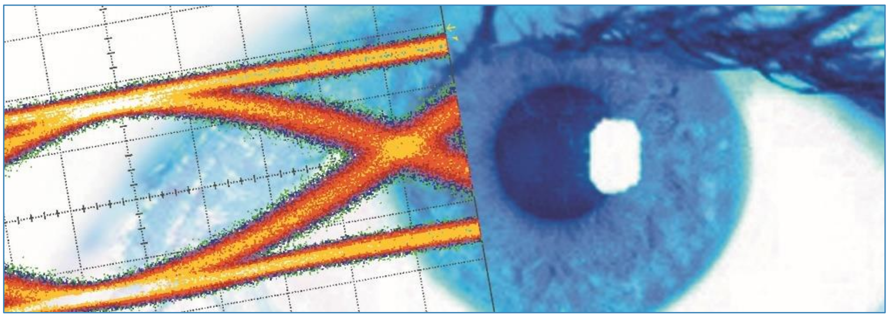


Data Sheet

SHF M804 C

Broadband Amplifier

Description

The SHF M804 C is a RoHS compliant ultra-broadband RF amplifier with a small footprint and a bandwidth of more than 66 GHz.

A distributed amplifier design is employed using our monolithic microwave integrated circuit (MMIC) inside special carriers to achieve the ultra-wide bandwidth.

This extreme bandwidth offers the capability to amplify binary signals of more than 100 GBaud while its good 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.

Options

MP:	Phase matching of two amplifiers
WFWM:	1.0 mm female input and 1.0 mm male output connectors

Specifications

Absolute Maximum Ratings

Parameter	Unit	Symbol	Min	Typ	Max	Comment
Maximum RF Input	dBm V	$P_{in\ max}$			4 1	 peak to peak voltage
DC Voltage at RF Input	V				±9	AC coupled input
DC Voltage at RF Output	V				±8	AC coupled output
Positive Supply Voltage	V		5.7	6	7	max. 0.3 A 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	°C	T_{case}	10	40	50	

Electrical Characteristics (At 40°C case temperature, unless otherwise specified)

Parameter	Unit	Symbol	Min	Typ	Max	Comment
High Frequency 3 dB Point	GHz	f_{High}	66			measured at P_{in}=-20 dBm
Low Frequency 3 dB Point	kHz	f_{Low}			90	measured at P_{in}=-20 dBm
Gain	dB	S_{21}	21	22		measured at P_{in}=-20 dBm @ 500 MHz
Max. Gain Reduction	dB		2.5	3	4	< 2.5 Vpp
Input Reflection	dB	S_{11}			-9 -6	< 30 GHz < 65 GHz
Output Reflection	dB	S_{22}			-10 -6	< 50 GHz < 65 GHz
Output Power at 1 dB Compression	dBm V	P_{01dB}	12 2.5			10 MHz … 30 GHz peak to peak voltage
Output Power at 2 dB Compression	dBm V	P_{02dB}	14 3.2			10 MHz … 30 GHz peak to peak voltage
Output Power at 3 dB Compression	dBm V	P_{03dB}	16 4			10 MHz … 28 GHz peak to peak voltage
Rise Time / Fall Time	ps	tr/tf			6 10	20%...80%, 2 V ≤ V_{out} ≤ 3 V @ 56 Gbps Deconvoluted [1,2] Full Setup [1]
Jitter	fs	JRMS			500 600	2 V ≤ V_{out} ≤ 3 V @ 56 Gbps Deconvoluted [1,2] Full setup [1]
Crossing Control Range	%		-4		4	> 2.3 Vpp
Power Consumption	W			1.5		typ. 6 V / 0.25 A

[1] Measured with the following setup: SHF 613 A DAC -> DUT (SHF M804 C) -> Agilent 86100C with 70 GHz sampling head and precision time base.

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

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

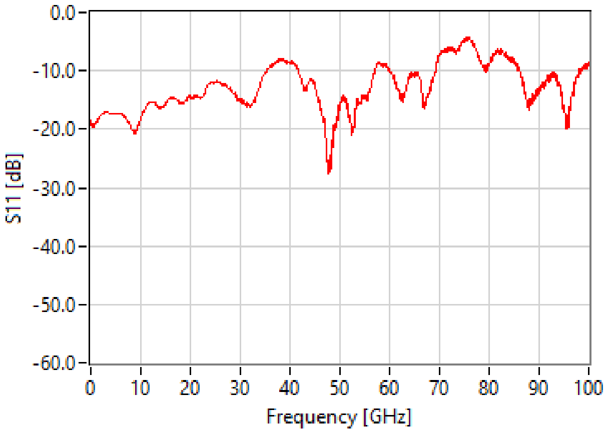
$$J_{RMS\ deconvoluted} = \sqrt{(J_{RMS\ full\ setup})^2 - \left(J_{RMS\ setup\ w/o\ DUT}\right)^2} = \sqrt{(J_{RMS\ full\ setup})^2 - 370\ fs^2}$$

