SHF Communication Technologies AG

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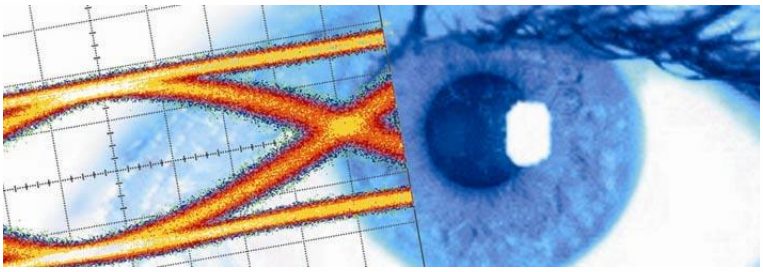


Datasheet

SHF 614 B

60 GBaud 6-Bit DAC

Description

The SHF 614 B is a 6-Bit Digital-to-Analog Converter (DAC) operating at symbol rates up to 60 GBaud for use in broadband test setups and telecom transmission systems. Up to six single ended serial data streams are accepted by the DAC and converted into one differential 64-level data signal. By using less than six input ports it is possible to generate 2-level NRZ as well as 4, 8, 16 or 32-level output signals.

With a programmable SHF BPG (e.g. SHF 12104 A) you have full control of the patterns into the DAC. Therefore our BPG/DAC combination can be seen as a full blown remote head non-interleaved 60 GBaud Arbitrary Waveform Generator (AWG).

A single ended clock signal with the same frequency as the data rate is required to drive the SHF 614 B. For data regeneration purposes all input data signals are re-sampled to mitigate any signal impairments resulting e.g. from long cables. Therefore, it becomes possible to place the DAC very close to the DUT. Clock input port and data output ports are AC-coupled. Data input ports are DC-coupled.

Features

- Broadband operation up to 60 GBaud
- Output baud rate = sample rate
- Differential data output, 3.0 V differential output swing (1.5 V in single-ended operation)
- Single ended clock and data inputs
- Latched input ports
- Output amplitude & input threshold level control (remote by software)

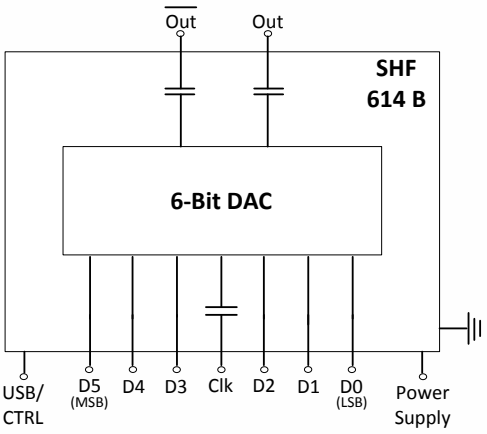
Applications

- 100, 200, 400 Gbps and 1 Tbps system evaluation & development
- Broadband test and measurement equipment
- PAM-N, OFDM, Advanced Modulation Experiments

Options

- Option Case: DAC module, power supplies, cooling measures and 1.85 mm panel adaptors are housed in a small benchtop case.

Block Diagram



Module Variants

In addition to the DAC itself, the power supplies, USB cable and heat sink are complementary parts of each delivery. It is recommended to use the DAC only with the delivered power supply module. The heat sink can be removed by the customer. In this case it is required to provide other cooling measures to ensure that the maximum case temperature specified on page 6 will not be exceeded.

SHF 614 B

With Option Case the SHF 614 B DAC module, the power supplies, cooling measures and the Mini-SMP to 1.85 mm panel adaptors are housed in a small benchtop case that can be easily embedded in the customer's test environment.

SHF 614 B – incl. Opt. Case

Ease of Use

The easy to use software package, SHF 600 Series Control is the most convenient way to control the DAC. The software reads the individual calibration tables of the DAC and sets the contribution of the bias voltages accordingly. The amplitude of the individual eye openings can be set and is displayed in the graphical user interface (GUI) as well as the input threshold level for the DC-coupled data inputs. This enables the user to generate a perfect signal just by a few intuitive clicks. The control software for other operating systems is available on request.

