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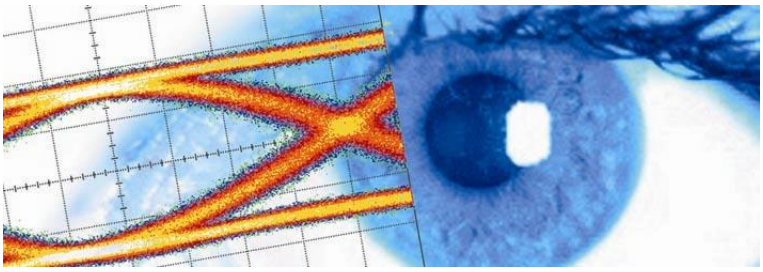


Datasheet

SHF 616 B

128 GBaud PAM4 Multiplexer

Description

The SHF 616 B is a PAM4 Multiplexer operating at PAM4 baud rates up to 128 GBaud (256 Gbps) for use in broadband test setups and telecom transmission systems.

The SHF 616 B is driven by four single ended serial NRZ data streams. Each two of these signals are multiplexed to two binary data steam of double the speed. These two high speed signals are internally combined to one differential PAM4 signal. With a programmable SHF BPG (e.g. the SHF 12105 A) you have full control of the patterns into the PAM4-MUX. The SHF BCC Control Center software package unifies the BPG to PAM4-MUX combination to virtually one 128 GBaud PAM4-Bit Pattern Generator. A typical setup is shown in the figure 1 below.

A single ended clock signal with a frequency equivalent to the input data rate is required to drive the SHF 616 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 is possible to place the PAM4-MUX very close to the DUT. Clock input port is AC-coupled. Data input and output ports are DC-coupled.

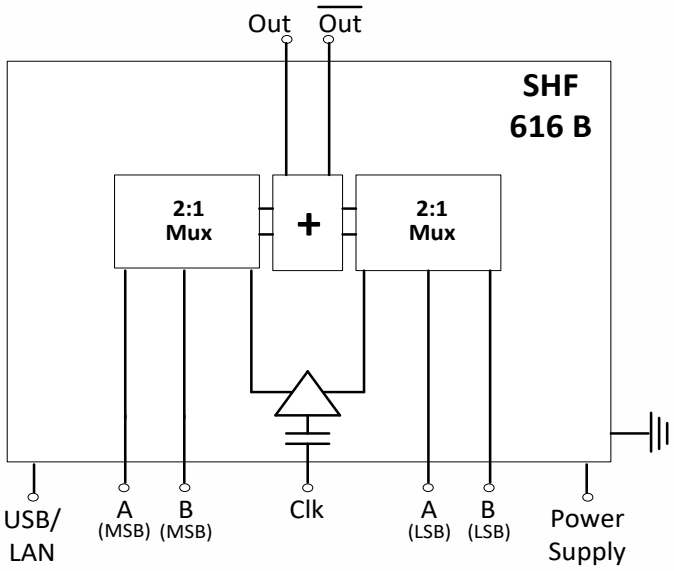
Features

- Broadband operation up to 128 GBaud
- Differential data output, 0.7 V differential output swing (0.35 V in single-ended operation)
- Single ended clock and data inputs
- Latched (re-timed and re-shaped) input ports
- Output amplitude & input threshold level control (remote by software)

Applications

- 100 Gbps (100GbE), 200 Gbps (200GbE), 400 Gbps (400GbE) & 1 Tbps (TbE) system evaluation
- Broadband test and measurement equipment
- PAM4 and Advanced Modulation Experiments

