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FL3X SFP 1000BASE-T1

Instructions for Use

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Any semiconductor devices have an inherent chance of failure. You have to protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over-current levels and other abnormal operating conditions.

The safety and handling instructions in this document have to be followed strictly.

EC Conformity

The FL3X SFP 1000BASE-T1 complies with the essential requirements of the following applicable European Community Directive(s) including current amendments, and carries the CE marking accordingly:

- 2014/30/EU EMC Directive

The following standard(s) have been used to assess the product:

- EN 61000-4-2
- EN 61000-4-3
- EN 61000-4-4
- EN 61000-4-5
- EN 61000-4-6
- EN 61000-6-2
- EN 61000-6-3
- EN 55011
- EN 61326-1

The FL3X SFP 1000BASE-T1 is designed, intended and authorized for industrial use only. Using the product in domestic environment may lead to electromagnetic disturbances.

This product is compliant with the European Community Directive 2011/65/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS).

Revision History

Document number: 3-0111-0A01-D11

Version	Date	Description
D1V0-F	22-10-2024	First release

Related Hardware / Software Versions

Product	Reference No.	Version	Remarks
FL3X SFP 1000BASE-T1	3-01110A01	50	

Contents

1 General

1.1 Intended User Group

This product may only be used by expert technicians and/or engineers who are qualified and familiar with electronic components and systems.

Each person involved with setup or operation of the product must

- be a qualified technician or engineer
- strictly adhere to this manual
- receive a briefing by an authorized person

NOTICE

If you are unsure of how to use the product as intended or have any questions about the use of the product, please discontinue use of the product immediately and contact the STAR ELECTRONICS Support.

⚠ WARNING

The product may only be used by expert technicians and/or engineers who are qualified and familiar with electronic components and systems!

The use of the product by non-professionals is not permitted and strictly forbidden!

1.2 Intended Use

The FL3X SFP 1000BASE-T1 is a testing equipment. It was developed to test the communication behavior of automotive bus systems and Ethernet together with Electronics Control Units and sensors in a fully controlled testing and/or laboratory environment.
For this intended use, the FL3X SFP 1000BASE-T1 offers the following options:

- Transmit and receive data (e.g. Use Case “Remaining Bus Simulation”).
- Exchange of data traffic between two or more bus systems (e.g. Use Case “Gateway”)
- Manipulation of data traffic (e.g. Use Case “Manipulation of signal values based on user configuration”)
- Recording of data traffic (e.g. Use Case “Logging”)

Any deviation from the intended use and/or installation in a testing vehicle is only permitted with specific **prior written approval** of STAR ELECTRONICS GmbH & Co. KG.

⚠ WARNING

The FL3X SFP 1000BASE-T1 may be used to communicate with networked electronic systems. E.g. FlexRay, CAN or Ethernet.

Any use of the product outside a fully controlled testing and/or laboratory environment may result in death or serious injury due to unpredictable behavior of a vehicle and/or potentially missing, deactivated, or malfunctioning safety devices on a vehicle!

The user is responsible to ensure the safety of the entire system. This includes amongst other things a safety shutdown.

	**⚠ WARNING**
	Any use of the device to control an actuator outside a fully controlled testing and/or laboratory environment may result in death or serious injury due to unpredictable behavior of a vehicle and/or potentially missing, deactivated or malfunctioning safety devices on a vehicle!

	**NOTICE**
	The device is not a calibrated measurement device. STAR ELECTRONICS GmbH & Co. KG accepts no liability whatsoever for the correctness of any measurement results.

	**⚠ WARNING**
	The FL3X SFP 1000BASE-T1 is NOT designed, intended, or authorized any may NOT be used for or in connection with the following purposes and/or devices: - use as part of medical systems - life support applications - aviation, space, nuclear, or military applications - use in areas where combustible or explosive gas mixtures are likely to occur - any other purposes / devices deviating from the intended use of the product specified by STAR ELECTRONICS GmbH & Co. KG.

	**⚠ WARNING**
	The product may only be used by expert technicians and/or engineers who are qualified and familiar with electronic components and systems! The use of the product by non-professionals is not permitted and strictly forbidden!

1.3 Used Pictograms

The meaning of used pictograms is shortly described below.

Follow the specific instructions in the document where these pictograms are placed.

