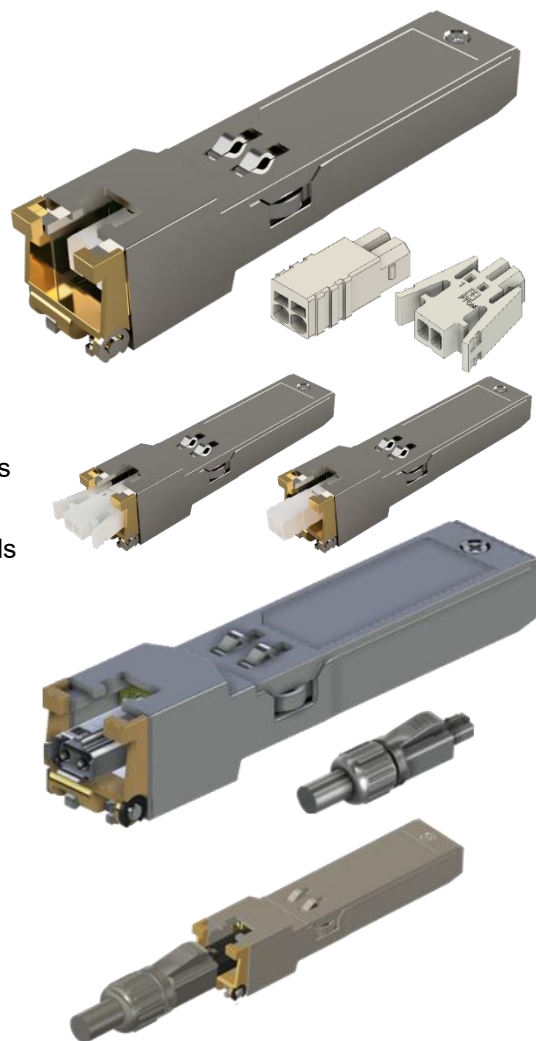


Product Features

- Industrial & Intelligent PAM Modem for copper lines
- Single Pair of Copper Wire to 100BASE-FX/1000BASE-X
- Automatic 100BASE-FX/1000BASE-X detection
- Packet size up to 2048 bytes
- Supports Flow Control (FC)
- Extends Ethernet up to 6200 Meters Over 1 Pair
- Pulse Amplitude Modulation (PAM)
- 1.536 ..18.048Mbps Bi-directional Data Transmission
- Automatic Speed Selection Mode (Auto Rate Mode)
- Fast Link Synchronisation, typical Time to Link is 3 seconds in Fixed Rate Mode
- Fast Link Recovery, typical Reconnection Time is 3 seconds if link interruption is shorter than 2 seconds
- HTTP Web GUI and Telnet CLI (Command Line Interface)
- Additionally configurable via the I2C Control/Status Fields
- Low Power (< 800mW)
- Digital Diagnostic Monitoring (DDM) Available
- Single +3.3V DC Power Supply
- Hot-pluggable SFP Modem
- Operating Temperature -40°C to +85°C
- Temperature Sensor Included
- Voltage Measurement Included
- Fully Metallic Enclosure for Low EMI
- Compliant with SFP MSA Specification
- Software Upgradable
- Push-in & Crimp Connectors Included
- Connector with Snap-in Locking
- I-Version with IEC 63171-6 Compliant Industrial Ethernet Connector



Applications

- Ethernet Extender, 1.5..18Mbps
- Industry 4.0 Applications
- Switch & Router Enhancement
- Single Pair Wire Ethernet Modem

Description

The new **Flexcom^{ONE}** is a single pair, low power SFP (Small Form-factor Pluggable) Ethernet copper wire modem using the transmission friendly Pulse Amplitude Modulation (PAM) technology. The modem is optimized for a duplex connection speed in the range of 1.5...18Mbps over a pair of copper wires up to 6200 meters. The **Flexcom^{ONE}** can be plugged into any Ethernet device with SFP ports that support 100BASE-FX and/or 1000BASE-X.

Pulse Amplitude Modulation means a much smaller frequency bandwidth than comparable modules with VDSL/ADSL technology. This technology influences the other systems less and the transmission on copper cables is more save and for harsh environments.

The configuration is possible by Web or Telnet access. The modem supports fixed and automatic transmission rate selection. The training or recovery time for the copper line connection (link synchronisation) in Fixed Rate Mode is very fast (2..10 seconds). In Auto Rate Mode, SFP modems automatically adjust the transmission rate to the optimum performance that line conditions can support. The copper line interface has 1500V RMS or 2250V DC isolation and its protection meets ITU-T Rec. K.20/K.21.