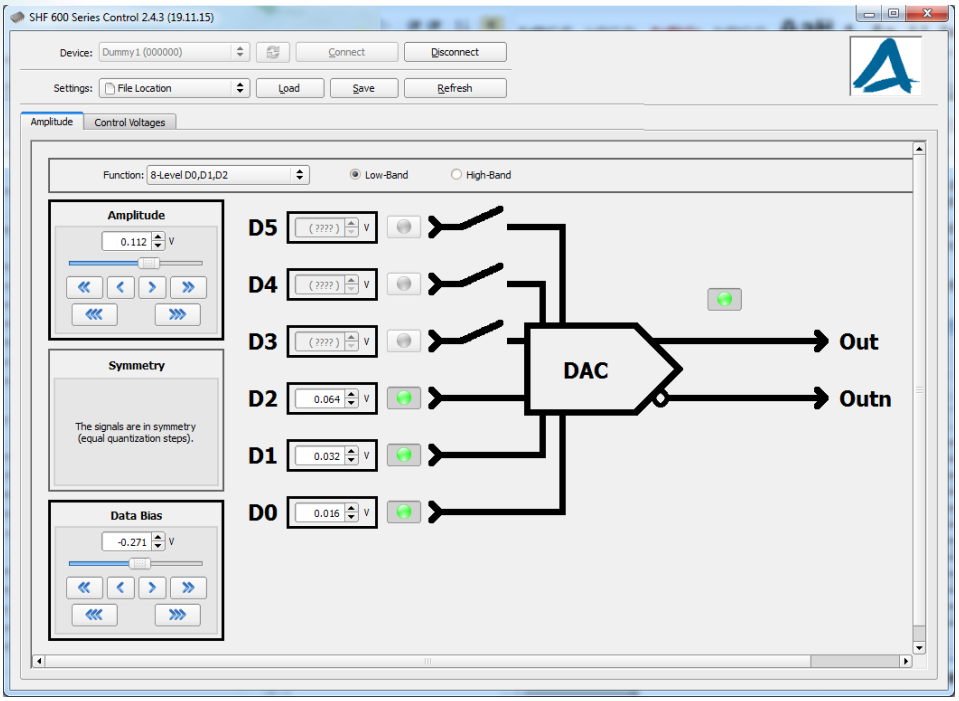


Fig. 2: "SHF 600 Series Control" – GUI

Absolute Maximum Ratings

Parameter	Unit	Symbol	Min.	Typ.	Max.	Comment
Input Parameters						
Data Input Voltage	mV	$V_{data\ in}$			900	Peak-to-Peak
Clock Input Voltage	mV	$V_{clk\ in}$			900	Peak-to-Peak
External DC Voltage on RF Clock Input Port	V	V_{DCin}	-10		+10	AC coupled input
External DC Voltage on RF Data Input Ports	V	V_{DCin}	-0.5		0	DC coupled inputs
External DC Voltage on RF Output Ports	V	V_{DCout}	-10		+10	AC coupled outputs
DC Supply Voltage	V	V_{cc}			13.0	

Specifications

Parameter	Unit	Symbol	Min.	Typ.	Max.	Comment
Input Parameters						
Min. Input Data Rate	Gbps	$R_{in,min}$			1	
Max. Input Data Rate	Gbps	$R_{in,max}$	60			
Data Input Voltage	mV	$V_{data\ in}$	300		800	Eye Amplitude; 500 mV recommended
External DC Voltage on RF Data Input Ports	V	V_{DCin}	-0.5		0	DC coupled inputs
Min. Clock Input Frequency	GHz	$f_{in,min}$			1	
Max. Clock Input Frequency	GHz	$f_{in,max}$	60			
Clock Input Voltage	mV	$V_{clk\ in}$	300		800	Peak-to-Peak; 500 mV recommended
External DC Voltage on RF Clock Input Port	V	V_{DCin}	-10		+10	AC coupled input

Parameter	Unit	Symbol	Min.	Typ.	Max.	Comment
Output Parameters						
Min. Output Data Rate	GBaud	$R_{out,min}$			1	
Max. Output Data Rate	GBaud	$R_{out,max}$	60			
Output Voltage	mV	V_{out}	1300	1512		Eye Amplitude; Single ended; Full scale; Adjustable up to -6 dB → see page 7
Rise / Fall Time	ps	t_r / t_f		8.2	10	20%...80%; deconvolved[1]
Equivalent Output Bandwidth	GHz	BW	22	27		Derived from Rise Time using formula[2]; -3 dB bandwidth
Differential Output Skew	ps	t_{skew}		±1	±2	
Power Requirements (without Option Case)						
Supply Voltage	V	V_c	+11.5	+12	+12.5	2.1 mm DC Power Jack
Supply Current	mA	I_c		1150		
Power Dissipation	W	P_d		13.8		@ V_C = +12V
Power Requirements (with Option Case)						
Supply Voltage	V	V_c	+11.5	+12	+12.5	2.1 mm DC Power Jack
Supply Current	mA	I_c		1350	1450	
Power Dissipation	W	P_d		16.2	17.4	@ V_C = +12V
Conditions						
Module Temperature[3]	°C	T_{case}	10		45	without Option Case

[1] Calculation based on typical rise / fall times from oscilloscope data sheet: $t_{r\ deconvolved} = \sqrt{(t_{r\ measured})^2 - (t_{r\ oscilloscope})^2} = \sqrt{(t_{r\ meas.})^2 - (3.68\ ps)^2}$

[2] Calculation based on formula: $BW = \frac{0,22}{Tr}$

[3] t_r / t_f of the output data signal can be slightly decreased by applying additional cooling measures like heat sinks or cooling fans.

Typical Output Amplitudes

Below mentioned values assume no attenuation to be set in the control software. The output amplitude of the DAC can be reduced by 0 to 6 dB by making the appropriate setting in the control software.

Input D5	Input D4	Input D3	Input D2	Input D1	Input D0	Typical Output Amplitude [mV]
-	-	-	-	-	On	**24**
-	-	-	-	On	-	**48**
-	-	-	On	-	-	**96**
-	-	On	-	-	-	**192**
-	On	-	-	-	-	**384**
On	-	-	-	-	-	**768**

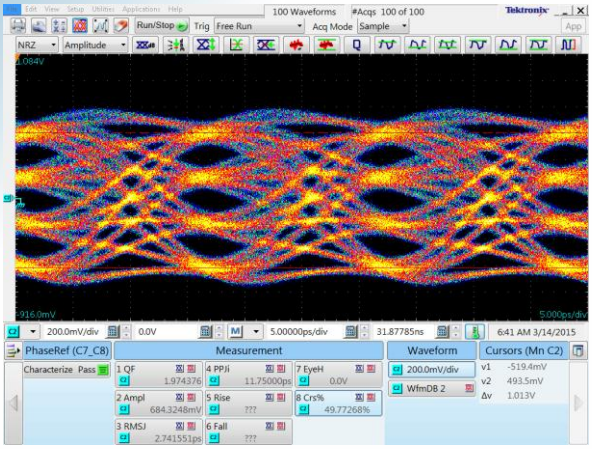
The typical output amplitude of a multilevel signal can be calculated by accumulating the typical output amplitudes of all applied input ports of the DAC as shown in the table above. Thus the full scale output swing (all inputs active) accumulates as follows:

On	On	On	On	On	On	**1512**

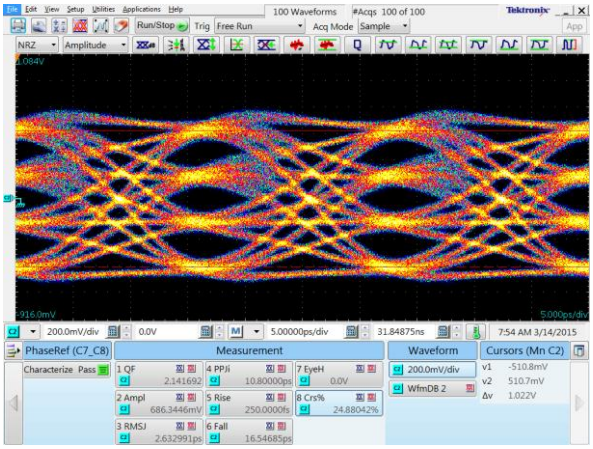
Typical Output Eye Diagrams

The measurements below had been performed using a SHF 12104 A Bit Pattern Generator (PRBS 2^{31}-1) and a Tektronix DSA 8300 Digital Serial Analyzer (DSA) with Phase Reference Module (82A04B-60G) and 70 GHz Sampling Module (80E11). The outputs of the DAC module had been connected directly to the DSA input with a 10 dB attenuator.

