

## 25Gb/s SFP28 Tunable DWDM 15km Transceiver

### HC -FLTS1x

#### Features

Up to 25.78125Gb/s data links

Monolithically integrated full C-band tunable transmitter and APD receiver

50 GHz ITU channel spacing with integrated wavelength locker

Up to 15km on 9/125μm SMF

Smart Features: Self-Negotiation, Remote DDM, Remote WL Locking

Hot-pluggable SFP+ footprint

Duplex LC/UPC type pluggable optical interface

RoHS-10 compliant and lead-free

Support Digital Monitoring interface

Single +3.3V power supply

Compliant with SFF+MSA and SFF-8472, SFF-8431, SFF-8690 and G.698.1

Metal enclosure, for lower EMI

Meet ESD requirements, resist 8KV direct contact voltage

Case operating temperature Commercial: 0 ~ +70°C Extended: -20 ~ +85°C Industrial: -40 ~ +85°C

#### Applications

CPRI 9.8304Gb/s, 10.1376Gb/s, 24.33024Gb/s

Ethernet 10.3125Gb/s, 25.78125Gb/s

#### Wavelength Selection: C-band λc Wavelength Guide Pin Descriptions

Channel (xx)	Wavelength h(nm)	Frequency (THZ)	Channel (xx)	Wavelength (nm)	Frequency (THZ)
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13	1567.13	191.30	37	1547.72	193.70
H3	1566.72	191.35	J7	1547.32	193.75
14	1566.31	191.40	38	1546.92	193.80
H4	1565.90	191.45	J8	1546.52	193.85
15	1565.50	191.50	39	1546.12	193.90
H5	1565.09	191.55	J9	1545.72	193.95
16	1564.68	191.60	40	1545.32	194.00
H6	1564.27	191.65	K0	1544.92	194.05
17	1563.86	191.70	41	1544.53	194.10
H7	1563.45	191.75	K1	1544.13	194.15
18	1563.05	191.80	42	1543.73	194.20
H8	1562.64	191.85	K2	1543.33	194.25
19	1562.23	191.90	43	1542.94	194.30
H9	1561.83	191.95	K3	1542.54	194.35
20	1561.42	192.00	44	1542.14	194.40
I0	1561.01	192.05	K4	1541.75	194.45
21	1560.61	192.10	45	1541.35	194.50
I1	1560.20	192.15	K5	1540.95	194.55
22	1559.79	192.20	46	1540.56	194.60
I2	1559.39	192.25	K6	1540.16	194.65
23	1558.98	192.30	47	1539.77	194.70
I3	1558.58	192.35	K7	1539.37	194.75
24	1558.17	192.40	48	1538.98	194.80
I4	1557.77	192.45	K8	1538.58	194.85
25	1557.36	192.50	49	1538.19	194.90
I5	1556.96	192.55	K9	1537.79	194.95
26	1556.55	192.60	50	1537.40	195.00
I6	1556.15	192.65	L0	1537.00	195.05

27	1555.75	192.70	51	1536.61	195.10
17	1555.34	192.75	L1	1536.22	195.15
28	1554.94	192.80	52	1535.82	195.20
18	1554.54	192.85	L2	1535.43	195.25
29	1554.13	192.90	53	1535.04	195.30
19	1553.73	192.95	L3	1534.64	195.35
30	1553.33	193.00	54	1534.25	195.40
J0	1552.93	193.05	L4	1533.86	195.45
31	1552.52	193.10	55	1533.47	195.50
J1	1552.12	193.15	L5	1533.07	195.55
32	1551.72	193.20	56	1532.68	195.60
J2	1551.32	193.25	L6	1532.29	195.65
33	1550.92	193.30	57	1531.90	195.70
J3	1550.52	193.35	L7	1531.51	195.75
34	1550.12	193.40	58	1531.12	195.80
J4	1549.72	193.45	L8	1530.72	195.85
35	1549.32	193.50	59	1530.33	195.90
J5	1548.91	193.55	L9	1529.94	195.95
36	1548.51	193.60	60	1529.55	196.00
J6	1548.11	193.65	M0	1529.16	196.05
<b>Non-ITU</b>	Peak wavelength between 1529.16nm-1567.13nm				

## Absolute Maximum Ratings

It has to be noted that the operation in excess of any individual absolute maximum ratings might cause permanent damage to this module.

