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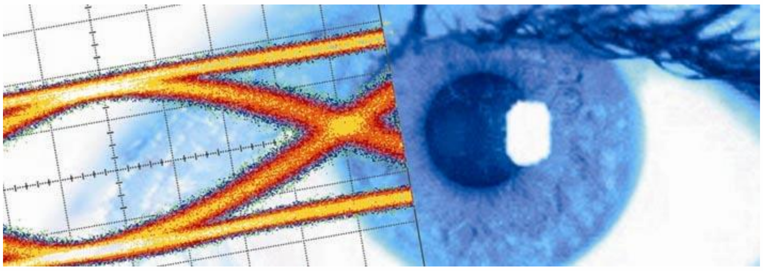


Datasheet

SHF D837 C

Differential to Single-Ended Linear Broadband Amplifier

Description

The SHF D837 C is a RoHS compliant differential input, single-ended output linear amplifier designed for PAM4 and 16QAM applications. The single-ended output drive amplitude of up to at least 3 V linear is particularly well suited for state-of-the-art single-drive DP-16QAM modulators. When driven from the differential outputs of a high performance DAC, the common-mode rejection characteristic of this differential input design helps to maintain the linearity and resolution of the DAC.

This amplifier is of a single chip design based on state-of-the-art commercial GaAs process, housed in a special low loss carrier PCB environment to maintain wide bandwidth and low group delay variation, necessary for high performance operation.

Like other amplifiers in the product family, this amplifier enjoys the same benefit of an internal voltage regulation to protect against accidental reverse voltage connection. Similarly, the output amplitude and crossing adjustment using software control via an USB connection. Once adjusted, the connection can be removed until the next time.

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 software 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 V1.7

Available Options

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

04: Built-in bias tee on output (max. ±7 V, max. 220 mA) [1]

[1] The options 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 80 kHz. The DC resistance of an bias tee is about 3 Ω.

Specifications – SHF D837 C

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Absolute Maximum Ratings						
Maximum RF Input Power in Operation	dBm V	$P_{in\ max}$			4 1	single ended peak to peak voltage
Maximum RF Input Power without Power Supply	dBm V	$P_{in\ max}$			10 2	single ended peak to peak voltage
DC Voltage at RF Input	V				±9	AC coupled input
DC Voltage at RF Output	V				±7	AC coupled output
Supply Voltage	V		8		12	0.4 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	$f_{HIGH\ InP}$	45			single ended [3], non-inverting input
	GHz	$f_{HIGH\ InN}$	32			single ended [3], inverting input
	GHz	$f_{HIGH\ Diff}$	35			Calculated from single ended
Low Frequency 3 dB Point	kHz	f_{LOW}			50	each inputs
Gain	dB	S_{21}	9	10		measured at P_{in}= -30 dBm
Gain Ripple	dB	ΔS_{21}		±0.5	±1	40 MHz…25 GHz, relative to gain-slope
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 3.6	16 4.0		10 MHz…25 GHz peak to peak voltage
Output Power at 3 dB Compression	dBm V	P_{03dB}	16 4.0	17 4.5		10 MHz…25 GHz peak to peak voltage
3^{rd} Order Intercept Point	dBm	IP_3	25			
Max. RF Input for Linear Operation	dBm V	$P_{in\ lin}$			-3 0.45	I.e. Pout ≤ P01dB peak to peak voltage, single ended
Max. Output Power Reduction	dB			tbd		P_{in} ≥ - 2 dBm Crossing might need to be readjusted by using the crossing control feature. Control via software interface
Crossing Control Range	%		-4		4	Control via software interface Vout ~2.5 V

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

[3] Single ended measurement condition with -30 dBm input power

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Input Reflection	dB	S_{11}			-12 -9	< 10 GHz, single ended < 30 GHz, single ended
Output Reflection	dB	S_{22}			-9	< 30 GHz
Rise Time/Fall Time	ps	t_r/t_f			7 11	20%...80%, 2.5 V ≤ Vout ≤ 3.5 V Deconvoluted [4, 5] Full Setup [4]
Jitter	fs	J_{RMS}		500 580	550 650	2.5 V ≤ Vout ≤ 3.5 V Deconvoluted [4, 5] Full Setup [4]
Group Delay Ripple	ps				±50	40 MHz…30 GHz, 100 MHz aperture
Power Consumption	W			2.7		9 V supply voltage
Mechanical Characteristics						
Input Connectors						1.85 mm (V) female [6]
Output Connector						1.85 mm (V) male [6]

[4] Measured with: SHF 613 A DAC -> DUT (SHF D837 C) -> Agilent 86100C with 70 GHz sampling head & precision time base.

