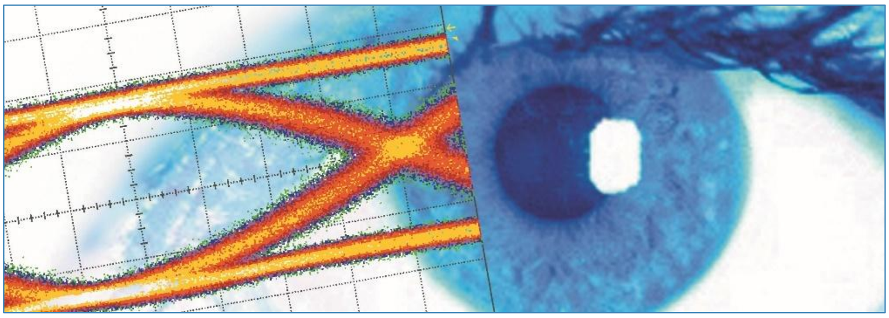
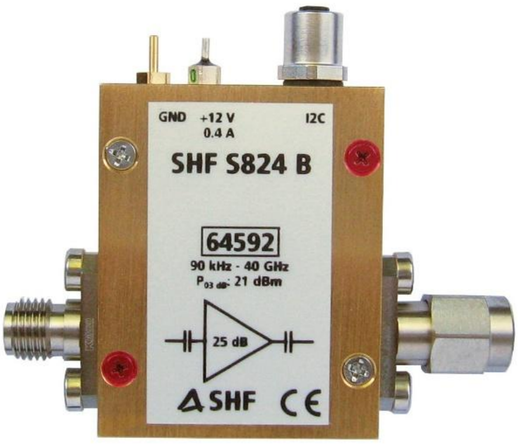


Data Sheet

SHF S824 B



Broadband Amplifier

Description

The SHF S824 B broadband amplifier is the successor of the popular SHF S824 A. By applying new MMIC's, this amplifier has more RF bandwidth and output power.

Data rates up to 50 Gbps with output amplitudes of up to 8 V are possible.

The S824 B is a two-stage amplifier design, using proprietary monolithic microwave integrated circuits (MMICs) inside. An internal voltage regulation protects the amplifier against accidental reverse voltage connection and makes it robust against line voltage ripple.

Ease of Use

Only a single 12 V supply is needed for operation.

Upon delivery, the amplifier is already pre-set to deliver maximum gain 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 .

GUI of the Control Center (SCC)

Individual Inspection

Each amplifier will be furnished with an individual inspection report showing the compliance to the data sheet as well as the time- and frequency domain performance. This data (including the touchstone® s2p-file) is accessible on-line. The specific link dedicated to each serial number will be provided with the delivery and is printed as a QR code on the heat sink.

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. ±6 V, max. 220 mA)[1]

MP: Matched Pair of two amplifiers

DHS: Dual Heat Sink, two amplifiers on one heatsink

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

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	
DC Voltage at RF Output	V				±6	
Positive Supply Voltage	V		11		13	current depends on voltage typ. 0.31 A at 12.0 V, allow 1 A
Case Temperature	°C	T_{case}	10	45	50	mounted Heatsink is part of delivery

Electrical Characteristics (At 45°C case temperature, unless otherwise specified)

Parameter	Unit	Symbol	Min	Typ	Max	Comment
High Frequency 3 dB Point	GHz	f_{High}	40			At P_{in}=-30 dBm
Low Frequency 3 dB Point	kHz	f_{Low}			90	At P_{in}=-30 dBm
Gain	dB	S_{21}	24	25		non-inverting At P_{in}=-30 dBm and 500 MHz
Max. Gain Reduction	dB		2.5	3	4	Control via software interface
Input Reflection	dB	S_{11}			-12 -10	1 MHz < f ≤ 25 GHz 25 GHz < f ≤ 40 GHz
Output Reflection	dB	S_{22}			-12 -10	1 MHz < f ≤ 25 GHz 25 GHz < f ≤ 40 GHz
Output Power at 1 dB Compression	dBm V	P_{01dB}	18.5 5.3			10 MHz ≤ f ≤ 25 GHz peak to peak voltage
Output Power at 2 dB Compression	dBm V	P_{02dB}	20 6.3			10 MHz ≤ f ≤ 25 GHz peak to peak voltage
Output Power at 3 dB Compression	dBm V	P_{03dB}	21.5 7.5			10 MHz ≤ f ≤ 25 GHz peak to peak voltage
Jitter	fs	JRMS			 630 700	V_{out} ~6 V @ 32 Gbps Deconvoluted [2, 3] Full setup [2]
Crossing Control Range	%		-3		3	Control via software interface @ 400 mV input signal amplitude

[2] Measured with the following setup: SHF C911 A DAC -> DUT (SHF S824 B) -> Agilent 86100A with 70 GHz sampling head and precision time base.

