Product Specification
10 GBd SFP+ 1310 nm Industrial Temperature Module
TRX10GDP0311A1

Product Features:

- Hot pluggable SFP+ optical transceiver
- Data rate transparent from 9.95 to 11.3 Gbps
- Excellent EMI performance
- Transmission distance up to 10 km SM fiber
- -40 °C to +85 °C case operating temperature
- 1310 nm DFB laser
- Duplex LC connector
- Laser Class 1
- RoHS 6/6 compliant

Applications:

- 10G Ethernet 10GBASE-LR/LW
- 10G Fibre Channel 1200-SM-LL-L

FCI's SFP+ optical transceiver TRX10GDP0311A1 is compliant with the SFP+ MSA specifications (SFF-8431, SFF-8432 and Diagnostic Monitor Function SFF-8472) and with 10GBASE-LR/LW per IEEE 802.3 as well as 1200-SM-LL-L per 10G Fibre Channel. It is RoHS 6/6 compliant per Directive 2002/95/EC and laser class 1 safety compliant per IEC/CDRH. The sub-Watt power consumption and the excellent EMI performance allows system designs with high port density.

Supported Standards

Application	Standard	Data Rate
10G Ethernet LAN/WAN	IEEE 802.3 10GBASE-LR/LW	10.3125 / 9.953 Gbps
10G Fibre Channel	1200-SM-LL-L	10.518 Gbps

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Maximum Ratings

Stress beyond any maximum rating may result in a permanent damage to the device. Characteristics are guaranteed only under recommended operating conditions.

Parameter	Conditions	Symbol	Min	Max	Units
Storage Temperature		ϑ_{St}	-40	+90	°C
Operating Case Temperature		ϑ_{C}	-40	+90	°C
Operating Relative Humidity	Non condensing	RH	0	85	%
Power Supply Voltage		$V_{CCT/R}$	-0.5	4.0	V
DC Voltage at High Speed Pins	At hot-plugging	V_D	-0.3	V_{cc}+0.3	V
Differential Input Swing	Differential peak-to-peak amplitude	v_{INmax}		1.5	V_{pp}
Voltage on Low Speed Inputs/Open Drain Outputs	SCL, SDA, RS0, RS1, Tx-Dis, Tx_FAULT, Rx_LOS	$V_{I/O}$	-0.5	V_{cc}+0.5	V
Sink Current Low Speed Output	SDA, INT_L/RST_L, Tx_FAULT, Rx_LOS	I_{SINK}		10	mA
Static Discharge Voltage on Low-Speed Signal and Power Pins	Human body model per JEDEC JESD22-A114-B			2	kV
	Charged device model per JEDEC JESD22-C101C			500	V
Static Discharge Voltage on High Speed Signal Pins	Human body model per JEDEC JESD22-A114-B			1	kV

Note: Chassis ground is internally isolated from circuit ground

General Recommended Operating Conditions

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Operating Case Temperature		ϑ_{Case}	-40	35	+85	°C
Power Supply Voltage		V_{CCT}	3.135	3.30	3.465	V
		V_{CCR}	3.135	3.30	3.465	V
Power Supply Noise	f ≤ 1MHz	V_{CCAC}			0.02V_{CC}	V_{pp}
	1MHz < f ≤ 10MHz				0.03V_{CC}	V_{pp}

General Characteristics

Unless otherwise noted under the complete recommended operating conditions.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Power Consumption Module	Total			0.726	1.213	W
Supply Current Module	@ $V_{CCT/R}$	I_{VCCTRX}		220	350	mA
Maximum Peak Current	At hot plug in	I_{VCCTX}			500	mA
		I_{VCCRX}			330	mA
Current Ramp	At hot plug in	dI_{VCCTX}/dt			50	mA/µs
		dI_{VCCRX}/dt			50	mA/µs

Transmitter Characteristics

Data Input

Unless otherwise noted under the complete recommended operating conditions.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Differential Input Resistance		R_{diff}	80	100	120	Ω
Input Coupling Capacitance	per lane	C_K	64	100	144	nF
Differential Input S-parameter	Z_{ref} = 100Ω f = 0.01 – 4.1 GHz	SDD11			$-12+2\sqrt{\frac{f}{1GHz}}$	dB
	Z_{ref} = 100Ω f = 4.1 – 11.1 GHz				$-6.3+13\cdot\log_{10}\left(\frac{f}{5.5GHz}\right)$	dB
Differential to Common Mode Conversion [1)]	Z_{ref} = 25Ω f = 0.01 – 11.1 GHz	SCD11			-10	dB

Recommended Operating Conditions Data Input

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Nominal Data Rate	PRBS 31; 8B/10B;	DR	9.95	10.3125	10.52	Gbd
Common Mode Input Voltage		V_{IDCM}	-0.3		4	V
Common Mode AC Input Voltage	RMS		0		25	mV
Differential Peak-to-Peak- Input Voltage		V_{ID}	150		800	mV_{pp}
Data Dependent Input Jitter	Peak-to-peak	DDJ	0		0.1	UI
Uncorrelated Jitter	RMS	UJ	0		0.027	UI
Total Input Jitter	Peak-to-peak, 10^{-12}-points	TJ	0		0.28	UI