	**NOTICE**
	Used to indicate a situation which may result in an operating failure. Damage of the product may occur, but there is no hazard of injury if not avoided.

	**NOTICE**
	Used to indicate an electrostatic discharge sensitive product. The product is subject to damage by ESD, if no precautions are taken.

	**Information**
	Used to indicate information provided only for purposes of clarification, illustration, and general information.

	**Reference**
	References to other documents.

	Product marking which shows the compliance of the product with the European Waste Electrical and Electronic Equipment Directive 2012/19/EU.

1.4 Safety and Handling Instructions

Please read the instructions for use carefully. To protect the device or the application against damage, or to avoid personal injury the FL3X SFP 1000BASE-T1 has to be handled as described herein.

Changes or modifications of the FL3X SFP 1000BASE-T1 are not allowed for safety and warranty reasons!

STAR ELECTRONICS GmbH & Co. KG is not liable for any damages arising from non-observance of the product information.

Follow the
a) specific safety and handling instructions placed at dedicated document positions
b) general safety and handling instructions below:

	**NOTICE** To prevent damage to the FL3X SFP 1000BASE-T1, or consequential damages: Do not open the FL3X SFP 1000BASE-T1. Do not connect any other signals to the interfaces as described in the chapter “Interfaces”. Ensure that all signals are within the specified range. Use only adapter cables from STAR ELECTRONICS GmbH & Co. KG for connecting the FL3X SFP 1000BASE-T1. High temperatures can damage the FL3X SFP 1000BASE-T1. Keep the FL3X SFP 1000BASE-T1 away from heaters, stoves, fireplaces, and other sources of heat. Do not expose the FL3X SFP 1000BASE-T1 to rain or use it near water. Do not use the FL3X SFP 1000BASE-T1 in areas of explosion hazard.

	**NOTICE** **ESD (Electrostatic Discharge) sensitive product** STAR ELECTRONICS GmbH & Co. KG products lacking protective enclosures are subject to damage by ESD. Take proper ESD precautions to avoid performance degradation or loss of functionality! Unpack, handle or operate these products only in environments where sufficient precautionary measures have been taken in respect to ESD hazards. A guideline is available in chapter 8.1. Only appropriately trained personnel (such as electricians, technicians and engineers) may handle and/or operate these products.

2 Product Description

2.1 FL3X SFP 1000BASE-T1 at a glance

The FL3X SFP 1000BASE-T1 is an automotive Ethernet interface in SFP formfactor.

- Marvel 88Q2221M transceiver
- Master and slave mode selectable via DIP-switch
- 100 Mbit/s and 1000 Mbit/s mode selectable via DIP-switch
- Status LEDs from SFP connector used
- MACSec support
- SPE connector for 1000BASE-T1 (Harting Tw1ster Rev2, IEC 63171-6)
    - Automatic selection of A0 and A2 mode
- SFP formfactor
- Temperature range -40°C to +85°C
- Fully compatible to any STAR COOPERATION networking products and many more SFP cards and devices (not compatible with all SFP+ connectors)

2.2 Accessory Parts

For further information about accessories for the FL3X SFP 1000BASE-T1 see chapter 7.2 Accessory Parts.

	NOTICE
	Use only accessory parts from STAR ELECTRONICS GmbH & Co. KG listed in chapter 7.2 Accessory Parts to ensure proper function and for warranty reasons! Other accessories without prior written consent of STAR ELECTRONICS GmbH & Co. KG must not be used.

3 Technical Data

3.1 Electrical Characteristics

Supply voltage			
	Min	Typ.	Max
Operating SFP Modul	-5 %	3.3 V	+ 5%
Supply current - operating	Typ.: 350 mA		

Table 1: Electrical Characteristics

3.2 Physical Characteristics

Connectors	
- SFP	SFP Modul formfactor
- Ethernet (BASE-T1)	Harting Tw1ster Rev2 (T1 IEC 63171-6)
Weight approx.	20 g
Dimensions approx. L x W x H	70 x 13,4 x 13,4 mm

Table 2: Physical Characteristics

3.3 Environmental Conditions

Temperature	Operating: -40°C - +85°C Non-operating: -40°C - +85°C Storage: -40°C - +85°C
Relative Humidity	0% - 90% r. H., Non-condensing

3.4 Block Diagram

The FL3X SFP 1000BASE-T1 is a transceiver module in SFP formfactor for 100/1000BASE-T1 automotive single pair ethernet.