[3] Calculation based on typical results of setup without DUT : $J_{RMS\,deconvoluted} = \sqrt{(J_{RMS\,full\,setup})^2 - (J_{RMS\,setup\,w/o\,DUT})^2} = \sqrt{(J_{RMS\,full\,setup})^2 - 300\,fs^2}$

Parameter	Unit	Symbol	Min	Typ	Max	Comment
Phase Delay Difference[4]	deg	Δ PD			±8	1 GHz to 30 GHz If option MP is chosen
Gain Difference[5]	dB	Δ S_{21}			±1	1 to 30 GHz If option MP is chosen
Power Consumption	W			3.6		12 V supply voltage

Mechanical Characteristics

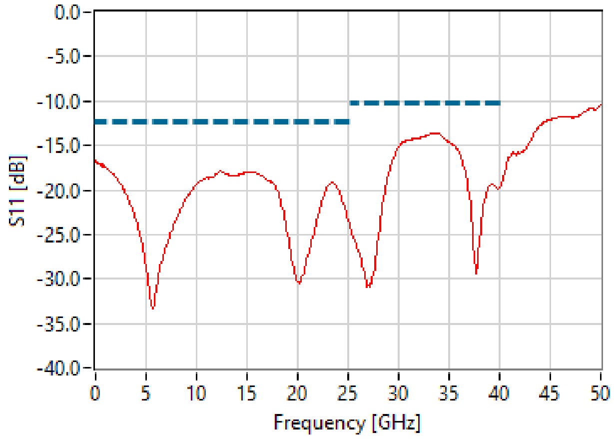
Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Input Connector	Ω			50		2.92 mm (K) female [6] Option VFVM: 1.85 mm female
Output Connector	Ω			50		2.92 mm (K) male [6] Option VFVM: 1.85 mm male
Dimensions	mm					see page 11 to 12
Weight	g			30 240 290		Amplifier only Heat Sink only Dual Heat Sink only

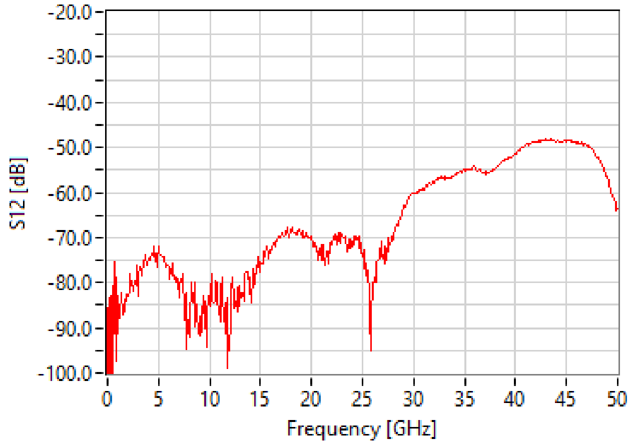
[4] The phase delay difference is defined as the phase difference in degrees of the output signals of both amplifiers. It is calculated as: $\Phi_{Amp1} - \Phi_{Amp2}$, where Φ_{Amp1} and Φ_{Amp2} indicate the unwrapped phase of $S_{21\ Amp1}$ and $S_{21\ Amp2}$, respectively.

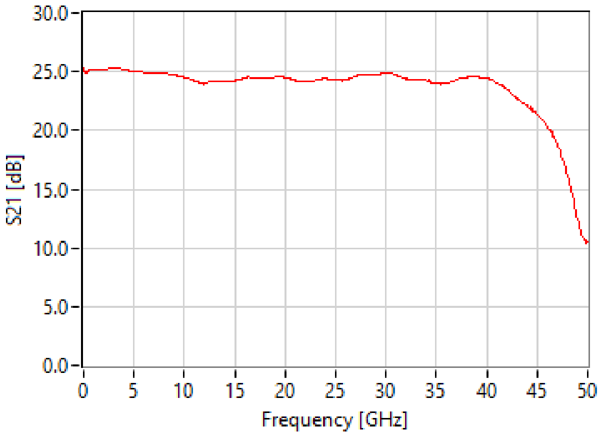
[5] The gain difference is defined as the gain difference in dB of the output signals of both amplifiers. It is calculated as: $|S_{21\ Amp1}|_{dB} - |S_{21\ Amp2}|_{dB}$.

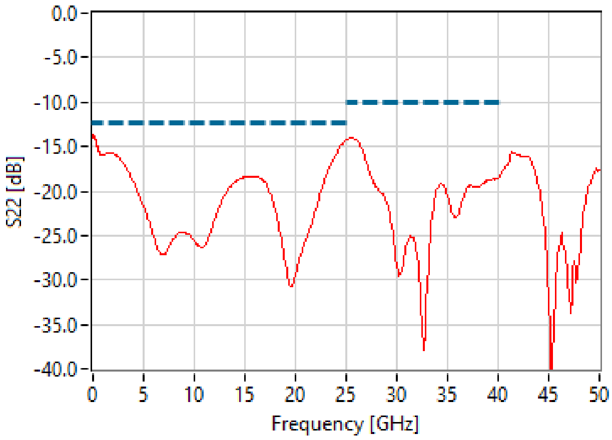
[6] Other gender configurations are available on request.