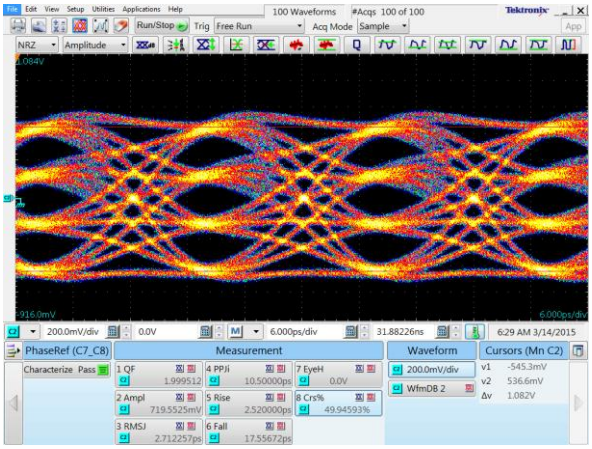
4-Level Output Signal Measurement



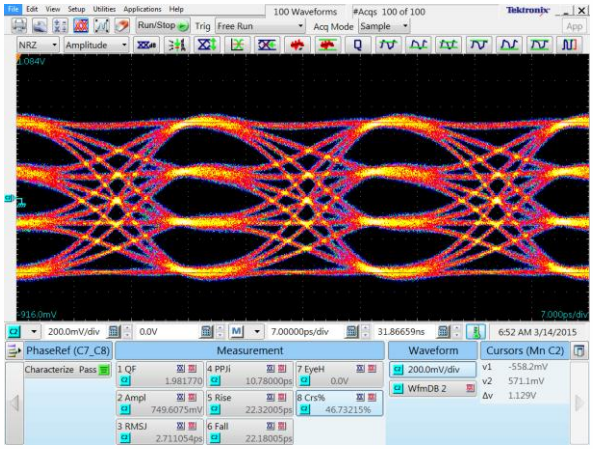
Out @ 64 GBaud



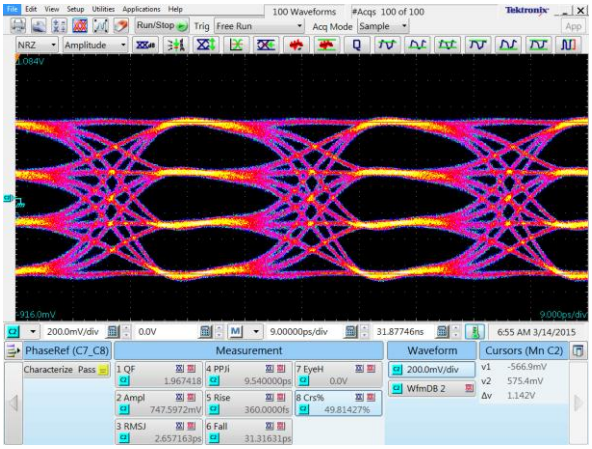
Out @ 60 GBaud



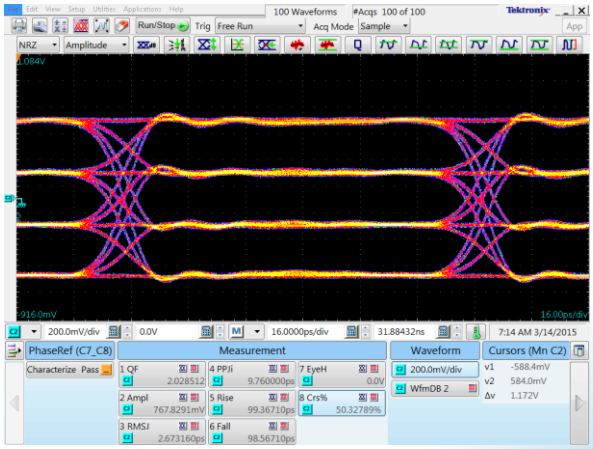
Out @ 56 GBaud



Out @ 43 GBaud

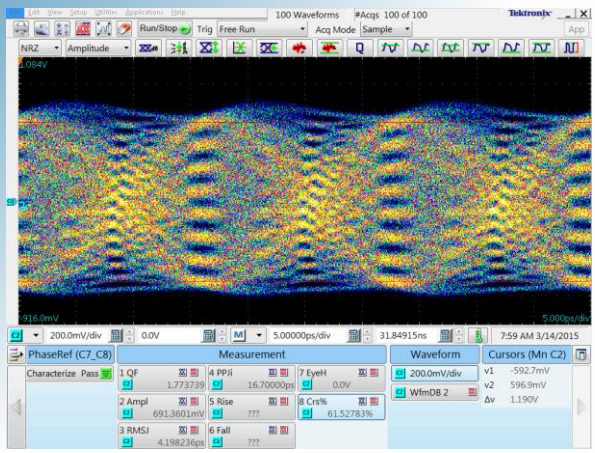


Out @ 32 GBaud

