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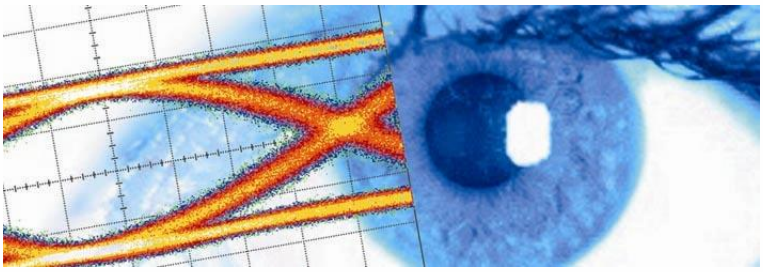


Datasheet

SHF 615 B

60 GBaud 3-Bit DAC

SHF Communication Technologies AG
the bandwidth company

Description

The SHF 615 B is a 3-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 three single ended serial data streams are accepted by the DAC and converted into one differential 8-level data signal. By using two input ports only it is possible to generate 4-level output signals. A single ended clock signal with the same frequency as the data rate drives the SHF 615 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, 4.8 V differential output swing (2.4 V in single-ended operation)
- Single ended clock and data inputs
- Latched input ports
- Output amplitude & input threshold level control (remote by software)

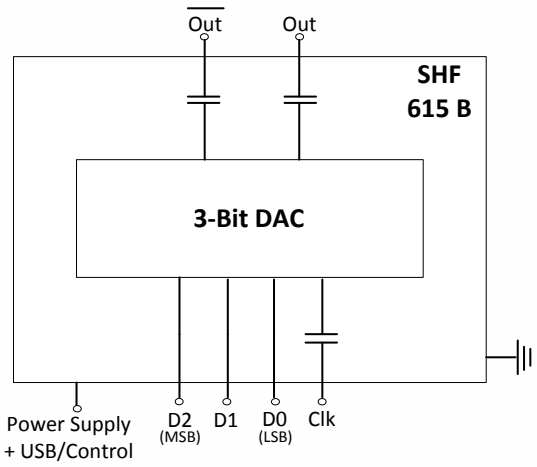
Applications

- 100, 200, 400 Gbps and 1 Tbps system evaluation & development
- Broadband test and measurement equipment
- PAM-4, PAM-8, Advanced Modulation Experiments

Options

- Option Case: DAC module, power supplies, heat sink 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 615 B

With Option Case the SHF 615 B DAC module, the power supplies, heat sink 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 615 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.

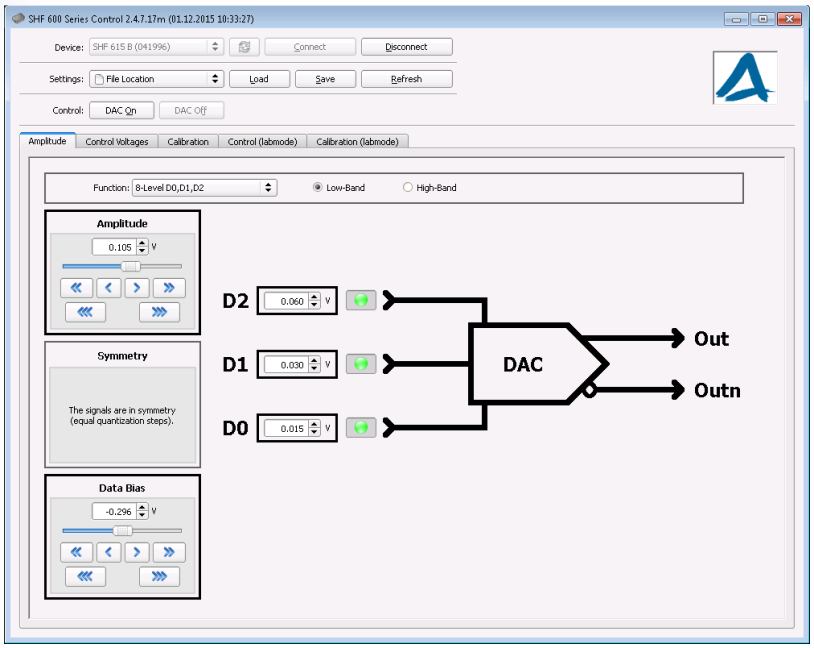


Fig. 1: "SHF 600 Series Control" – GUI

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}	-0.6		+0.05	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	62		
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}	-9		+9	AC coupled input

Parameter	Unit	Symbol	Min.	Typ.	Max.	Comment
Output Parameters						
Minimum Output Data Rate	GBaud	$R_{out,min}$			1	
Maximum Output Data Rate	GBaud	$R_{out,max}$	60	62		
Output Voltage	mV	V_{out}	2200	2415		Eye Amplitude; Single ended; Full scale; Adjustable up to -6 dB → see page 7
External DC Voltage on RF Output Ports	V	V_{DCout}	-9		+9	AC coupled outputs
Rise / Fall Time	ps	t_r		7.1	9.3	20%...80%; deconvolved[1]
Equivalent Output Bandwidth	GHz	BW	24	31		Derived from Rise Time using formula[2]; -3 dB bandwidth
Power Requirements (incl. Power Supply)						
Supply Voltage	V	V_c	+11.5	+12	+12.5	2.1 mm DC Power Jack
Supply Current	mA	I_c		650		
Power Dissipation	W	P_d		7.8		@ 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		850	950	
Power Dissipation	W	P_d		10.2	11.4	@ V_C = +12V
Conditions						
Case Temperature[3]	°C	T_{case}	10		45	

