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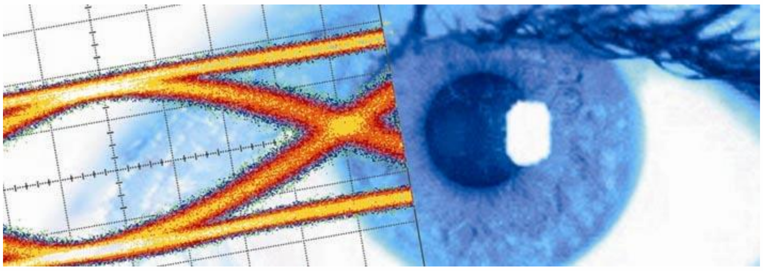
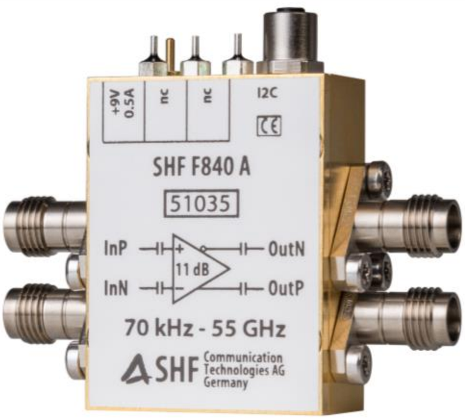


Datasheet

SHF F840 A

Differential Linear Broadband Amplifier



Description

The SHF F840 A is a RoHS- compliant differential linear amplifier designed for high data rate NRZ and PAM4 (16QAM) applications. The differential output amplitude of up to at least 4 V linear is well suited to drive differential-drive modulators at baud rates of up to at least 80 GBaud.

The SHF F840 A is optimized for differential drive and amplifies both inputs with a common gain circuitry to have the output amplitude and the propagation delay of both outputs most equal. The two inputs cannot be used single-ended i.e. both, the signal and the inverted signal have always to be applied to the amplifier.

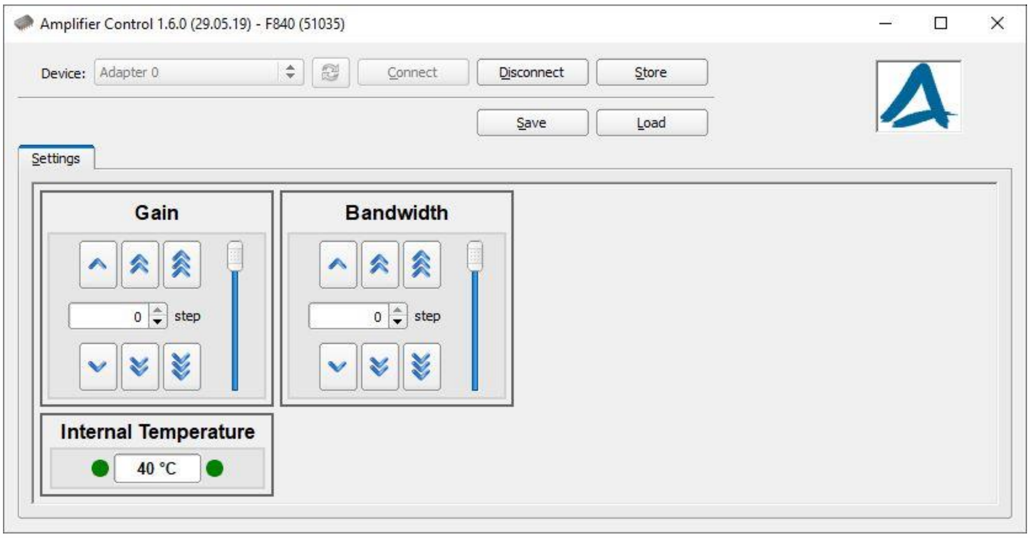
Like other SHF amplifiers this driver is supposed for use in an RF laboratory environment and enjoys the benefit of an internal voltage regulation to protect against accidental reverse voltage connection.

Ease of Use

Upon delivery, the amplifier is already pre-set to deliver maximum gain and maximum bandwidth. 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 is included with each amplifier at 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 and bandwidth adjustments are to be made.