Optical Output

Unless otherwise noted over complete lifetime under the general recommended operating conditions and recommended data input signal conditions specified above.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Optical Return Loss		ORL_{Tx}			12	dB
Center Wavelength		λ_{TRP}	1260	1310	1355	nm
Spectral Width	-20dB-Width	$\Delta\lambda_{TRP20}$			1	nm
Side Mode Suppression Ratio		SMSR	30			dB
Optical Output Power	Operational (Tx enabled)	P_{Tx}	-7.2		0.5	dBm
	Off-State (e.g. Tx_Dis=H)	P_{Tx}			-30	dBm
Optical Modulation Amplitude	Begin of Life	P_{OMA}	442	700		μW_{pp}
			381			μW_{pp}
Transmitter and Dispersion Penalty		TDP	0		2	dB
Extinction Ratio		ER	3.5	5		dB
Relative Intensity Noise		RIN			-128	dB/Hz
Total Output Jitter	Peak-to-Peak, 10^{-12}-points	TJ	0		0.5	UI
Transmitter Eye Mask	Peak-to-Peak, 10^{-12}-points X1, X2, X3, Y1, Y2, Y3	Eye Opening	0.25, 0.40, 0.45, 0.25, 0.28, 0.40			UI

Receiver Characteristics

Recommended Operating Conditions Optical Input

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate	PRBS 31; 8B/10B;	DR	9.95	10.3125	10.52	Gbd
Center Wavelength		λ_C	1260	1310	1355	nm
Average Input Power		P_{lavg}	-15.6*		0.5	dBm
Opitcal Modulation Amplitude	Peak-to-Peak	OMA_I	55			μW_{pp}
Data Dependent Input Jitter	Peak-to-Peak	DDJ	0		0.1	UI
Uncorrelated Jitter	RMS	UJ	0		0.027	UI
Total Input Jitter	Peak-to-Peak, 10^{-12}-points	TJ	0		0.28	UI

*)For informational purposes only. If the average power drops below, the operational condition of OMA cannot be satisfied anymore.

Optical Input

Unless otherwise noted under the general recommended operating conditions and recommended optical input signal conditions specified above.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Optical Return Loss		ORL_{Rx}			12	dB
Receiver Sensitivity	PRBS 2^{31}-1, BER < $1*10^{-12}$ @10.3125GBd	OMA_{sens}		15	55	μW_{pp}
Stressed Receiver Sensitivity	PRBS 2^{31}-1, BER < $1*10^{-12}$ @ 10.3125GBd	OMA_{sensSt}			93	μW_{pp}
Receiver Overload	PRBS 2^{31}-1, BER < $1*10^{-12}$	$P_{sat(OMA)}$	0.5			dBm
Loss of Signal Detect Levels	Assert-Level	P_{LOSA}	-30	-22		dBm
	De-Assert-Level	P_{LOSD}		-20	-17	
Loss of Signal Hysteresis		Hyst	0.5	2		dB

Data Output

Unless otherwise noted under the general recommended operating conditions and recommended optical input signal conditions specified above.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Differential Output Resistance		R_{diff}	80	100	120	Ω
Termination Mismatch	f = 1MHz	ΔR_I	-5	0	5	%
Output Coupling Capacitance		C_K	64	100	144	nF
Differential Output S-parameter	R_{ref} = 100Ω f = 0.01 – 4.1 GHz	SDD22			$-12+2\sqrt{\frac{f}{1GHz}}$	dB
	R_{ref} = 100Ω f = 4.1 – 11.1 GHz				$-6.3+13\cdot\log_{10}\left(\frac{f}{5.5GHz}\right)$	dB
Common Mode Output Return Loss	R_{ref} = 25Ω f = 0.01 – 2.5 GHz	SCC22			$-7+\frac{1.3\cdot f}{1GHz}$	dB
	f = 2.5 – 11.1 GHz				-3	dB

Data Output continued

Unless otherwise noted under the general recommended operating conditions and recommended optical input signal conditions specified on the page before.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Differential Peak-to-Peak Output Amplitude	R_{Load} = 100 ohm	V_{OSPP}	350	530	800	mV_{pp}
Output AC Common Mode Voltage	RMS				7.5	mV
Output Rise and Fall Time	20 % to 80 %	t_R, t_F	28			ps
Deterministic Jitter	Peak-to-Peak	DJ			0.42	UI(p-p)
Total Jitter	See SFP+ MSA	TJ			0.7	UI(p-p)

Low Speed Interface Characteristics

General Conditions Low Speed

Unless otherwise noted in this section the general recommended operating conditions are true.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Power Supply Voltage		V_{CCT}	2	3.3	3.465	V
High-Level Input Voltage	Tx_Dis, RS0, RS1	V_{IH}	2		V_{CCT} + 0.3	V
Low-Level Input Voltage		V_{IL}	-0.3		0.8	V
High-Level Output Voltage	Tx_FLT, Rx_LOS	V_{OH}			V_{CCT} + 0.3	V
Low-Level Output Voltage		V_{OL}	-0.3			V

Static Characteristics

Unless otherwise noted under the complete recommended operating conditions and general conditions low speed.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Open-Drain Leackage Current	Open-Drain Output at Off-State (High). Tx_FLT, Rx_LOS	I_{QH}	0		1	µA
Low Level Ou tput Voltage	I_{OL_max} = 4 mA	V_{OL}	0		0.4	V
High Input Current Tx Dis	Tx_Dis internally pulled-up to V_{CCT} by R=4,465..10,5kΩ	I_{IH}	-329		66	µA
Low Input Current Tx Dis		I_{IL}	-845		-221	µA
High Input Current RS1,RS0	RS0, RS1, internally pulled-up to V_{CCT} by R≥30kΩ	I_{IH}	-50		11	µA
Low Input Current RS1,RS0		I_{IL}	-127		1	µA
Mod_ABS Resistance	Pull-Down to V_{EE} within Module	R_{Mad}	0		1	Ω