Parameter	Symbol	Min	Max	Unit	Notes
Storage Temperature	T <sub>s</sub>	-40	85	°C	

Power Supply Voltage (no damaged)	V <sub>CC</sub>	-0.5	3.6	V	
Relative Humidity (non-condensation)	RH	5	95	%	
Damage Threshold	TH <sub>d</sub>	0		dBm	

## Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Operating Case Temperature	T <sub>OP</sub>	0		70	°C	commercial
		-20		85		extended
		-40		85		Industrial
Power Supply Voltage	V <sub>CC</sub>	3.135	3.3	3.465	V	
Data Rate		9.8304		25.78125	Gb/s	
Control Input VoltageHigh		2		V <sub>CC</sub>	V	
Control Input Voltage Low		0		0.8	V	
Link Distance (SMF)	D			15	km	9/125um

## General Description

HC 25G tunable transceiver is an integrated fiber optic transceiver that provides a high-speed serial link at signaling rates from 9.8304 Gb/s to 25.78125 Gb/s. The module complies with the Enhanced Small Form Factor Pluggable (SFP+) multisource agreement-MSA (SFF-8431) and

SFF-8432, SFF-8690, SFF-8472. It complies with the ITU-T G.698.1 standard with 100 GHz channel spacing for CPRI and Ethernet applications.

The transceiver integrates the receiver and transmitter path on one module. The transceiver contains a C-band-tunable integrated Mach-Zehnder (MZ) laser, enabling data transmission over single-mode fiber through an industry-standard LC connector. On the receiver side, the 25 Gbps data stream is recovered from a trans-impedance amplifier, and passed to an output driver. This module features a hot-pluggable electrical interface.

the transceiver provides a unique enhanced digital diagnostic monitoring interface, which allows real-time access to device operating parameters such as transceiver temperature, laser bias current, transmitted optical power,

and received optical power and transceiver supply voltage. It also defines a sophisticated system of alarm and warning flags, which alerts end-users when particular operating parameters are outside of a factory set normal range.

The SFP+ MSA defines a 256-byte memory map in EEPROM that is accessible over a 2-wire serial interface at the 8bit address 1010000X (A0h). The digital diagnostic monitoring interface makes use of the 8bit address 1010001X (A2h), so the originally defined serial ID memory map remains unchanged.

## Pin Assignment and Pin Description

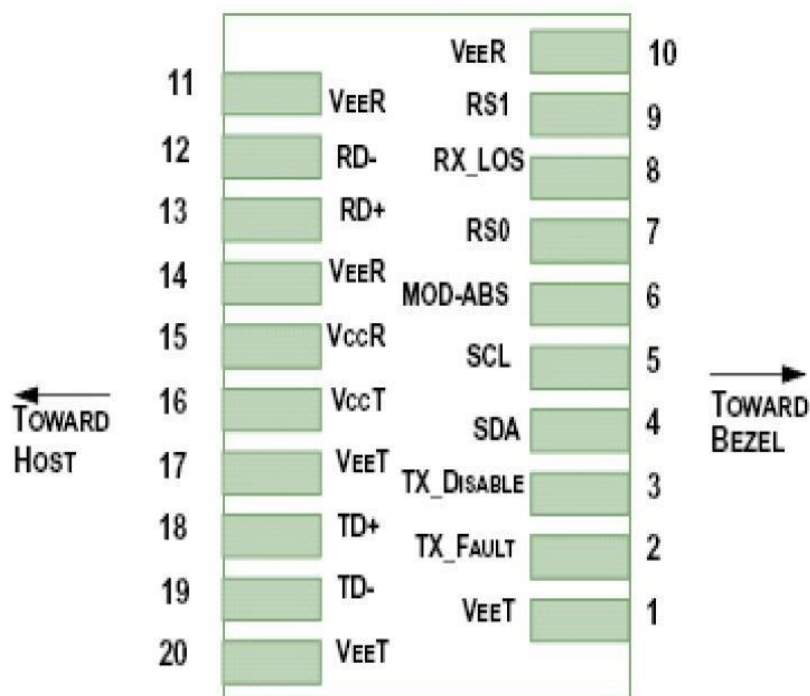


Figure1. Diagram of host board connector block pin numbers and names

Pin	Symbol	Name/Description	Notes
1	V <sub>EET</sub>	Transmitter Ground (Common with Receiver Ground)	1
2	T <sub>FAULT</sub>	Transmitter Fault.	2
3	T <sub>DIS</sub>	Transmitter Disable. Laser output disabled on high or open.	3
4	SDA	2-wire Serial Interface Data Line	4
5	SCL	2-wire Serial Interface Clock Line	4