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



GUI of the SHF Amplifier Control software V1.6

Available Options

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

DHS: Dual Heat Sink, two amplifiers on one heatsink

Applications

- Optical Communications
- High-Speed Pulse Experiments
- Satellite Communications
- Research and Development
- Data Transmission studies for 100 Gbps (100GbE), 200 Gbps (200GbE), 400 Gbps (400GbE) & 1 Tbps (TbE) system evaluation
- Broadband test and measurement equipment
- PAM4 and Advanced Modulation Experiments

[1] In case a bias tee option is chosen it may impact the specifications. Gain and 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 a bias tee is about 6 Ω. There is a separate DC path for each output.

Specifications – SHF F840 A

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Absolute Maximum Ratings						
Maximum Single Ended RF Input Signal	dBm	$P_{in\ max}$			0	each input port
	V				0.7	each input port peak-to-peak input voltage
DC Voltage at RF Input	V				±2	AC coupled input
DC Voltage at RF Output	V				±9	AC coupled output
Supply Voltage	V		8		12	9 V recommended
Case Temperature[2]	°C	T_{case}	10	40	50	
Electrical Characteristics (At 40°C case temperature, unless otherwise specified)						
High Frequency 3 dB Point[3]	GHz	f_{HIGH}	55			
Low Frequency 3 dB Point[3]	kHz	f_{LOW}			70	
Gain[3]	dB	S_{21}	10	11		differential out/differential in
Max. Gain Reduction[4]	dB		-1.5	-2		control via software interface
Maximum Single Ended Output Signal[4]	dBm	P	10			each output port
	V		2			each output port peak-to-peak output voltage
Maximum Differential Output Voltage	V		4			peak-to-peak output voltage
Common Mode Rejection Ratio	dB	CMRR		t.b.d.		
Differential Output Skew	ps	t_{skew}		t.b.d.		
Jitter	fs	J_{RMS}		460 550	580 650	deconvoluted[5,6] full setup[5]
Power Consumption	W			3.6		i.e. 0.4 A @ 9 V supply voltage

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

[3] Measured with an active 70 GHz balun at the inputs and a passive balun at the outputs.

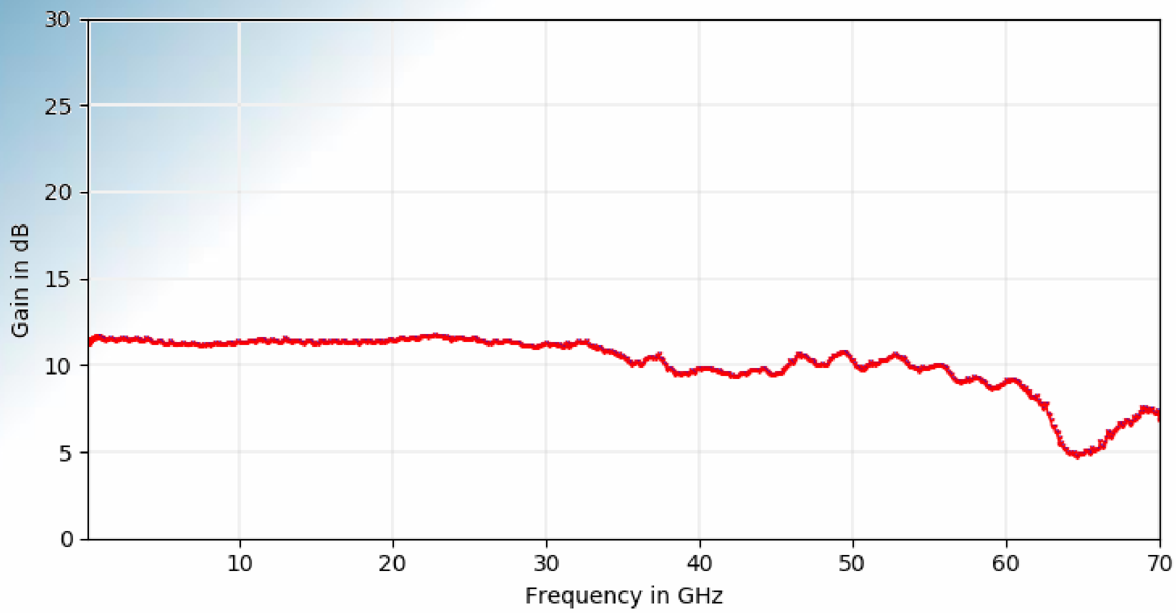
[4] Measured with a SHF 604 A power mux at the inputs