Timing Characteristics

Unless otherwise noted under the complete recommended operating conditions.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Module Initialization Time	After Hot plug	t_{start}			300	ms
Tx Disable Assert Time	Assert to10% P_{Tx}	t_{Off}			10	µs
Tx Disable De-Assert Time	De-Assert to 90% P_{Tx}	t_{On}			2	ms
Tx Fault Assert Time		t_{FLT}			1	ms
Tx Fault Reset Time	Hold time of Tx_Dis to reset Tx-Fault	tT_{RST}			10	µs
Rx –LOS Assert DelayTime		t_{LOSA}			100	µs
Rx –LOS De-Assert DelayTime		t_{LOSD}			2	ms

Monitor Characteristics

Unless otherwise noted under the general recommended operating conditions.

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Temperature Monitor Error		F_{ϑ}	-3	0	3	°C
Supply Voltage Monitor Error		F_{VCC}	-3	0	3	%
Rx Power Monitor Error	P_{In} = -15 dBm to 0.5 dBm	F_{PTx}	-3	0	3	dB
Tx Power Monitor Error		F_{PRx}	-3	0	3	dB
Laser Bias Current Monitor Error		F_{IBIAS}	-10	0	10	%

Memory Map

Register Overview

Communication is done by a serial 2-wire interface compatible to the I2C bus protocol. Refer to SFF-8472 for a more detailed explanation of the registers itself:

Base Address A0h	
Register	**Content**
0 - 95	Serial Transceiver ID as defined in SFP MSA
96 - 127	FCI Specific
128 - 255	Reserved

Base Address A2h	
Register	**Content**
0 - 55	Alarm & Warnings Thresholds & Limits
56 - 95	External calibration constants (not used)
96 – 119	Values from real time diagnostic monitoring
128 – 247	Customer specific, writable area
248 - 255	Reserved

Memory Contents

In this chapter the contents of the memory is described in detail.

Register Address A0 (Module Identification and Informations)

Bytes 0 to 19: Basic ID Field Area

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
0	Identifier	Type of transceiver	SFP or SFP+	03
1	Ext. Identifier	Extended identifier of type of transceiver	GBIC/SFP function is defined by two-wire interface ID only	04
2	Connector	Code for connector type	LC	07
3	Transceiver	Code for electronic or optical compatibility	10GBASE-LR	20
4				00
5				00
6				00
7				00
8				00
9				00
10				00
11	Encoding	Code for high speed serial encoding algorithm	64B/66B	06
12	BR, Nominal	Nominal signaling rate, units of 100MBd	10.3GBd	67
13	Rate Identifier	Type of rate select functionality	Unspecified	00
14	Length(SMF, km)	Link length supported for single mode fiber, units of km	10km	0A
15	Length (SMF)	Link length supported for single mode fiber, units of 100 m	100*100m	64
16	Length (50um)	Link length supported for 50 um OM2 fiber, units of 10 m	0m	00
17	Length (62.5um)	Link length supported for 62.5 um OM1 fiber, units of 10 m	0m	00
18	Length (cable)	Link length supported for copper or direct attach cable, units of m	0m	00
19	Length (OM3)	Link length supported for 50 um OM3 fiber, units of 10 m	0m	00

Bytes 20 to 59: Vendor Information Area

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
20	Vendor Name	SFP vendor name (ASCII)	FCI MergeOptics	46
21				43
22				49
23				20
24				4D
25				65
26				72
27				67
28				65
29				4F
30				70
31				74
32				69
33				63
34				73
35				20
36	Transceiver	Code for electronic or optical compatibility	Unallocated	00
37	Vendor OUI	SFP vendor IEEE company ID	FCI Deutschland GmbH MergeOptics	00
38				0A
39				0D
40	Vendor PN	Part number provided by SFP vendor (ASCII)	T	54
41			R	52
42			X	58
43			1	31
44			0	30
45			G	47
46			D	44
47			P	50
48			0	30
49			3	33
50			1	31
51			1	31
52				20
53				20
54				20
55				20
56	Vendor Rev.	Revision level for part number provided by vendor (ASCII)	A	65
57			1	30
58			A	65
59			1	30

Bytes 59 to 63: Rest of ID Field Area

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
60	Wavelength	Laser wavelength (Passive/Active Cable Specification Compliance)	1310nm	05
61				1E
62	Unallocated			00
63	CC_BASE	Check code for Base ID Fields (addresses 0 to 62)		xx*

* For informational purposes only. Checksum shall be calculated automatically and may vary due to register contents.