[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 D2	Input D1	Input D0	Typical Output Amplitude [mV]
-	-	On	**345**
-	On	-	**690**
On	-	-	**1380**

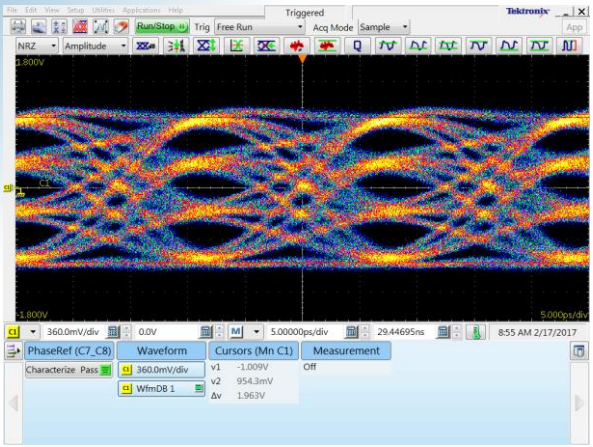
The typical output amplitude of a multilevel signal can be calculated by accumulating the typical output amplitudes of all applied input ports of the DAC as shown in the table above. Thus the full scale output swing (all inputs active) accumulates as follows:

On	On	On	**2415**

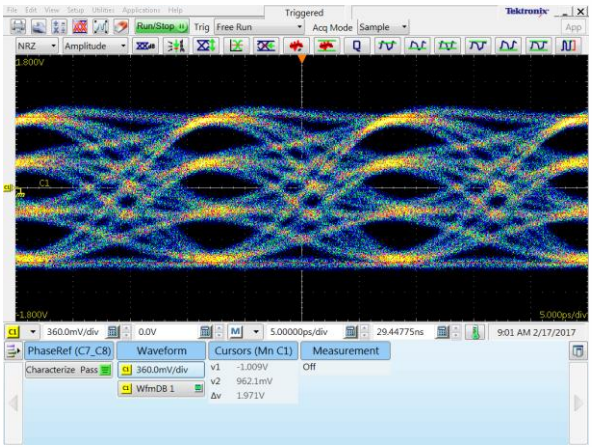
Typical Output Eye Diagrams

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 20 dB attenuator.