Ordering Information

Table 1. Ordering Information

Part Number	Description
FG-COP-SFPMSPAM	Industrial 1.5..18Mbps SFP Ethernet Copper Wire Modem (PAM), Reach up to 6200 Meter, 100BASE-FX/1000BASE-X SFP Connection, -40°C to 85°C, AWG 18-26 Combicon XC with Snap-in Locking connector.
FG-COP-SFPMSPAM-I	Industrial 1.5..18Mbps SFP Ethernet Copper Wire Modem (PAM), Reach up to 6200 Meter, 100BASE-FX/1000BASE-X SFP Connection, -40°C to 85°C, AWG 18-28 IEC 63171-6 Compliant with Metal Latch connector.

Application

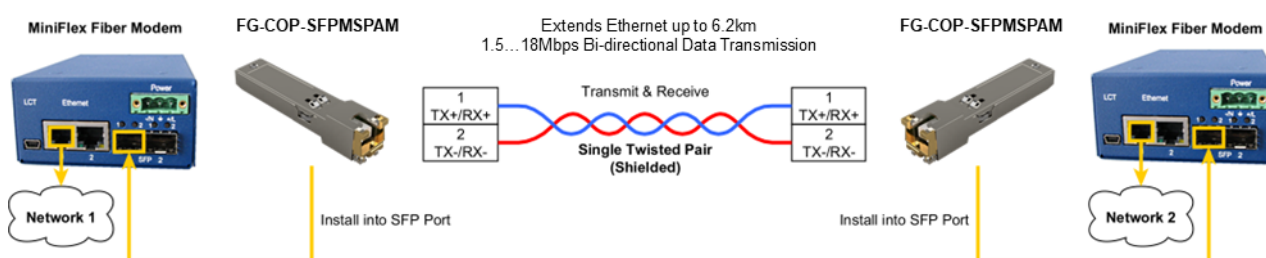


Figure 1. Application Example

Web Interface Configuration

SUMMARY	Summary
STATUS	
CONFIGURATION	
MISCELLANEOUS	
COMMAND REFERENCE	
Model:	COPSFPMSPAM
Model Description:	Flexcom SFP/100BASE-FX 1000BASE-X/ Copper 1.536-18.048 Mbps
HW:	01AA
SW:	1.7, 13-06-2025
SN:	BPR240800001
Runs:	0d 03:12:14
Alarm:	NO
IP Address:	192.168.0.1
MAC Address:	00-0F-D9-18-8E-11

SUMMARY	Status
STATUS	
CONFIGURATION	
MISCELLANEOUS	
COMMAND REFERENCE	
Mode:	master
Baserate:	282 18.048 Mbps
SNR:	26.00 good
LAN / FC:	100F / on
Voltage:	3.308 V
Temperature:	67.53 °C
SW:	ok
SFP Switch:	normal

SUMMARY STATUS CONFIGURATION MISCELLANEOUS COMMAND REFERENCE	Configuration	
	Network IP address: 192.168.0.1 Subnet mask: 255.255.255.0 Gateway: 192.168.0.254 Speed: AUTO Flow control ☒	Copper wire Mode: MASTER Baserate: 282 18.048 Mbps
	Services Telnet ☒ HTTP ☒	
	TFTP Server IP: 192.168.0.10 Retries: 3 Timeout: 10 SW file path: SFMS_V1-0.bin	
	Compatibility Mode: OFF	
	Save	

SUMMARY STATUS CONFIGURATION MISCELLANEOUS COMMAND REFERENCE	Miscellaneous	
	Controls Factory Default Restart TFTP SW Update	
	Selected Software ☒ 1: ver.: 1.0, date: 23-04-2024, length: 516096 bytes, CRC: 0xbac7, fixed ☐ 2: ver.: 1.0, date: 23-04-2024, length: 516096 bytes, CRC: 0xbac7, fixed	

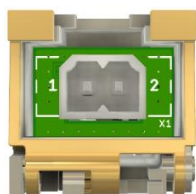
Telnet CLI Command Structure

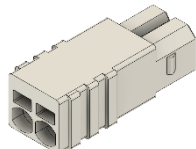
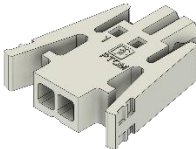
The command structure is according to ITU-T Rec. M.3400 (Telecommunication Management Networks). Please see the Help for the command descriptions in the CLI or the COMMAND REFERENCE Menu in the WEB interface for further information.