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

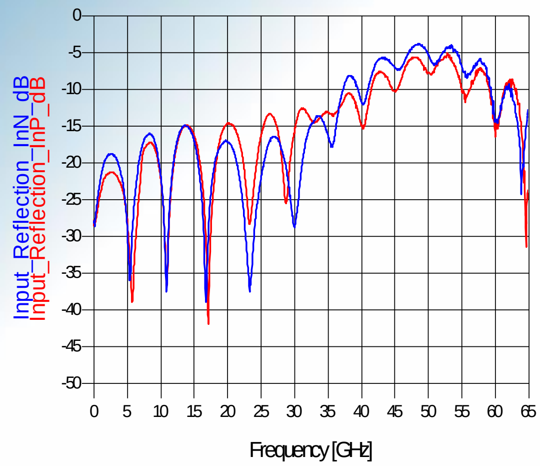
$$t_r/t_{f\ deconvoluted} = \sqrt{(t_r/t_{f\ full\ setup})^2 - (t_r/t_{f\ setup\ w/o\ DUT})^2} = \sqrt{(t_r/t_{f\ full\ setup})^2 - 11\ ps^2}$$

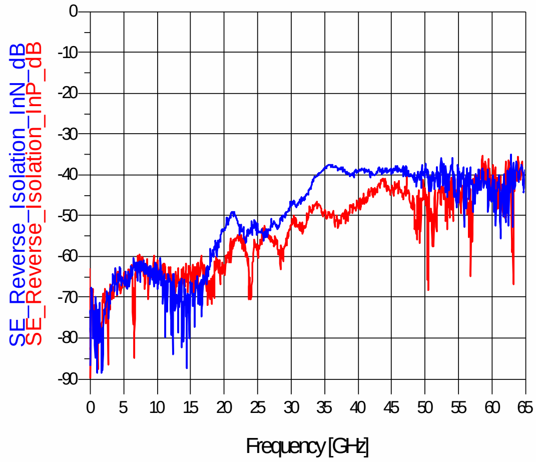
$$J_{RMS\ deconvoluted} = \sqrt{(J_{RMS\ full\ setup})^2 - \left(J_{RMS\ setup\ w/o\ DUT}\right)^2} = \sqrt{(J_{RMS\ full\ setup})^2 - 360\ fs^2}$$

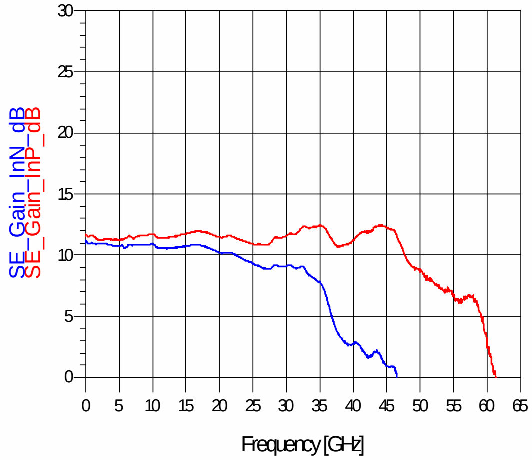
[6] Other gender configurations are available on request. Other connector types are also available but may impact bandwidth & reflection.

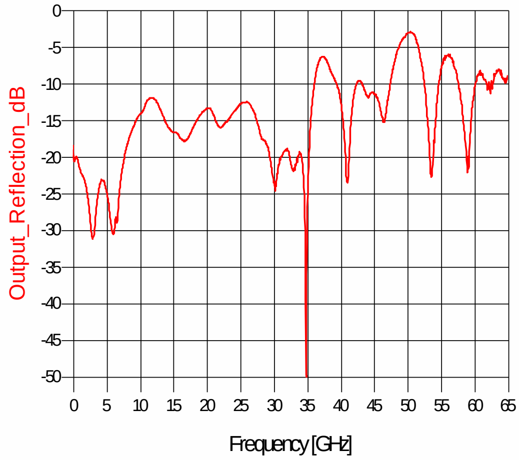
Typical S-Parameters, Group Delay and Phase Response