Bytes 64 to 95: Extended ID Field Area

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
64	Options	Indicates which optional transceiver signals are implemented	Power Level2, no cooling, no linear Rx Output	02
65			No Rate Select, Support of Tx-Dis ,Tx-FLT & LOS	1A
66	BR, max	Upper bit rate margin, units of %	2%	02
67	BR, min	Lower bit rate margin, units of %	8%	08
68	Vendor SN	Serial number provided by vendor (ASCII)	E	45
69			S	53
70			Y_u (tenth digit of year)	$3y_u$
71			Y_l (once digit of year: 20 Y_u Y_l)	$3y_l$
72			cw_u (tenth digit of calendar week)	$3cw_u$
73			Cw_l (tenth digit of calendar week)	3 Cw_l
74			-	2D
75			Z_4 (tenthousandth digit of week counter)	$3Z_4$
76			Z_3 (thousandth digit of week counter)	$3Z_3$
77			Z_2 (hundredth digit of week counter)	$3Z_2$
78			Z_1 (tenth digit of week counter)	$3Z_1$
79			Z_0 (once digit of week counter)	$3Z_0$
80				20
81				20
82				20
83				20
84	Date code	Vendor's manufacturing date,digit of tenth of the year		3x
85		digit of onces of the year		3x
86		upper digit of month		3x
87		lower digit of month		3x
88		upper digit of day		3x
89		lower digit of day		3x
90		upper digit of lot or space		3x
91		lower digit of lot or space		3x
92	Diagnostic Monitoring Type	Indicates which type of diagnostic monitoring is implemented (if any) in the transceiver	Alarm/warning for all monitored, soft TX_DISABLE, soft TX_FAULT monitoring and soft RX_LOS implemented	68
93	Enhanced Options	Indicates which optional enhanced features are implemented (if any) in the transceiver	Digital diagnostic monitoring implemented; Internally calibrated; Received power measurement type average power	F0
94	SFF-8472 Compliance	Indicates which revision of SFF-8472 the transceiver complies with.	Includes functionality described in Rev 10.4 of SFF-8472.	04
95	CC_EXT	Check code for the Extended ID Fields (addresses 64 to 94)	Automatically calculated checksum	xx

Bytes 96 to 255: Vendor Specific Area

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
96 to 127	Vendor Specific	Vendor specific area	FCI used area	xx
128 to 255	Reserved	Reserved for SFF-8079 All bits that are unallocated or reserved for SFF-8472 shall be set to zero and/or ignored. Bits labeled as reserved or optional for other usage, such as for SFF-8079, shall be implemented per such other documents, or set to zero and/or ignored if not implemented. If optional features for SFF-8472 are implemented, they shall be implemented as defined in SFF-8472. If they are not implemented, then write bits will be ignored, and state bits shall be set to zero.		00

Register Address A2 (Monitoring Registers)

Under the Register addressed by A2 all to the monitoring related information and the monitor values, alarm and warning flags are located.

Bytes 0 to 55: Alarm and Warning Thresholds

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
0	Temp High Alarm	Most significant Byte at lower address	85°C	55
1		Lower significant Byte at higher address		00
2	Temp Low Alarm	Most significant Byte at lower address	-40°C	D8
3		Lower significant Byte at higher address		00
4	Temp High Warning	Most significant Byte at lower address	82°C	52
5		Lower significant Byte at higher address		00
6	Temp Low Warning	Most significant Byte at lower address	-37°C	DA
7		Lower significant Byte at higher address		00
8	Voltage High Alarm	Most significant Byte at lower address	3.6V	8C
9		Lower significant Byte at higher address		A0
10	Voltage Low Alarm	Most significant Byte at lower address	3V	75
11		Lower significant Byte at higher address		30
12	Voltage High Warning	Most significant Byte at lower address	3.465V	87
13		Lower significant Byte at higher address		5A
14	Voltage Low Warning	Most significant Byte at lower address	3.135V	7A
15		Lower significant Byte at higher address		76
16	Bias High Alarm	Most significant Byte at lower address	100mA	C3
17		Lower significant Byte at higher address		50
18	Bias Low Alarm	Most significant Byte at lower address	100µA	00
19		Lower significant Byte at higher address		32
20	Bias High Warning	Most significant Byte at lower address	80mA	9C
21		Lower significant Byte at higher address		40
22	Bias Low Warning	Most significant Byte at lower address	500µA	00
23		Lower significant Byte at higher address		FA

Alarm and Warning Thresholds continued

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
24	Tx Power High Alarm	Most significant Byte at lower address	1.4125mW (1,5dBm)	37
25		Lower significant Byte at higher address		2D
26	Tx Power Low Alarm	Most significant Byte at lower address	120.2µW (-9,2dBm)	04
27		Lower significant Byte at higher address		B2
28	Tx Power High Warning	Most significant Byte at lower address	1.122mW (0.5dBm)	2B
29		Lower significant Byte at higher address		D4
30	Tx Power Low Warning	Most significant Byte at lower address	151.4µW (-8.2dBm)	05
31		Lower significant Byte at higher address		EA
32	Rx Power High Alarm	Most significant Byte at lower address	1.4125mW (1,5dBm)	37
33		Lower significant Byte at higher address		2D
34	Rx Power Low Alarm	Most significant Byte at lower address	28.8µW (-15.41dBm)	01
35		Lower significant Byte at higher address		20
36	Rx Power High Warning	Most significant Byte at lower address	1.122mW (0.5dBm)	2B
37		Lower significant Byte at higher address		D4
38	Rx Power Low Warning	Most significant Byte at lower address	36.3µW (-14.4dBm)	01
39		Lower significant Byte at higher address		6B
40 to 55	Unallocated	Reserved by SFF for future monitored quantities	Not used	00