Main Menu		
PM Performance management	FMM Fault and maintenance management	CM Configuration management
	SFPVIEW RESET SERNUM SOFTUPDATE SOFTINFO STATUS TFTP SOFTUPDATE M(AIN) H(ELP)	MASTER BASERATE ETHSD FC GATEWAY NETCONFIG NETMASK SETIP TFTPIP TFTP RETRIES TFTP TIMEOUT TFTP FILEPATH TELNET ON/OFF HTTP ON/OFF COMPAT SOFTSELECT 1/2 FACTORY DEFAULT APPLY M(AIN) H(ELP)

Connector & Pin Description

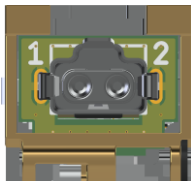
Table 2. Connector & Pin Description SFP Module FG-COP-SFPMSPAM

Part Number	Type	Description	
	Phoenix Contact, 1815264 PTSM 0,5/ 2-HV-2,5-THR WH R32	Pin 1	Analog TX+/RX+
		Pin 2	Analog TX-/RX-

Matching Connectors, included when ordering the SFP Module FG-COP-SFPMSPAM			
Part Number	Type	Description	
	Phoenix Contact, 1704853 PTSM 0,5/ 2-P-2,5 WH	Connection method	Push-in spring connection
		Conductor cross section solid	0.14 mm² ... 0.5 mm²
		Conductor cross section flexible	0.2 mm² ... 0.5 mm²
		Conductor cross section AWG	24 ... 20
		Stripping length	6 mm
	Phoenix Contact, 1015464 PTCM 0,5/ 2-PL-2,5 WH	Connection method	Crimp connection
		Conductor cross section flexible	0.14 mm² ... 0.75 mm²
		Conductor cross section AWG	26 ... 18
		Stripping length	4.1 mm ... 4.6 mm
	Phoenix Contact, 1013780 PTCM-MP-P 0,34-0,75	Connection method	Crimp connector for 1015464
		Conductor cross section flexible	0.34 mm² ... 0.75 mm²
		Conductor cross section AWG	22 ... 18
		Stripping length	4.1 mm ... 4.6 mm

	Phoenix Contact, 1013781 PTCM-MP-P 0,14-0,5	Connection method	Crimp connector for 1015464
		Conductor cross section flexible	0,14 mm² ... 0,5 mm²
		Conductor cross section AWG	26 ... 20
		Stripping length	4.1 mm ... 4.6 mm

Table 3. Connector & Pin Description SFP Module FG-COP-SFPMSPAM-I

Part Number	Type	Description	
	AMPHENOL MSPE-J2L0-E00	Pin 1	Analog TX+/RX+
		Pin 2	Analog TX-/RX-

Matching Connectors, included when ordering the SFP Module FG-COP-SFPMSPAM-I

Part Number	Type	Description	
	AMPHENOL MSPE-P2L0-2A0	Connection method	Solder Pad
		Conductor cross section	0.08 mm² ... 0.75 mm²
		Conductor cross section AWG	28 ... 18

Matching Cables, not included

	Part Number	Description
 SPE IP20 Plug-Plug Cable, Latch Locking, various lengths	MSPE-C2L0-BA010	SPE IP20 Plug-Plug Cable 1m
	MSPEC2L0BB010	SPE IP20 Plug-Plug Cable 2m
	MSPEC2L0BC010	SPE IP20 Plug-Plug Cable 3m
	MSPEC2L0BD010	SPE IP20 Plug-Plug Cable 4m
	MSPEC2L0BE010	SPE IP20 Plug-Plug Cable 5m
	MSPEC2L0BK010	SPE IP20 Plug-Plug Cable 10m
	MSPEC2L0BL010	SPE IP20 Plug-Plug Cable 20m
	MSPEC2L0BM210	SPE IP20 Plug-Plug Cable 50m
	MSPEC2L0BM710	SPE IP20 Plug-Plug Cable 100m

Performance on Copper Cable

Table 4. Performance

Part Number	Diameter	Distance (Meter)					
		1536 kbps	4352 kbps	7168 kbps	10000 kbps	14016 kbps	18048 kbps
Cable U72 (installation cable)	0.4mm, AWG-26	1600	1100	950	800	650	450
Cable U72 (installation cable)	0.5mm, AWG-24	2100	1400	1100	950	750	500
Cable U72 (installation cable)	0.8mm, AWG-20	3800	2500	2100	1800	1400	1000
Siemens 6XV1830-5EH10 (PROFIBUS cable)	1.0mm, AWG-18	6200	4100	3400	2900	2300	1600

The performance (distance) results may differ from this table, because

- noisy environment or multipair cable with additional disruptive services
- differences in cable values (bandwidth, crosstalk etc), just same diameter
- bad installation, cables are not twisted, not using a paired cable

Table 5. SFP Latency

Parameter	Symbol	Packet Size (byte)	Typical @ kbps			Unit	Note
			1536	10000	18048		
Latency	L	64	0.788	0.137	0.085	ms	
		128	1.144	0.283	0.136	ms	
		256	1.670	0.390	0.239	ms	
		512	2.980	0.658	0.444	ms	
		1024	6.131	1.250	0.856	ms	
		1280	7.557	1.614	1.061	ms	
		1518	8.641	1.852	1.252	ms	
		2048	11.530	2.439	1.678	ms	

For a link connection (SFP to SFP) you must double this value.