Block Diagram

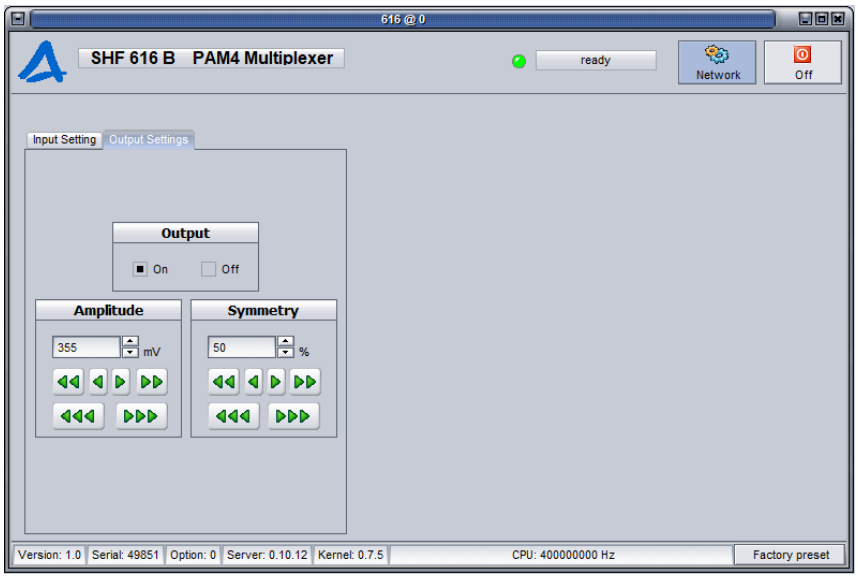


Ease of Use

Housed in a small benchtop case, this remote head can be easily embedded in the customer's test environment close to the DUT.

Figure 1 - Typical setup with SHF clock source, SHF BPG and the PAM4-MUX

The easy to use software package, SHF BCC Control Center is the most convenient way to control the MUX. The software reads the individual calibration tables of the multiplexers and sets the contribution of the bias voltages accordingly. The symmetry of the output signal can be set and is displayed in the graphical user interface (GUI). The duty cycle (clock bias) of the multiplexer stages as well as the input threshold level for the DC-coupled data inputs can be set. This enables the user to generate a perfect signal just by a few intuitive clicks.



BCC Control Center - SHF 616 B

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		+0.1	DC coupled inputs
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	$R_{in,max}$	64[1]			
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	$f_{in,max}$	64			
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

[1] The upper baud rate limit is defined by the absence of errors (BER < 10^{-12}) of a NRZ output generated with the MSB + LSB bit synchronized. The PAM4-MUX operates beyond this limit as shown in the typical eye diagrams below. However, it is just not currently possible to verify a true BER beyond this limit.

Parameter	Unit	Symbol	Min.	Typ.	Max.	Comment
Output Parameters						
Min. Output Data Rate	GBaud	$R_{out,min}$			2	
Max. Output Data Rate	GBaud	$R_{out,max}$	128[2]			
Output Voltage[3]	mV	V_{out}	300 270	350 320		≤ 100 GBaud > 100 GBaud Eye amplitude; Single ended; DC coupled; Full scale; Adjustable up to -6 dB
Rise / Fall Time	ps	t_r / t_f		5	6	20%...80%; Full scale; deconvolved[4]
Equivalent Output Bandwidth	GHz	BW	37	44		Derived from Rise Time using formula[5]; -3 dB bandwidth
Differential Output Skew	ps	t_{skew}		1	2	
General						
Supply Voltage	V	V_c	+11.5	+12	+12.5	2.1 mm DC Power Jack
Supply Current	mA	I_c		1000	1100	
Power Dissipation	W	P_d		12	13.2	@ V_C = +12V
Operating Temperature	°C	$T_{ambient}$	10		35	
Height	mm	H		50.8		
Width	mm	W		221.4		
Depth	mm	D		177		
Weight	g	m		1700		

[2] The upper baud rate limit is defined by the absence of errors (< 10^{-12}) of a NRZ output generated with the MSB + LSB bit synchronized. The PAM4-MUX operates beyond this limit as shown in the typical eye diagrams below. However, it is just not currently possible to verify a true BER beyond this limit.