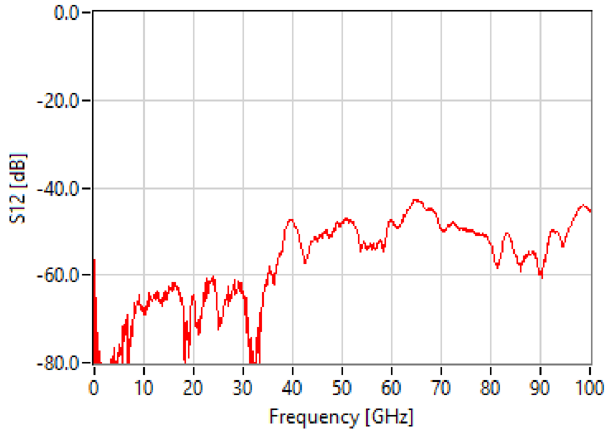
Mechanical Characteristics

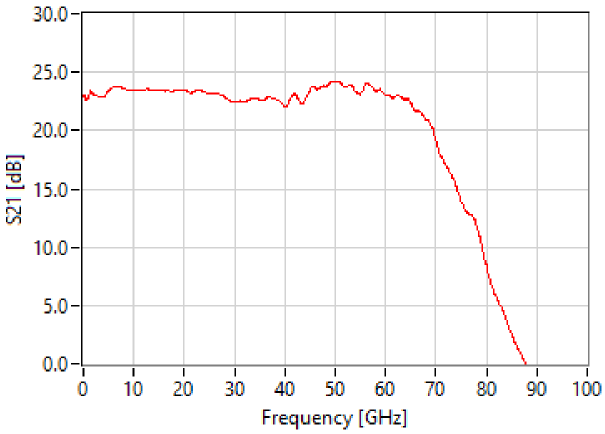
Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Input Connector	Ω			50		1.85 mm female [3] Option WFWM: 1.0 mm female
Output Connector	Ω			50		1.85 mm male [3] Option WFWM: 1.0 mm male
Dimensions	mm					see page 12 to 14
Weight	g			20 55		without heatsink with heatsink

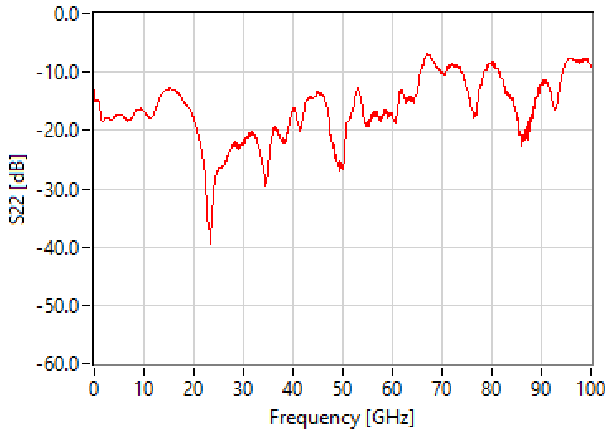
[3] Other gender configurations are available on request.