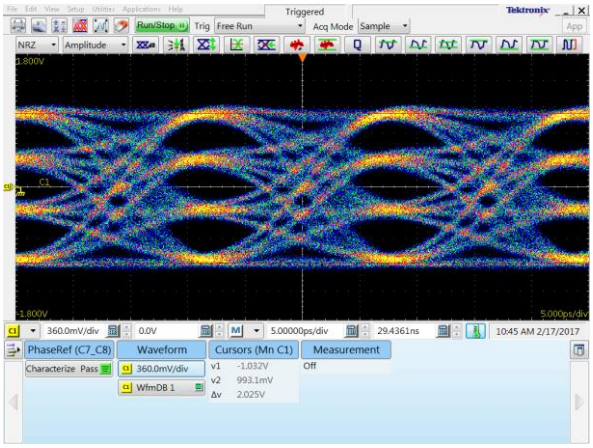
4-Level Output Signal Measurement



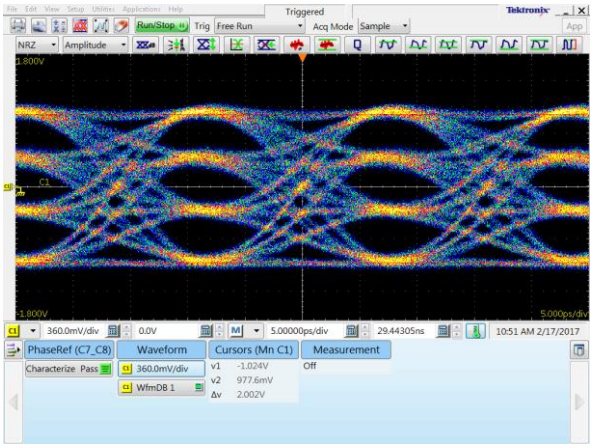
Out @ 62 GBaud



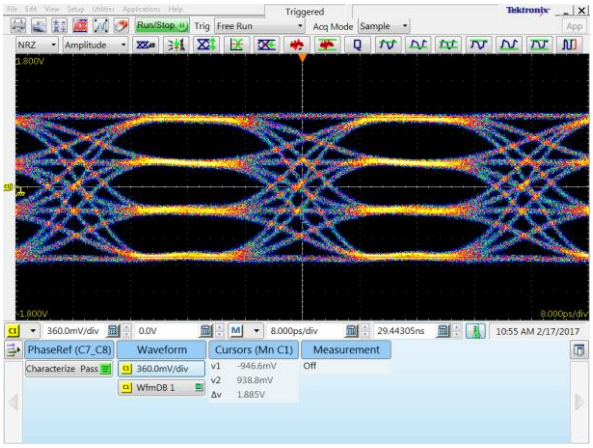
Out @ 60 GBaud



Out @ 56 GBaud



Out @ 50 GBaud



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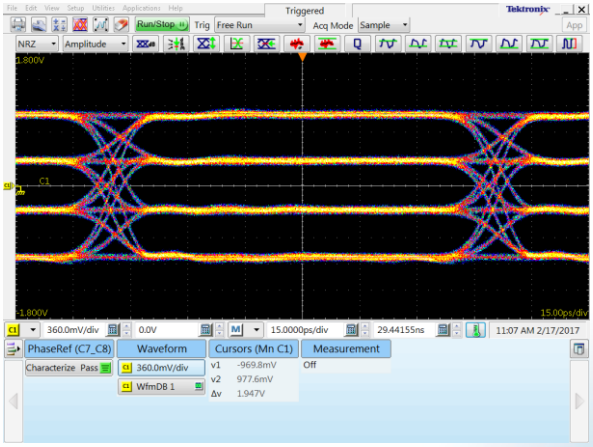

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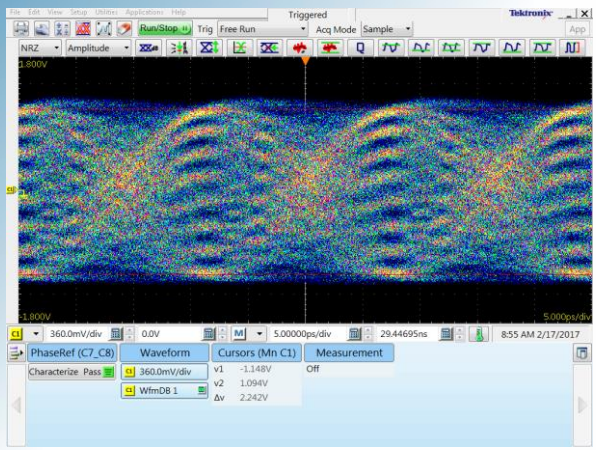
8-Level Output Signal Measurement



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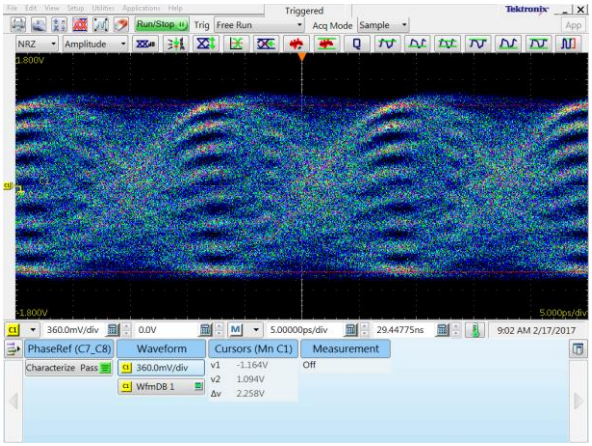

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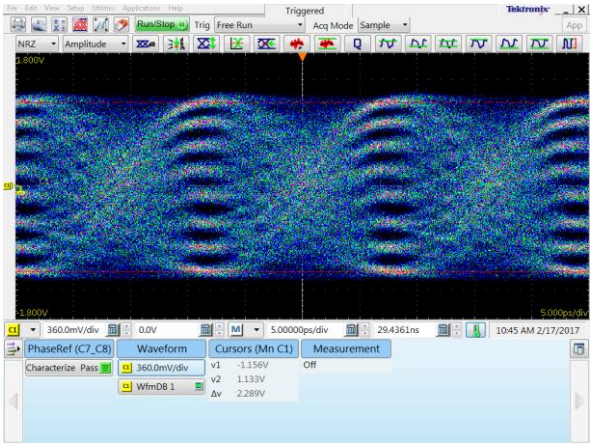

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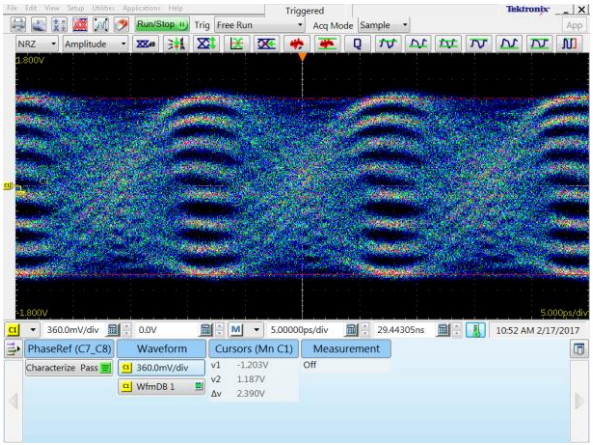