[3] During start up / shut down of the SHF 616 B and turning on / off the RF outputs, voltage spikes up to +0.7 V can occur at the data output ports

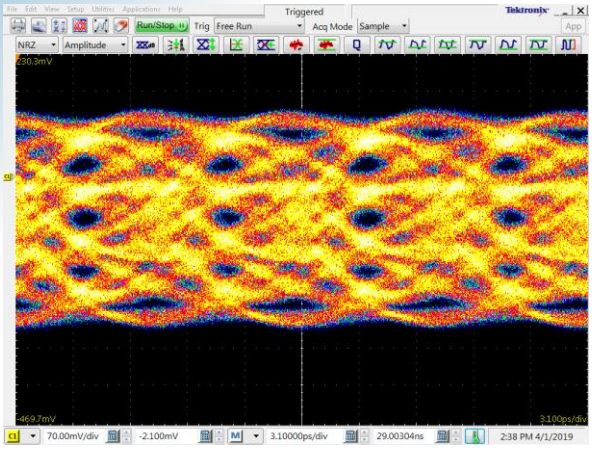
[4] Calculation based on typical rise / fall times from oscilloscope data sheet and with a NRZ output generated by bit synchronization of the MSB + LSB
$t_{r\ deconvolved} = \sqrt{(t_{r\ measured})^2 - (t_{r\ oscilloscope})^2} = \sqrt{(t_{r\ meas.})^2 - (3.68\ ps)^2}$

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

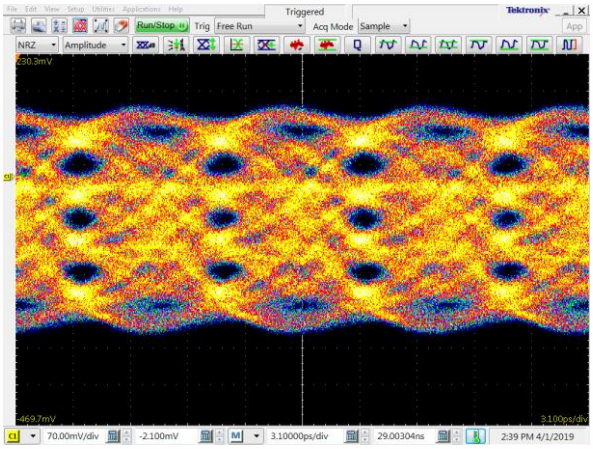
Typical Output Eye Diagrams

The measurements below had been performed using a SHF 12105 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 PAM4 MUX module had been connected directly to the DSA input.