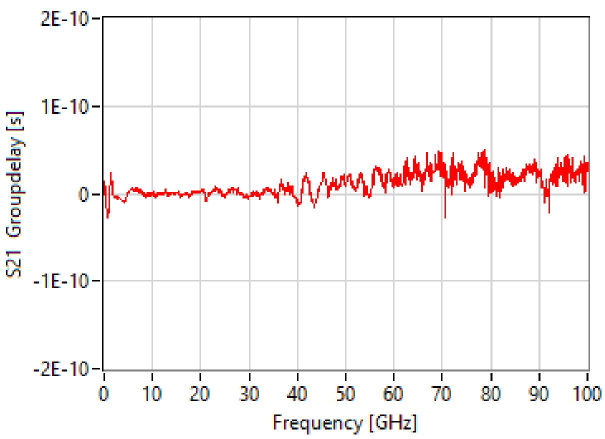
Typical S-Parameters

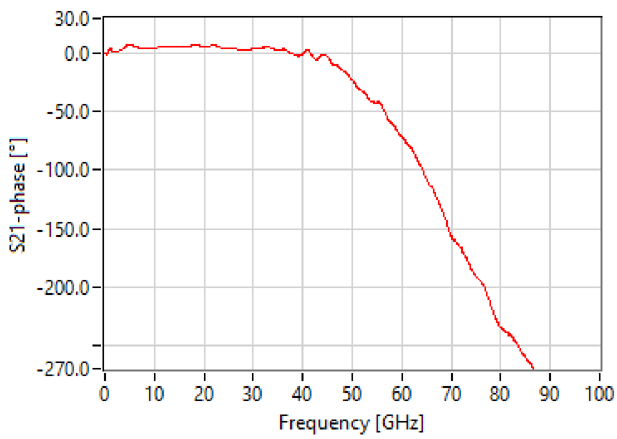










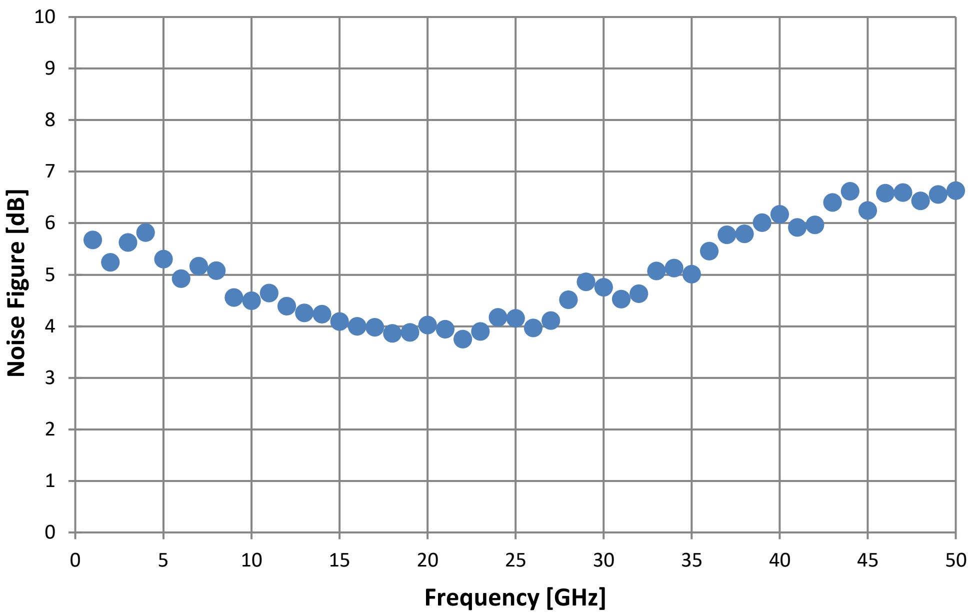


Aperture of group delay measurement: 160 MHz

Printed S-Parameters are part of the inspection report for each individual amplifier. However, unless option WFWM is ordered, the maximum frequency in the inspection report is 70 GHz.

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.



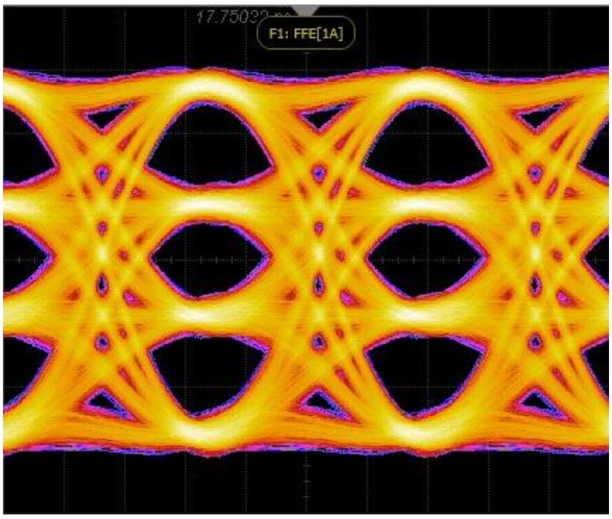
Typical Waveforms

The measurements below had been performed using a SHF 12105 A Bit Pattern Generator, a PAM-MUX or a DAC and one of the scopes mentioned below. The outputs of the SHF module had been connected directly to the amplifier input. The output of the amplifier had been connected with a 20 dB attenuator (SHF ATT110 A) to the scope's input.

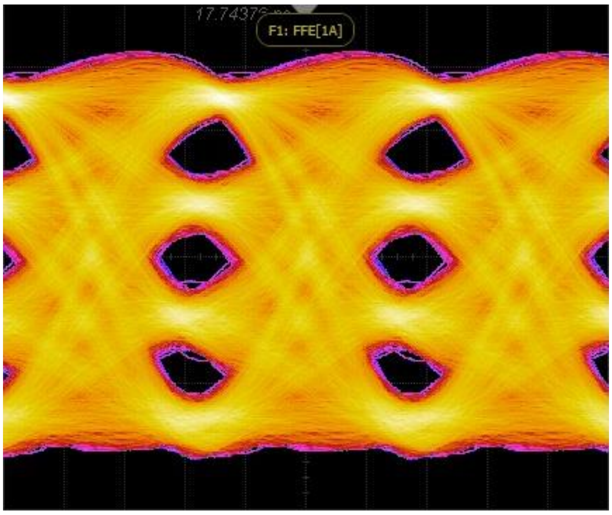
Please note that only the measurements taken with the Agilent DCA 86100 will be part of the inspection report.