Bytes 56 to 95: Monitor Calibration Constant

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
56	Rx_PWR(4)	Single precision floating point calibration data - Rx optical power. Bit7 of byte 56 is MSB. Bit 0 of byte 59 is LSB. Rx_PWR(4) should be set to zero for “internally calibrated” devices.	Factor a_4 of polynom fourth order a_4=0 (since internally calibrated)	00
57				00
58				00
59				00
60	Rx_PWR(3)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 60 is MSB. Bit 0 of byte 63 is LSB. Rx_PWR(3) should be set to zero for “internally calibrated” devices	Factor a_3 of polynom fourth order a_3=0 (since internally calibrated)	00
61				00
62				00
63				00
64	Rx_PWR(2)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 64 is MSB, bit 0 of byte 67 is LSB. Rx_PWR(2) should be set to zero for “internally calibrated” devices.	Factor a_2 of polynom fourth order a_2=0 (since internally calibrated)	00
65				00
66				00
67				00
68	Rx_PWR(1)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 68 is MSB, bit 0 of byte 71 is LSB. Rx_PWR(1) should be set to 1 for “internally calibrated” devices.	Factor a_1 of polynom fourth order a_1=1 (since internally calibrated)	3F
69				80
70				00
71				00
72	Rx_PWR(0)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 72 is MSB, bit 0 of byte 75 is LSB. Rx_PWR(0) should be set to zero for “internally calibrated” devices.	Offset a_0 of polynom fourth order a_0=0 (since internally calibrated)	00
73				00
74				00
75				00

General Rx-Power Calibration Equation with constants above:

$$P = a_0 + a_1 \cdot n_{AD} + a_2 \cdot n_{AD}^2 + a_3 \cdot n_{AD}^3 + a_4 \cdot n_{AD}^4$$

Monitor Calibration Constants continued

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
76	Tx_I(Slope)	Fixed decimal (unsigned) calibration data, laser bias current. Bit 7 of byte 76 is MSB, bit 0 of byte 77 is LSB. Tx_I(Slope) should be set to 1 for “internally calibrated” devices	Byte 76 represents integer, Lower Byte 77 is the fraction down to 1/256. Since internally calibrated 1	01
77				00
78	Tx_I(Offset)	Fixed decimal (signed two’s complement) calibration data, laser bias current. Bit 7 of byte 78 is MSB, bit 0 of byte 79 is LSB. Tx_I(Offset) should be set to zero for “internally calibrated” devices.	Signed twos´s complement, Byte 78 represents integer, Lower Byte 79 is the fraction down to 1/256. Since internally calibrated 0	00
79				00
80	Tx_PWR(Slope)	Fixed decimal (unsigned) calibration data, transmitter coupled output power. Bit 7 of byte 80 is MSB, bit 0 of byte 81 is LSB. Tx_PWR(Slope) should be set to 1 for “internally calibrated” devices.	Byte 80 represents integer, Lower Byte 81 is the fraction down to 1/256. Since internally calibrated 1	01
81				00
82	Tx_PWR(Offset)	Fixed decimal (signed two’s complement) calibration data, transmitter coupled output power. Bit 7 of byte 82 is MSB, bit 0 of byte 83 is LSB. Tx_PWR(Offset) should be set to zero for “internally calibrated” devices.	Signed twos´s complement, Byte 82 represents integer, Lower Byte 83 is the fraction down to 1/256. Since internally calibrated 0	00
83				00
84	T (Slope)	Fixed decimal (unsigned) calibration data, internal module temperature. Bit 7 of byte 84 is MSB, bit 0 of byte 85 is LSB. T(Slope) should be set to 1 for “internally calibrated” devices	Byte 84 represents integer, Lower Byte 85 is the fraction down to 1/256. Since internally calibrated 1	01
85				00
86	T (Offset)	Fixed decimal (signed two’s complement) calibration data, internal module temperature. Bit 7 of byte 86 is MSB, bit 0 of byte 87 is LSB. T(Offset) should be set to zero for “internally calibrated” devices.	Signed twos´s complement, Byte 86 represents integer, Lower Byte 87 is the fraction down to 1/256. Since internally calibrated 0	00
87				00
88	V (Slope)	Fixed decimal (unsigned) calibration data, internal module supply voltage. Bit 7 of byte 88 is MSB, bit 0 of byte 89 is LSB. V(Slope) should be set to 1 for “internally calibrated” devices.	Byte 88 represents integer, Lower Byte 89 is the fraction down to 1/256. Since internally calibrated 1	01
89				00
90	V (Offset)	Fixed decimal (signed two’s complement) calibration data, internal module supply voltage. Bit 7 of byte 90 is MSB. Bit 0 of byte 91 is LSB. V(Offset) should be set to zero for “internally calibrated” devices.	Signed twos´s complement, Byte 90 represents integer, Lower Byte 91 is the fraction down to 1/256. Since internally calibrated 0	00
91				00
92	Unallocated	All bits that are unallocated or reserved for SFF-8472 shall be set to zero and/or ignored. Bits labeled as reserved or optional for other usage, such as for SFF-8079, shall be implemented per such other documents, or set to zero and/or ignored if not implemented. If optional features for SFF-8472 are implemented, they shall be implemented as defined in SFF-8472. If they are not implemented, then write bits will be ignored, and state bits shall be set to zero.		00
93				00
94				00
95	Checksum	Check sum for the Monitor Calibration Constants Fields (addresses 0 to 94)	Automatically calculated checksum	xx*

* For informational purposes only. Checksum shall be calculated automatically and may vary due to register contents.