6	MOD_ABS	Module Absent. Grounded within the module	4
7	RS0	Rate Select 0	5
8	LOS	Loss of Signal indication. Logic 0 indicates normal operation.	6
9	RS1	No connection required	
10	$V_{EER}$	Receiver Ground (Common with Transmitter Ground)	1
11	$V_{EER}$	Receiver Ground (Common with Transmitter Ground)	1
12	RD-	Receiver Inverted DATA out. AC Coupled	
13	RD+	Receiver Non-inverted DATA out. AC Coupled	
14	$V_{EER}$	Receiver Ground (Common with Transmitter Ground)	1
15	$V_{CCR}$	Receiver Power Supply	
16	$V_{CCT}$	Transmitter Power Supply	
17	$V_{EET}$	Transmitter Ground (Common with Receiver Ground)	1
18	TD+	Transmitter Non-Inverted DATA in. AC Coupled.	
19	TD-	Transmitter Inverted DATA in. AC Coupled.	
20	$V_{EET}$	Transmitter Ground (Common with Receiver Ground)	1

Notes:

1. Circuit ground is internally isolated from chassis ground.
2. TFAULT is an open collector/drain output, which should be pulled up with a 4.7k $\Omega$ -10k $\Omega$  resistor on the host board if intended for use. Pull up voltage should be between 2.0V to Vcc + 0.3V. A high output indicates a transmitter fault caused by either the TX bias current or the TX output power exceeding the preset alarm thresholds. A low output indicates normal operation. In the low state, the output is pulled to <0.8V.
3. Laser output disabled on TDIS >2.0V or open, enabled on TDIS <0.8V.
4. Should be pulled up with 4.7k $\Omega$ -10k $\Omega$  on host board to a voltage between 2.0V and 3.6V. MOD\_ABS pulls line low to indicate module is plugged in.
5. Internally pulled down per SFF-8431 Rev 4.1.
6. LOS is open collector output. It should be pulled up with 4.7k $\Omega$ -10k $\Omega$  on host board to a voltage between 2.0V

and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.

## Electrical Characteristics

The following electrical characteristics are defined over the Recommended Operating Environment unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max	Unit	Notes
Power Consumption	p			2.8	W	
Supply Current	I <sub>cc</sub>			892	mA	
<b>Transmitter</b>						
Single-ended Input Voltage Tolerance	V <sub>cc</sub>	-0.3		4.0	V	
AC Common Mode Input Voltage Tolerance (RMS)		15			mV	
Differential Input Voltage Swing	V <sub>in,pp</sub>	120		820	mV <sub>pp</sub>	
Differential Input Impedance	Z <sub>in</sub>	90	100	110	Ohm	1
Transmit Disable Assert Time				10	us	
Transmit Disable Voltage	V <sub>dis</sub>	V <sub>cc</sub> -1.3		V <sub>cc</sub>	V	
Transmit Enable Voltage	V <sub>en</sub>	V <sub>ee</sub>		V <sub>ee</sub> +0.8	V	2
<b>Receiver</b>						
Differential Output Voltage Swing	V <sub>out,pp</sub>	350		850	mV <sub>pp</sub>	
Differential Output Impedance	Z <sub>out</sub>	90	100	110	Ohm	3
Data output rise/fall time	Tr/Tf	28			ps	4
LOS Assert Voltage	V <sub>losH</sub>	V <sub>cc</sub> -1.3		V <sub>cc</sub>	V	5
LOS De-assert Voltage	V <sub>losL</sub>	V <sub>ee</sub>		V <sub>ee</sub> +0.8	V	5
Power Supply Rejection	PSR	100			mV <sub>pp</sub>	6

Notes:

1. Connected directly to TX data input pins. AC coupled thereafter.
2. Or open circuit.
3. Input 100 ohms differential termination.

4. These are unfiltered 20-80% values.

5. Loss of Signal is LVTTL. Logic 0 indicates normal operation; logic 1 indicates no signal detected.

Receiver sensitivity is compliant with power supply sinusoidal modulation of 20 Hz to 1.5 MHz up to specified value applied through the recommended power supply filtering network.

## Optical Characteristics

The following optical characteristics are defined over the Recommended Operating Environment unless otherwise specified.