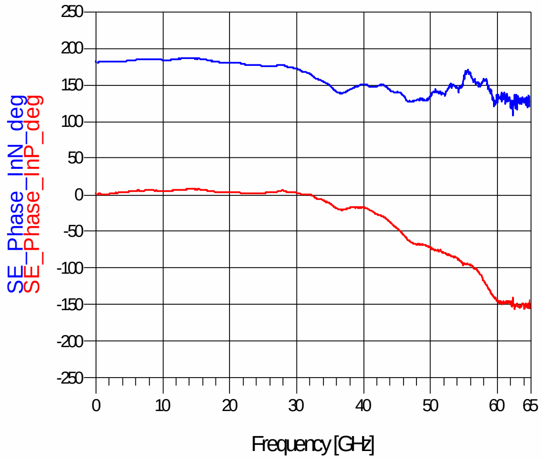
Single-Ended Measurements

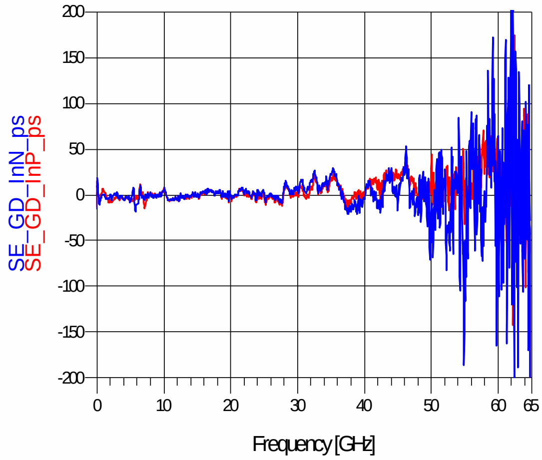






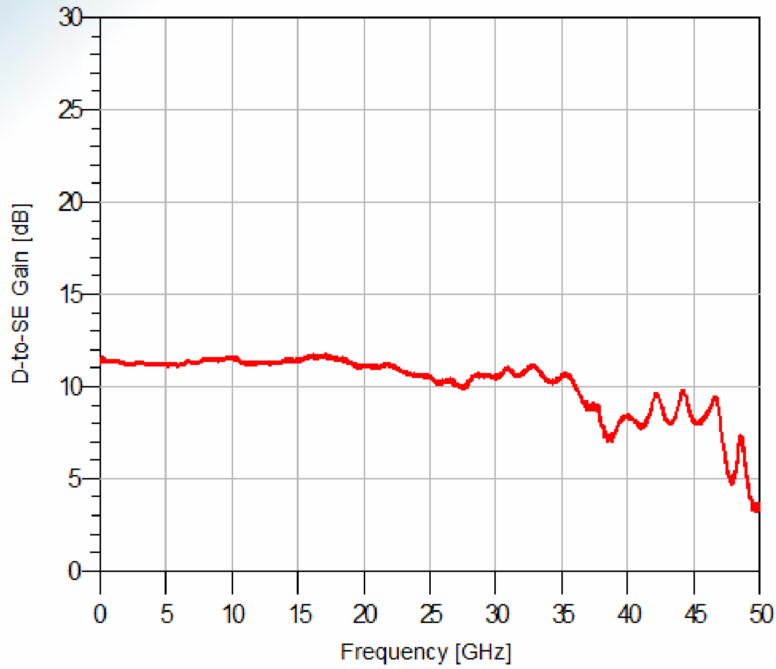




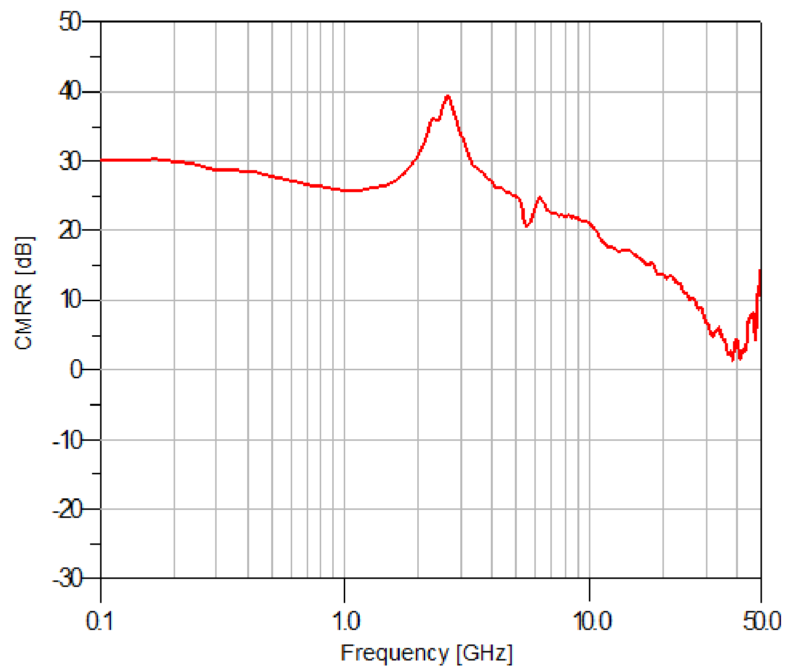


Typical Frequency Response

Differential to Single-Ended (calculated from Single-Ended Measurements)