Bytes 96 to 119: A/D Values and Status Bits

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
96	Temperature	Internally measured module temperature. Signed 2 Complement.	Temperature MSB (LSB=1°C)	XX
97			Temperature LSB (LSB=1/256°C)	XX
98	Voltage	Internally measured supply voltage in transceiver	Voltage MSB	XX
99			Voltage LSB (LSB=100µV)	XX
100	Laser Bias Current	Internally measured TX Bias (Laser Bias) Current.	Tx Bias MSB	XX
101			Tx Bias LSB (LSB=2µA)	XX
102	Tx Power	Internally measured Tx output power.	Tx Power MSB	XX
103			Tx Power LSB (LSB=100nW)	XX
104	Rx Power	Internally measured Rx input power.	Rx Power MSB	XX
105			Rx Power LSB (LSB=100nW)	XX
106	Unallocated	Reserved for future diagnostic definitions		00
107				00
108	Unallocated	Reserved for future diagnostic definitions		00
109				00
110	Optional Status/Control Bits	States and Controls of Tx-Dis, Rate Select, Tx-Alarm, Rx-LOS, Data Ready		XX
111	Reserved	Reserved for SFF-8079.		00
112	Alarm Flags	Alarm Bits High and Low for Temp, Vcc, Tx Bias and Tx Power		XX
113		Alarm Bits High and Low for Rx Power, Rest reserved Alarm Bits		XX
114	Unallocated			00
115				00
116	Warning Flags	Warning Bits High and Low for Temp, Vcc, Tx Bias and Tx Power		XX
117		Warning Bits High and Low for Rx Power, Rest reserved Alarm Bits		XX
118	Extended Control/Status			XX
119	Unallocated			00

Bytes 120 to 247: User EEPROM Area

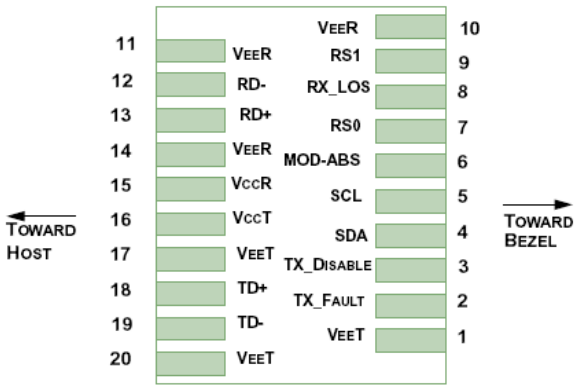
Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
120 - 247	User EEPROM	User writable EEPROM area		XX

Bytes 246 to 255: Vendor Specific Control Area

Register Byte Dec.	SFF-Name	General Description	Module Contents Meaning	Contents in Hex
120 - 247	Vendor Specific	Vendor specific control functions		XX