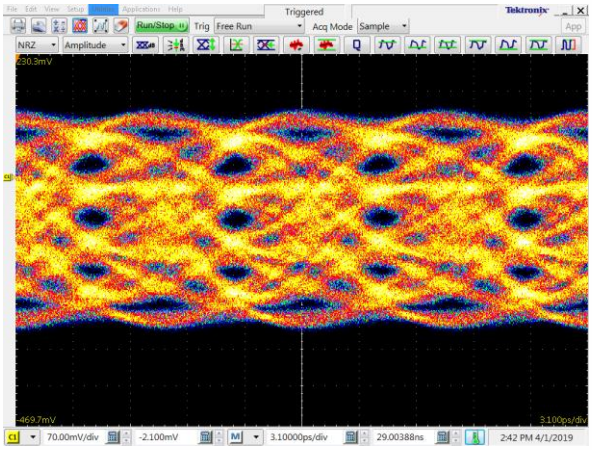
PAM4 Output Signal Measurement



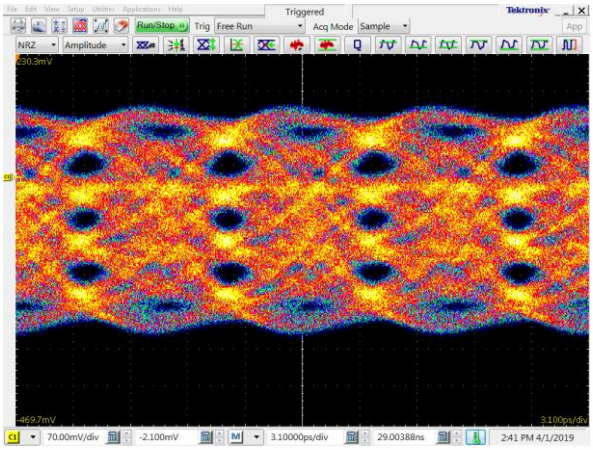
Out @ 130 GBaud



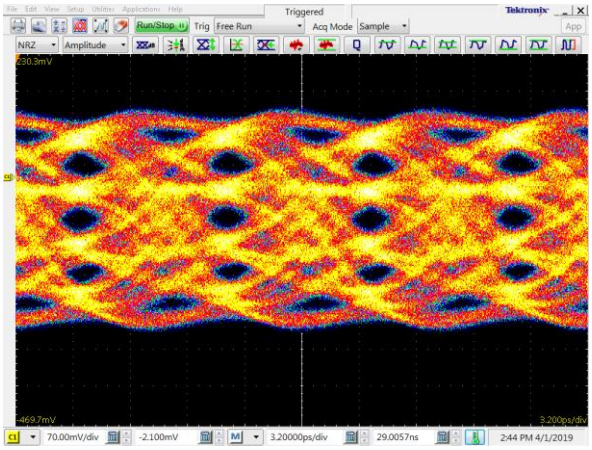
Out! @ 130 GBaud



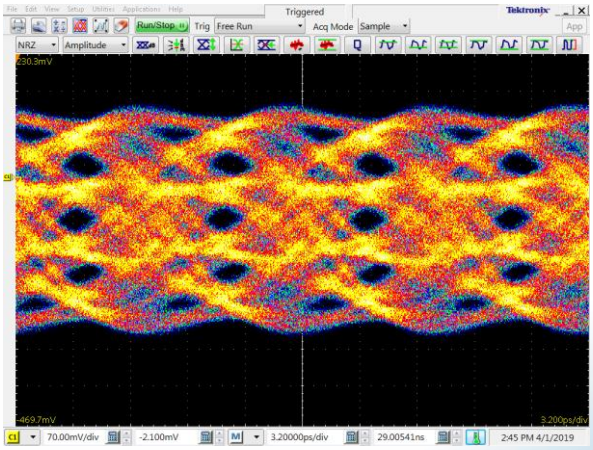
Out @ 128 GBaud



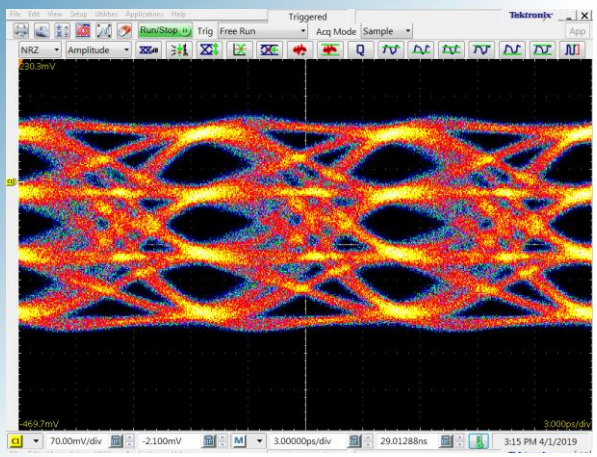
Out! @ 128 GBaud



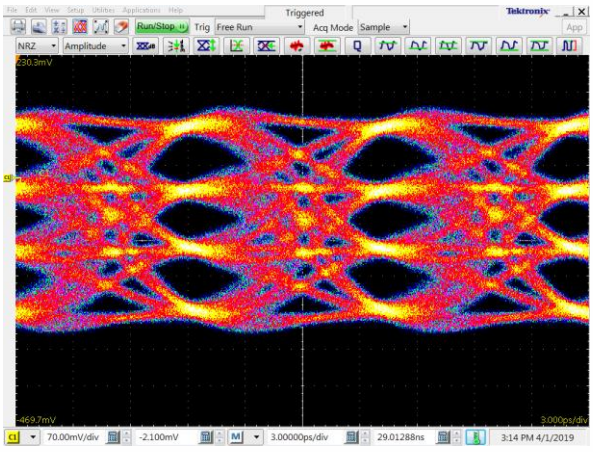
Out @ 124 GBaud



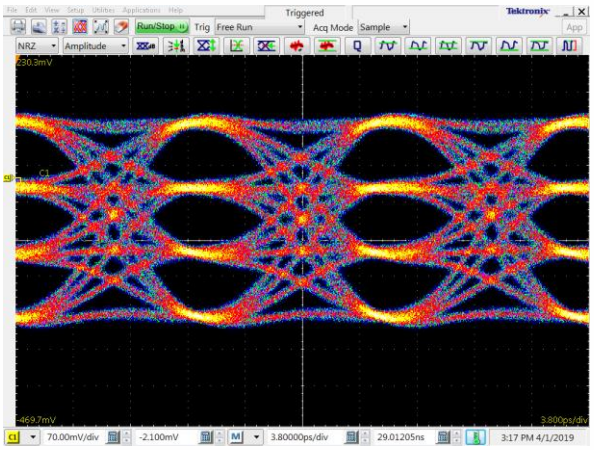