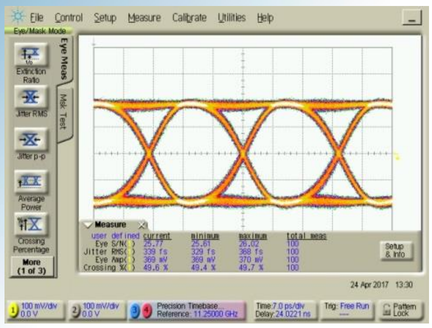
Typical Common-Mode-Rejection-Ratio (CMRR)



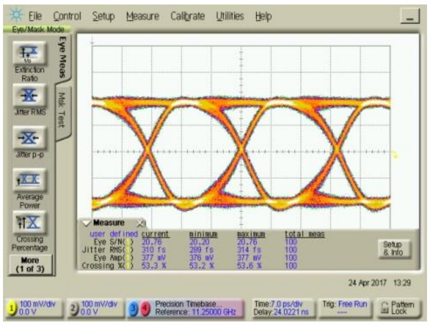
SHF Communication Technologies AG
the bandwidth company

Typical Binary Eye Diagrams

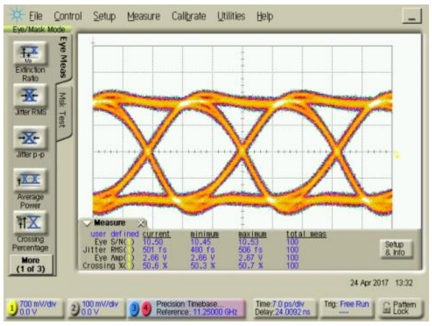
The measurements below had been performed using a SHF 613 A DAC and an Agilent 86100D DCA with Precision Time Base Module (86107A) and 70 GHz Sampling Head (86118A).



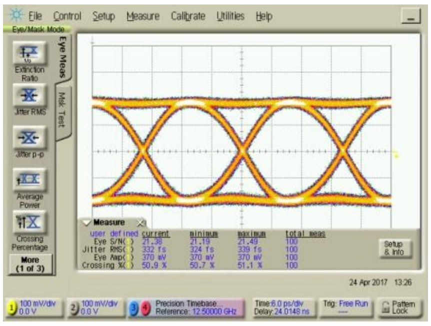
Input Signal InP @ 45 Gbps, Eye amplitude: 369 mV



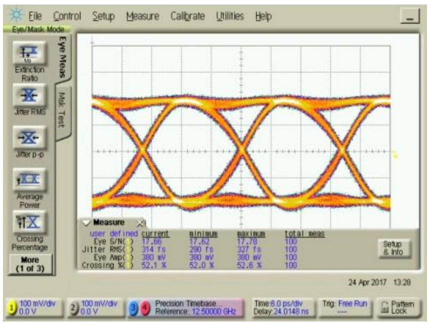
Input Signal InN @ 45 Gbps, Eye amplitude: 377 mV



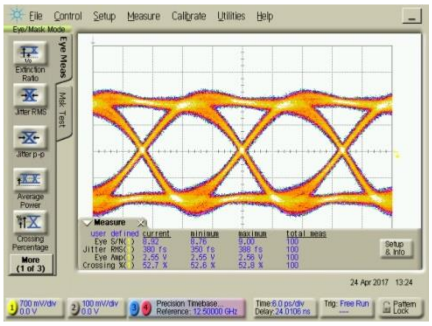
Output Signal @ 45 Gbps, Eye amplitude: 2.7 V



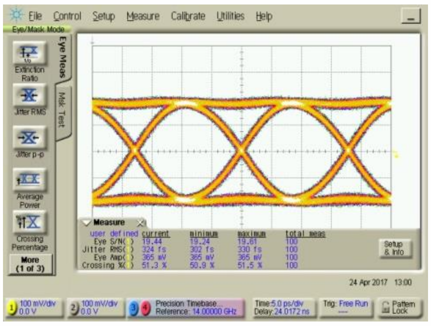
Input Signal InP @ 50 Gbps, Eye amplitude: 370 mV