Application Information

Connector Pinning



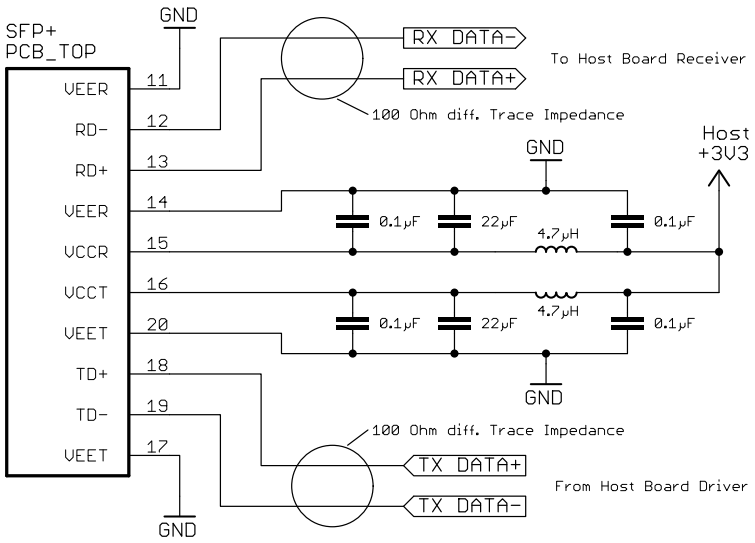
Electrical Pin Definition

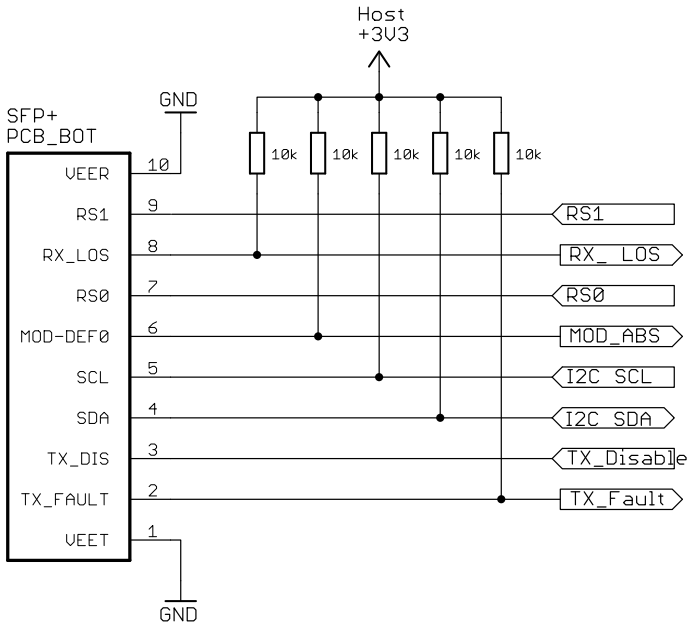
PIN	Logic	Symbol	Name / Description	Note
1		VeeT	Module Transmitter Ground	1
2	LVTTL-O	TX_Fault	Module Transmitter Fault, Open drain output, needs an pull-up resistor on Host-Board	
3	LVTTL-I	TX_Dis	Transmitter Disable; Turns off transmitter laser output, internally pulled-up with 4,7kΩ to 10kΩ to V_{CCT}	
4	LVTTL-I/O	SDA	2-Wire Serial Interface Data Line	2
5	LVTTL-I	SCL	2-Wire Serial Interface Clock	2
6		MOD_ABS	(=MOD_DEF0) Module Absent, shorted to module ground	
7	LVTTL-I	RS0	Receiver Rate Select, internally pulled-up to V_{CCT} with ≥30kΩ	
8	LVTTL-O	RX_LOS	Receiver Loss of Signal Indication, Open drain output, needs an pull-up resistor on Host-Board	
9	LVTTL-I	RS1	Transmitter Rate Select, internally pulled-up to V_{CCT} with ≥30kΩ	
10		VeeR	Module Receiver Ground	1
11		VeeR	Module Receiver Ground	1
12	CML-O	RD-	Receiver Inverted Data Output	
13	CML-O	RD+	Receiver Data Output	
14		VeeR	Module Receiver Ground	1
15		VccR	Module Receiver 3.3 V Supply	
16		VccT	Module Transmitter 3.3 V Supply	
17		VeeT	Module Transmitter Ground	1
18	CML-I	TD+	Transmitter Non-Inverted Data Input	
19	CML-I	TD-	Transmitter Inverted Data Input	
20		VeeT	Module Transmitter Ground	1

1. Module ground pins Vee are isolated from the module case.
2. Shall be pulled up with 1k-10k ohms to a voltage between 3.13 V and 3.47 V on the host board.

Application Schematics

Recommended electrical connections to transceiver are shown below. Pull-ups: 1k – 10k ohms.





Digital Optical Monitoring

The transceiver offers the ability to monitor important module parameter during operation. All five parameters listed below are continuously monitored for getting information about the current module status. All data is calibrated internally; there is no need for external post processing.

Temperature

Internally measured temperature data is represented as two's complement of a signed 16-bit value in increments of 1/256 °C over a range of -40 to +100 °C. Accuracy is better than +/-3 °C.

Supply Voltage (VCC)

Internally measured supply voltage. Represented as a 16-bit unsigned integer with the voltage defined as the full 16 bit value (0 – 65535) with LSB equal to 100 µVolt, which yields to a total range of 0 to +6.55 Volts. Accuracy is better than +/-3 %.

Laser Bias Current

The DFB laser bias current is represented as a 16 bit unsigned integer with the current defined as the full 16-bit value (0 – 65535) with LSB equal to 2 µA. Accuracy is better than +/-10 %.

Optical Transmitter Power

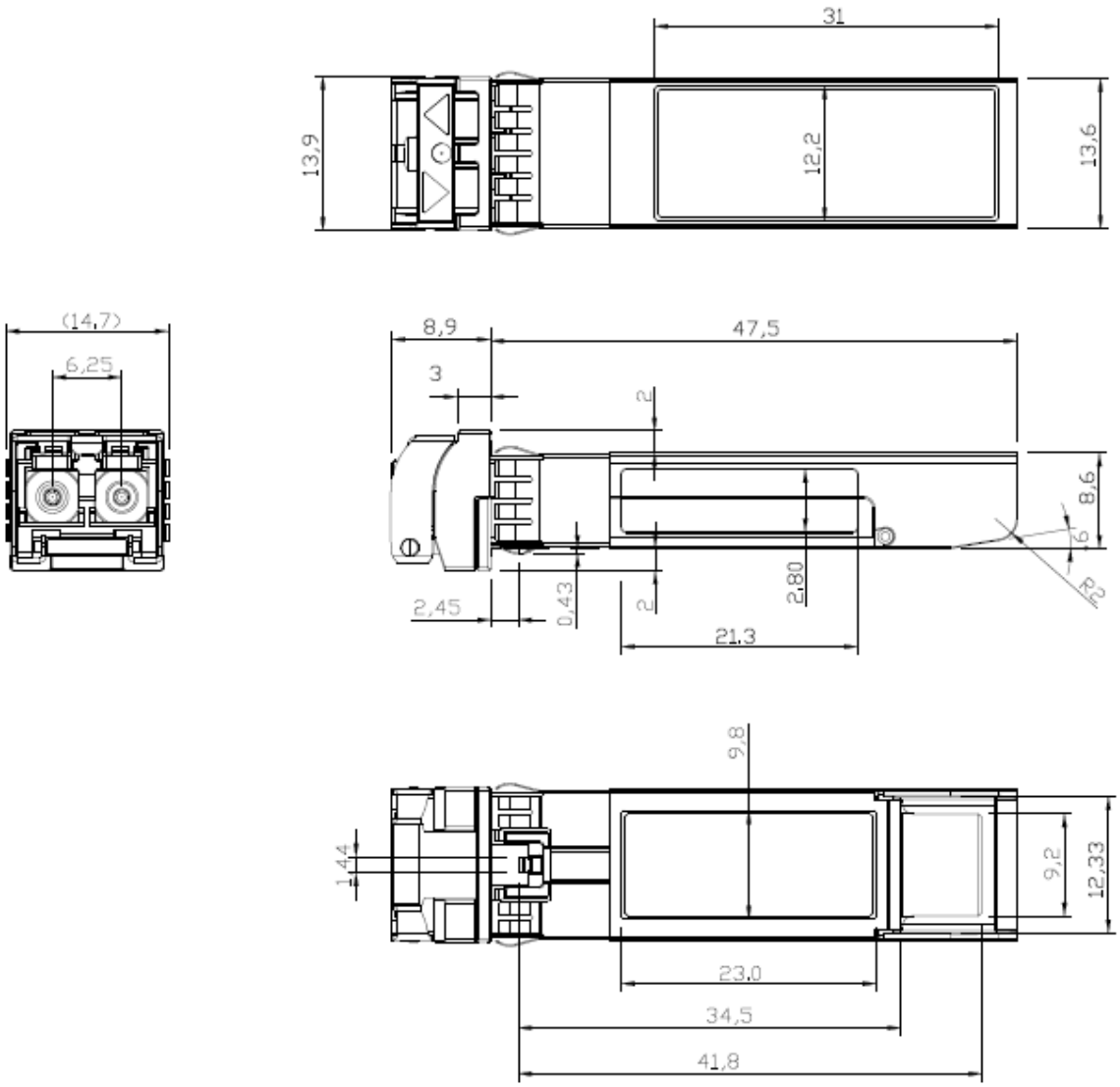
TX output power measurement is based on internal monitor diode feedback. Represented as a 16-bit unsigned integer with the power defined as the full 16 bit value (0 – 65535) with LSB equal to 0.1 µW. Accuracy is better than +/-3 dB over a range of $Pavg_{min}$ to $Pavg_{max}$.