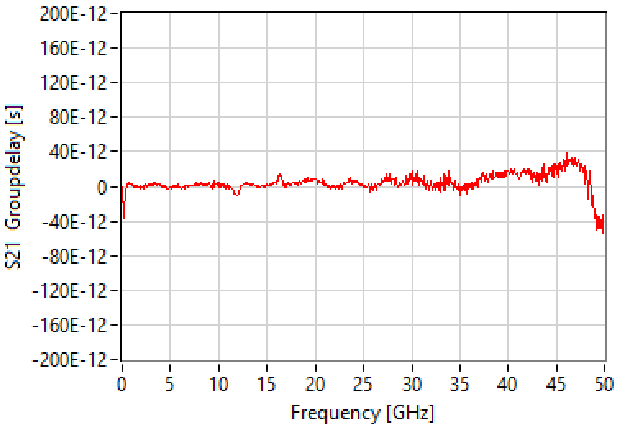
Typical S-Parameters

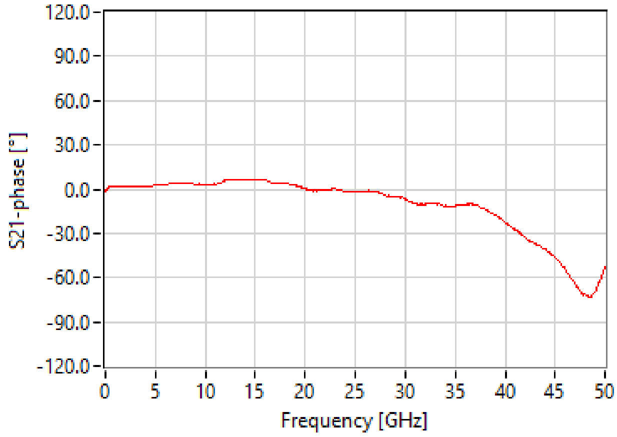










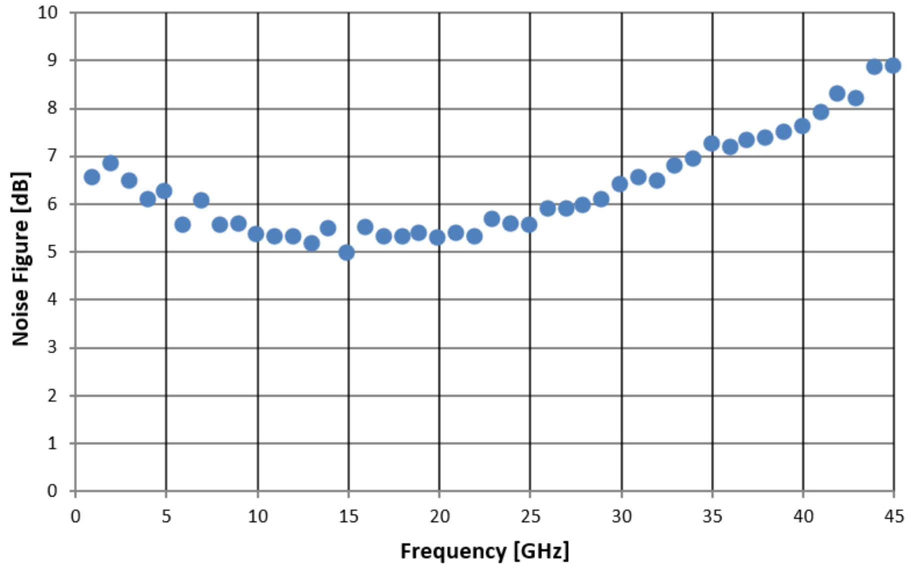


S-Parameters are part of the inspection report for each individual amplifier.