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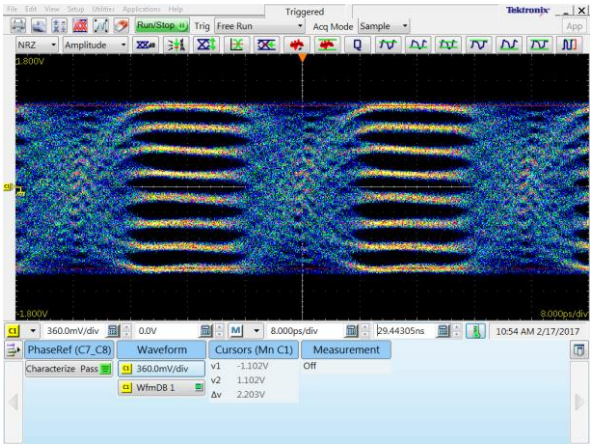

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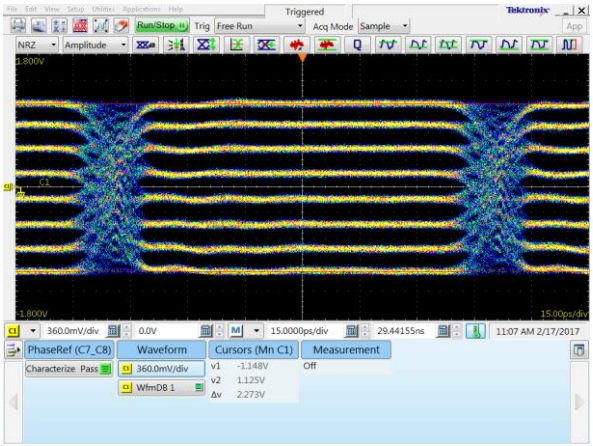
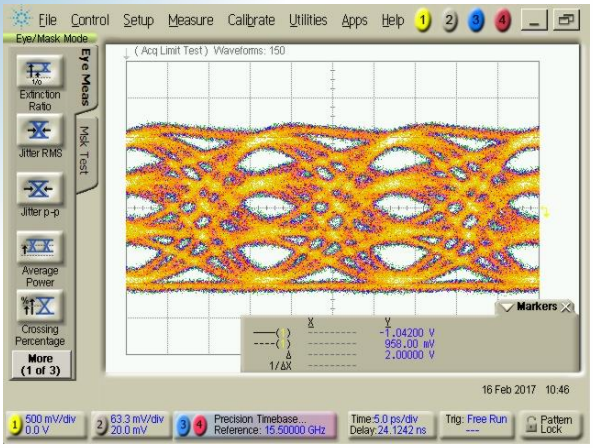


Out @ 10 GBaud

Typical Output Eye Diagrams

The measurements below had been performed using a SHF 12104 A Bit Pattern Generator (PRBS 2^{31}-1) and an Agilent Digital Communication Analyzer (DCA) with Precision Timebase Module (86107A) and 70 GHz Sampling Module (86118A). The outputs of the DAC module had been connected directly to the DCA input with a 20 dB attenuator.

4-Level Output Signal Measurement



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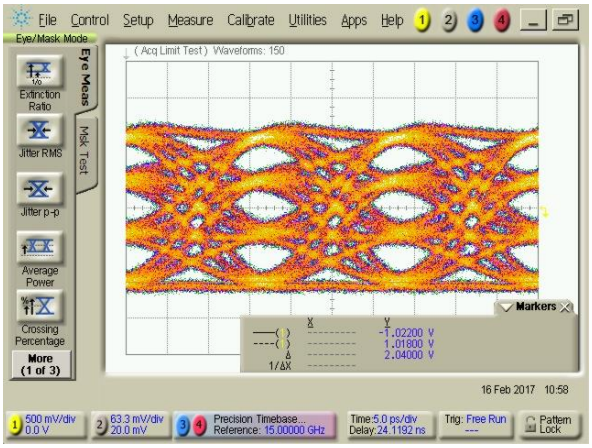
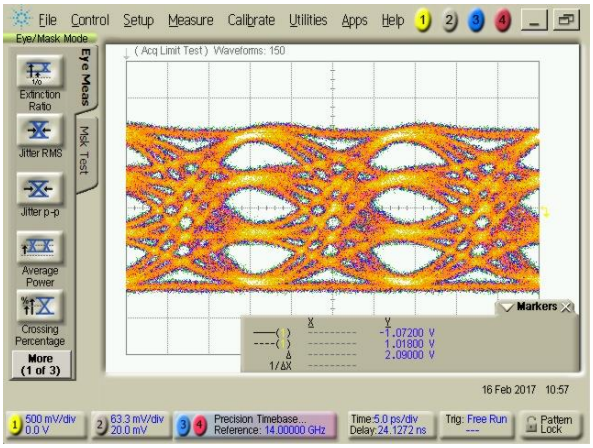