Receiver Optical Power

RX input power measurement is based on photodiode average current. Represented as a 16-bit unsigned integer with the power defined as the full 16 bit value (0 – 65535) with LSB equal to 0.1 µW. Accuracy is better than +/-3 dB over a range of -15 dBm to 0.5 dBm.

Note: The specified characteristics are met within the recommended range of operating conditions regarding temperature and voltage.

Module Outline



All dimensions shown are in millimeters.

Module Safety & Compliance

FCI's SFP+ LR module is designed to meet international standards and requirements. The module is RoHS compliant according to the European Parliament requirements on the restriction of the use of hazardous substances in electrical and electronic equipment (RoHS). The module optical output power meets Class 1 requirements for laser safety.

Requirements	Standard
Module Safety	IEC 60950-1:2001 EN 60950-1:2001
RoHS Compliance	RoHS 6/6 Directive 2002/95/EC Amendment 4054 (2005/747/EC)
Laser Safety (Class 1)	CDRH 21 CFR 1040.10 and 1040.11 (according FDA) IEC 60825-1 Rev2 2007 (according IEC)

ESD & Electromagnetic **Compatibility**

Requirements	Standard	Value
EMI (Emission)	FCC Part 15 B EN 55022 Class B CISPR 22 30 MHz … 40 GHz	At least 6 dB margin to Class B limit
EMI (Immunity)	IEC 61000-4-3, 10 MHz … 1 GHz	No bit errors at sensitivity limit
ESD (Electrical connector)	EIA/JESD22-A114-B MIL-STD 883C Method 3015.7	≥ 2 kV ≥ 1 kV (SFI signals)
ESD (Module case)	Air Discharge EN61000-4-2, Criterion B	≥ 15 kV
ESD (Module case)	Contact Discharge EN61000-4-2, Criterion B	≥ 8 kV

Eye Safety

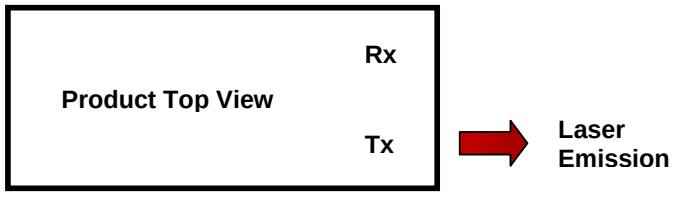
This laser based singlemode transceiver is a Class 1 product. It complies with IEC 60825-1 Edition 2 and FDA performance standards for laser products (21 CFR 1040.10 and 1040.11) except for deviations pursuant to Laser Notice 50, dated July 26, 2001.

CLASS 1 LASER PRODUCT

To meet laser safety requirements the transceiver shall be operated within the Absolute Maximum Ratings.

Note: All adjustments have been made at the factory prior to shipment of the devices. No maintenance or alteration to the device is required. Tampering with or modifying the performance of the device will result in voided product warranty. Failure to adhere to the above restrictions could result in a modification that is considered an act of "manufacturing", and will require, under law, recertification of the modified product with the U.S. Food and Drug Administration (ref. 21 CFR 1040.10 (i)).

LASER EMISSION DATA



Wavelength	1310 nm
Maximum total output power (as defined by IEC: within 7 mm aperture at 70 mm distance)	15.6 mW / 11.9 dBm
Beam divergence (full angle) / NA (half angle)	11° / 0.1 rad

Ordering Information

Application	Standard	Part Number
10G Ethernet LAN/WAN	IEEE 802.3 10GBASE-LR/LW	TRX10GDP0311A1
10G Fibre Channel	10GFC 1200-SM-LL-L	TRX10GDP0311A1

REVISION RECORD

Rev	Page	Description	EC#	Date
A		Initial version.		04 Dec 2012

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