Measurements with:

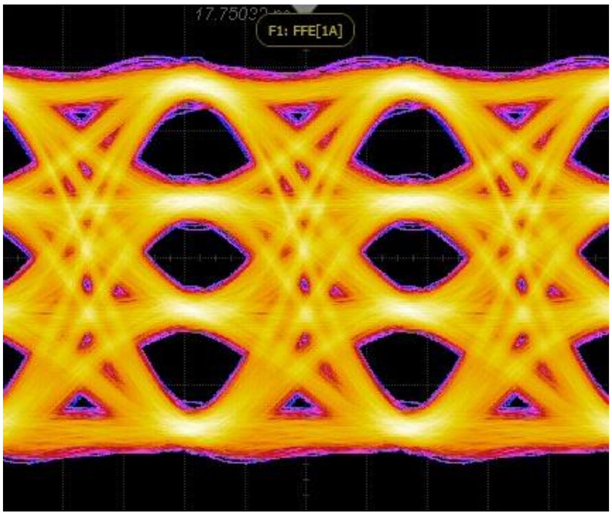
- **SHF 616 C PAM-MUX generating PAM4 signals (PRBS 2^{13}-1)**
- **Keysight DCA N1000A, Precision Timebase & 122 GHz Sampling Module (N1046A)**
- **Linear FFE (7-Tap with 2 pre cursors) applied**



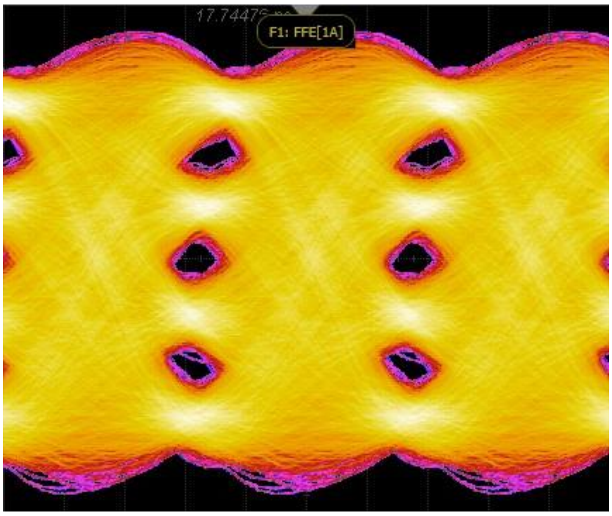
80 Gbaud (160 Gbps) 200 mV Input Signal



80 Gbaud (160 Gbps) 2.5 V Output Signal



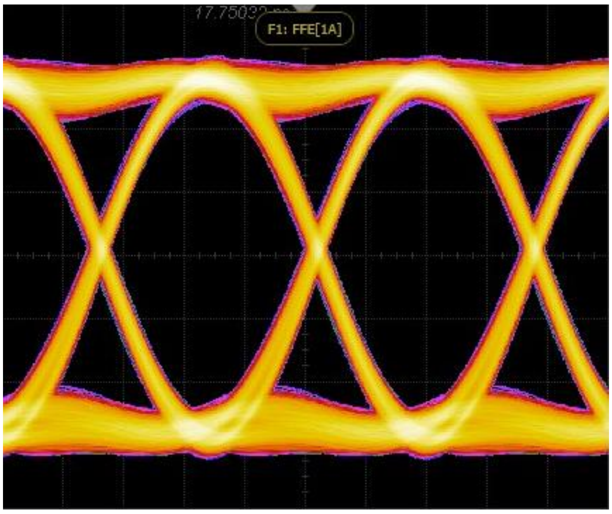
100 Gbaud (200 Gbps) 200 mV Input Signal



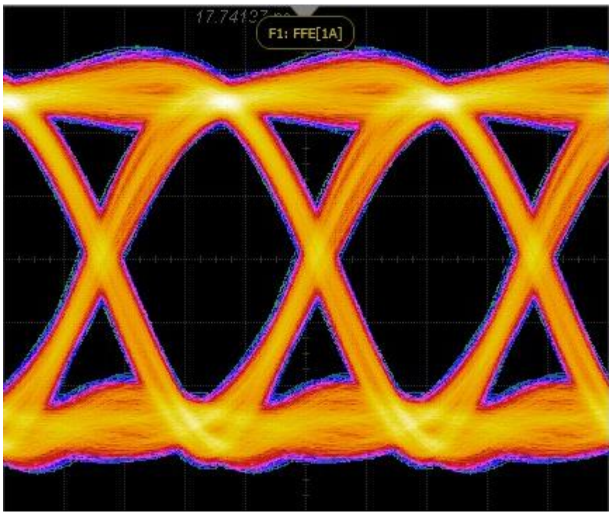
100 Gbaud (200 Gbps) 2.5 V Output Signal