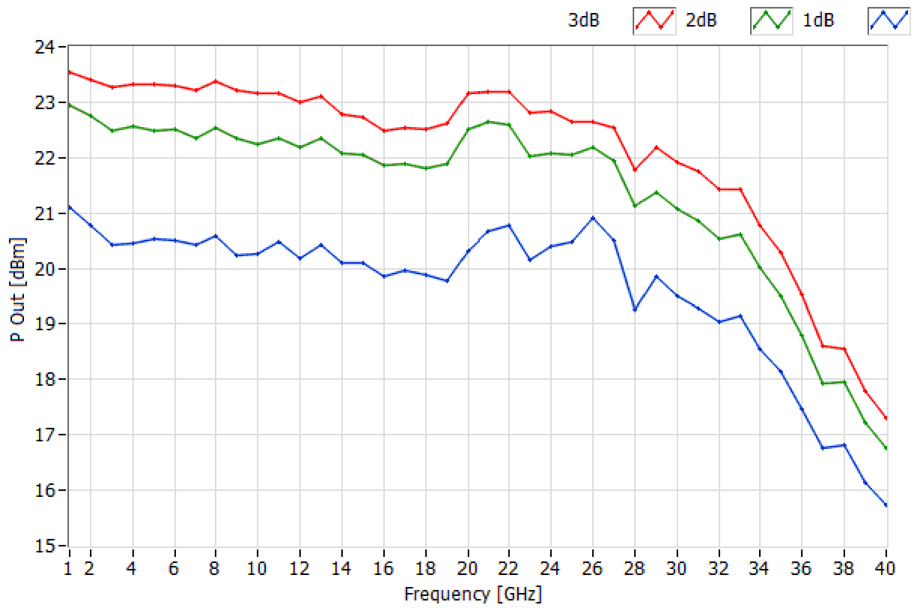
Blue dashed lines = Specifications

Typical Noise Figure

The measurement had been performed using a FSW85 Spectrum Analyzer by Rhode & Schwarz. The noise figure defines the extent to which the signal-to-noise ratio degrades when the signal passes through an amplifier. An ideal amplifier would amplify the noise at its input, as well as the signal. However, a real amplifier introduces additional noise from its components, which degrades the signal-to-noise ratio. Please note that this only applies to small signals. When the amplifier is used close to or in its saturation region, additional non-linear effects impact the signal-to-noise ratio and the signal waveform.



Typical Saturation Power



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

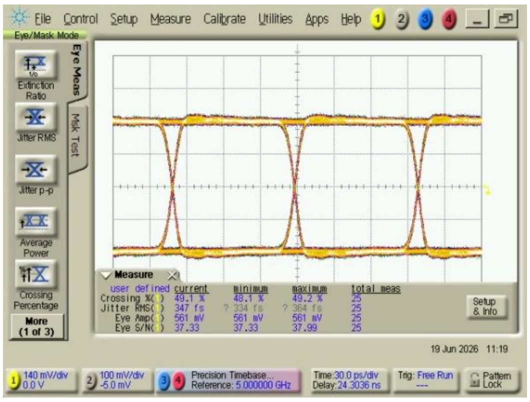
Typical Waveforms

The following measurements had been performed using the hardware mentioned below. The output of the amplifier had been connected with an attenuator (10 + 20 dB) to the scope's sampling module.

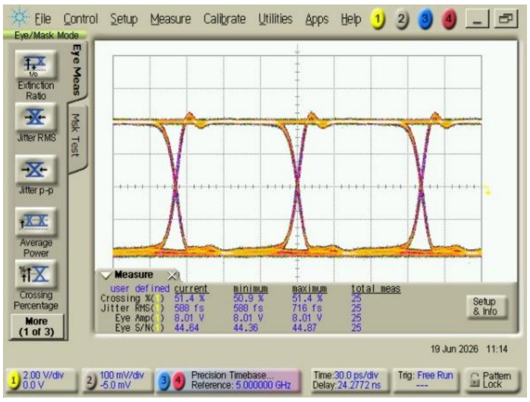
A measurement at 32 Gbps with 6 V Amplitude will be part of each inspection report.

Measurements with:

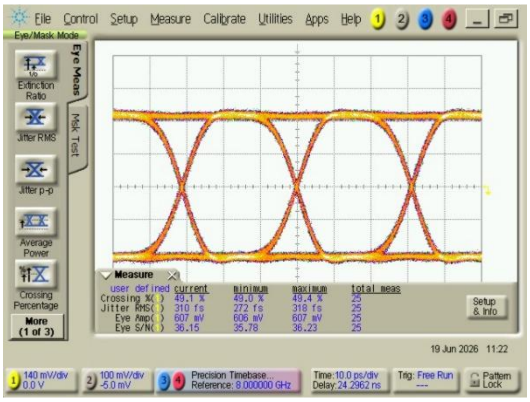
- **SHF C911 A DAC generating binary signals (PRBS 2^{31}-1)**
- **Agilent DCA 86100D with PTB 86107A and Sampling Head 86118A**
- **No Filter applied**