Out @ 60 GBaud



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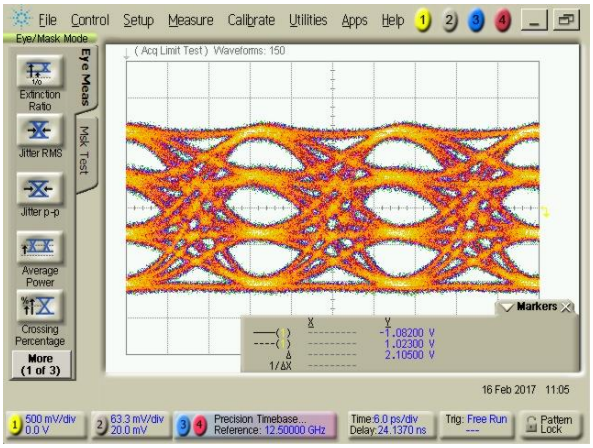
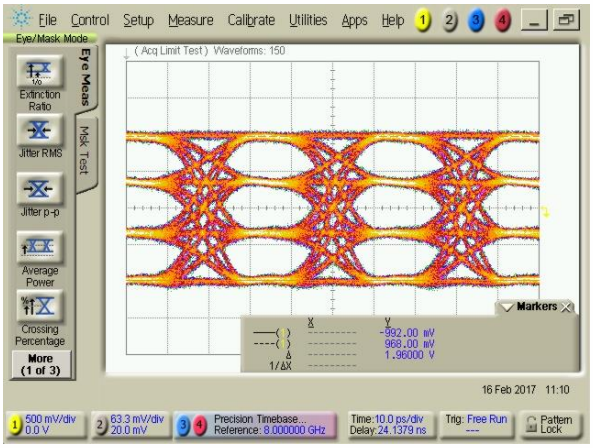


Out @ 50 GBaud



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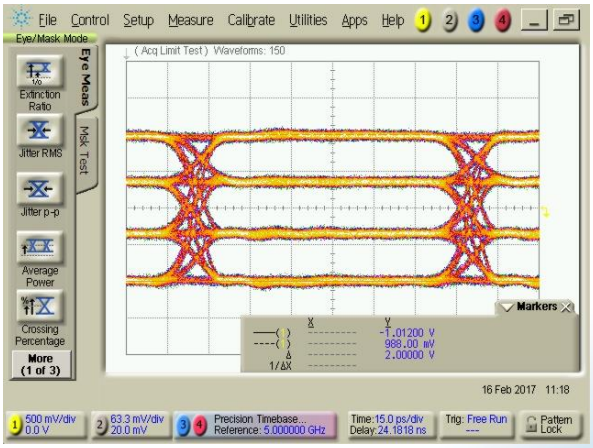
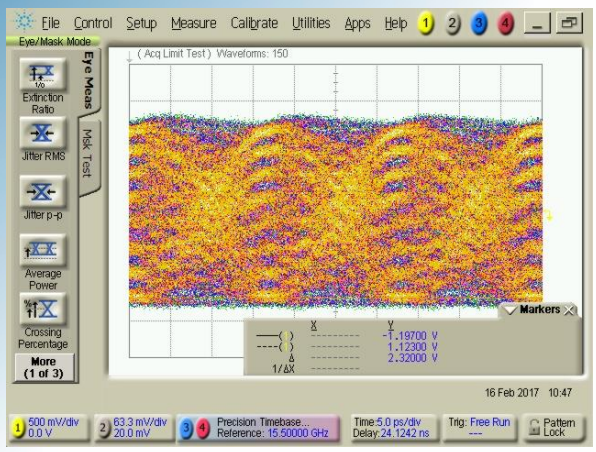


Out @ 10 GBaud

8-Level Output Signal Measurement



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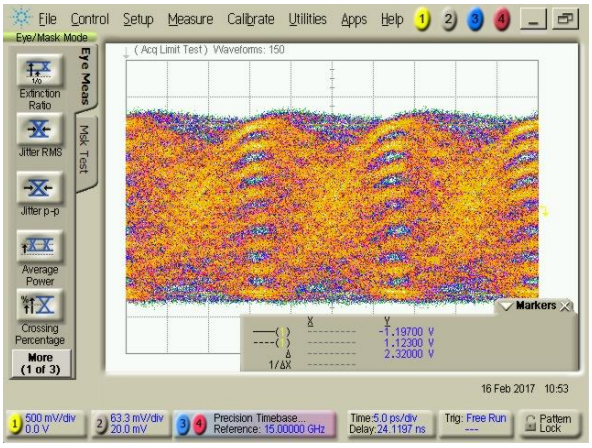
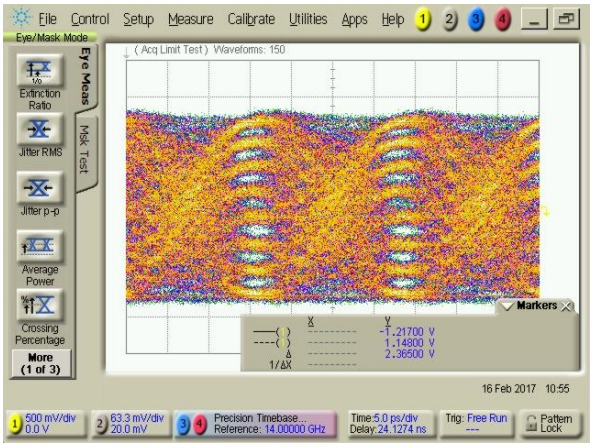


