

Features

- SFF-8431 Compliant
- Broadband serial data rate operation: 10 Mbps to 12 Gbps
- Power Level I: 15 mW per cable end
- 100 Ohm differential impedance
- Retractable pin latch
- EEPROM signature
- Pull to Release latch design
- 360° cable braid crimp
- Enhanced EMI skirt design
- Color options for strain relief and pull tab
- Linear design for use with EDCs
- AC-coupled inputs and outputs
- 30AWG to 24AWG cable available

Applications

- 10 Gigabit Ethernet and Gigabit Ethernet (IEEE 802.3ae)
- Fibre Channel: 1, 2, 4, 8, and 10GFC
- Infiniband SDR, DDR, and QDR
- Fibre Channel over Ethernet (FCoE)
- Serial data transmission

Overview

The passive SFP+ direct attach copper cable assembly is a low cost alternative for short reach applications. The design allows for a serial data transmission up to 12Gbps in each direction. The passive design has no signal amplification in the cable assembly. Electronic Dispersion Compensation (EDC) is typically used on host board designs when passive copper cable assemblies are utilized. EDC allows for an extended length of passive cable assemblies. EEPROM signature enables the host to differentiate between a passive copper cable assembly and a fiber optic module. The mechanical design of the braid crimp and EMI skirt ensure that EMI radiation is sufficiently suppressed. Additionally, the copper cable acts as a natural heatsink. The low power consumption assists in making the passive copper cable assembly an economic solution for within rack or rack to rack applications.

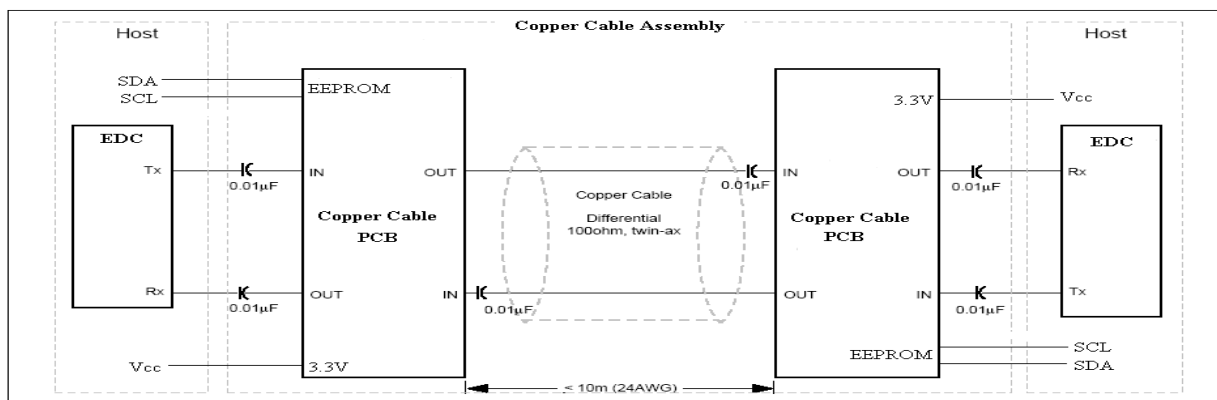


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Assembly Characteristics

Mechanical Design

The mechanical design of the passive SFP+ cable assembly is fully compliant to the SFF-8431 SFP+ MSA. The cable construction is a 100 Ω two pair shielded twinax with drain wires for digital ground. Madison Cable is the typical vendor used for this 10Gbps cable construction. The 24AWG cable is Madison part number 04KF2LF008. The 30AWG cable is Madison part number 04KB2LF004. The shield consists of a foil and braid to maximize signal integrity while minimizing EMI radiation. The backshell design includes a 360° braid crimp, molded strain relief, EMI skirt, and a retractable pin latch. The strain relief and cable are designed to meet EIA-455-1B cable flex requirements. The EMI skirt and 360° braid crimp are designed to minimize EMI. The retractable pin latch and pull tab allows for easy belly to belly applications and simple extraction. The pull tab and strain relief can be color coded to the customer's requirements. Additionally, the pull tab length can be varied depending on the customer's application. The PCB gold finger contacts have a minimum of 30 microinches of gold and will survive a porosity test as specified by EIA-364-53. A lubricant can be added to the gold finger contacts to extend the number of insertions the contacts can survive. All components in the cable assembly are RoHS compliant.