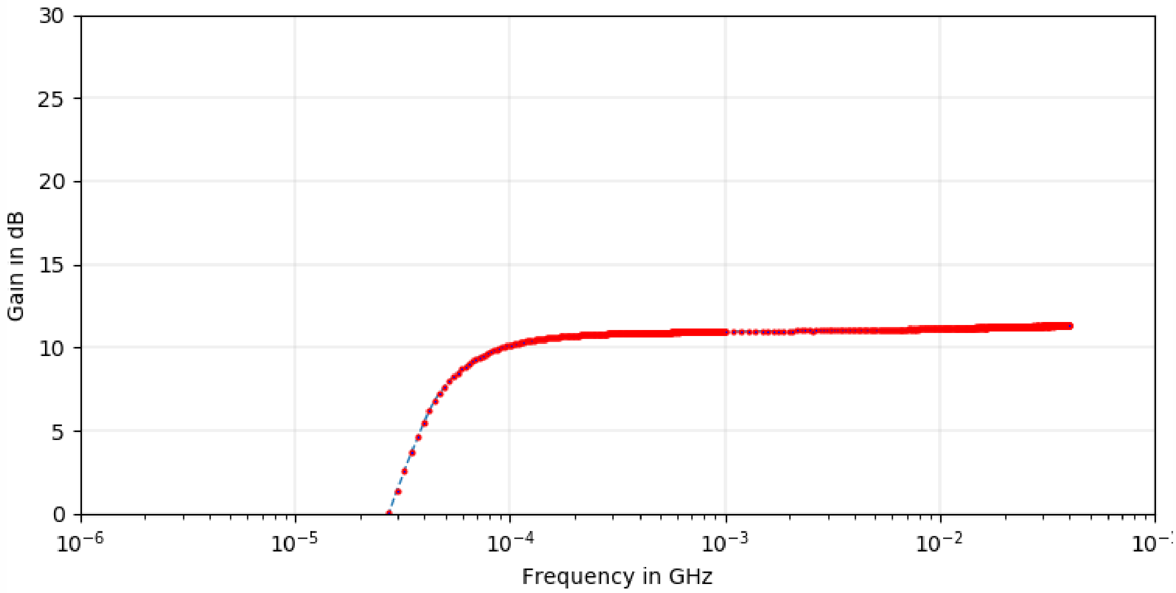
[5] Measured with the following setup: SHF 616 A PAM-MUX -> DUT (SHF F840 A) -> Tektronix DSA 8300 with 70 GHz sampling module (80E11) and phase reference module (82A04B-60G).

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

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Mechanical Characteristics						
Input Connectors						1.85 mm (V) female
Output Connectors						1.85 mm (V) female
Dimensions	mm					see page 10 to 12
Weight	g			45 255 320		without heat sink with single heat sink DHS: two amplifier on one heat sink

Typical Differential Frequency Response[7]





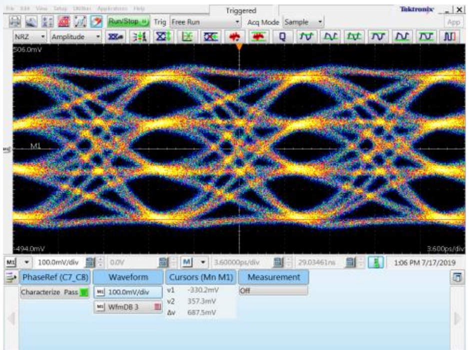
[7] Measured with an active 70 GHz balun at the inputs and a passive balun at the outputs

Typical Differential 4-Level Waveforms

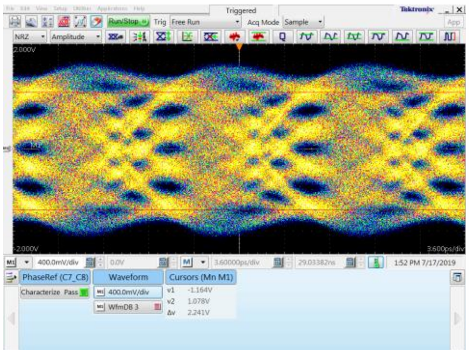
The measurements below had been performed using a SHF 12104 A Bit Pattern Generator (PRBS 2^{31}-1), a SHF 616 A PAM-MUX and a Tektronix DSA 8300 Digital Serial Analyzer (DSA) with Phase Reference Module (82A04B-60G), 70 GHz Sampling Module (80E11), 60 mm semi-rigid cable between SHF 616 A and F840 A and 60 mm semi-rigid cable between F840 A and Sampling Module. The Amplifier was measured with 10 dB Attenuators between the outputs and the Sampling Module. Gain and Bandwidth of the amplifier was set to maximum.