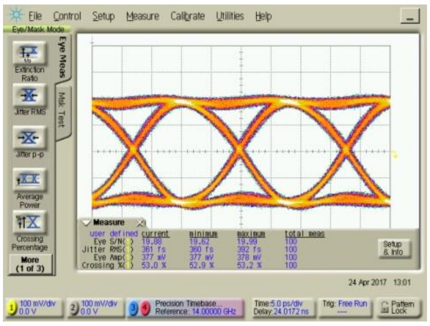
Input Signal InN @ 50 Gbps, Eye amplitude: 380 mV



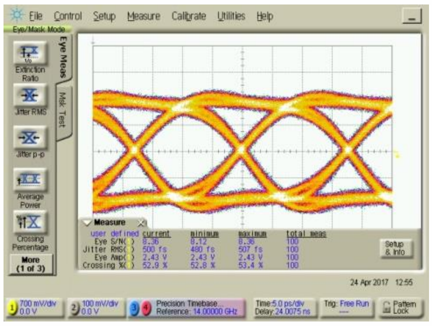
Output Signal @ 50 Gbps, Eye amplitude: 2.6 V



Input Signal InP @ 56 Gbps, Eye amplitude: 365 mV



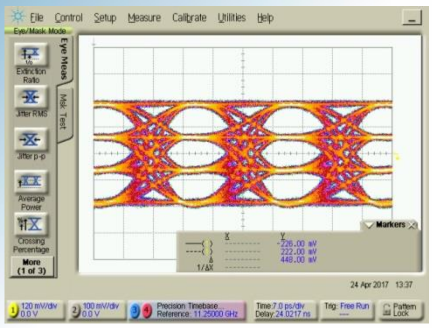
Input Signal InN @ 56 Gbps, Eye amplitude: 377 mV



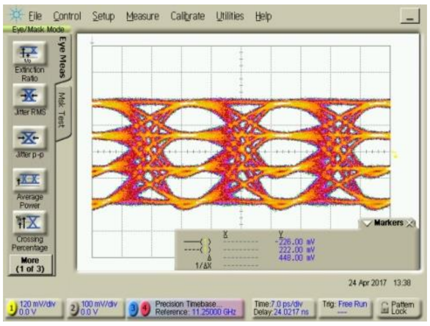
Output Signal @ 56 Gbps, Eye amplitude: 2.4 V

Typical 4-Level Eye diagrams

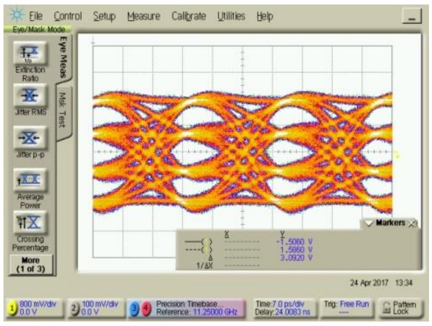
The measurements below had been performed using a SHF 613 A DAC and an Agilent 86100D DCA with Precision Time Base Module (86107A) and 70 GHz Sampling Head (86118A).



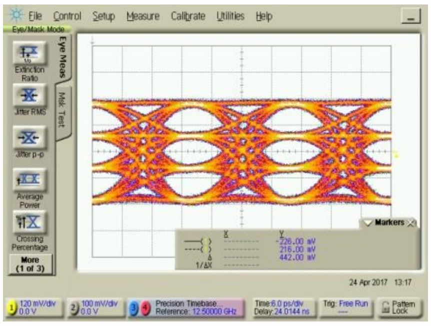
Input Signal InP @ 45 GBaud, Eye amplitude: 448 mV



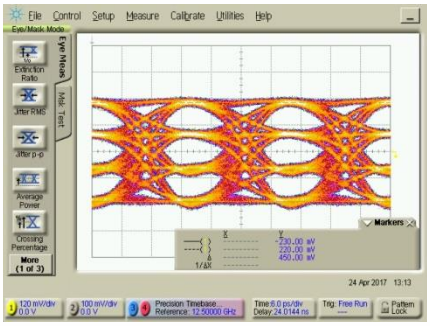
Input Signal InN @ 45 GBaud, Eye amplitude: 448 mV



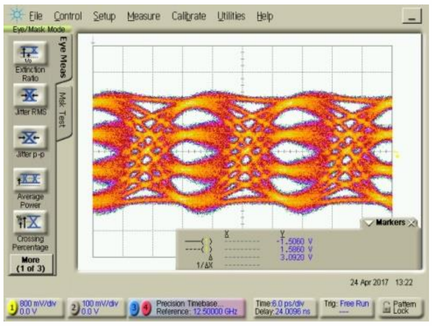
Output Signal @ 45 GBaud, Eye amplitude: 3.1 V