Table 6. SFP Jitter

Link Health	Symbol	Maximum @ kbps			Unit	Note
		1536	10000	18048		
Jitter	J	3.151	0.963	1.174	us	

Table 7. Link Health SNR (Signal-to-Noise Ratio)

Link Health	Symbol	SNR Value	Unit	Note
Poor	SNR	< 17.29	dB	
Marginal	SNR	17.29 < SNR < 20.38	dB	
Good	SNR	> 20.38	dB	

Table 8. Time to link

Parameter	Symbol	Min	Typical	Max	Unit	Note
Time to link <i>Fixed Rate mode</i>		2	3	10	second	Note ¹⁾
Time to link <i>Auto Rate mode</i>		25	30	180	second	Note ¹⁾

Note¹⁾: The line parameters must allow link establishing with the selected Baserate

Table 9. Link reconnection time

Operation mode		Link interruption duration	
Master	Slave	shorter than 2 seconds	longer than 2 seconds
Fixed Rate	Fixed Rate	fast reconnection in 2..10 seconds	fast reconnection in 2..10 seconds
Fixed or Auto Rate	Auto Rate	fast reconnection in 2..10 seconds	full handshake in 30..180 seconds

Technical Specification

Table 10. SFP Host Interface

SFP Host Connector Power (MSA Compliant)						
Parameter	Symbol	Min	Typical	Max	Unit	Note
Input Voltage	Vcc	3.135	3.3	3.465	V DC	
Input Current	Icc		230	255	mA	

SFP Host Connector Data (MSA Compliant)						
Parameter	Symbol	Min	Typical	Max	Unit	Note
Data Rate	TD/RD		100		Mbps	100Base-FX
			1000		Mbps	1000Base-X

Table 11. SFP Modem Interface

SFP Analog Modem Interface						
Parameter	Symbol	Min	Typical	Max	Unit	Note
Output Voltage	Vout	2.0	2.4	2.6	Vp2p	Peak-to-peak
Line Impedance	Z		114		Ohm	
Data Rate		1.536		18.048	Mbps	Duplex
Isolation		1500			Vrms	

Table 12. Transmission Bandwidth

Transmission Bandwidth (90% of power)					
Baserate	Data rate (Mbps)	Bandwidth (MHz)	Baserate	Data rate (Mbps)	Bandwidth (MHz)
24	1.536	0 - 1.15	157	10.000	0 - 7.50
32	2.048	0 - 1.54	176	11.264	0 - 8.45
48	3.072	0 - 2.30	192	12.288	0 - 9.22
64	4.096	0 - 3.07	208	13.312	0 - 9.98
80	5.120	0 - 3.84	224	14.336	0 - 10.75
96	6.144	0 - 4.61	240	15.360	0 - 11.52
112	7.168	0 - 5.38	256	16.384	0 - 12.29
128	8.192	0 - 6.14	282	18.048	0 - 13.54

Table 13. Environment

Operating Conditions						
Parameter	Symbol	Min	Typical	Max	Unit	Note
Storage Temperature	Ts	-40		+85	°C	
Operating Temperature	To	-40		+85	°C	
Relative Humidity	RH	5		95	%	non-condensing

ID & Diagnostic and Control/Status Fields Memory Map

The SFP MSA defines an enhanced memory map with a digital diagnostic monitoring interface for SFP transceivers that allows pseudo real time access to device operating parameters. It defines a 256 bytes memory map which is accessible over a 2-wire serial interface at the 8-bit address 1010000X (A0h), the ID fields. The digital diagnostic monitoring interface makes use of the 8-bit address 1010001X (A2h).