Out @ 60 GBaud



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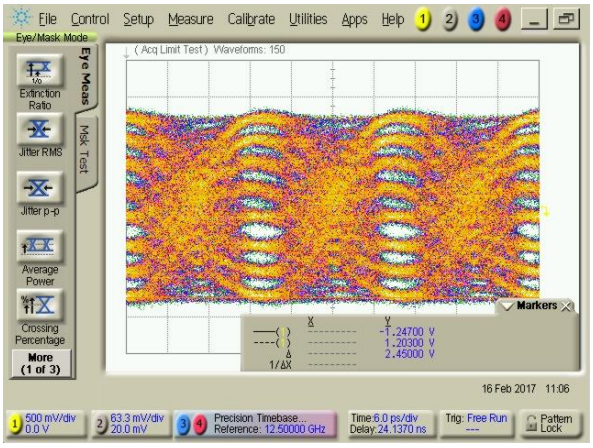

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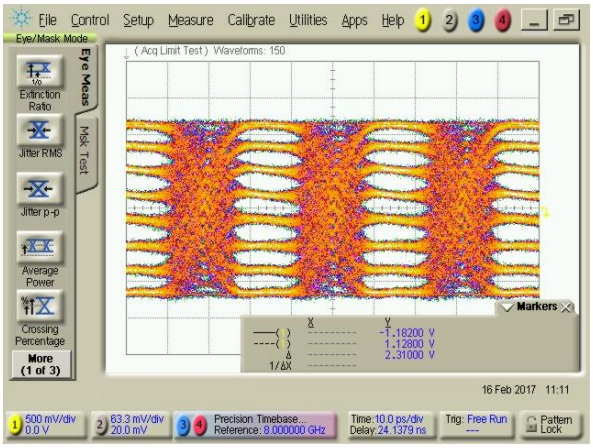

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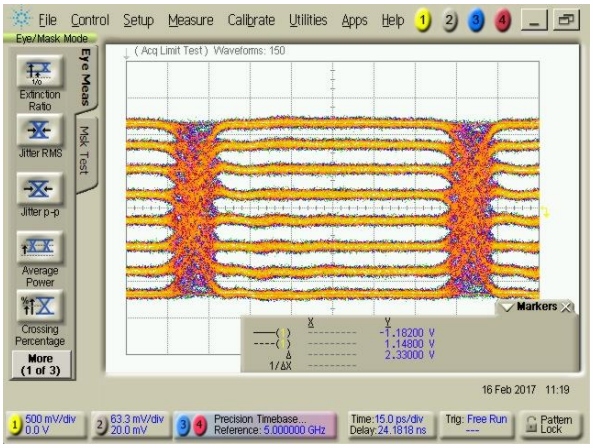
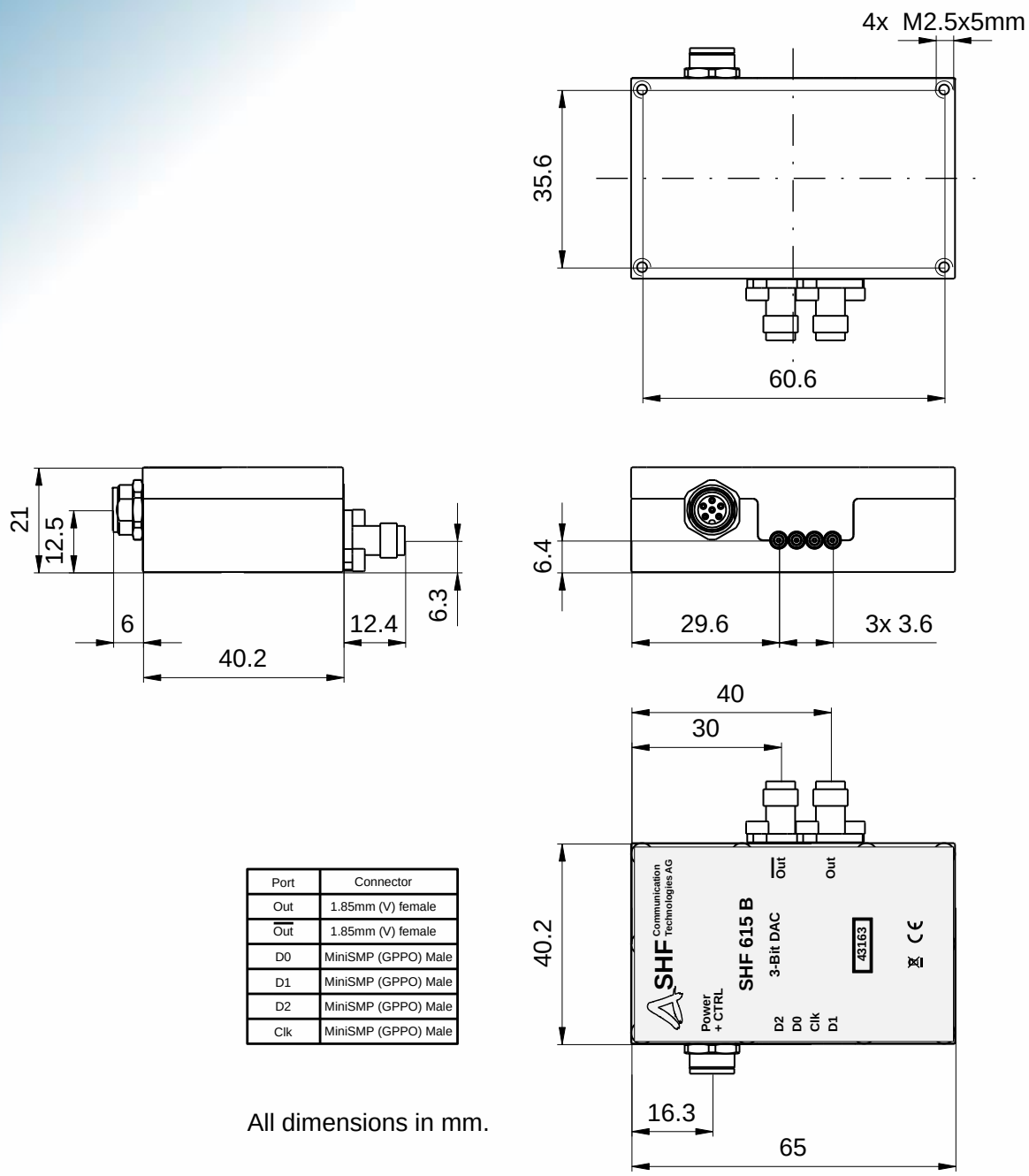