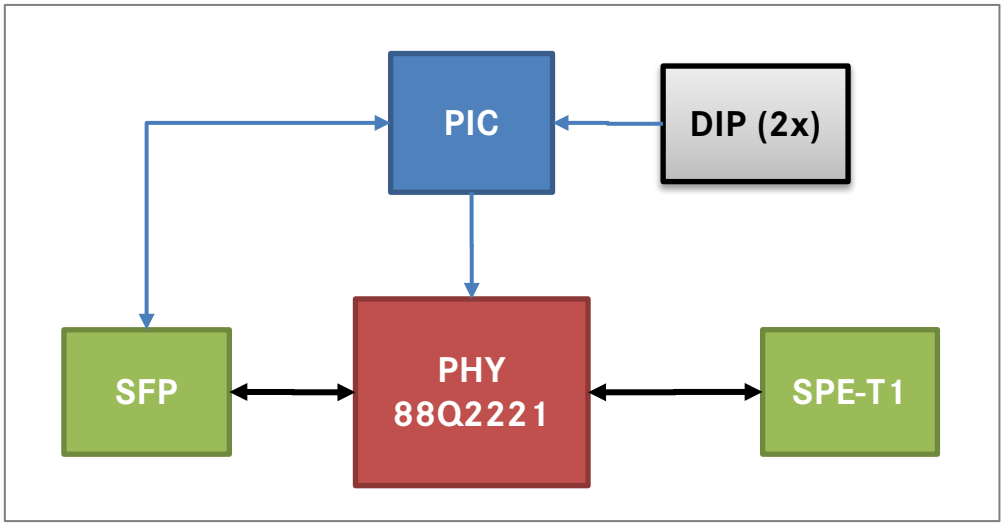

Figure 1: Block diagram from the FL3X SFP 1000BASE-T1

3.5 DIP Switch (Master/Slave and 100/1000BASE-T1)

The FL3X SFP 1000BASE-T1 has two DIP switches for setting the Baud rate and the master/slave mode.

To change the setting insert a small fine part and change carefully the switch position.

DIP switch function			
Nr.	Pos	Name	Description
1	On	Master	The 100/1000BASE-T1 interface is in slave mode
	Off	Slave	The 100/1000BASE-T1 interface is in master mode
2	On	1000BASE-T1	The 100/1000BASE-T1 interface is in 1000BASE-T1 mode
	Off	100BASE-T1	The 100/1000BASE-T1 interface is in 100BASE-T1 mode

Table 3: DIP switch function

The following figure shows the position from the DIP switch.

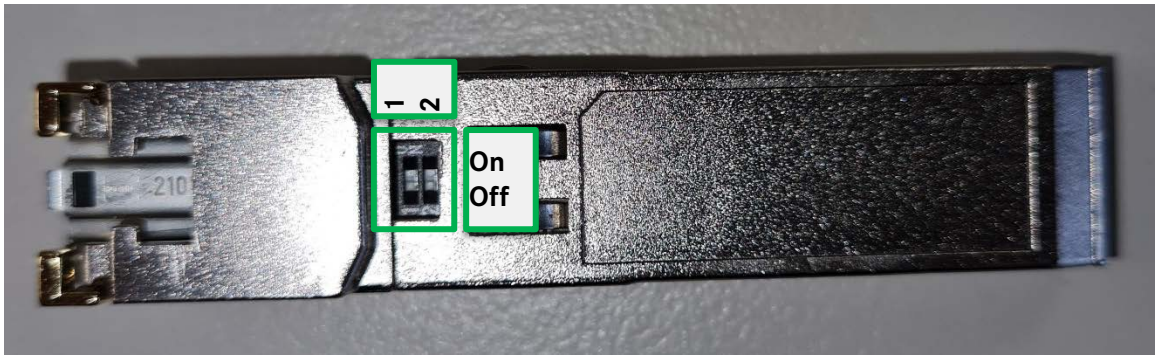

Figure 2: Position from the DIP switch

NOTICE

The DIP switch can only modify when outside of the SFP-cage.

3.6 Interfaces

The FL3X SFP 1000BASE-T1 has one SPE T1 connector for 100/1000BASE-T1 ethernet, see the following figure.