Mechanical Specifications

Mechanical				
Parameter	Minimum	Typical	Maximum	Unit
Cable Diameter (24 AWG)		0.255		Inches
Bend Radius (24 AWG)	1.25			Inches
Cable Diameter (26 AWG)		0.215		Inches
Bend Radius (26 AWG)	1			Inches
Cable Diameter (28 AWG)		0.185		Inches
Bend Radius (28AWG)	0.8			Inches
Cable Diameter (30 AWG)		0.175		Inches
Bend Radius (30 AWG)	0.7			Inches
Within Pair Skew			120	ps/10m
Cable Insertion Loss		10		dB/10m
Bulk Cable Crosstalk			1	%
Bulk Cable Time Delay			4.3	ns/m
Cable Capacitance (intra-pair)			43	pF/m
Bulk Cable Impedance	95	100	105	Ohms

Assembly Characteristics

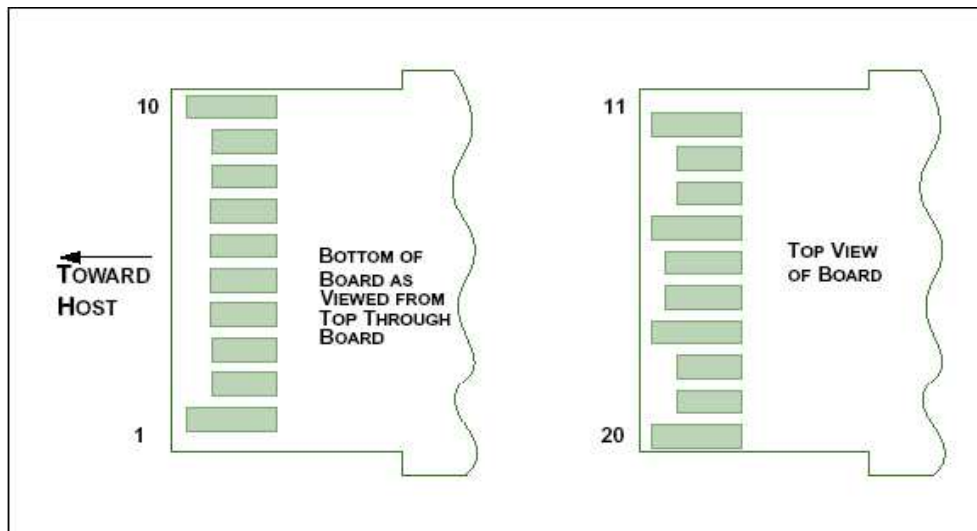
Electrical Design

The electrical design of the passive SFP+ direct attach copper cable assembly is fully compliant to the SFF-8431 SFP+ MSA. The electrical design incorporates a PCB and wire management design to minimize crosstalk, insertion loss, and return loss. Reducing these frequency domain characteristics result in improved WDP measurements. Because of the common use of EDCs with passive SFP+ cable assemblies WDP measurements are a requirement instead of time domain measurements such as eye patterns. For simplicity, this datasheet includes WDP measurements from samples of different cable assembly lengths and gauges. The design also includes an EEPROM that can be customized to any specific requirement.

Electrical Specifications

Electrical					
Parameter	Symbol	Minimum	Typical	Maximum	Unit
Operating Temp.		0		70	C
Input Voltage	VccT, VccR	1.8	3.3	5.5	Volts
Clock Frequency	f _{SCL}			400	kHz
Maximum Power				15	mW
Maximum Average Current	I _{cc}			4	mA
Data Rate		0.010		10.3125	Gbps

Pin Designation Drawing



Pin Designation

	Logic	Symbol	Power up Sequence	Name	Note
Pin 1		VeeT	1	Module Transmitter Ground	1
Pin 2	LVTTTL-O	Tx_Fault	3	Transmitter Fault	2, 7*
Pin 3	LVTTTL-I	Tx_Disable	3	Transmitter Disable	3, 7*
Pin 4	LVTTTL-I/O	SDA	3	MOD-DEF2 2-wire serial interface data line	4
Pin 5	LVTTTL-I/O	SCL	3	MOD-DEF1 2-wire serial interface clock line	4
Pin 6		Mod_Abs	3	Module Absent	5
Pin 7	LVTTTL-I	RS0	3	Rate Select Zero	6, 7*
Pin 8	LVTTTL-O	Rx_LOS	3	Module Receiver Loss of Signal	2, 7*
Pin 9	LVTTTL-I	RS1	3	Rate Select One	6, 7*
Pin 10		VeeR	1	Module Receiver Ground	1
Pin 11		VeeR	1	Module Receiver Ground	1
Pin 12	CML-O	RD-	3	Receiver Inverted Data Output	
Pin 13	CML-O	RD+	3	Receiver Non-Inverted Data Output	
Pin 14		VeeR	1	Module Receiver Ground	1
Pin 15		VccR	2	Module Receiver 3.3V Supply	
Pin 16		VccT	2	Module Transmitter 3.3V Supply	
Pin 17		VeeT	1	Module Transmitter Ground	1
Pin 18	CML-I	TD+	3	Transmitter Non-Inverted Data Input	
Pin 19	CML-I	TD-	3	Transmitter Inverted Data Input	
Pin 20		VeeT	1	Module Transmitter Ground	1