Measurements with:

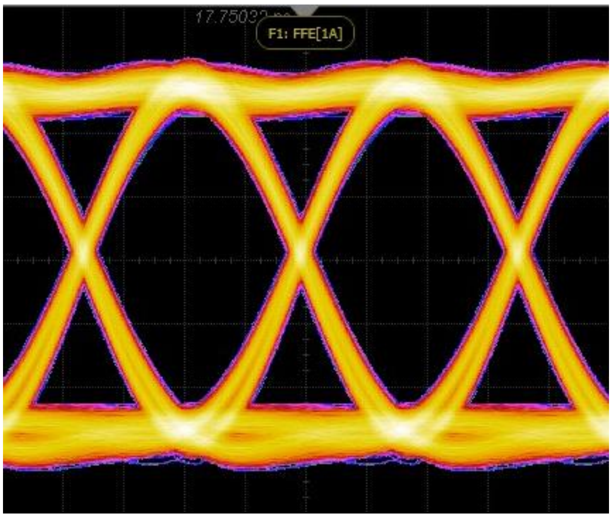
- **SHF 616 C PAM-MUX generating binary signals (PRBS 2^{13}-1)**
- **Keysight DCA N1000A, Precision Timebase & 122 GHz Sampling Module (N1046A)**
- **Linear FFE (7-Tap with 2 pre cursors) applied**



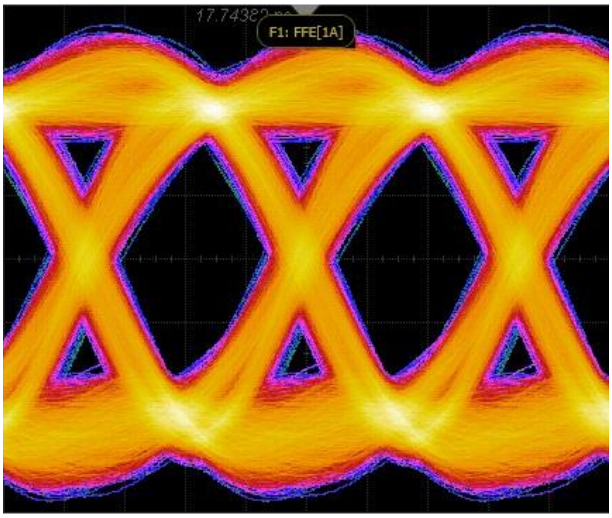
80 Gbps 200 mV Input Signal



80 Gbps 2.6 V Output Signal



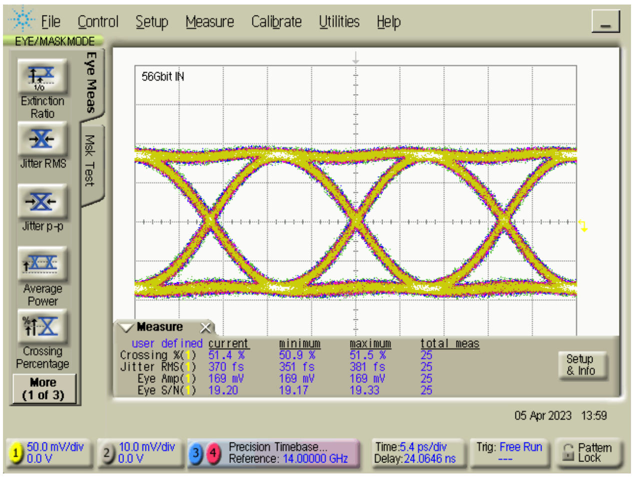
100 Gbps 200 mV Input Signal



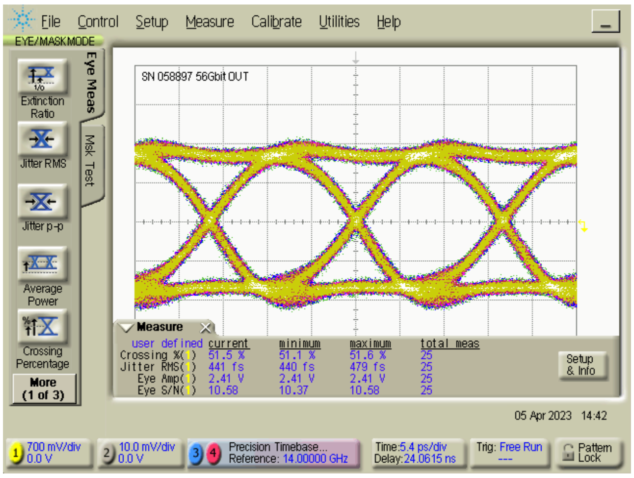
100 Gbps 2.3 V Output Signal

Measurements with:

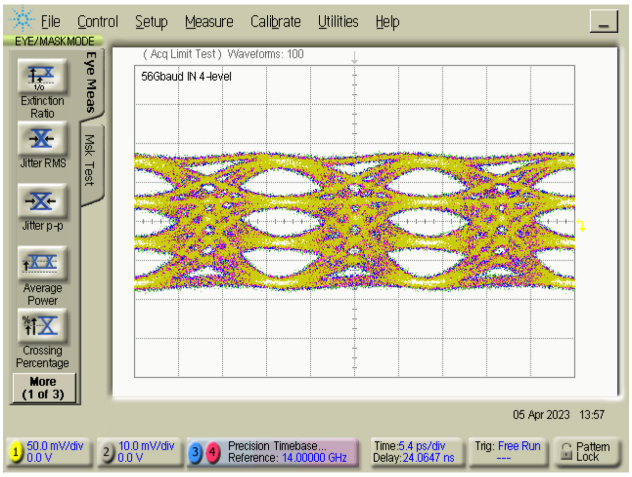
- **SHF 613 A DAC generating binary signals (PRBS 2^{31}-1)**
- **Agilent DCA 86100D with Time Base Module 86107A and Sampling Head 86118A**
- **No Filter applied**



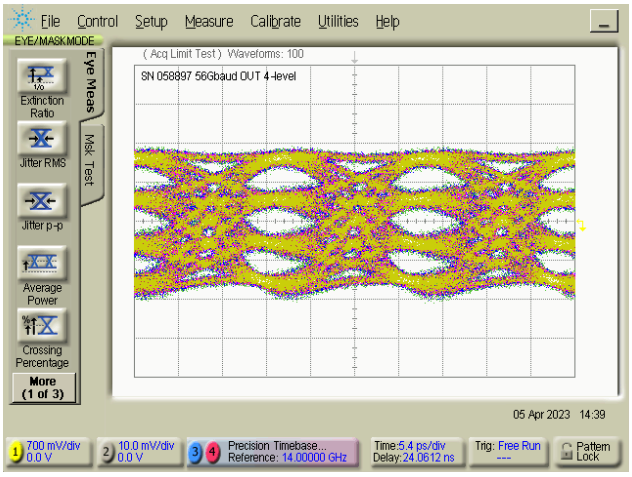
56 Gbps 170 mV Input Signal



56 Gbps 2.4 V Output Signal



56 Gbaud 160 mV Input Signal

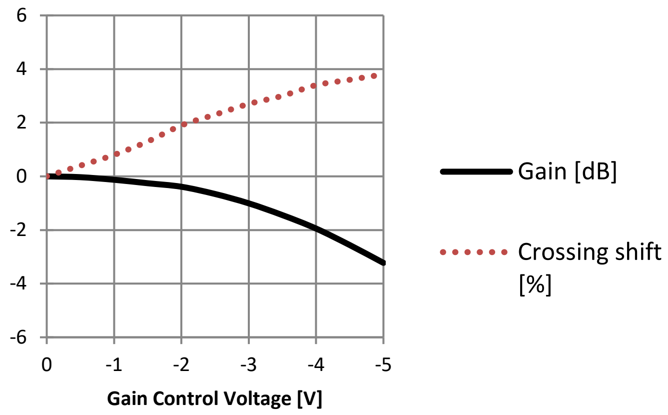


56 Gbaud 2.3 V Output Signal

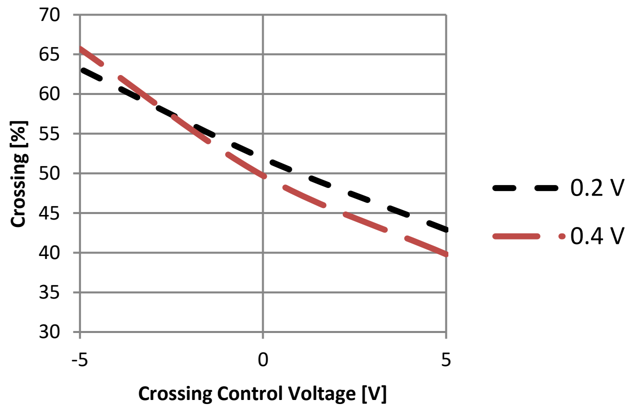
Handling Instructions

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

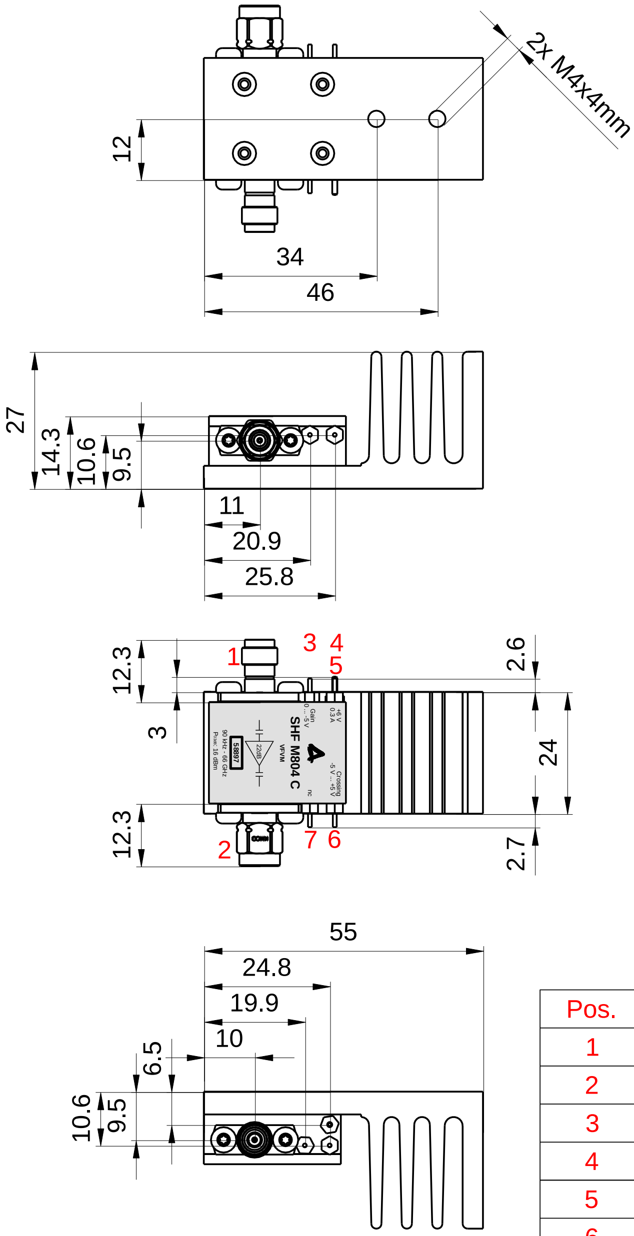
The gain can be adjusted by applying a voltage of 0 to -5 V. If this pin is left open, the amplifier