The screen shots were taken by using the math function of the scope to display the sum of the single ended input- and output signals.

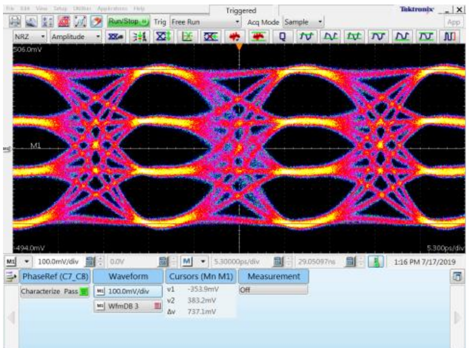
The measurement at 60 GBaud will be part of the inspection report delivered with each particular device.



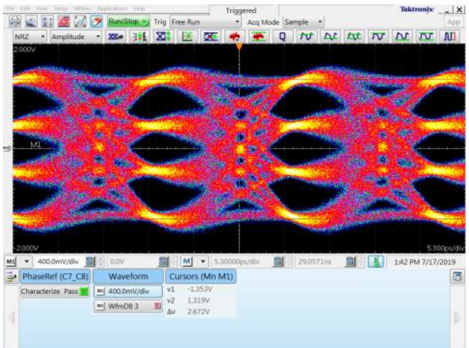
Input Signal @ 90 GBaud, Amplitude: 688 mV



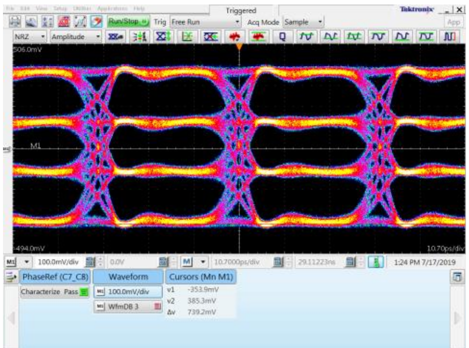
Output Signal @ 90 GBaud, Amplitude: 2.24 V



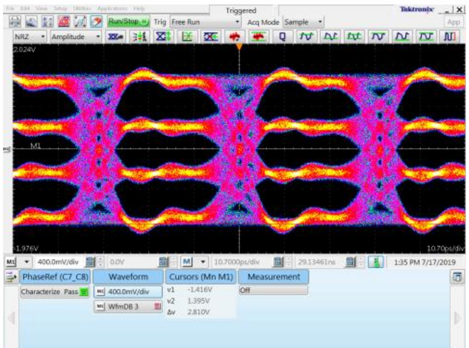
Input Signal @ 60 GBaud, Amplitude: 737 mV



Output Signal @ 60 GBaud, Amplitude: 2.67 V



Input Signal @ 30 GBaud, Amplitude: 739 mV

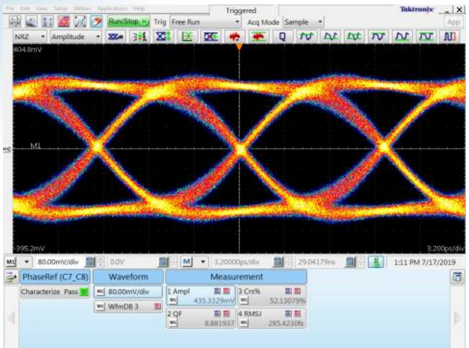


Output Signal @ 30 GBaud, Amplitude: 2.81 V

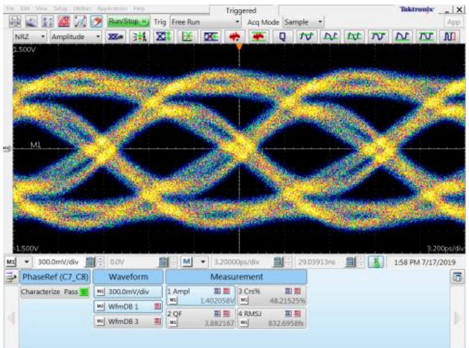
Typical Differential Binary Waveforms (Low Voltage Drive)

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 SHF 616 A and F840 A and 60 mm semi-rigid cable between F840 A and Sampling Module. The Amplifier was measured with 10 dB Attenuators between the outputs and the Sampling Module. Gain and Bandwidth of the amplifier was set to maximum.