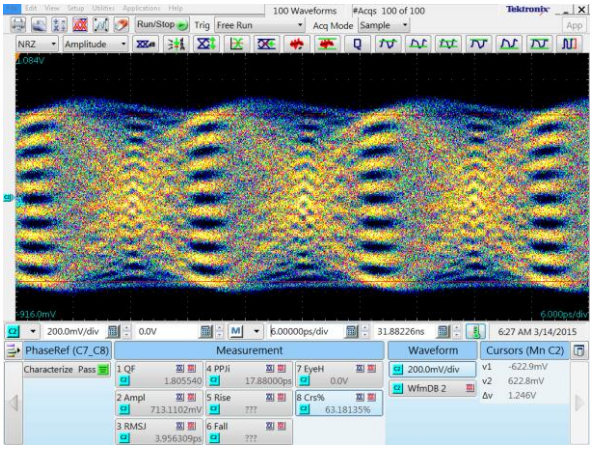


Out @ 10 GBaud

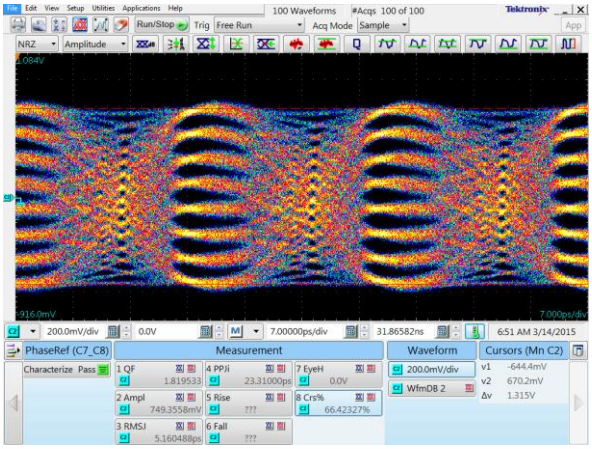
8-Level Output Signal Measurement



Out @ 60 GBaud



Out @ 56 GBaud



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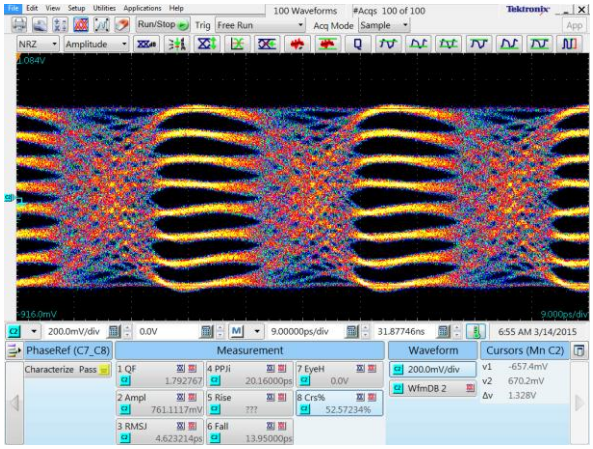
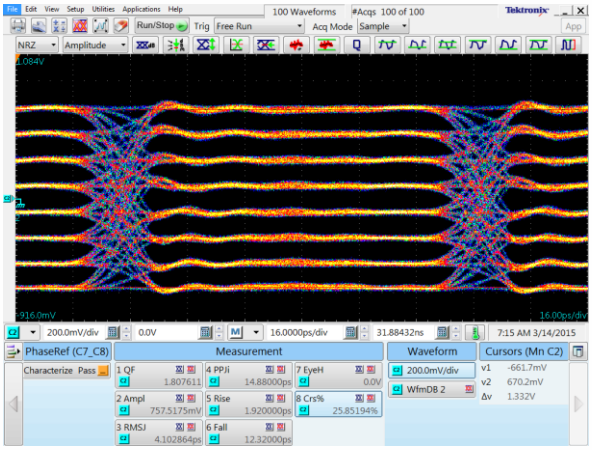
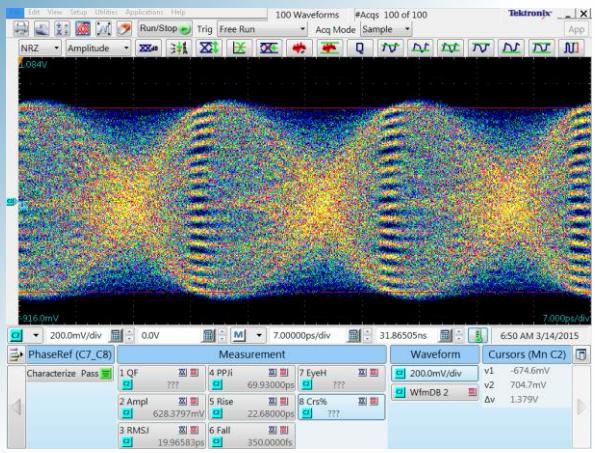