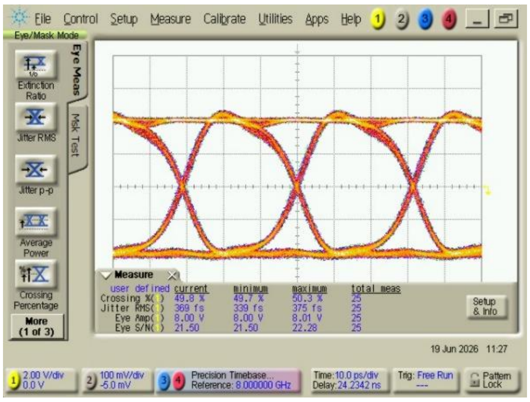
10 Gbps 560 mV Input Signal



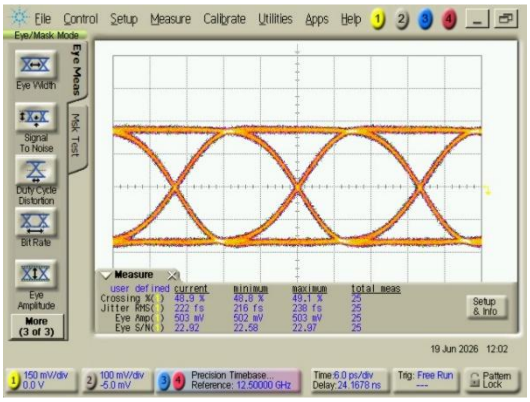
10 Gbps 8 V Output Signal



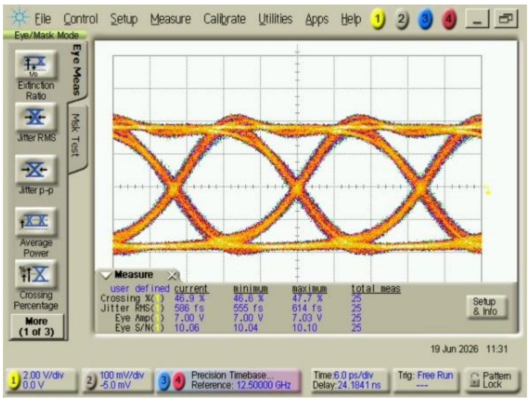
32 Gbps 610 mV Input Signal



32 Gbps 8 V Output Signal



50 Gbps 500 mV Input Signal



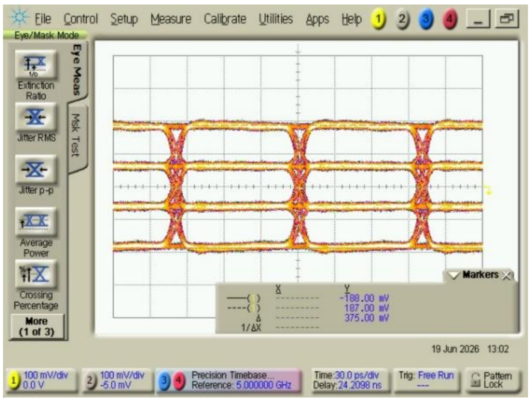
50 Gbps 7 V Output Signal

The following measurements had been performed using the hardware mentioned below. The output of the amplifier had been connected with an attenuator (10 + 20 dB) to the scope's sampling module.

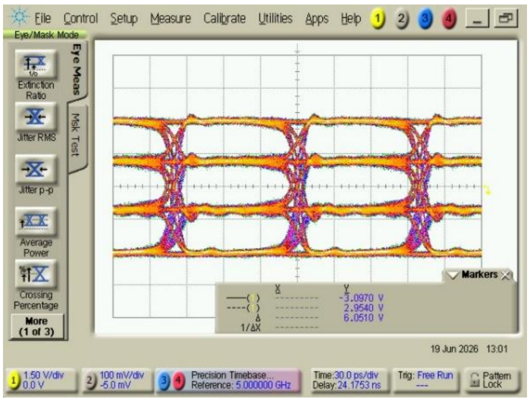
The measurement at 32 GBaud will be part of each inspection report.

Measurements with:

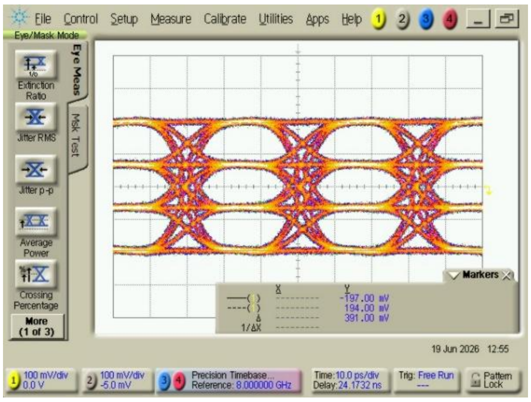
- **SHF C911 A DAC generating PAM4 signals (PRBS 2^{31}-1)**
- **Agilent DCA 86100D with PTB 86107A and Sampling Head 86118A**