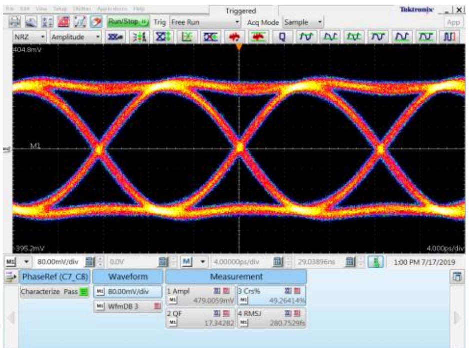
The measurement at 60 Gbps will be part of the inspection report delivered with each particular device.



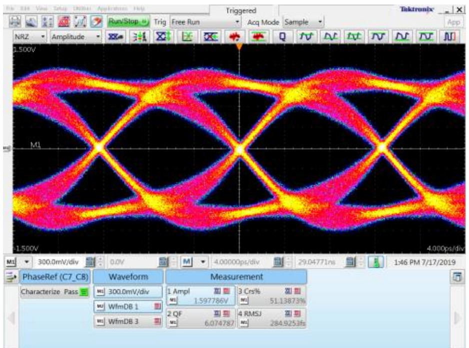
Input Signal @ 100 Gbps, Amplitude: 435 mV



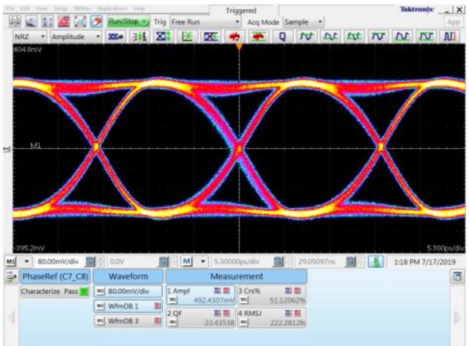
Output Signal @ 100 Gbps, Amplitude: 1.40 V



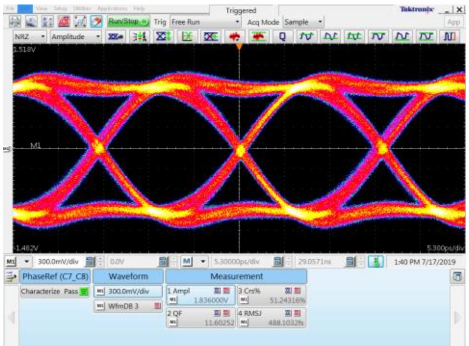
Input Signal @ 80 Gbps, Amplitude: 479 mV



Output Signal @ 80 Gbps, Amplitude: 1.60 V



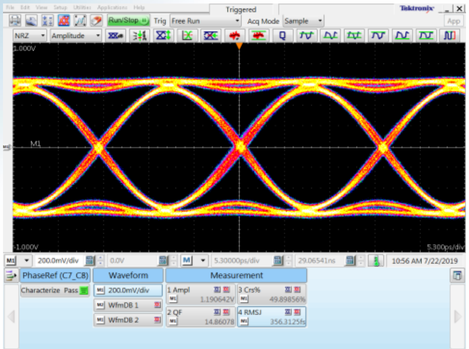
Input Signal @ 60 Gbps, Amplitude: 492 mV



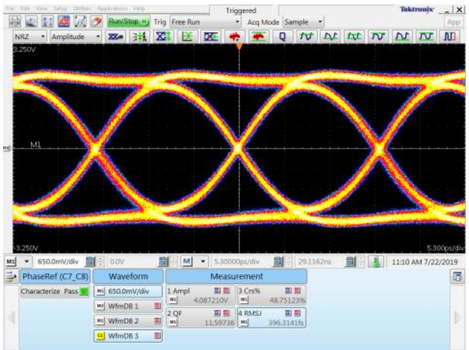
Output Signal @ 60 Gbps, Amplitude: 1.84 V

Typical Differential Binary Waveforms (High Voltage Drive)