Note 1. The module signal ground pins, VeeR and VeeT, shall be isolated from the module case.

Note 2. This pin is an open collector/drain output pin and shall be pulled up with 4.7-10 k Ω to Vcc_Host on the host board. Pull ups can be connected to multiple power supplies, however the host board design shall ensure that no module pin has voltage exceeding module VccT/R + 0.5 V.

Note 3. This pin is an open collector/drain input pin and shall be pulled up with 4.7-10 k Ω to VccT in the module.

Note 4. See 2-wire Electrical Specifications .

Note 5. This pin shall be pulled up with 4.7-10 k Ω to Vcc_Host on the host board.

Note 6. If implementing SFF-8079 pin 7 and 9 are used for AS0 and AS1 respectively.

Note 7*. This function is not implemented in Passive SFP+ Cable Assemblies 2032237, 2032247, 2053649, & 2032246.



Pin Description

- Tx_Fault:** Tx_Fault is an output pin to indicate a fault condition of a laser. Tx_Fault is not implemented in 2032237, 2032247, 2053649, and 2032246. This pin is connected to ground in the module.
- Tx_Disable:** Tx_Disable is an input pin to disable the transmitter output. Tx_Disable is not implemented in 2032237, 2032247, 2053649, and 2032246. This pin is pulled high in the module with a 5.11 kOhm resistor.
- SDA/SCL:** SDA and SCL are the data and clock pins for the I²C interaction with the EEPROM. These pins are connected to the SDA and SCL pins of the EEPROM in the module.
- MOD_ABS:** Mod_Abs is an output pin to indicate that a module is present in the port. This pin is connected to ground in the module.
- RS0/RS1:** RS0 and RS1 are module rate select pins to determine the transmit data rate for lasers. RS0 and RS1 are not implemented in 2032237, 2032247, 2053649, and 2032246. 2032237, 2032247, 2053649, and 2032246 are broadband cable assemblies.
- Rx_LOS:** Rx_LOS is an output pin to indicate if the signal amplitude is below the receiver threshold. Rx_LOS is not implemented in 2032237, 2032247, 2053649, and 2032246. This pin is connected to ground in the module.
- Ground:** VeeT and VeeR are connected within the module and are used as a digital ground for signal integrity. This digital ground does not connect to the module case or the copper cable braid.
- Power:** VccT and VccR are connected within the module and are used to power the EEPROM. Typical voltage is 3.3 Volts and each pin has a maximum current capacity of 500 mA.
- Signal:** The two high speed signal pairs, TD+/TD- and RD+/RD-, are 100 Ohm differential impedance transmission lines with AC coupling on each RD trace.



High Speed Electrical Measurements

WDP Measurements

WDP measurements listed in the table below are for set lengths at two different cable gauges. Any cable with the same gauge and a shorter length than the length listed will have a lower dWDP number. Measurements were taken with an input signal that had pre-emphasis applied to achieve a WDPi of 2.4 dBe while using the SFP+ Module Compliance Board (MCB) and Host Compliance Board (HCB). A copper cable assembly will be compliant with the SFP+ MSA Rev 3.2 if the dWDP number is less than 6.75 dBe.

WDP Specifications

WDP				
Cable Gauge	Cable Length	WDPo (dB)	WDPi (dB)	dWDP
Spec Limit	--	--	--	6.75
30 AWG	3 meter	6.16	2.4	3.76
28 AWG	5 meter	7.49	2.4	5.09
26 AWG	6 meter	8.36	2.4	5.96
24 AWG	7 meter	7.44	2.4	5.04

VMA and VCR Measurements

VMA and VCR measurements listed in the table below are for the set lengths. To be compliant with SFF 8431 Rev 3.2 the VMA measurements must be less than 4.5 dB while testing with the module compliance test board. The VCR measurement is determined by computing VMA and NEXT RMS voltage measurements. The VCR measurement must be greater than 33 dB to be SFF-8431 Rev 3.2 compliant.