Out @ 32 GBaud

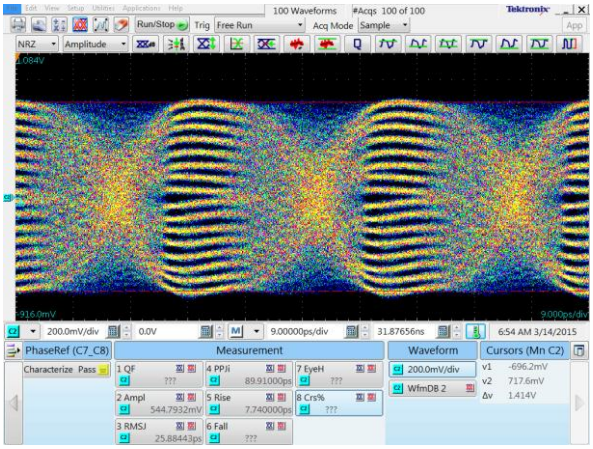


Out @ 10 GBaud

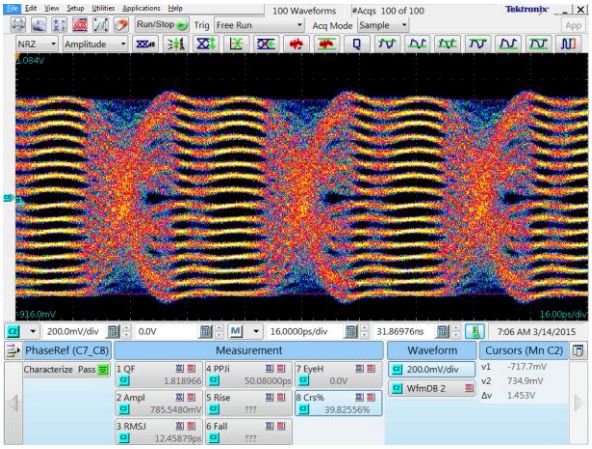
16-Level Output Signal Measurement



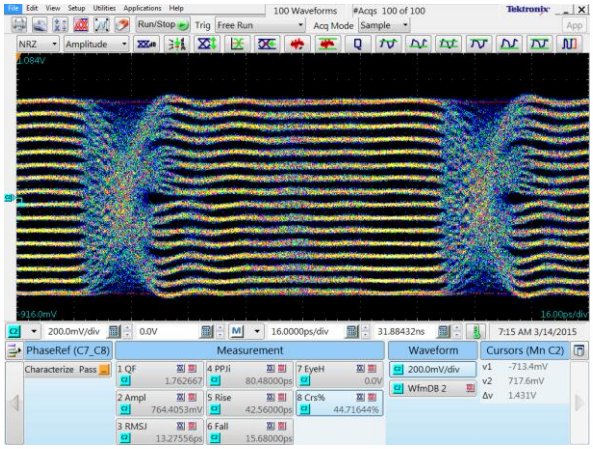
Out @ 43 GBaud



Out @ 32 GBaud

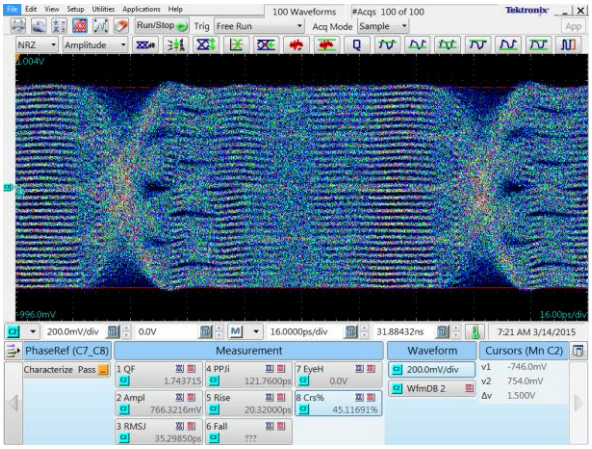


Out @ 20 GBaud

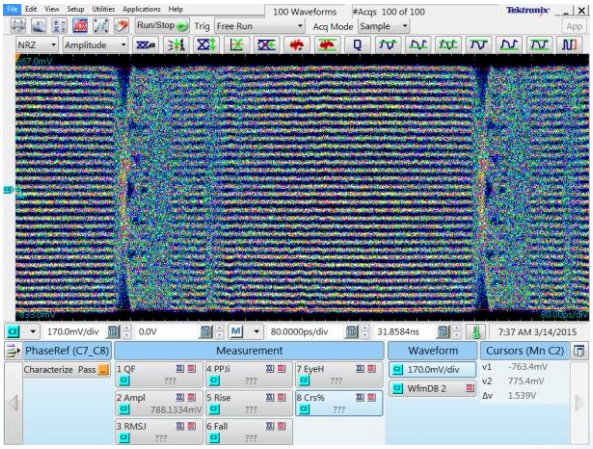


Out @ 10 GBaud

32-Level Output Signal Measurement

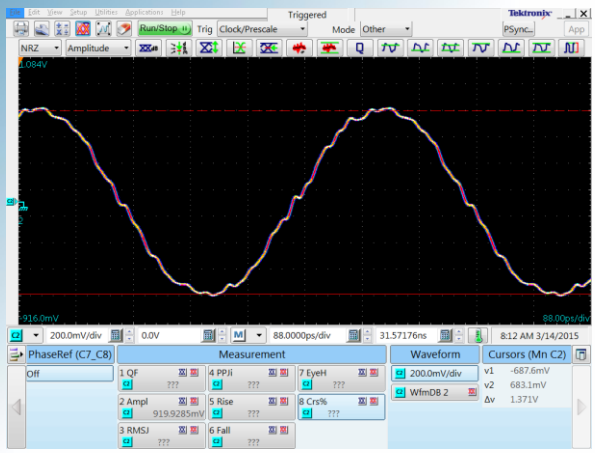


Out @ 10 GBaud

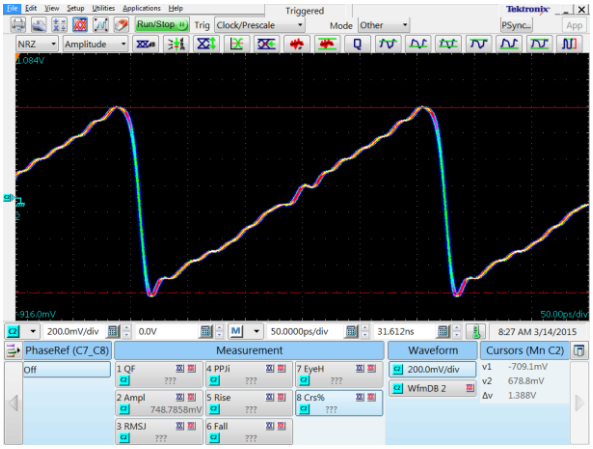


Out @ 2 GBaud

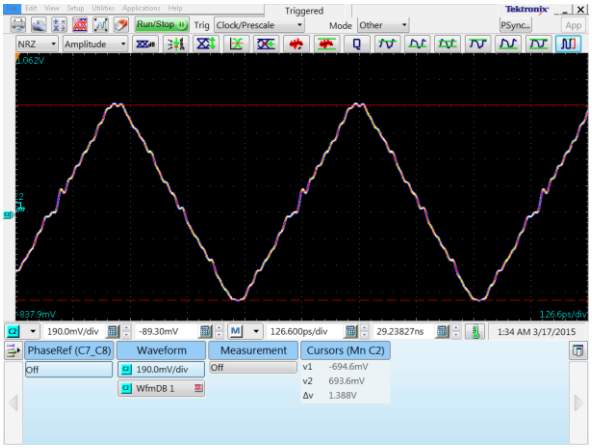
Arbitrary Waveform Generation (4-Bit Mode)