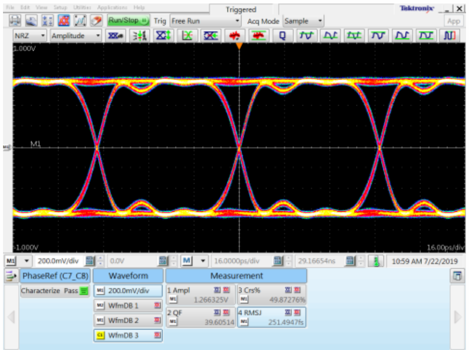
The measurements below had been performed using a SHF 12104 A Bit Pattern Generator (PRBS 2^{31}-1), a SHF 604 A POWER-MUX and a Tektronix DSA 8300 Digital Serial Analyzer (DSA) with Phase Reference Module (82A04B-60G), 70 GHz Sampling Module (80E11), 60 mm semi-rigid cable between SHF 616 A and F840 A and 60 mm semi-rigid cable between F840 A and Sampling Module. The Amplifier was measured with 10 dB Attenuators between the outputs and the Sampling Module. Gain and Bandwidth of the amplifier was set to maximum.



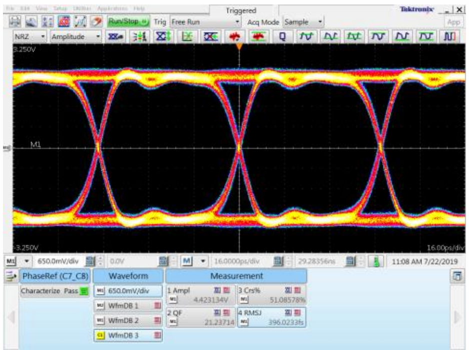
Input Signal @ 60 Gbps,
Amplitude: 1.19 V



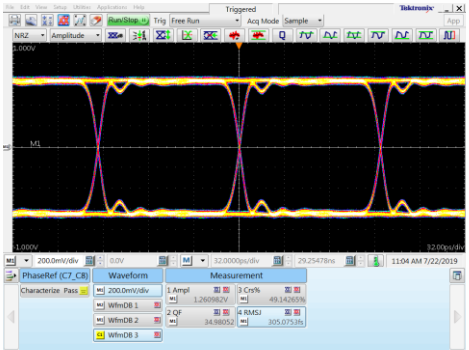
Output Signal @ 60 Gbps,
Amplitude: 4.09 V



Input Signal @ 20 Gbps,
Amplitude: 1.27 V



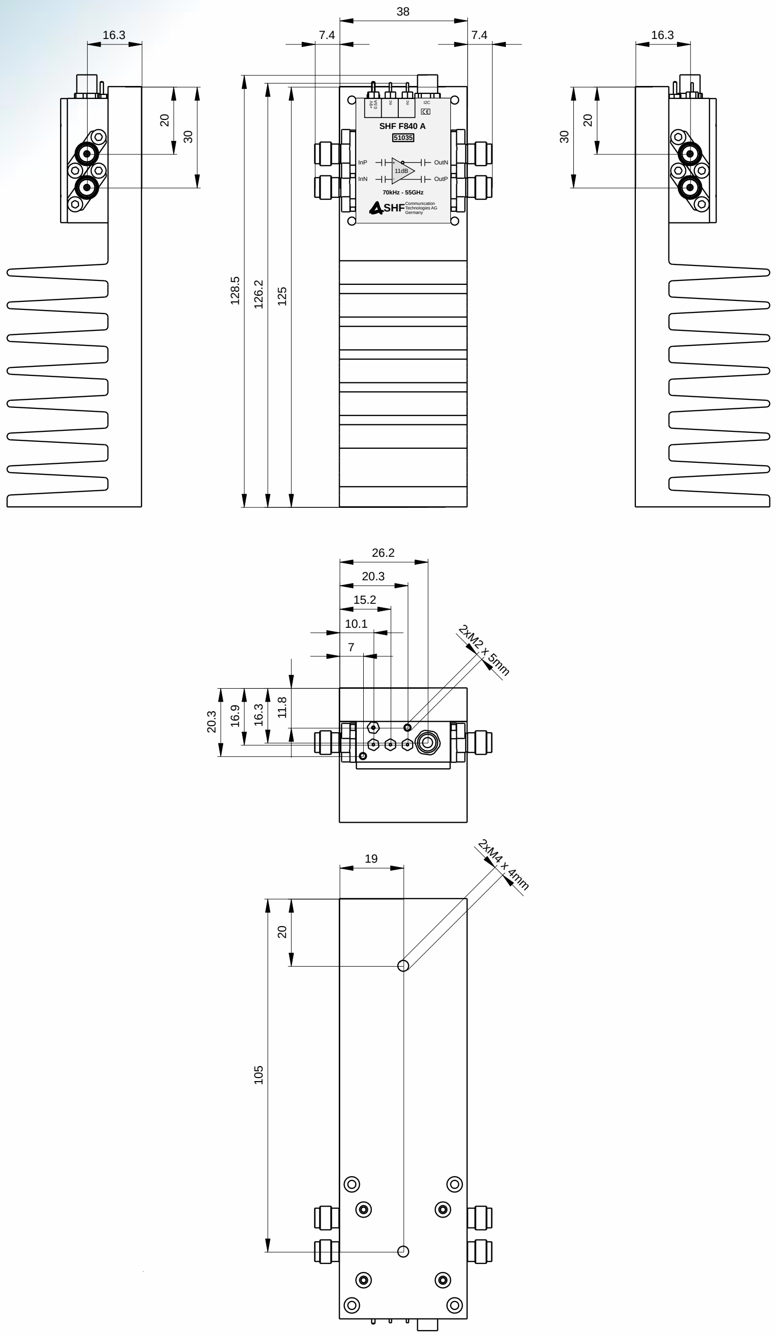
Output Signal @ 20 Gbps,
Amplitude: 4.42 V