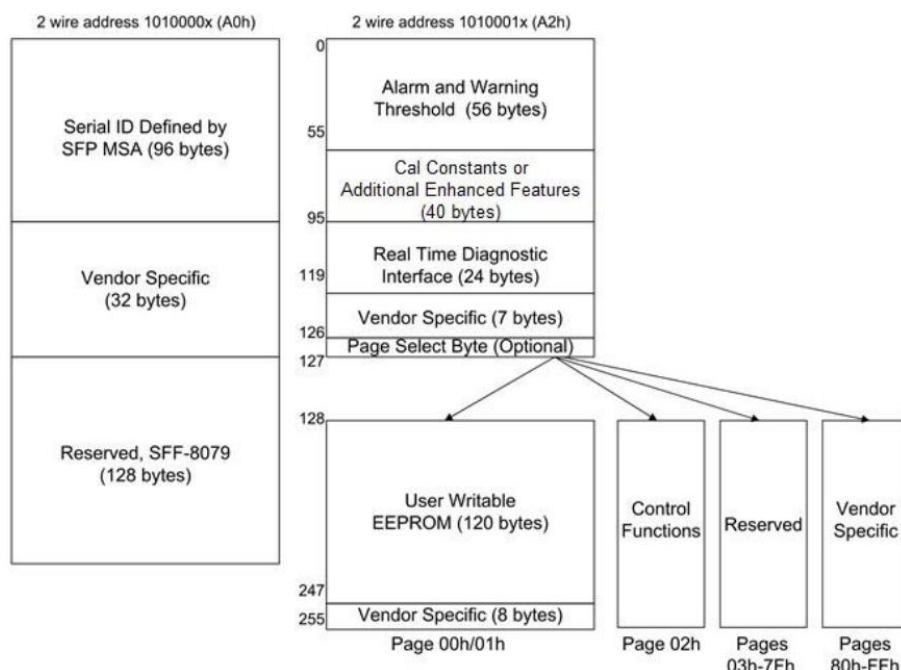


Figure 2. Digital Diagnostic Memory Map Specific Data Field Descriptions

Table 14. Base/Extended ID Fields, Address A0h

Address	Name	Content (Hex)	Description
0	Identifier	03	SFP
1	Ext. Identifier	04	SFP function is defined by 2-wire interface ID
2	Connector	00	Unspecified
3-10	Transceiver	00 00 00 00 00 00 40 00	Twisted Pair (TP)
11	Encoding	00	Unspecified
12	Signaling Rate, Nominal	00	Unspecified
13	Rate Identifier	00	Unspecified
14-17	Link length fiber	00 00 00 00	
18	Length copper cable	C8	Minimum 200 meter
19	Supported length copper cable	FA	5800 meters
20-35	Vendor name	46 6C 65 78 44 53 4C 20 20 20 20 20 20 20 20 20	FlexDSL
36	Transceiver compliance	00	Not specified
37-39	Vendor OUI	00 0F D9	00 0F D9
40-55	Vendor PN	43 4F 50 53 46 50 4D 53 50 41 4D 20 20 20 20 20	COPSFPMSPAM

56-59	Vendor rev	31 2E 30 20	1.0
60-61	Wavelength	00 00	
62	Fiber Channel Speed 2	00	
63	CC_BASE	xx	Check code for Base ID Fields (addresses 0-62)
64-65	Options	00 12	TX_DISABLE and Loss of Signal implemented
66	Signaling Rate, max	00	Unspecified
67	Signaling Rate, min	00	Unspecified
68-83	Vendor Serial Number	xx	
84-91	Date code	yy yy mm mm dd dd 20 20	Year yy yy, Month: mm mm, Day: dd dd, Lot:
92	Diagnostic Monitoring Type	20	Internally calibrated
93	Enhanced Options	00	
94	SFF-8472 Compliance	09	Includes functionality described in Rev 12.4 of SFF-8472
95	CC_EXT	xx	Check code for the Extended ID Fields (addresses 64-94)
96-106	Vendor Specific, Flex PN	xx	SFPMS xxxx
107-118	Vendor Specific, Flex SN	xx	Manufacturer/Year/Week/SerialNumber
119-124	Vendor Specific, MAC-address	00 0F D9 xx yy zz	00:0F:D9:xx:yy:zz
125-127	Vendor Specific		Unspecified
128-255	Reserved		

Table 15. Diagnostic and Control/Status Fields, Address A2h

Address	Name	Content (Hex)	Description
0-119	Standard DDM values	00	Unspecified
96	Temperature MSB	xx	Internally measured temperature, according SFF-8472
97	Temperature LSB	xx	Internally measured temperature, according SFF-8472
96	Supply Voltage MSB	xx	Internally measured supply voltage, according SFF-8472
97	Supply Voltage LSB	xx	Internally measured supply voltage, according SFF-8472
106	Actual Baserate MSB	xx	0 = OFF, Range 24 – 282 (1.536...18.048 Mbps)
107	Actual Baserate LSB	xx	
120	SW Version MSB	zz	Value zz.yy
121	SW Version LSB	yy	Value zz.yy
122	RX SNR MSB	zz	Value in dB zz.yy
123	RX SNR LSB	yy	Value in dB zz.yy
124	TX Voltage	00 or 01	0 = 1.2V _{p2p} , 1 = 2.4V _{p2p}
125-126	Vendor Specific	00	Unspecified
127	Optional Page Select	02	Optional Page, support up to A2h, address 255
248 ¹⁾	Master / Slave Mode	xx	0 = MASTER, 1 = SLAVE
249 ¹⁾	Baserate MSB	Xx	0 = AUTO, Range 24 – 282 (1.536...18.048 Mbps)
250 ¹⁾	Baserate LSB	xx	
251 ¹⁾	LAN Speed	xx	0 = AUTO, 1 = 100F, 2 = 1000F
252 ¹⁾	HTTP / Telnet enable / disable	0bxxxxxx11	Bit 0 = Telnet, Bit 1 = HTTP, 0 = disabled, 1 = enabled
253 ¹⁾	Normal / Factory Mode	0bxxxxxx1	0 = normal operation, 1 = factory default