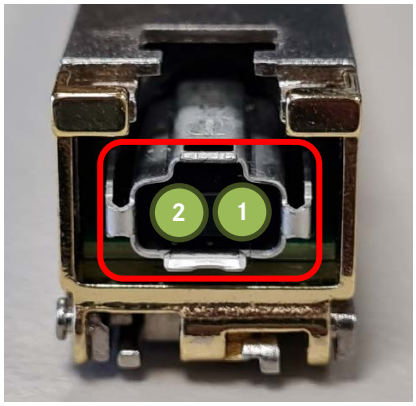

Figure 3: SPE connector

The following table shows the SPE connector assignment.

Connector SPE (1000BASE-T1 2-wire ethernet)		
Pin	**Signal Name**	**Description**
1	ETH_BP	1000BASE-T1 bus plus signal
2	ETH_BM	1000BASE-T1 bus minus signal

Table 4: Connector assignment for SPE (2-wire ethernet)

3.7 LED

The FL3X SFP 1000BASE-T1 has one LED for showing Link and Activity, see the following figure. The LED is behind the golden colored clamp on the bottom side of PCB.

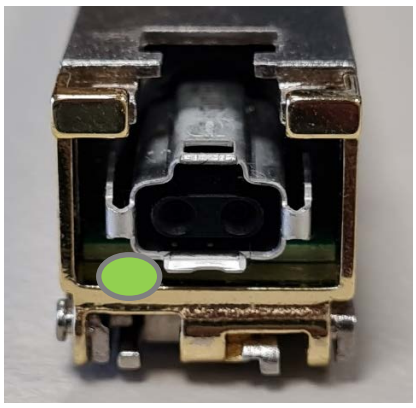

Figure 4: Position of LED

The following table shows the LED status.

LED	
Status	**Description**
Off	No or wrong connection
On	Link established
Blinking	Data transmission

Table 5: LED status

4 Getting Started

4.1 Assembly and Line-up

Read and follow these instructions when connecting and using the FL3X SFP 1000BASE-T1:

	NOTICE
	Ensure that all signal lines connected to the FL3X SFP 1000BASE-T1 are in the allowed range. Be sure to connect all cables as described in this manual. Never insert anything metallic into the openings of the FL3X SFP 1000BASE-T1. Ensure to grasp the plug and not the cable when disconnecting the FL3X SFP 1000BASE-T1.

4.2 Configuration and Operation

The SFP module complies with the SFF-8431 Rev 4.1 specification.

The FL3X SFP 1000BASE-T1 starts automatically after receiving power. The PHY MV88Q2221 power up in the selected configuration, which is controlled via the DIP switch on the top of the module.

The specification-specific I2C interface is available for operating information and settings. The SFP EEPROM content can be read out at address 0xA0. Address 0x80 can be used to configure the SFP module.

4.2.1 I²C Interface

Addresses:

- 0xA0: SFP Data Register
- 0x80: STAR Tunnel
  - PHY access over PIC
    - Chip Target = 0
  - PIC Register access
    - Chip Target =1
    - Ignore Device Number = 0x00

General writing and reading via I2C is explained in the next chapter. The STAR tunnel can be accessed via the address 0x80. This can be used to configure the PHY manually or to use register commands. For an operation, the register Device number, Register_Address_MSB, Register_Address_LSB and Operation Status must be written in the STAR Tunnel. The progress of the operation is displayed in Operation Status. If data is expected, it appears in the Data_MSB and Data_LSB registers.

I2C address 0x80: STAR Tunnel	
Address	**Register name**
0x00	Device Number
0x01	Register_Address_MSB
0x02	Register_Address_LSB
0x03	Operation Status
0x04	Data_MSB
0x05	Data_LSB

Table 6: STAR tunnel register

Operation Status				
Bits	**Field**	**Mode**	**Rst**	**Description**
0	Read/Write	RW	0x0	Write = 0 Read = 1
1	Read done	RO	0x0	Get set from the Slave if read is done.
2	Write done	RO	0x0	Get set from the Slave if write is done.
3	No command pending	RO	0x0	Is set by the slave if the read was successful and no read or write command was previously submitted.
4	Error during command	RO	0x0	Is set by the slave if the write or read command has failed.
5	Reserved	RO	0x0	Reserved for future use
6	Chip Target	RW	0x0	0 = access to PHY 1 = access to PIC register
7	Reserved	RO	0x0	Reserved for future use