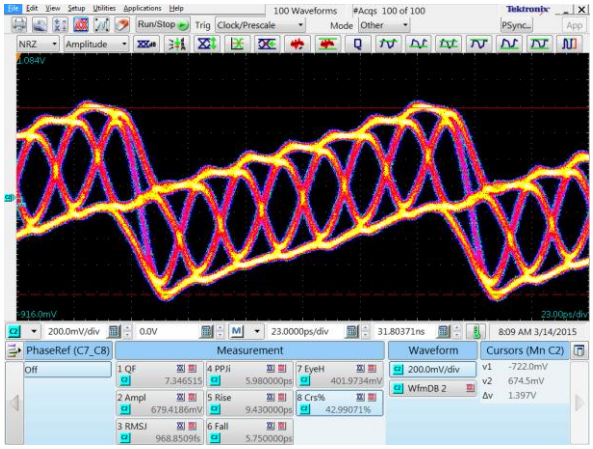
Sine @ 60 GBaud



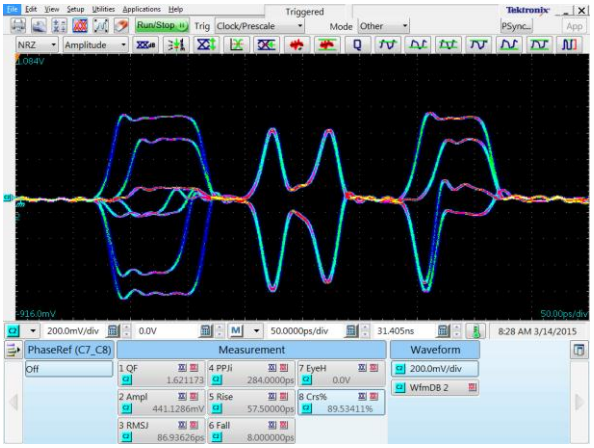
Saw @ 60 GBaud



Triangle @ 60 GBaud

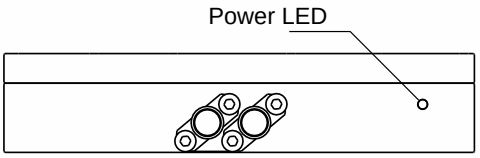


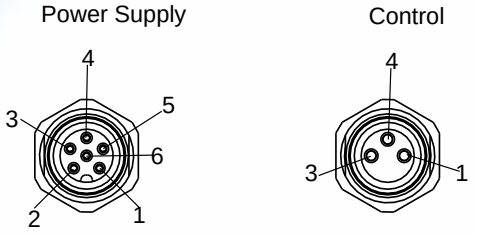
Stepped Eye @ 60 GBaud

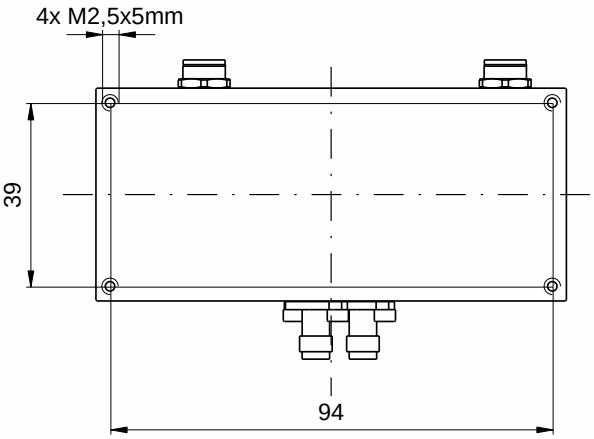


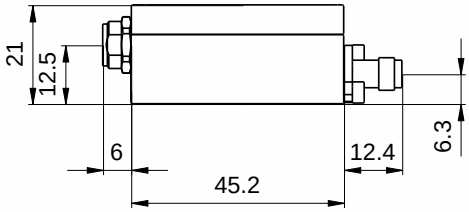
“SHF”- writing @ 60 GBaud

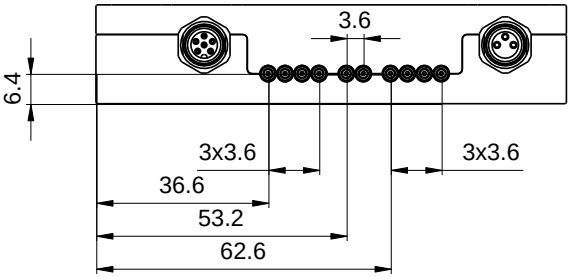
Outline Drawing - Module







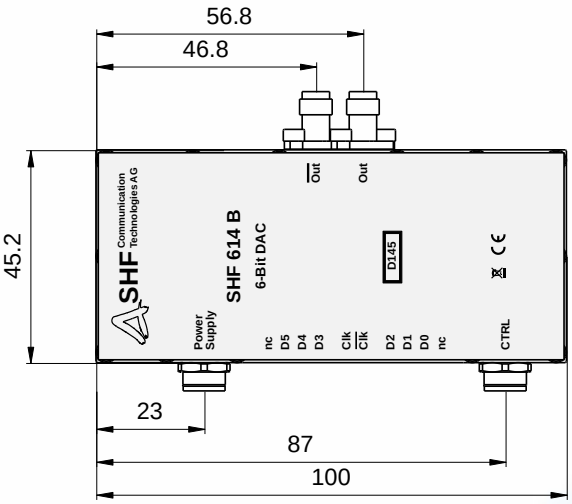




Port	Connector
Out	1.85mm (V) female
$\overline{Out}$	1.85mm (V) female
D0	MiniSMP (GPPO) Male
D1	MiniSMP (GPPO) Male
D2	MiniSMP (GPPO) Male
D3	MiniSMP (GPPO) Male
D4	MiniSMP (GPPO) Male
D5	MiniSMP (GPPO) Male
Clk	MiniSMP (GPPO) Male
$\overline{Clk}$	MiniSMP (GPPO) Male

Power Supply		
Pin	Colour	Voltage
1	brown	Vee
2	white	Vcc
3	blue	GND
4	black	GND
5	grey	Vee
6	pink	GND

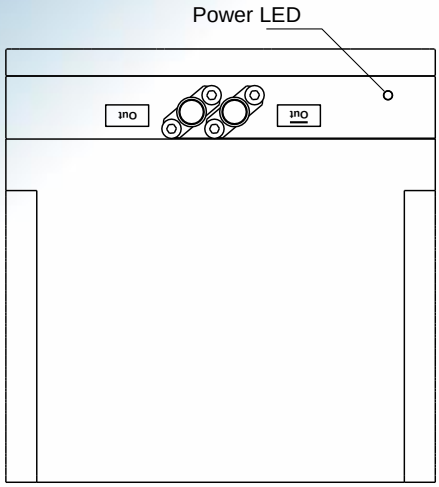
Control (I2C-Bus)		
Pin	Colour	Designation
1	brown	SCL
3	blue	GND
4	black	SDA



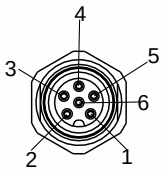
All dimensions in mm.