¹⁾ R/W possible

Safety / EMC / ROHS / WEEE / MTBF

Table 16. Standards

Safety	EN 62368-1:2020/A11:2020 IEC 62368-1:2020/A11:2020
EMC	EN 50121-4:2016/A1 :2019 EN 55032:2015/A11:2020 Class B EN 55035:2017/A11:2020 Criterion A EN 61000-4-2:2009 ± 6 kV contact discharge, ± 8 kV air discharge EN 61000-4-3:2020 20 V/m (80-1000 MHz) EN 61000-4-4:2012 ± 2 kV data line EN 61000-4-5:2014 + A1:2017 ± 4 kV data line EN 61000-4-6:2014 + AC:2015 10 V (150 kHz-80 MHz)
RoHS	RoHS2 Directive 2011/65/EU and 2015/863/EU
WEEE	WEEE Directive 2012/19/EU
MTBF	Lifetime: 1'158'748 H, λ (10^{-9} h^{-1}) = 863, Siemens Norm SN 29500, Temperature 40°C

Mechanical Specification

Outline Drawing SFP Module FG-COP-SFPMSPAM

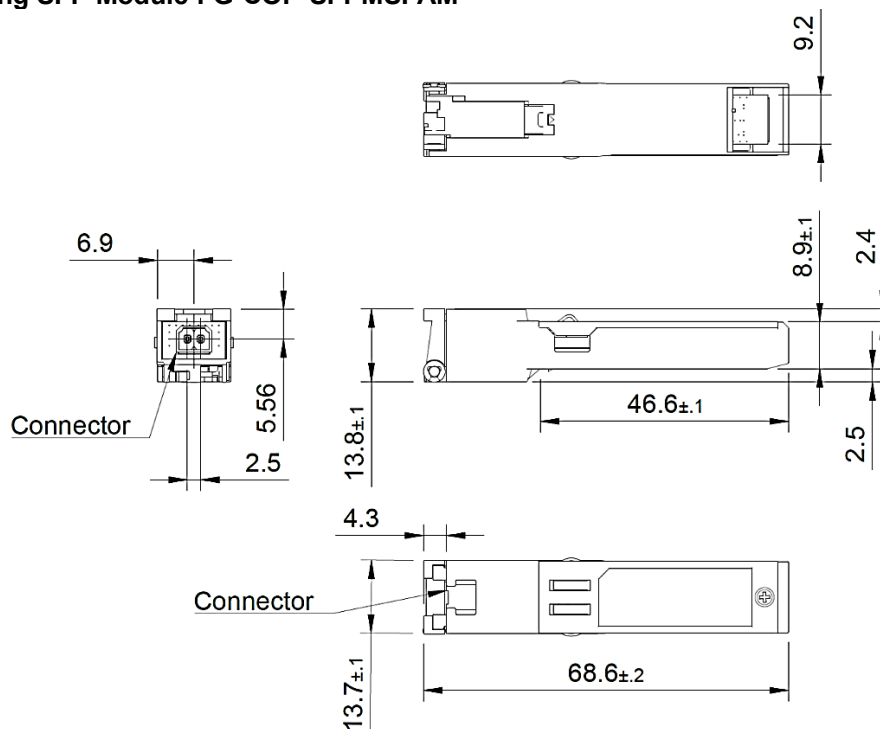


Figure 3. Outline Drawing SFP Module FG-COP-SFPMSPAM

Outline Drawing FG-COP-SFPMSPAM with Connector

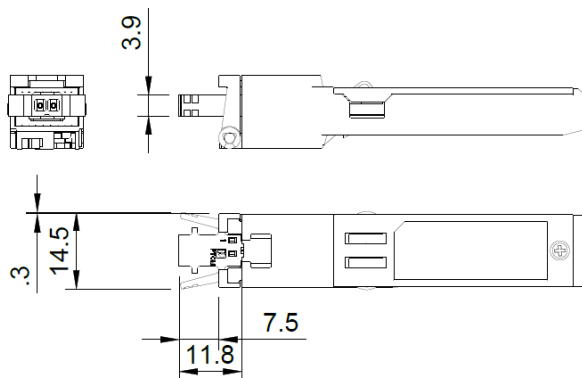


Figure 4. Outline Drawing FG-COP-SFPMSPAM
with Connector 1015464

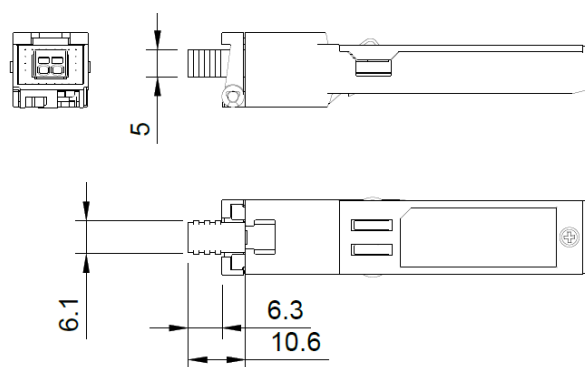


Figure 5. . Outline Drawing FG-COP-SFPMSPAM
with Connector 1704853

Outline Drawing SFP Module FG-COP-SFPMSPAM-I

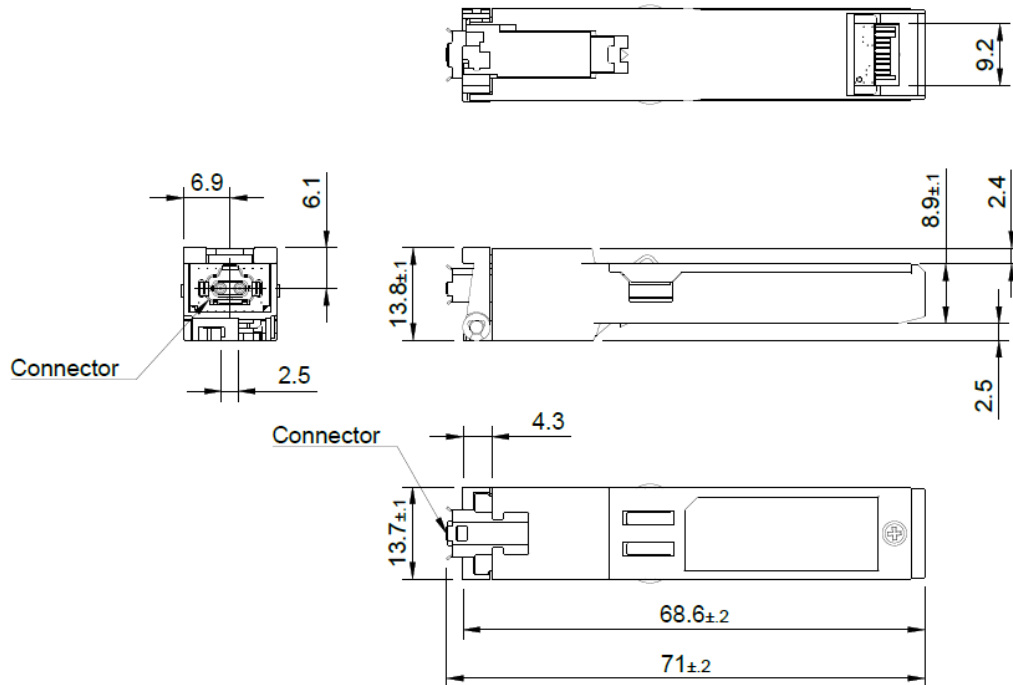