Out @ 10 GBaud

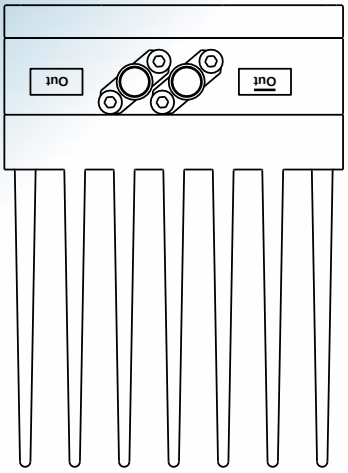
Outline Drawing – Module



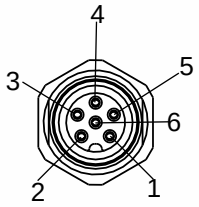
Port	Connector
Out	1.85mm (V) female
$\overline{\text{Out}}$	1.85mm (V) female
D0	MiniSMP (GPPO) Male
D1	MiniSMP (GPPO) Male
D2	MiniSMP (GPPO) Male
Clk	MiniSMP (GPPO) Male

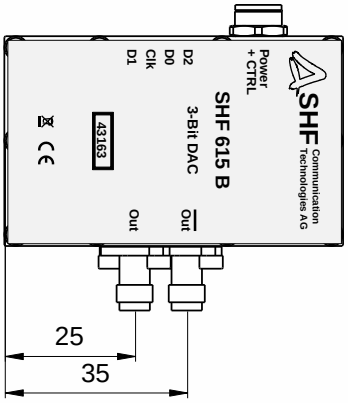
All dimensions in mm.

Outline Drawing – Module with Heat Sink



Power Supply & Control (I2C-Bus)