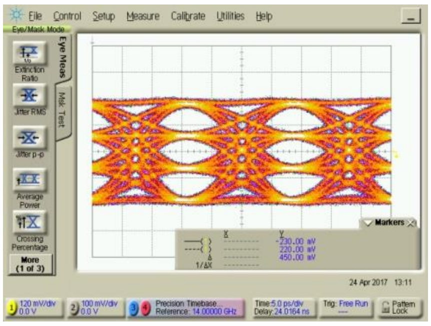
Input Signal InP @ 50 GBaud, Eye amplitude: 442 mV



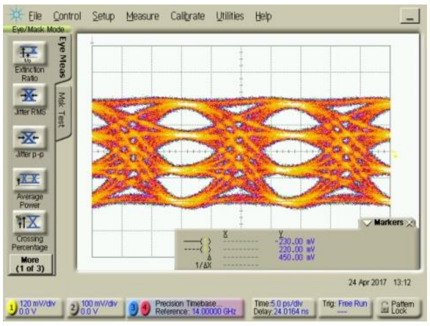
Input Signal InN @ 50 GBaud, Eye amplitude: 450 mV



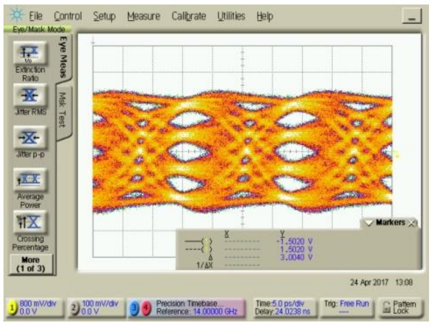
Output Signal @ 50 GBaud, Eye amplitude: 3.1 V



Input Signal InP @ 56 GBaud, Eye amplitude: 450 mV

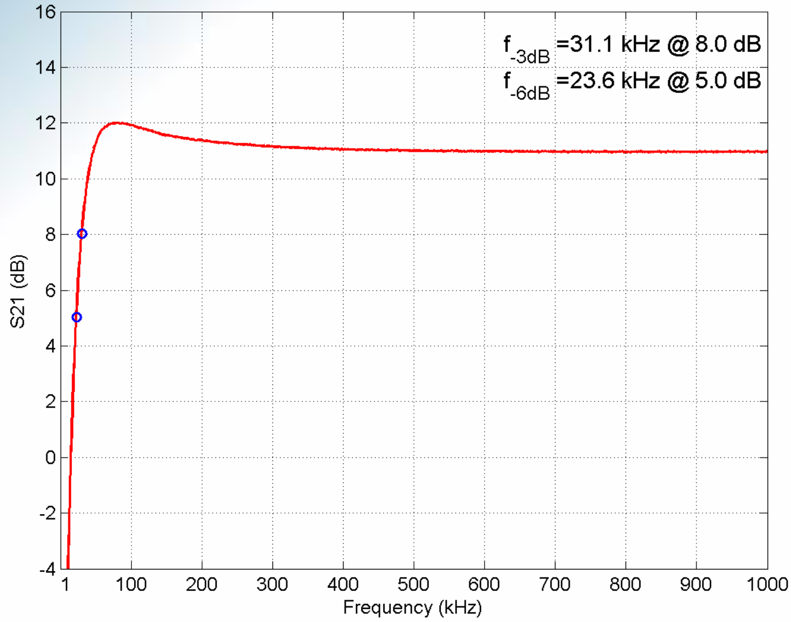


Input Signal InN @ 56 GBaud, Eye amplitude: 450 mV



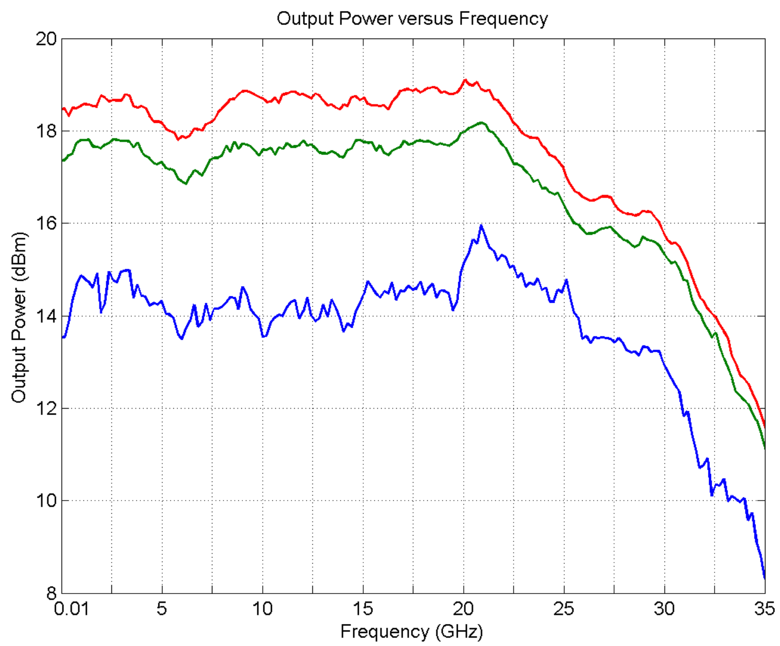
Output Signal @ 56 GBaud, Eye amplitude: 3.0 V