will have maximum gain. By reducing the gain the crossing will shift. Typical characteristics are shown in the following diagram for an input voltage of 0.2 V with 50% crossing.



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 0.2, and 0.4 V with 50% crossing.



Mechanical Drawing with Heat Sink



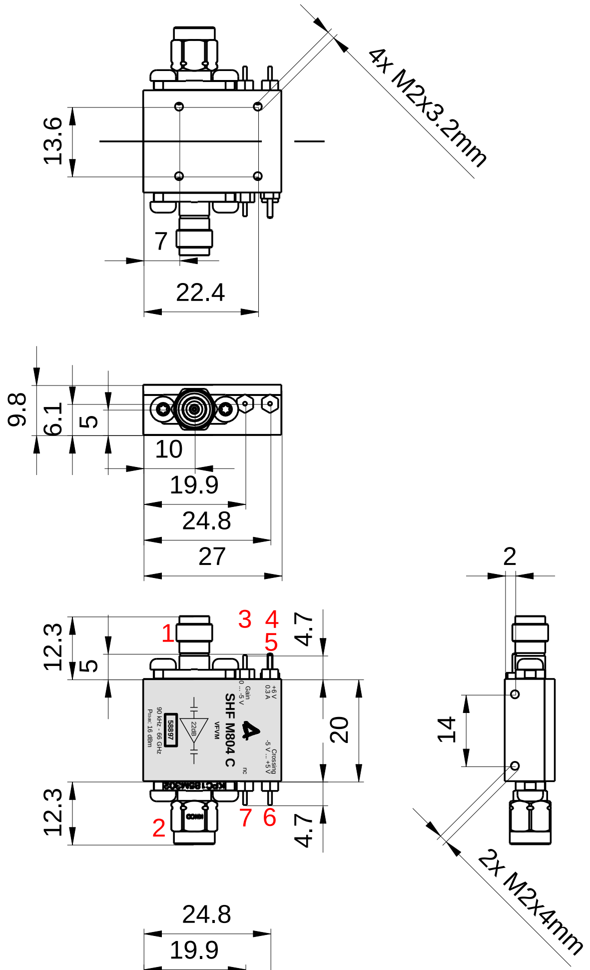
All dimensions in mm

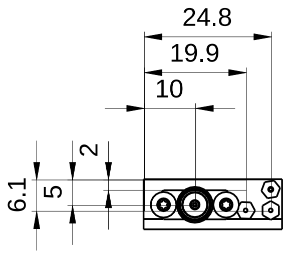
Pos.	Connector
1	Input
2	Output
3	Gain control
4	+6 V / 0.3 A
5	GND
6	Crossing control
7	nc

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

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 gap pad is used between the heat sink and the amplifier housing.