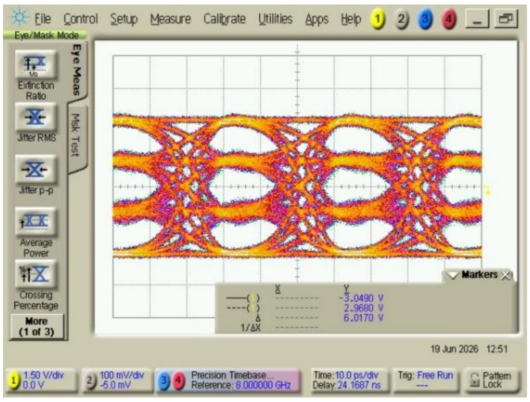
10 GBaud (20 Gbps) 375 mV Input Signal



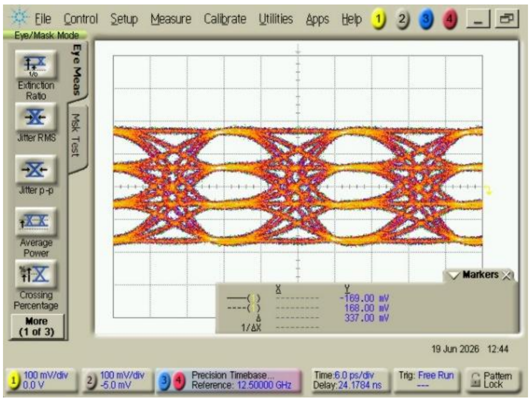
10 GBaud (20 Gbps) 6 V Output Signal



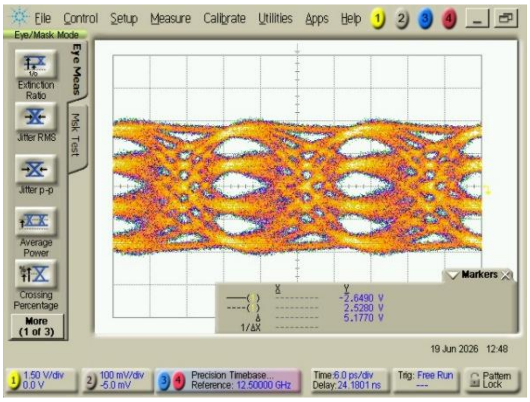
32 GBaud (64 Gbps) 390 mV Input Signal



32 GBaud (64 Gbps) 6 V Output Signal



50 GBaud (100 Gbps) 340 mV Input Signal



50 GBaud (100 Gbps) 5.2 V Output Signal

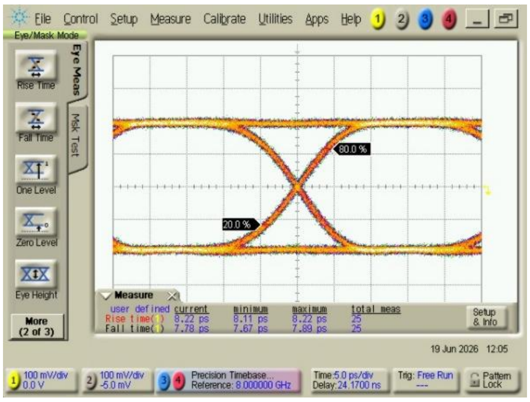
Typical Rise and Fall Time

The following measurements had been performed using the hardware mentioned below. The output of the amplifier had been connected with an attenuator (10 + 20 dB) to the scope's sampling module.

The measurement shows the typical rise and fall time from 20 to 80 %.

Measurements with:

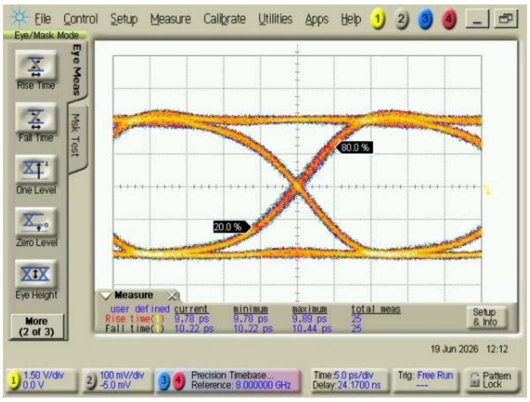
- **SHF C911 A DAC generating binary signal (PRBS 2^{31}-1)**
- **Agilent DCA 86100D with PTB 86107A and Sampling Head 86118A**
- **no Filter applied**