Typical Low Frequency Response (<1 MHz)



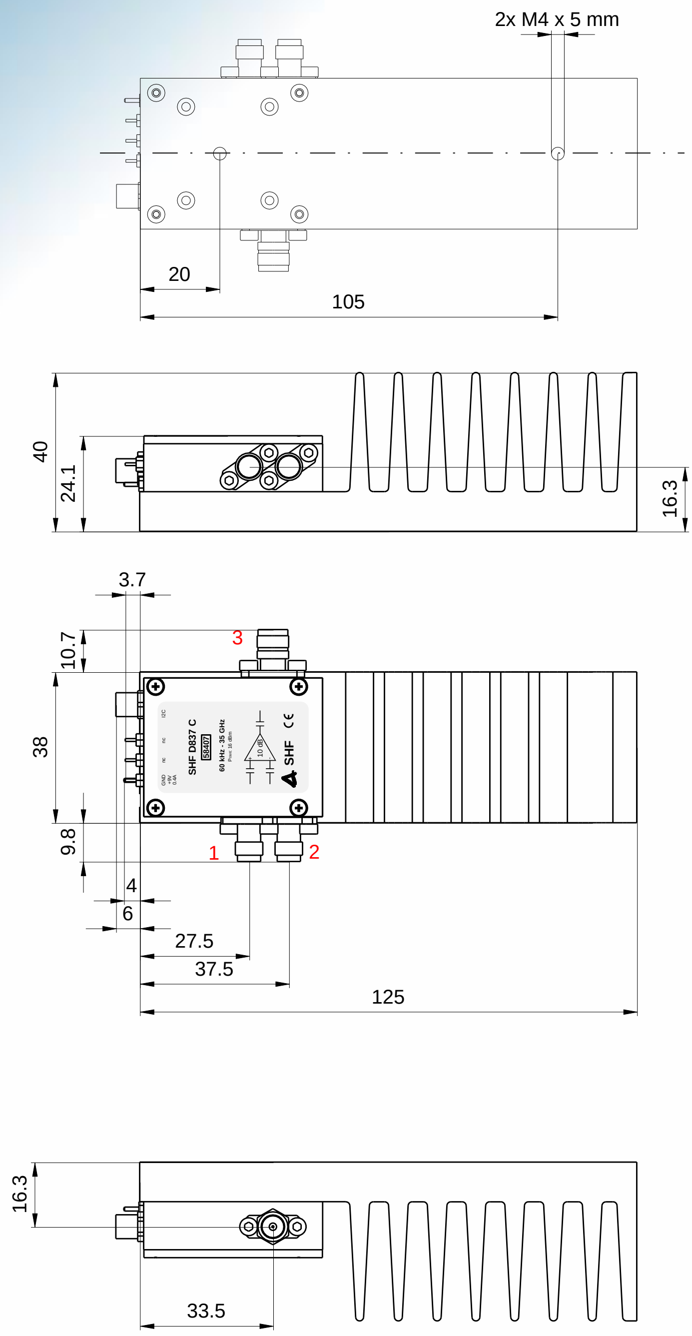
Typical Saturation Power Characteristic

(single-ended measurement InN to Out)

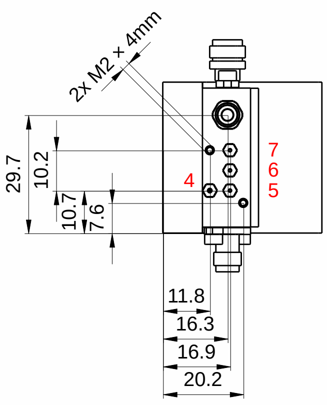


Top (**red**): 3 dB compression;
Middle (**green**): 2 dB compression;
Bottom (**blue**): 1 dB compression