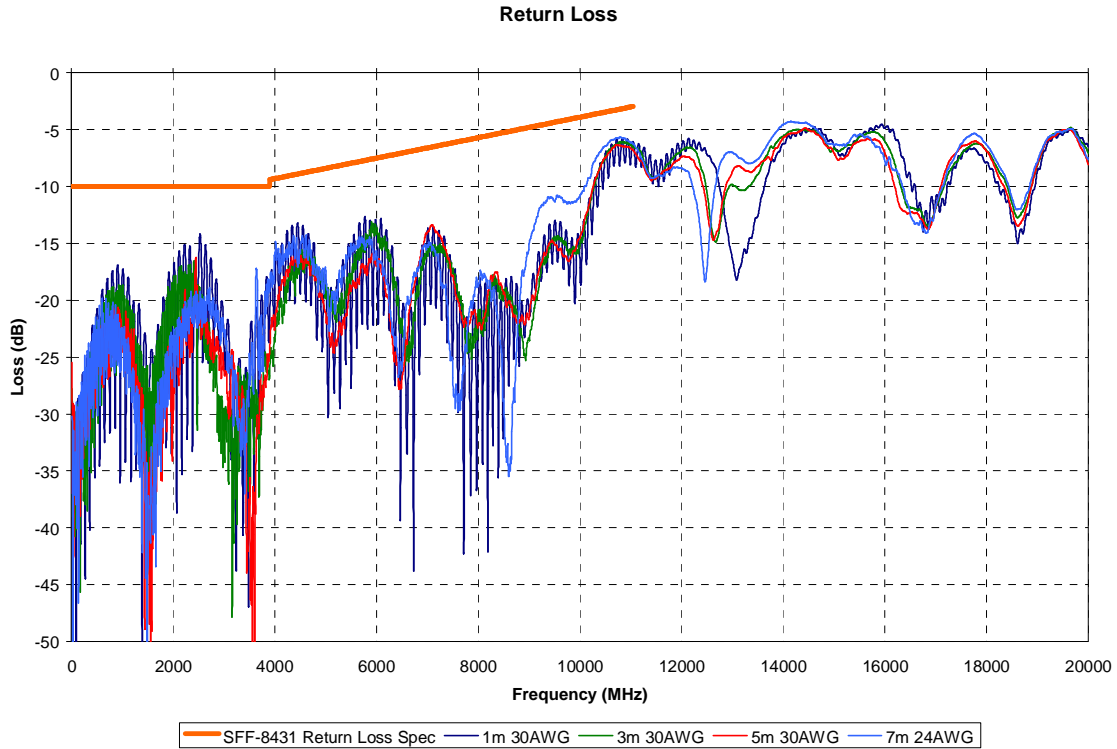
VMA and VCR Specifications

VMA & VCR			
Cable Gauge	Cable Length	VMA (dB)	VCR (dB)
Spec Limit	--	4.5	33
30 AWG	3 meter	3.03875	40.6572
28 AWG	5 meter	3.93609	38.53281
26 AWG	6 meter	3.94267	35.82669
24 AWG	7 meter	3.86154	37.79826