Input Signal @ 10 Gbps,
Amplitude: 1.26 V

Output Signal @ 10 Gbps,
Amplitude: 4.48 V

Mechanical Drawing with Heat Sink



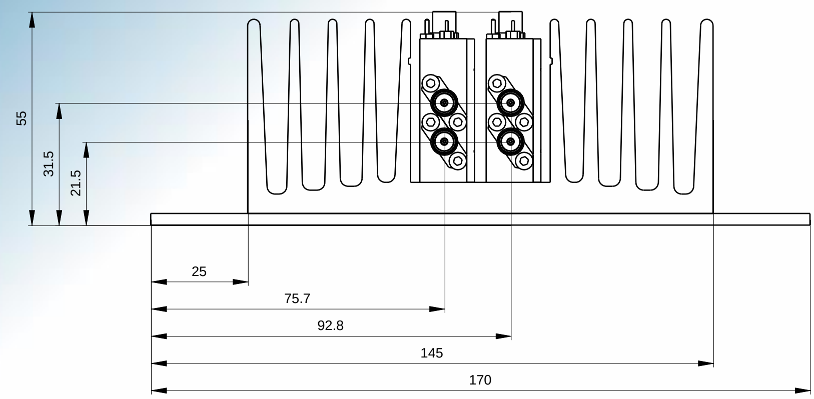
Pin assignment might change if a bias tee option is chosen.

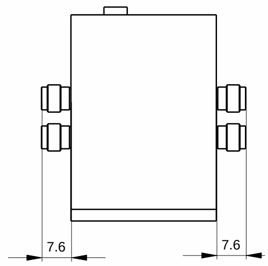
Thermal resistance of heat sink approx. 4 K/W

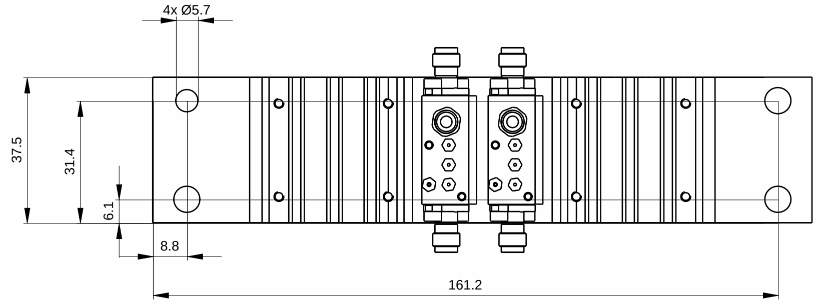
For permanent mounting remove the heat sink from the amplifier. In that case please ensure that adequate cooling of the amplifier is guaranteed. It is recommended to use thermal paste or a thermal gap pad for the mounting. In order to separate the heat sink from the amplifier, remove the four screws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