SHF Communication Technologies AG
the bandwidth company

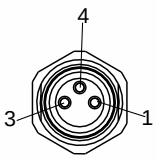
Outline Drawing – Module with Heat Sink

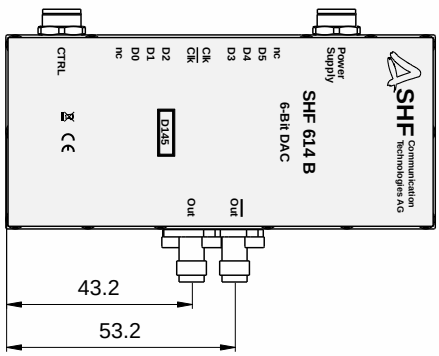


Power Supply



Control



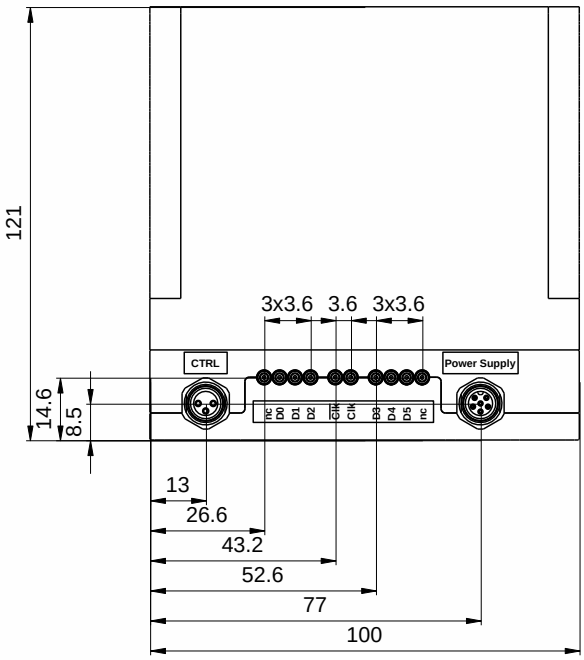


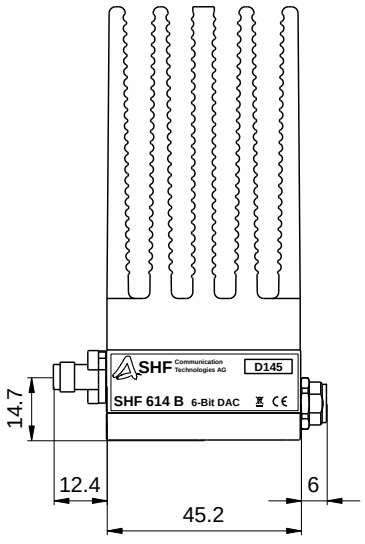
Port	Connector
Out	1.85mm (V) female
$\overline{Out}$	1.85mm (V) female
D0	MiniSMP (GPPO) Male
D1	MiniSMP (GPPO) Male
D2	MiniSMP (GPPO) Male
D3	MiniSMP (GPPO) Male
D4	MiniSMP (GPPO) Male
D5	MiniSMP (GPPO) Male
Clk	MiniSMP (GPPO) Male
$\overline{Clk}$	MiniSMP (GPPO) Male

Power Supply		
Pin	Colour	Voltage
1	brown	Vee
2	white	Vcc
3	blue	GND
4	black	GND
5	grey	Vee
6	pink	GND

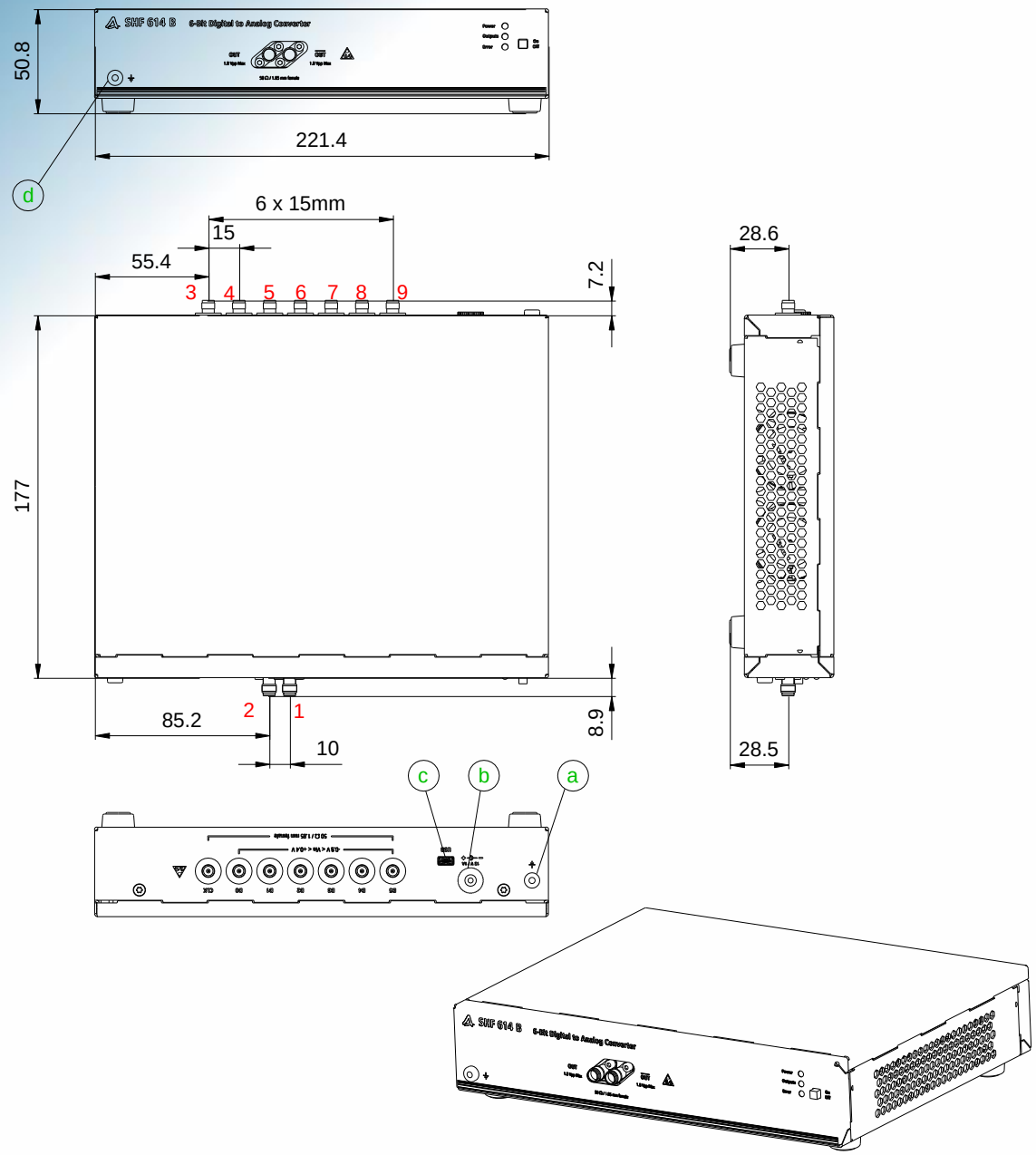
Control (I2C-Bus)		
Pin	Colour	Designation
1	brown	SCL
3	blue	GND
4	black	SDA

All dimensions in mm.





Outline Drawing – SHF 614 B with Option Case



Pos.	Designation	Connector
1	$\overline{\text{Data Out}}$	1.85mm (V) Female
2	Data Out	1.85mm (V) Female
3	Clock In	1.85mm (V) Female
4	D0	1.85mm (V) Female
5	D1	1.85mm (V) Female
6	D2	1.85mm (V) Female
7	D3	1.85mm (V) Female
8	D4	1.85mm (V) Female
9	D5	1.85mm (V) Female

Pos.	Designation
a	GND
b	Power Supply
c	USB
d	GND