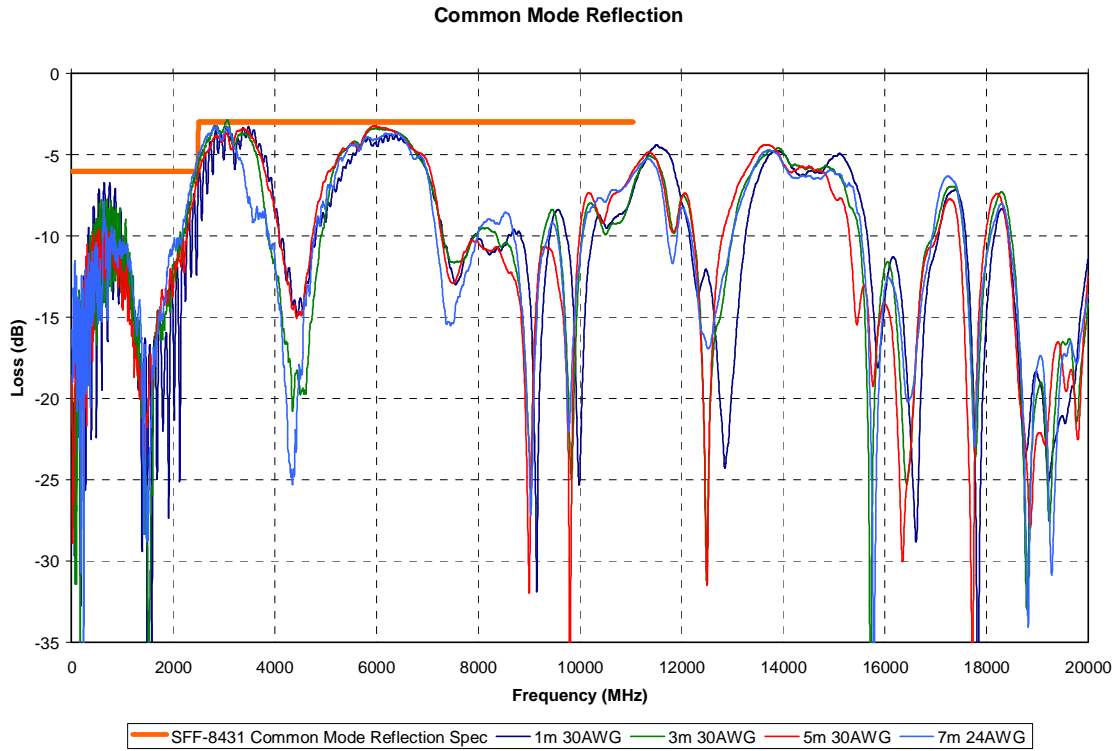
SDD11 and SCC11 Measurements

SFF-8431 has requirements on differential and common mode return loss. The return loss measurements were measured on a VNA with the module compliance test boards. Below are measurements of all cable assemblies with the SFF-8431 spec. limit in orange.