Out! @ 124 GBaud



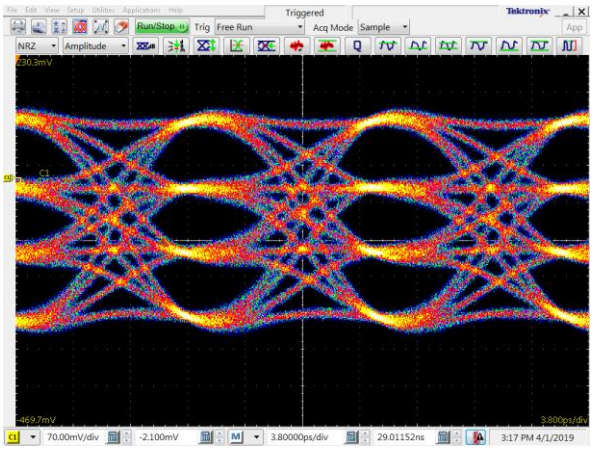
Out @ 100 GBaud



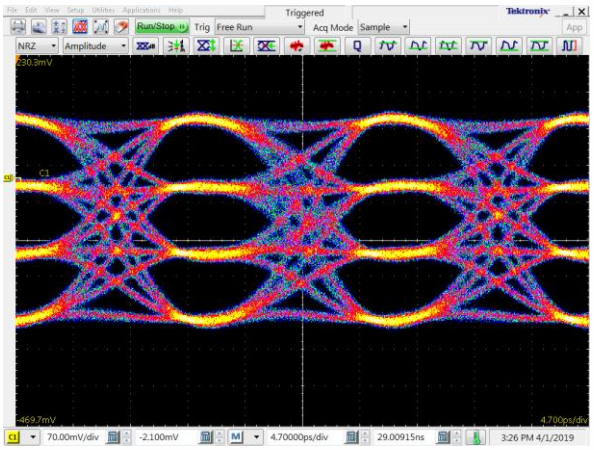
Out! @ 100 GBaud



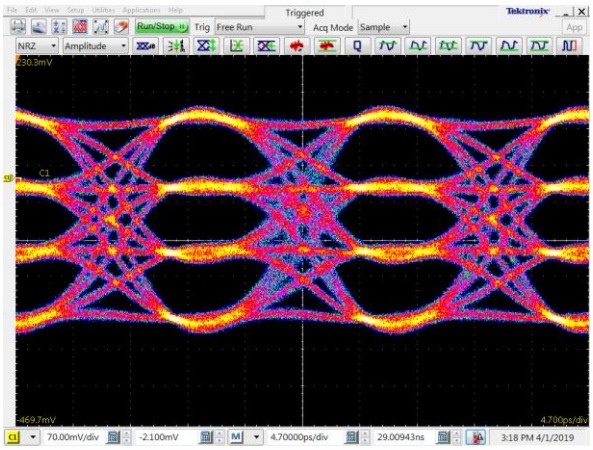
Out @ 80 GBaud



Out! @ 80 GBaud

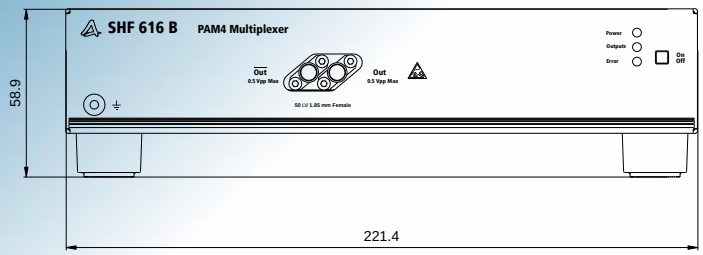


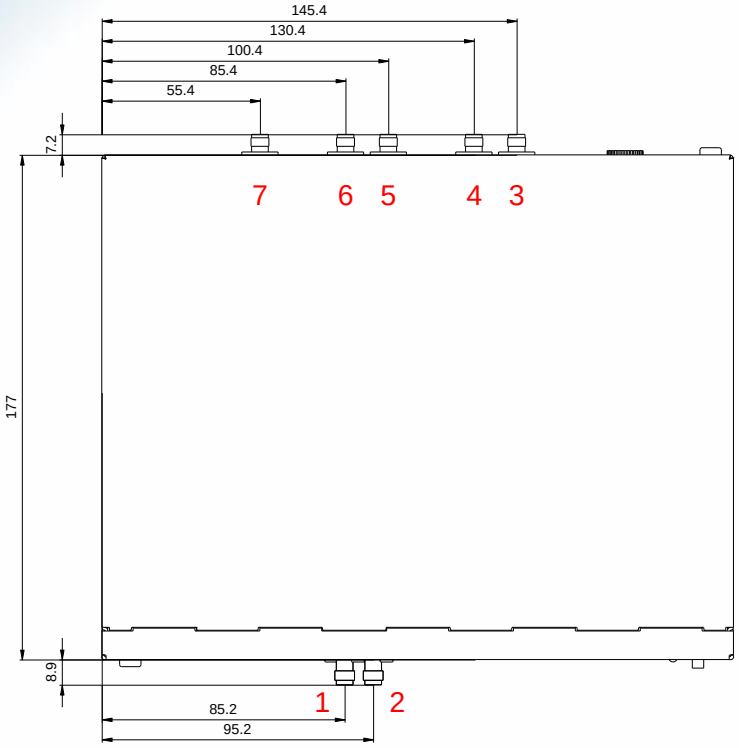
Out @ 64 GBaud

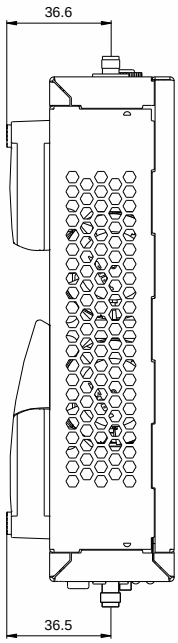


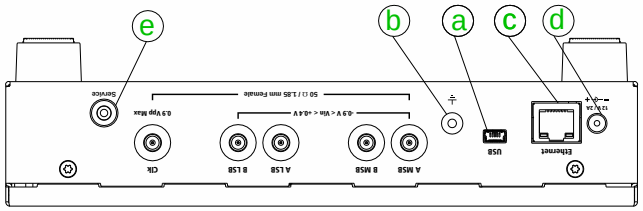
Out! @ 64 GBaud

Outline Drawing – SHF 616 B









Pos.	Designation	Connector
1	$\overline{\text{Output}}$	1.85mm (V) Female
2	Output	1.85mm (V) Female
3	A MSB	1.85mm (V) Female
4	B MSB	1.85mm (V) Female
5	A LSB	1.85mm (V) Female
6	B LSB	1.85mm (V) Female
7	Clock Input	1.85mm (V) Female

Pos.	Designation
a	USB
b	GND
c	Ethernet
d	Power Supply
e	Service

all dimensions in mm