Figure 6. Outline Drawing SFP Module FG-COP-SFPMSPAM-I

Outline Drawing FG-COP-SFPMSPAM-I with Connector

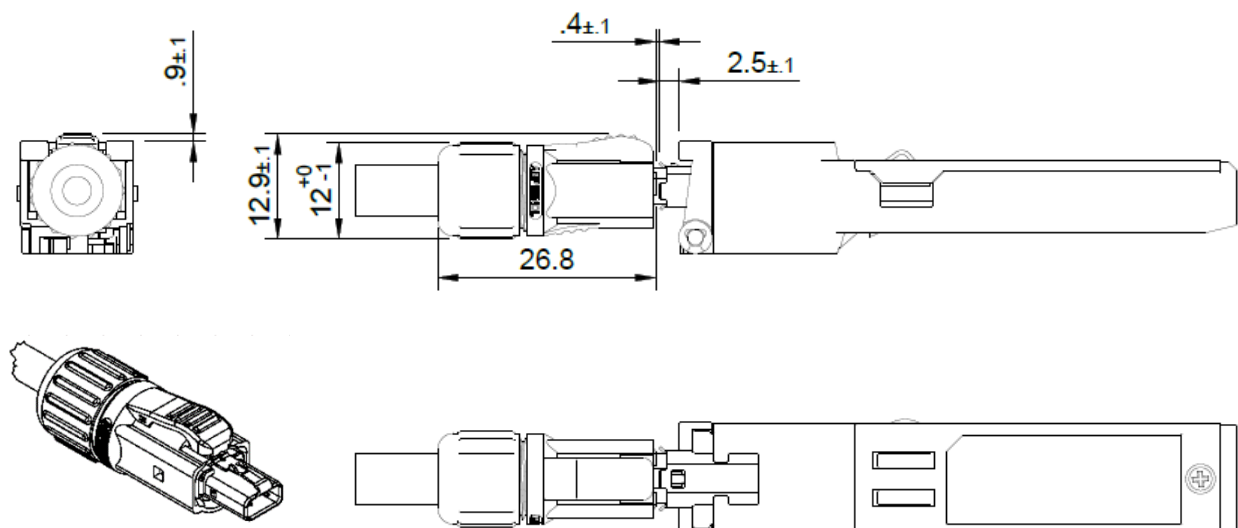


Figure 7. Outline Drawing FG-COP-SFPMSPAM-I with Connector MSPE-P2L0-2A0XX

SAFETY REGULATIONS

IF THE UNIT IS NOT USED IN ACCORDANCE WITH REGULATIONS DESCRIBED AND DEFINED IN THE CHAPTERS "TECHNICAL SPECIFICATION", FLEXDSL TELECOMMUNICATIONS AG REFUSES TO TAKE ANY RESPONSIBILITY. FURTHERMORE, NO WARRANTY IS GRANTED IN SUCH CASE! IT'S ONLY ALLOWED TO USE THE SFP-COPPER WIRE MODEM WITH CARRIER-UNITS THAT ARE APPROVED ACCORDING TO THE SAFETY STANDARD IEC/EN 62368-1. THE PLUGIN SFP-CAGE OF THE CARRIER-UNITS HAS TO BE CONNECTED PERMANENTLY TO A RELIABLE PROTECTIVE EARTH CONDUCTOR.

Please read this datasheet carefully before operating the system. The installation of this equipment must be done by **qualified** personnel only.

Precaution

The present document describes devices of the **Flexcom^{ONE}** family. The document contains the technical description of the devices, configuration, and operation instructions.



WARNING