SDD11 and SCC11 Specifications



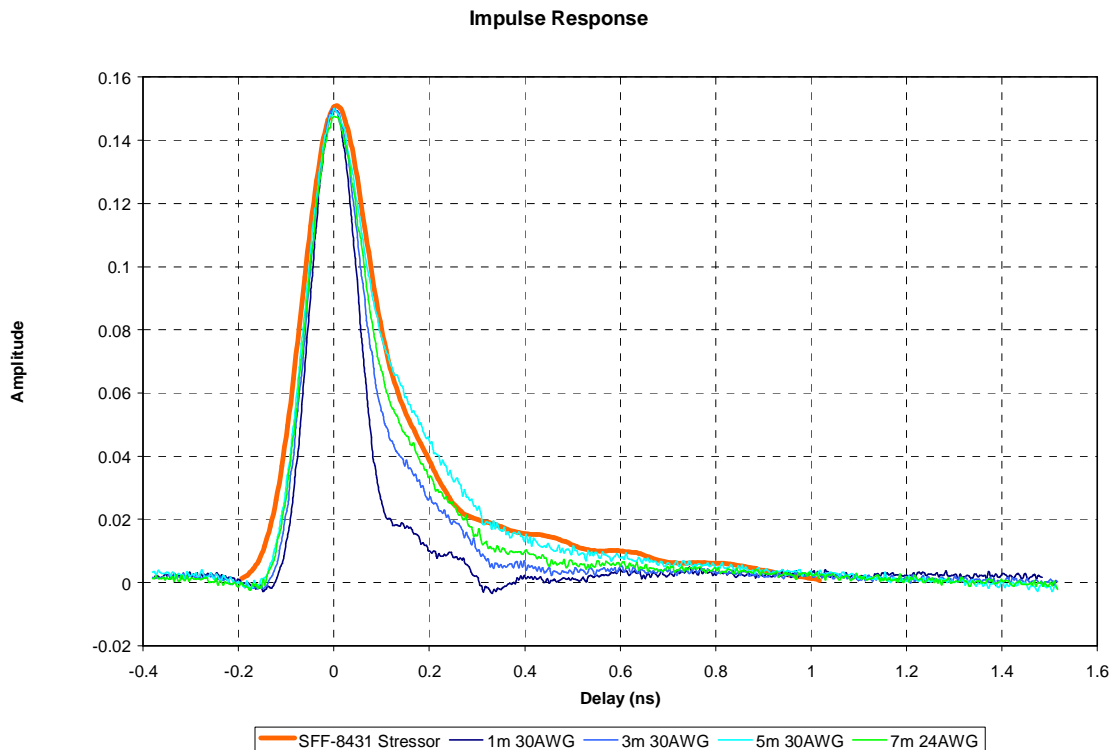
SDD11 and SCC11 Specifications



Impulse Response Measurements

SFF-8431 provides a copper cable stressor. The chart below shows measurements of the cable in comparison to the suggested copper cable stressor in orange. Measurements were taken with the module compliance test boards. The requirement for the cable assembly is to have an integrated magnitude of all samples after 10.5 UI from peak amplitude shall be <1% of the integrated magnitude between -2.5 UI and 10.5 UI from the peak amplitude. Pre-cursor integrated magnitude <-2.5 UI relative to the peak max value shall be <0.5%.

Impulse Response Specifications

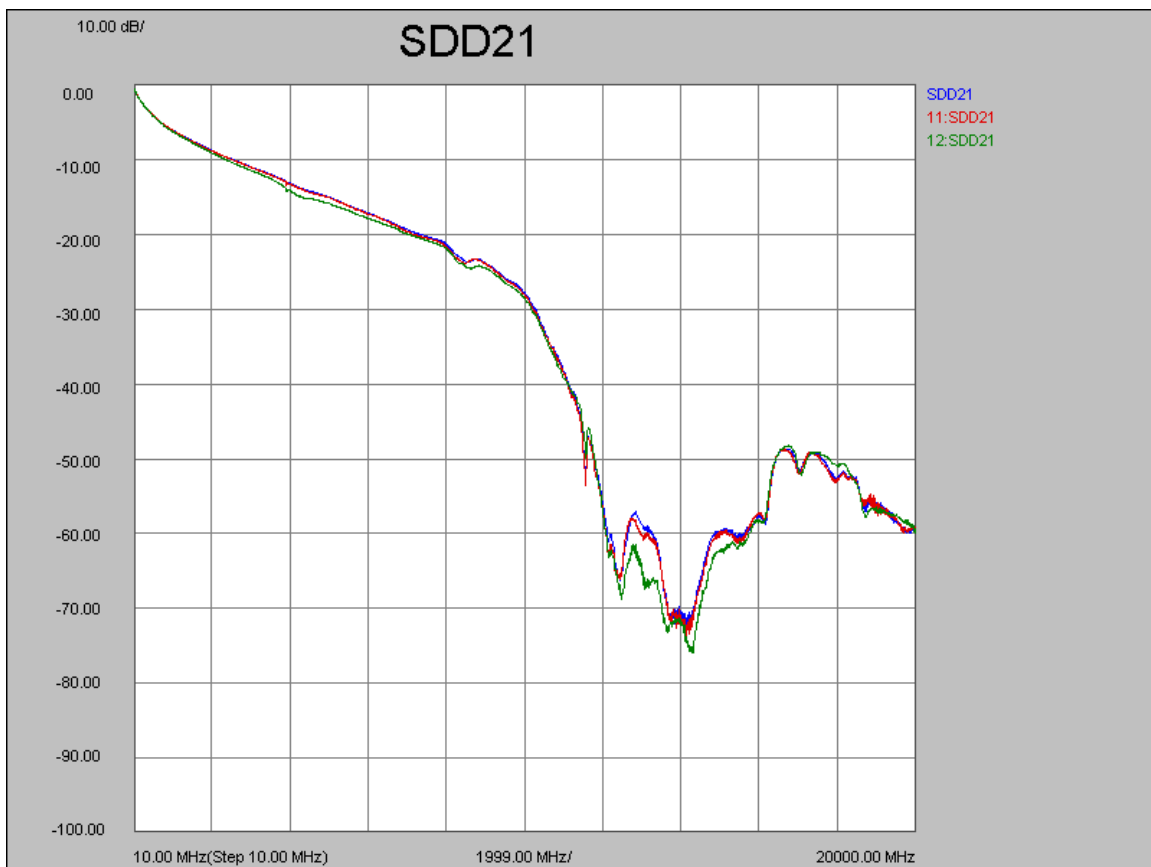


Variation over Temperature

Temperature Analysis

As the temperature of the environment rises the cable will exhibit higher loss. To demonstrate that Tyco Electronics cable assemblies are compliant over a temperature range we have tested cable assemblies at 0° C, 22° C, and 70° C. The SDD21 curves below show that the cable assembly does not vary much as the temperature changes between 0° C and 70° C. The data show below is from a 7 meter 24AWG cable assembly.