Mechanical Drawing with Heat Sink



Port	Connector
1	Non-Inverting Input
2	Inverting Input
3	Output
4	GND
5	+9 V / 0.4 A
6	nc (BiasT)
7	nc

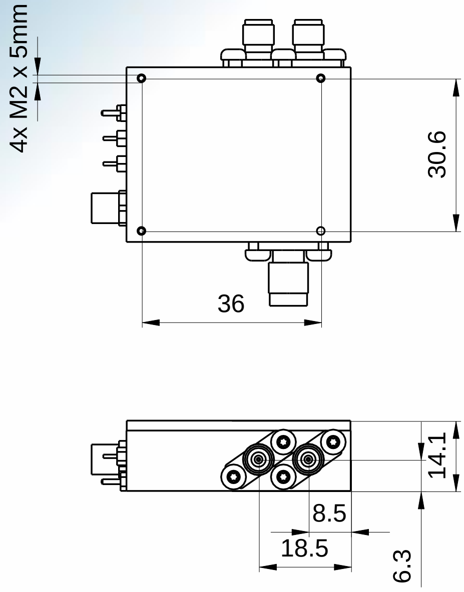


In standard configuration pin 6 is not connected (nc). If an output bias-tee (option 04) is included the DC bias can be connected to pin 6 (BiasT).

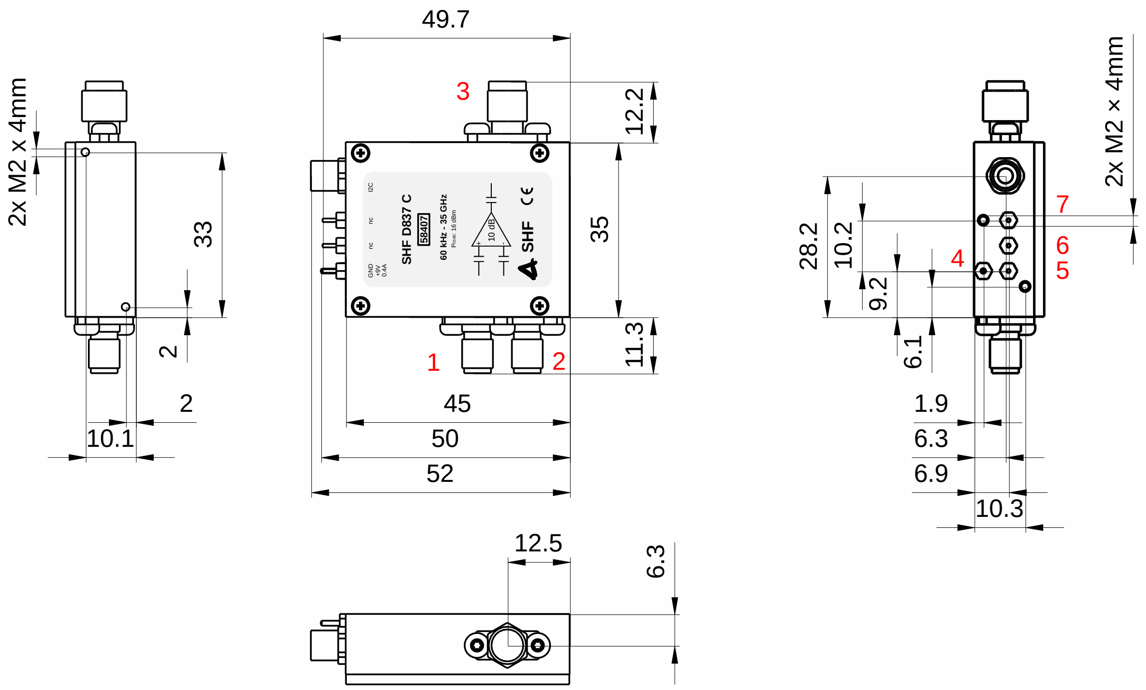
Thermal resistance of heat sink approx. 4 K/W

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 without Heat Sink



Port	Connector
1	Non-Inverting Input
2	Inverting Input
3	Output
4	GND
5	+9 V / 0.4 A
6	nc (BiasT)
7	nc



In standard configuration pin 6 is not connected (nc). If an output bias-tee (option 04) is included the DC bias can be connected to pin 6 (BiasT).

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, 0.4 A 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 0.4 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. A differential input signal of about 1 Vpp will produce output swing of about 3 Vpp. 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 (single ended) should never be greater than 2 Vpp equivalent to 10 dBm input power.
9. 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.
10. 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.