Parameter	Symbol	Min.	Typical	Max	Unit	Notes
Transmitter						
Wavelength range (ITU Grid)	$\Lambda$	1529.16		1567.13	nm	
Center Wavelength Spacing			50		GHz	1
Optical Spectral Width	$\Delta\lambda$			1	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Average Optical Power	$P_{AVG}$	0		5	dBm	2
Optical Extinction Ratio	ER	6.0			dB	
Transmitter and Dispersion Penalty	TDP			3	dB	
Transmitter OFF Output Power	POff			-30	dBm	
Frequency stability (BOL)		-1.5		1.5	GHz	
Frequency stability (EOL)		-2.5		2.5	GHz	
Transmitter Eye Mask		Compliant with IEEE802.3ae				
Receiver						
Center Wavelength	$\lambda_c$	1270		1610	nm	
Receiver Sensitivity (Average Power, BtoB)	Sen.			-16	dBm	3
Receiver Sensitivity (EOL, 15km Fiber)	Sen.			-16	dBm	3



Input Saturation Power (overload)	Psat	0			dBm	
LOS Assert	LOSA	-27			dBm	
LOS De-assert	LOSD			-18	dBm	
LOS Hysteresis	LOSH	0.5			dB	
Receiver reflectance	dB			-26	dB	

Notes:

1.  $\lambda_c$  refer to wavelength selection, and corresponds to approximately 0.4 nm.
2. Class 1 Laser Safety per FDA/CDRH and IEC-825-1 regulations.
3. Measured with Light source 1529.16~1567.13nm, Data rate 25.78125Gb/s, ER>6dB; BER≤5E-5 @PRBS=2<sup>31</sup> -1 NRZ.
- 4.

## Digital Diagnostic Functions

The following digital diagnostic characteristics are defined over the Recommended Operating Environment unless otherwise specified. It is compliant to SFF-8472 Rev10.2 with internal calibration mode. For external calibration mode please contact our sales staff.

Parameter	Symbol	Min.	Max	Unit	Notes
Temperature monitor absolute error	DMI_Temp	-3	3	°C	Over operating temp
Supply voltage monitor absolute error	DMI_VCC	-3	3	%	Full operating range
RX power monitor absolute error	DMI_RX	-3	3	dB	
Bias current monitor	DMI_bias	-10	10	%	
TX power monitor absolute error	DMI_TX	-3	3	dB	

## Mechanical Dimensions

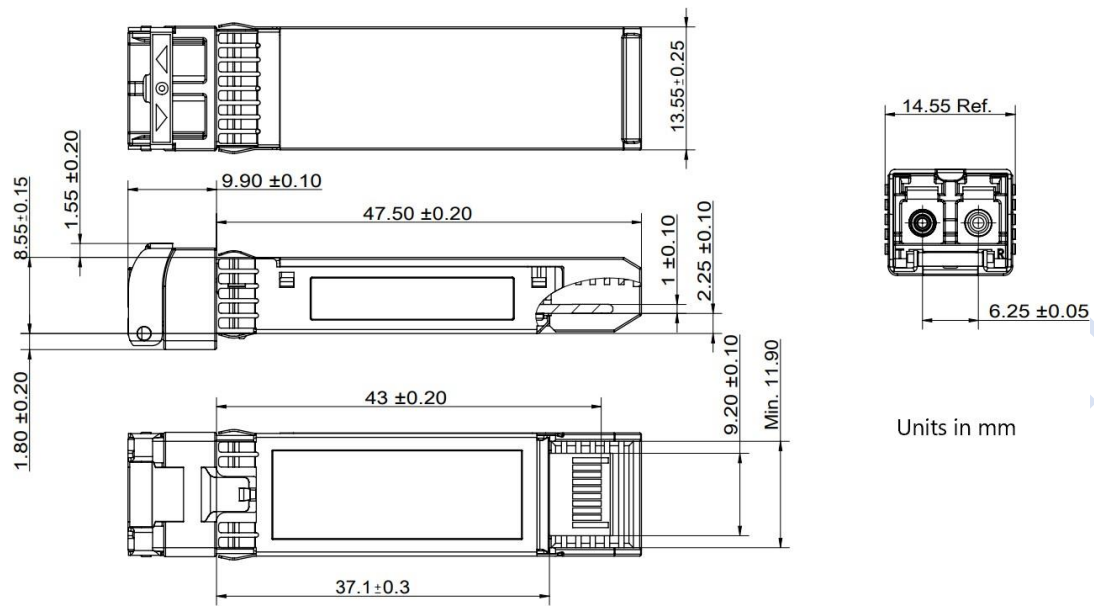


Figure2. Mechanical Outline

## Ordering Information

Part Number	Data Rate (Gb/s)	Wavelength (nm)	Transmission Distance(km)	Temperature (°C) (Operating Case)
HC -FLTS1C	25.78125	Refer to wavelength selection	15	0~70 commercial
HC -FLTS1E	25.78125		15	-20~85 extended
HC -FLTS1I	25.78125		15	-40~80 Industrial