Mechanical Drawing without Heat Sink



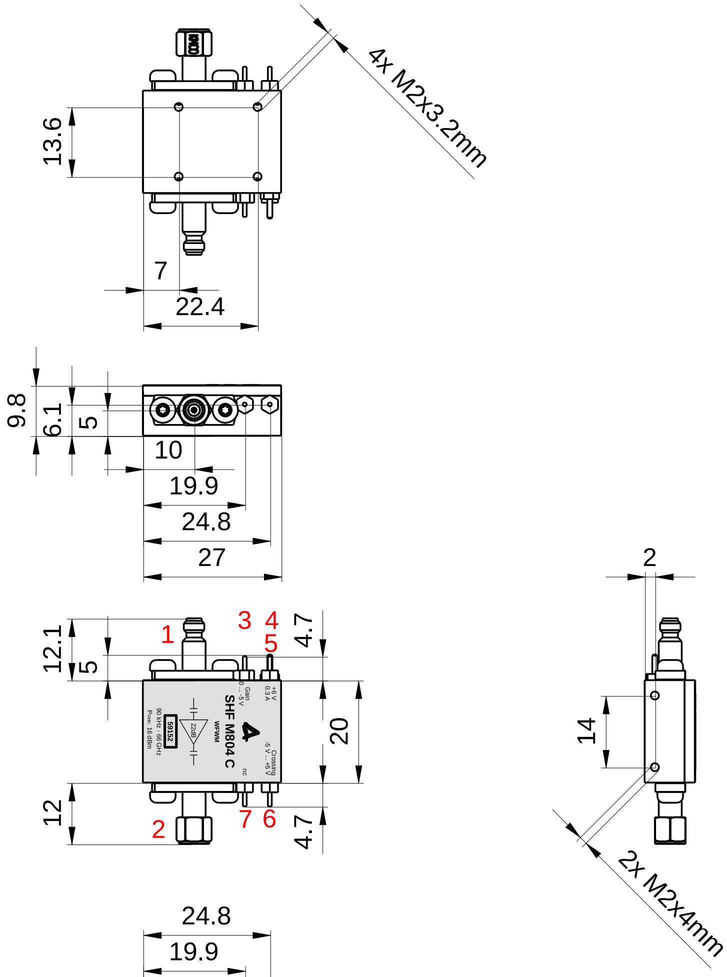


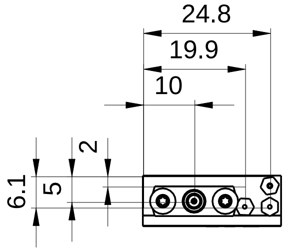
Pos.	Connector
1	Input
2	Output
3	Gain control
4	+6 V / 0.3 A
5	GND
6	Crossing control
7	nc

All dimensions in mm

Please ensure that adequate cooling of the amplifier is guaranteed.

Mechanical Drawing without Heat Sink and Option WFWM





Pos.	Connector
1	Input
2	Output
3	Gain control
4	+6 V / 0.3 A
5	GND
6	Crossing control
7	nc

All dimensions in mm

Please ensure that adequate cooling of the amplifier is guaranteed.

User Instructions

Electrostatic sensitive device

1. To prevent damage through static charge build up, cables should be always discharged before connecting them to the amplifier!
2. First make the connections between amplifier, signal source and a 50 Ohm output load before supplying DC power to the amplifier!
3. The supply voltage can be taken from any regular 5.7…7 V, 0.5 A DC power supply and can be connected to the supply feed-through filter via an ON / OFF switch. Do not increase the supply voltage slowly from 0!
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 65 GHz!
5. While using a reflective load the output voltage has to be reduced to a safe operating level according to the magnitudes of the reflections.
6. 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)!
7. The input voltage should never be greater than 1 Vpp equivalent to 4 dBm input power.
8. In case a bias tee is connected to the amplifier, please note that abrupt connection or disconnection of the RF port of such bias tees may cause harmful transients. Therefore, it is always recommended not to connect or disconnect bias tees under bias voltage. For example, ramp down the bias to 0 V before lifting a waver prober.
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 feed-through. The ground pin requires significantly more heat as it is connected to the solid housing.

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