Mechanical Drawing with Heat Sink Option DHS

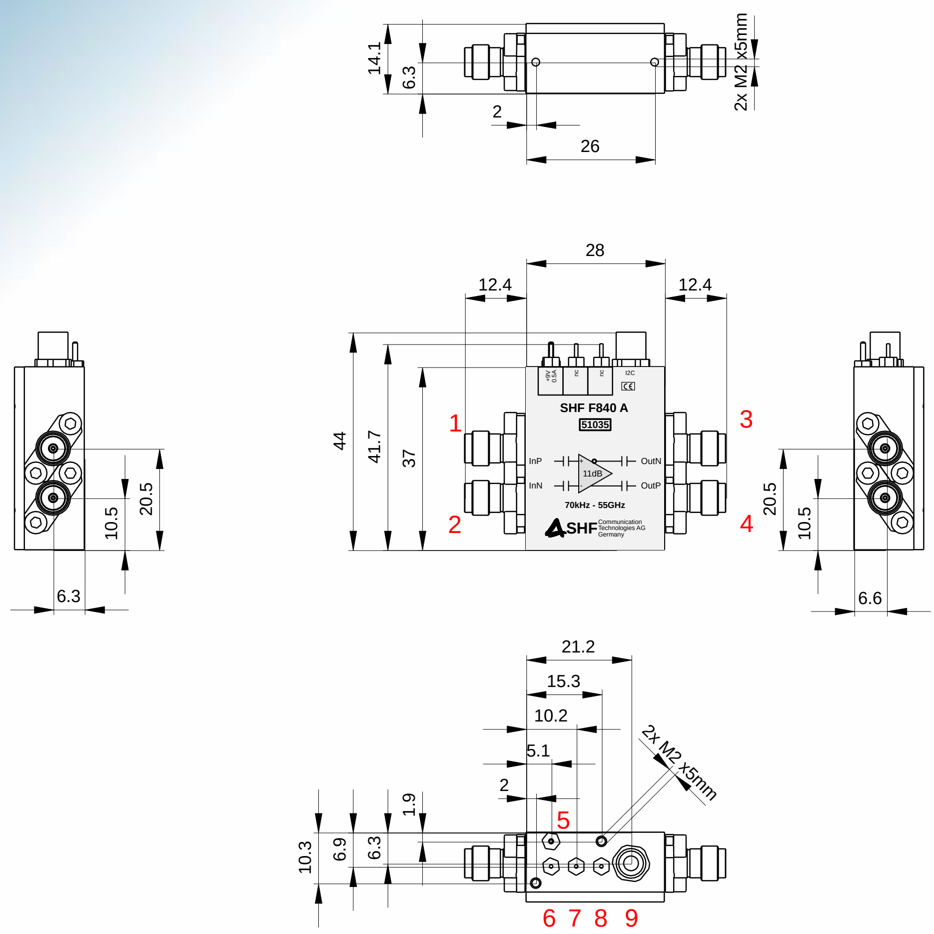
Dual Heat Sink, two amplifiers on one heatsink



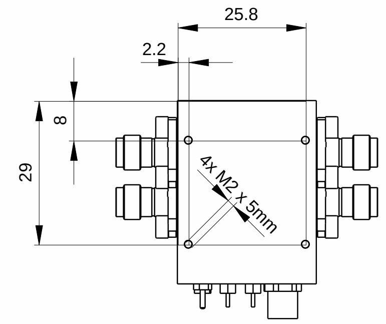




Mechanical Drawing without Heat Sink



Port	Connector
1	Non-Inverting Input (InP)
2	Inverting Input (InN)
3	Inverting Output (OutN)
4	Non-Inverting Output (OutP)
5	GND
6	+9 V / 0.5 A
7	nc / Opt. Bias Tee OutP
8	nc / Opt. Bias Tee OutN
9	I^2C



all dimensions in mm

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 InP 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 on each of the two outputs before supplying DC power to the amplifier!
3. The supply voltage can be taken from any regular 8…12 V, (0.5 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 0.5 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 1.2 Vpp will produce differential output swing of about 4 Vpp. Higher input voltages are leading to waveform degradation.
6. The amplifier can only be used without damage by connecting two 50 Ohm loads to the outputs.
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 (single ended) input voltages should never be greater than 1 Vpp equivalent to 4 dBm input power for each input port, without power supply or 0.7 Vpp resp. 0 dBm in operation.
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 tees pin). The ground pin requires significantly more heat as it is connected to the solid housing.