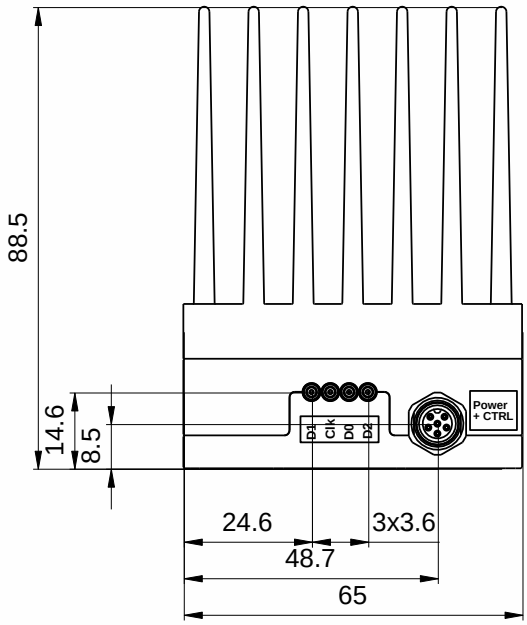


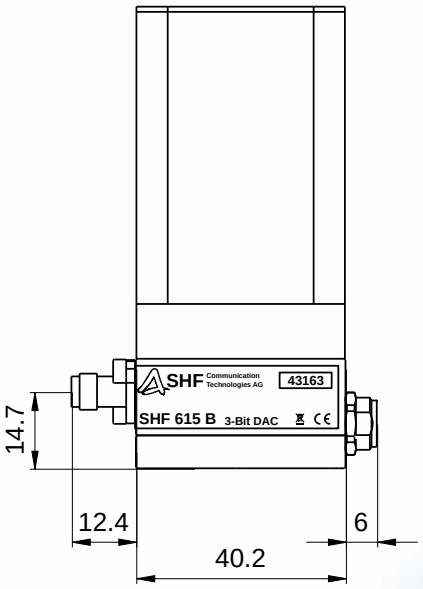


Port	Connector
Out	1.85mm (V) female
$\overline{\text{Out}}$	1.85mm (V) female
D0	MiniSMP (GPPO) Male
D1	MiniSMP (GPPO) Male
D2	MiniSMP (GPPO) Male
Clk	MiniSMP (GPPO) Male

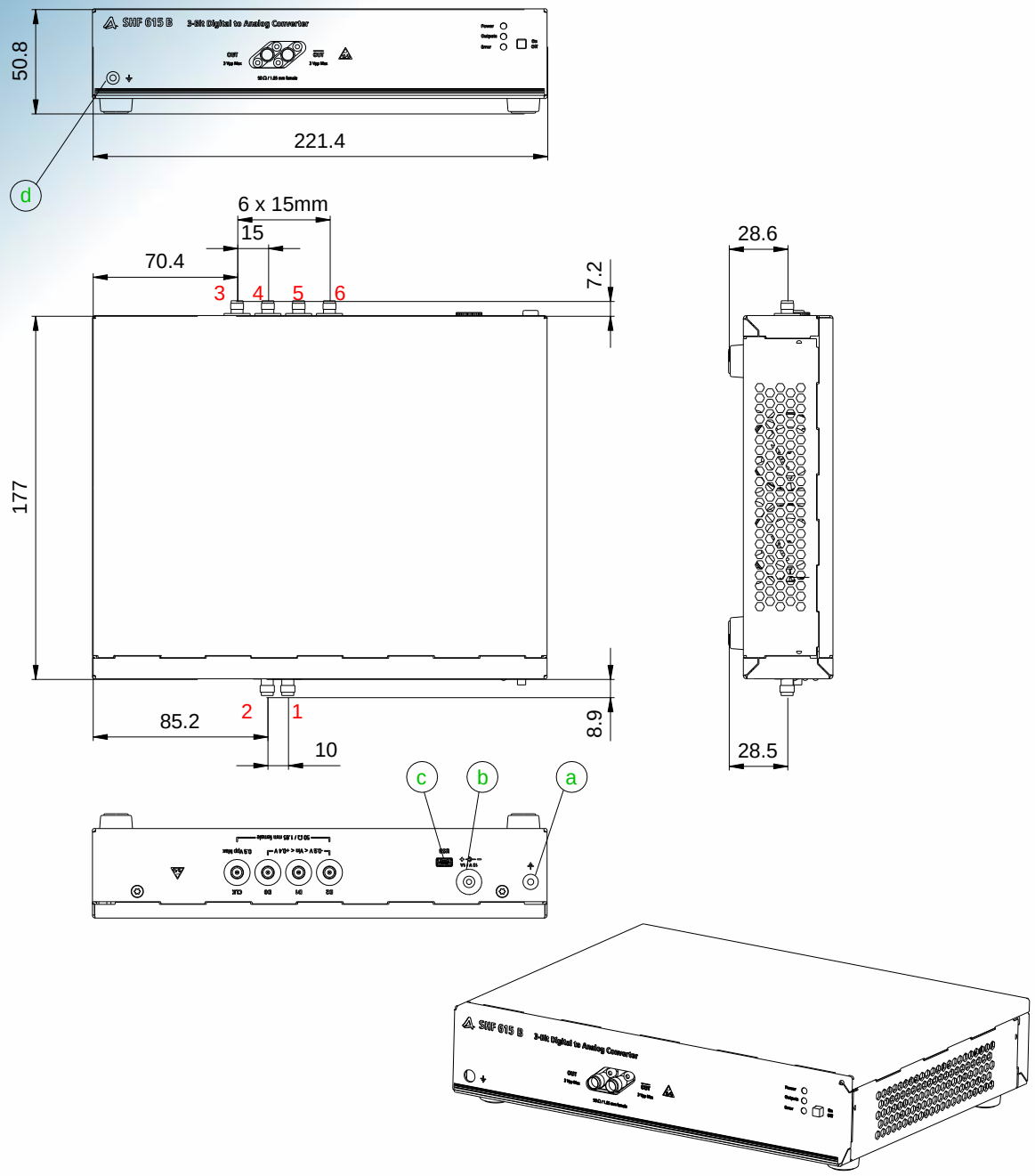
Power Supply & Control (I2C-Bus)		
Pin	Colour	Designation
1	brown	SCL
2	white	Vcc
3	blue	GND
4	black	Vee
5	grey	SDA
6	pink	GND

All dimensions in mm.





Outline Drawing – SHF 615 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

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