SDD21 Measurement over Temperature



Blue Curve = 0° C; Red Curve = 22° C; Green Curve = 70° C

2 Wire Interface EEPROM

The EEPROM on the SFP+ passive cable assembly is designed for 256 addresses. The information for addresses 0 to 127 is listed below. This information can be tailored to any customer request. Any address can be altered to display customer specific information and more memory can be added if more addresses are needed. Addresses 128 to 255 can be reserved for customer specific information that is in addition to the SFF 8431 specification.

SFP+ EEPROM Addresses 0 to 127

Data Address	Hex Data Code	Name of field	Description of field	Description of Data Code
0	03(h) 3.	Identifier	Type of serial transceiver	SFP Transceiver
1	04(h) 4.	Ext. Identifier	Extended type of serial transceiver	Indicates SFP serial ID module definition
2	21(h) 33.	Connector	Code for connector type	Copper Pigtail
3	81(h) 129.		10G Ethernet Compliance Codes	Unallocated
				10G Base LRM
				10G Base LR
				10G Base SR
			Infiniband Compliance Codes	1X SX
				1X LX
				1X Copper Active
				1X Copper Passive
4	00(h) 0.		ESCON and SONET Compliance codes	
5	00(h) 0.		SONET compliance codes	Does not apply to Copper GBIC
6	04(h) 4.		Gigabit Ethernet Compliance codes	1000BASE-CX
7			Fibre Channel link length	Short distance (S)



	41(h) 65.	Transceiver		
			Fibre Channel transmitter Technology	Electrical inter-enclosure (EL)
8	04(h) 4.			Copper Active
				Copper Passive
			Fibre Channel Transmission Media	Twin Axial Pair(TW)
10	D5 (h) 213.		Fibre Channel Speed	1200 Mbytes/Sec
				800 Mbytes/Sec
				Unallocated
			400 Mbytes/Sec	
			Unallocated	
			200 Mbytes/Sec	
			Unallocated	
			100 Mbytes/Sec	
11	00(h) 0.	Encoding	Code for serial encoding algorithm	Unspecified
12	67(h) 103.	BR, Nominal	Nominal bit rate, units of 100 Mbits/sec.	10,300 Mbits/sec
13	00(h) 0.	Reserved		
14	00(h) 0.	Length (9μ)	Units of km	
15	00(h) 0.	Length (9μ)	Units of 100m	
16	00(h) 0.	Length (50μ)	Units of 10m	
17	00(h) 0.	Length (62.5μ)	Units of 10m	
18	01(h) 1.	Length (Copper)	Units of 1m	
19	00(h) 0.	Reserved		
20	54(h) 84.	Vendor Name	GBIC vendor name (ASCII)	ASCII "T"
21	79(h) 121.			ASCII "y"
22	63(h) 99.			ASCII "c"
23	6F(h) 111.			ASCII "o"
24	20(h) 32.			ASCII "space"
25	45(h) 69.			ASCII "E"
26	6C(h) 108.			ASCII "I"
27	65(h) 101.			ASCII "e"



28	63(h) 99.	Vendor name (continued)		ASCII "c"	
29	74(h) 116.			ASCII "t"	
30	72(h) 114.			ASCII "r"	
31	6F(h) 111.			ASCII "o"	
32	6E(h) 110.			ASCII "n"	
33	69(h) 105.			ASCII "i"	
34	63(h) 99.			ASCII "c"	
35	73(h) 115.			ASCII "s"	
36	00(h) 0.	Reserved			
37		Vendor OUI	GBIC vendor IEEE company ID		
38					
39					
40		Vendor PN	Part number provided by GBIC Vendor (ASCII)		
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53	20(h) 32.			TYCO part number	
54	20(h) 32.				
55	20(h) 32.				
56	41(h) 65.	Vendor rev.	Revision level for part number Provided by GBIC vendor (ASCII)	Rev. A	
57	20(h) 32.				
58	20(h) 32.				
59	20(h) 32.				
60	00(h) 0.			Laser wavelength	
61	00(h) 0.			Laser wavelength	
62	00(h) 0.	Reserved			
63	xx(h)	CC_BASE	Check code for base ID fields(addr 0 to 62)		
64	00(h) 0.		Reserved		