32 Gbps 400 mV Input Signal

8.22 ps Rise time

7.78 ps Fall time



32 Gbps 6 V Output Signal

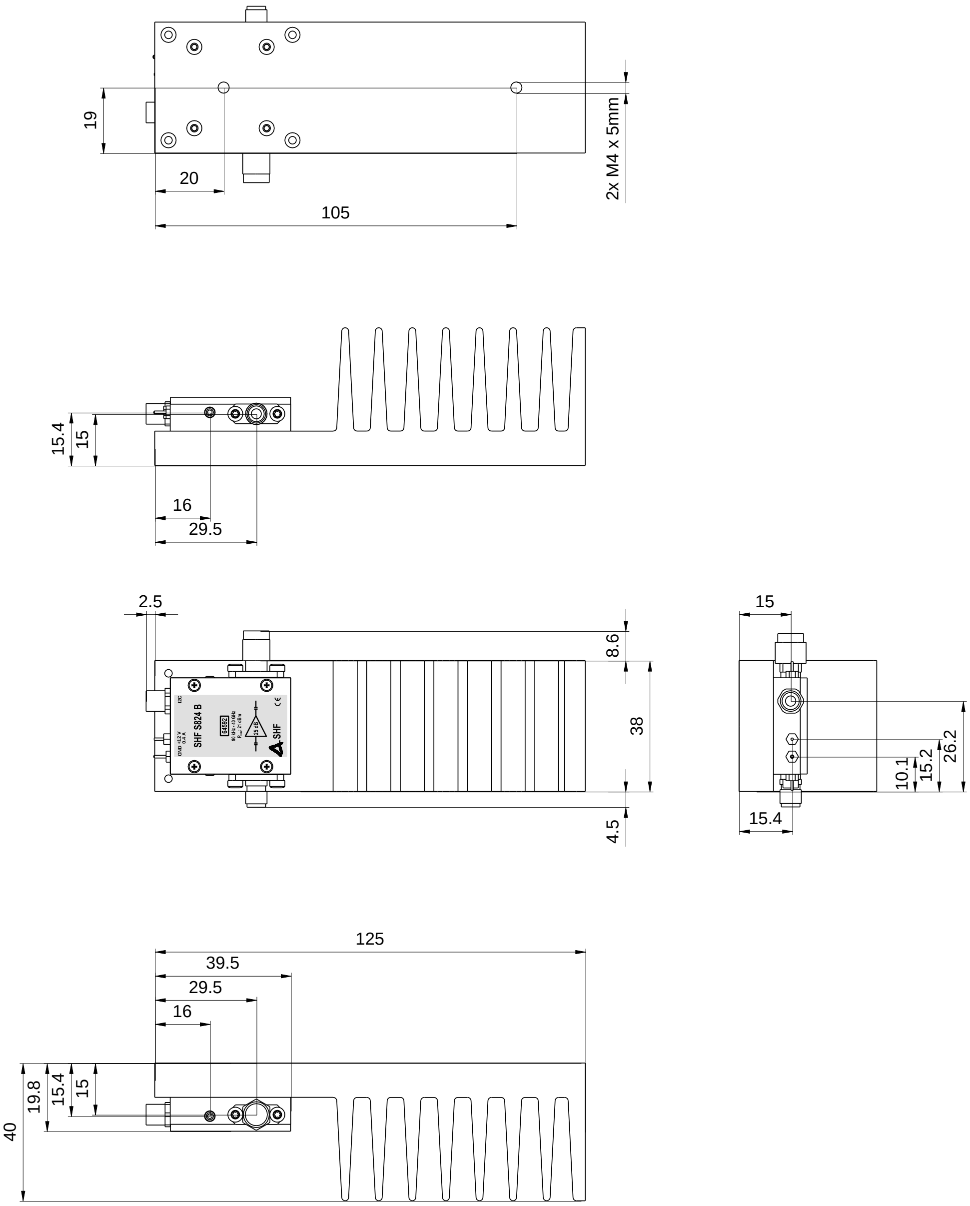
9.78 ps Rise time

10.22 ps Fall time

$$t_{r\ deconvoluted} = \sqrt{(t_{r\ full\ setup})^2 - (t_{r\ setup\ w/o\ DUT})^2} = \sqrt{(9.78\ ps)^2 - (8.22\ ps)^2} = 5.3\ ps$$

$$t_{f\ deconvoluted} = \sqrt{(t_{f\ full\ setup})^2 - (t_{f\ setup\ w/o\ DUT})^2} = \sqrt{(10.22\ ps)^2 - (7.78\ ps)^2} = 6.6\ ps$$