BEFORE STARTING OPERATING THE EQUIPMENT, READ CAREFULLY THE CURRENT DATASHEET. FLEXDSL TELECOMMUNICATIONS AG REFUSES NEITHER TAKING ANY RESPONSIBILITY NOR GRANTING ANY WARRANTY TO ANY DEVICE MALFUNCTIONING OR ANY DAMAGES DUE TO FAILURE TO COMPLY WITH THE REQUIREMENTS STATED IN THE DATASHEET.



WARNING

IMPROPER USE OF OUR EQUIPMENT, USE IN ANY OTHER ENVIRONMENT OR IMPROPER INSTALLATION AND MAINTENANCE MIGHT LEAD TO HARMFUL CONDITIONS. FLEXDSL TELECOMMUNICATIONS AG REFUSES NEITHER TAKING ANY RESPONSIBILITY NOR GRANTING ANY WARRANTY IN SUCH CASE.



WARNING

ELECTRONIC MODULES CAN BE DAMAGED OR DECREASED IN RELIABILITY BY STATIC ELECTRICAL DISCHARGE. BEFORE HANDLING MODULES, WEAR AN ANTISTATIC DISCHARGE WRIST STRAP TO PREVENT DAMAGE TO ELECTRONIC COMPONENTS. PLACE MODULES IN ANTISTATIC PACKING MATERIAL WHEN TRANSPORTING OR STORING. WHEN WORKING ON MODULES, ALWAYS PLACE THEM ON AN APPROVED ANTISTATIC MAT THAT IS ELECTRICALLY GROUNDED. TO PREVENT ELECTRICAL SHOCK, DO NOT INSTALL EQUIPMENT IN A WET LOCATION OR DURING A LIGHTNING STORM.



WARNING

THE PROTECTIVE GROUND CONNECTION MUST BE APPLIED TO THE CARRIER-UNIT. MAKE SURE THAT THE CARRIER-UNIT AND ALL EQUIPMENT CONNECTED TO IT USE THE SAME PROTECTIVE GROUND FOR THE PURPOSE OF REDUCING NOISE INTERFERENCE AND SAFETY HAZARDS.