65	00(h) 0.	Options	Reserved	
			Indicated which optional GBIC signals are implemented	RATE_SELECT not implemented
				TX_DISABLE not implemented
				TX_FAULT not implemented
				Inverted Loss of Signal NOT implemented
			Loss of signal not implemented	
Reserved				
66	00(h) 0.	BR, max	Upper bit rate margin, units of %	“00(h)” indicates that this field is not specified
67	00(h) 0.	BR, min	Lower bit rate margin, units of %	“00(h)” indicates that this field is not specified
68		Vendor SN	Serial number provided by vendor (ASCII)	The vendor serial number is a 16 character field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces, defining the vendor’s serial number for the GBIC. For this part, the serial numbers must be sequential for the modules on each end of the cable.
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				
84				ASCII code, two lower-order digits of the year
85				
86		Date Code	Vendor’s manufacturing date code	ASCII code, digits of the month
87				
88				ASCII code, day of the month



89				
90				ASCII code, vendor specific lot code, may be blank
91				
92	00(h) 0.	Reserved		
93	00(h) 0.			
94	00(h) 0.			
95		CC_EXT	Check code for extended ID Fields (addresses 64 to 94)	
96		Supplier ID	TYCO Vendor Number	The vendor number is the purchasing code assigned to the vendor that performs the assembly operation. It is a 6 character field that contains ASCII Characters, left-aligned and padded on the right with ASCII spaces
97				
98				
99				
100				
101				
102		Supplier Tracking Number	TYCO Specific Lot Identification at vendor	The Supplier Tracking Number is the reference used by the supplier to reference this lot of modules Currently it is the TYCO PO number The Tracking number is a 12 character field that contains ASCII Characters, left-aligned and padded on the right with ASCII spaces
103				
104				
105				
106				
107				
108				
109				
110				
111				
112				
113				
114	FF(h) 255.			
115	FF(h) 255.			
116	FF(h) 255.			
117	FF(h) 255.			
118	FF(h) 255.			
119	FF(h) 255.			



120	FF(h) 255.		Reserved for future TYCO Information	
121	FF(h) 255.			
122	FF(h) 255.			
123	FF(h) 255.			
124	FF(h) 255.			
125	FF(h) 255.			
126	FF(h) 255.			
127	FF(h) 255.			

Part Numbers

Passive SFP+ Cable Assemblies

Length	24 AWG P/N	26 AWG P/N	28 AWG P/N	30AWG P/N
0.5 meter	2032237-1	2032247-1	2053649-1	2032246-1
1.0 meter	2032237-2	2032247-2	2053649-2	2032246-2
2.0 meter	2032237-3	2032247-3	2053649-3	2032246-3
3.0 meter	2032237-4	2032247-4	2053649-4	2032246-4
4.0 meter	2032237-5	2032247-5	2053649-5	2032246-5
5.0 meter	2032237-6	2032247-6	2053649-6	
6.0 meter	2032237-7	2032247-7	2053649-7	
7.0 meter	2032237-8	2032247-8		
8.0 meter	2032237-9	2032247-9		
9.0 meter	2032237-10	2032247-10		
10.0 meter	2032237-11	2032247-11		
11.0 meter	2032237-12			
12.0 meter	2032237-13			
13.0 meter	2032237-14			
14.0 meter	2032237-15			
15.0 meter	2032237-16			

Equalized Passive SFP+ Cable Assemblies

Equalized passive SFP+ cable assemblies are also available upon request. Equalized cable assemblies may be used with systems that are using pre-emphasis and/or EDCs. A set equalization value may be used in conjunction with pre-emphasis and EDCs to achieve longer cable lengths in certain applications. This is application based – please contact your sales representative to discuss the implementation of equalization in the cable assembly.

Active SFP+ Cable Assemblies

For designs that only support SR and LR applications Tyco Electronics provides active direct attach copper cable assemblies. Active cable assemblies provide functions such as Transmit Disable and Receiver Loss of Signal in addition to signal amplification. Please ask your sales representative to discuss active SFP+ cable assemblies for your specific application. Current active SFP+ part numbers: 2032757 and 2074752.

Revision History

Revision	Date	Change Description
A	10/8/2008	Initial Release
B	11/18/2008	Updated test specs and data for SFF-8431 Rev. 3.2 Included variance over temperature measurements
C	2/4/2009	Corrected part numbers on page 19.