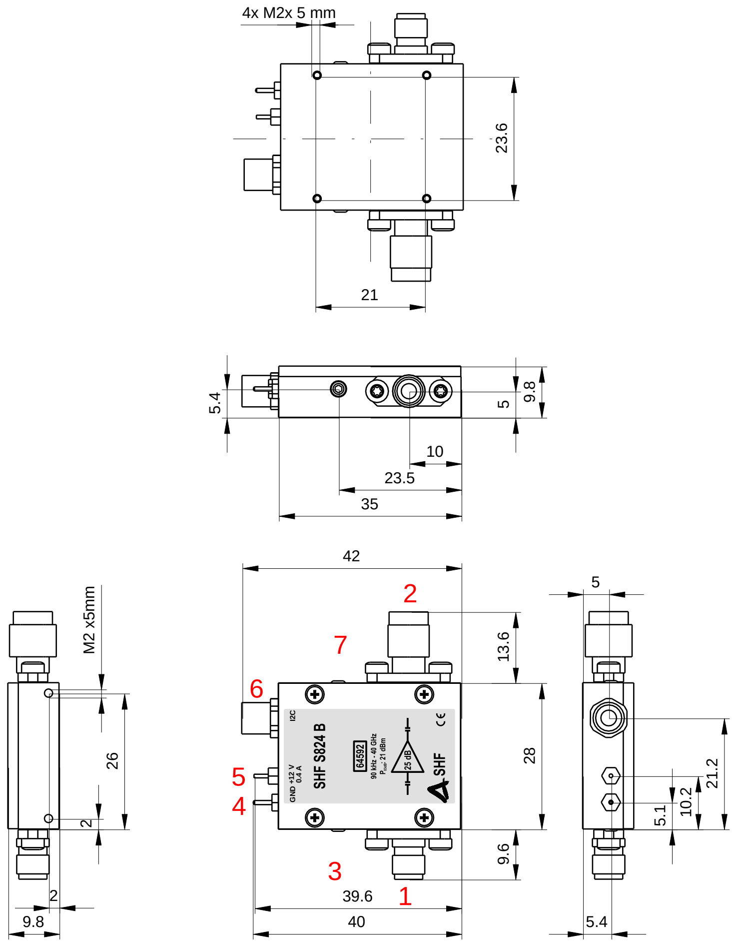
Mechanical Drawing with Heat Sink

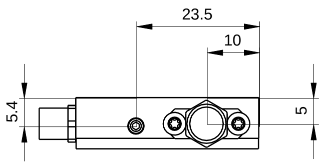


all dimensions in mm

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

Mechanical Drawing without Heat Sink





all dimensions in mm

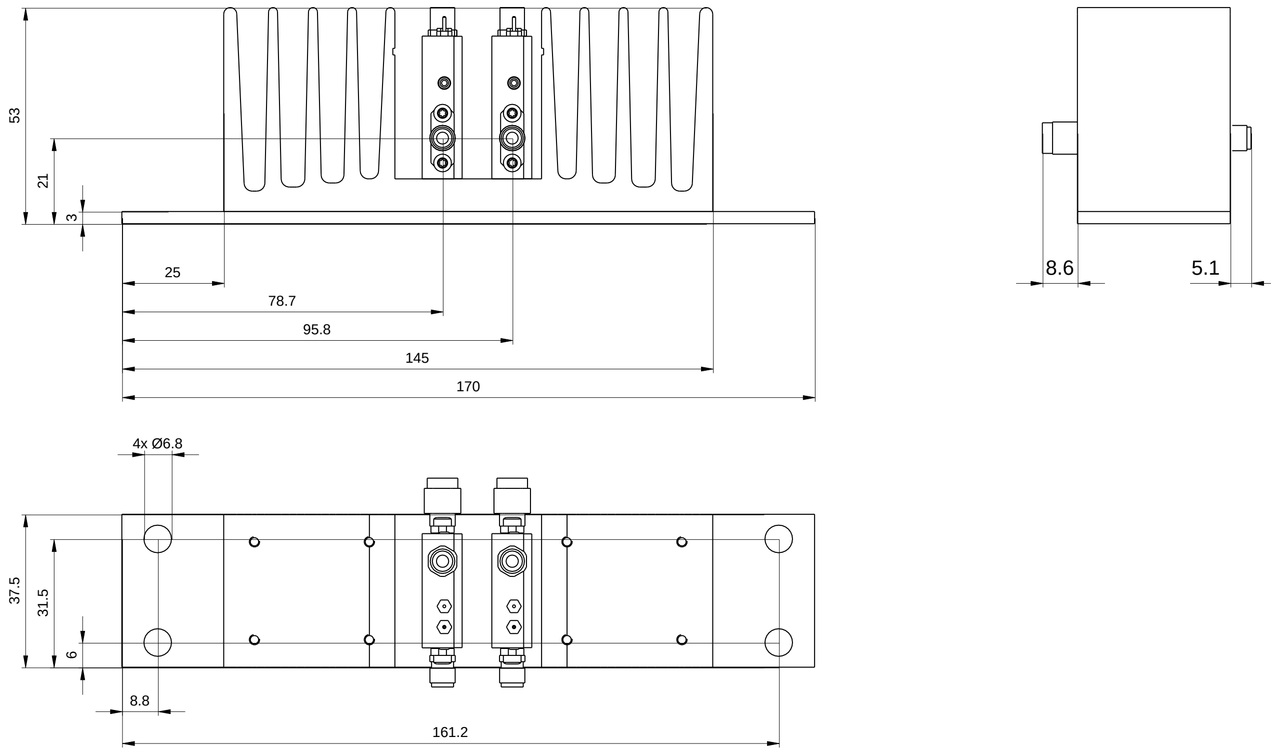
Pos.	Connector
1	Input
2	Output
3	Option 02
4	GND
5	+12 V / 0.4 A
6	I^2C
7	Option 04

Please ensure that adequate cooling of the amplifier is guaranteed.

In standard configuration pin 3 and 7 are not mounted. If a bias tee (option 02 or 04) is included the DC bias can be connected to the mounted pin (BiasT). It is the same feed through filter like the supply pin 5.

Mechanical Drawing with Heat Sink Option DHS

Dual Heat Sink, two amplifiers on one heatsink



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 amplifiers, remove the two screws for each of both amplifiers on the heat sink. Please note a thermal gap pad is used between the heat sink and the amplifier housing.

User Instructions

Electrostatic sensitive device

1. To prevent damage through static charge build up, cables should always be 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 11…13 V, 1 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!
   In case 12 V are applied to the amplifier typically 0.3 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 40 GHz (K / 2.92 mm attenuators)!
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. In case an AWG is used as signal source, please check the maximum output voltage and be carefull with the filter settings, while the amplifier is connected.
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. In case of a short circuit, first ramp down the bias to 0 V then open the short.
9. For the DC-connections flexible cables 0.33 … 0.5 mm^2 / AWG 22 … 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.

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