Table 7: operation status register

PIC Register (0x0000)				
Bits	**Field**	**Mode**	**Rst**	**Description**
15:6	Reserved	RO	0x0	
5	Dip switch speed	RO	Dip switch	1 = 1000Mbits 0 = 100Mbits
4	Dip switch Master/Slave	RO	Dip switch	1 = Slave 0 = Master
3	Use dip switch config	RW	0x0	Setting this bit will cause the use of the dip switch config, self-cleaning 1 = dip config
2	Speed	RW	Dip switch	1 = 1000Mbits 0 = 100Mbits
1	Master/Slave	RW	Dip switch	1 = Slave 0 = Master
0	Mode	RW	0x0	Complete Mode must be 1 to use the PIC Register 1 = Complete 0 = Pretend

Table 8: PIC register 0x0000

PIC Register (0x0001)				
Bits	**Field**	**Mode**	**Rst**	**Description**
15:0	PHY ID	RO	0x002B	0x002B

Table 9: PIC register 0x0001

PIC Register (0x0002)				
Bits	**Field**	**Mode**	**Rst**	**Description**
15:0	PHY ID	RO	0x02B0	0x02B0

Table 10: PIC register 0x0002

4.2.2 I²C Access

The following Tables describe the I²C Access to the Addresses 0x80 and 0xA0. The access commands are for example with the address 0xA0.

4.2.2.1 Read (Current Address)

Read current Address

HOST	START	MSB						LSB	READ										NACK	STOP
		1	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	0	
SFP										ACK	MSB							LSB		
		Address + W/R									Data									

4.2.2.2 Read (with set Address)

Two steps are necessary to read with set Address

First Step: Write address to read

HOST	START	MSB						LSB	WRITE		MSB							LSB	
		1	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	0
SFP										ACK									ACK
		Address + W/R									Register Address								

Second Step: Read the data from the Register

HOST	START	MSB						LSB	READ										NACK	STOP
		1	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	0	
SFP										ACK	MSB							LSB		
		Address + W/R									Register									

4.2.2.3 Sequential read

Sequential read current Address

HOST		START	MSB						LSB	READ										ACK								NACK
			1	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	1
SFP											ACK	MSB							LSB		MSB							LSB	
			Address + W/R									Data n									Data n+1								

4.2.2.4 Sequential read (With set Address)

Two steps are necessary to sequential read with set Address

First Step: Write address to read

HOST	START	MSB							LSB	WRITE		MSB							LSB	
		1	0	0	0	0		0	0	0	0	X	X	X	X	X	X	X	X	0
SFP											ACK									ACK
			Address + W/R									Register Address								

Second Step: Sequential Read the data from the Register

HOST	START	MSB						LSB	READ										ACK									NACK
		1	0	0	0	0	0	0	1	0	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	1
SFP										ACK	MSB							LSB		MSB							LSB	
		Address + W/R									Data n									Data n+1								

4.2.2.5 Write (Current Address)

Write current Address

HOST	START	MSB							LSB	WRITE		MSB							LSB		MSB							LSB		STOP
		1	0	0	0	0		0	0	0	0	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	0	
SFP											ACK									ACK									ACK	
			Address + W/R									Register									data									

4.2.2.6 Sequential write

Sequential write

HOST	START	MSB						LSB	WRITE		MSB							LSB		MSB							LSB		MSB							LSB		STOP
		1	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	0	
SFP										ACK									ACK									ACK									ACK	
		Address + W/R									Register									Data n									Data n+1									

5 Shipping, Maintenance and Disposal

	Dispose off properly per regulations of the country where end-of-life occurs.

6 Troubleshooting

This chapter contains some frequently asked questions about the FL3X SFP 1000BASE-T1.

1	Effect	
	Solution	

2	Effect	
	Solution	

7 Ordering Information

7.1 FL3X SFP 1000BASE-T1

Product	Description	Ordering number
FL3X SFP 1000BASE-T1	SFP transceiver for 100BASE-T1 and 1000BASE-T1	3-01110A01

7.2 Accessory Parts

Product	Description	Ordering number
Single-SFP-module mPCIe	Single SFP module with mPCIe interface to carry SFP+ transceiver	Please contact *STAR ELECTRONICS GmbH & Co. KG*
4x-SFP-module mPCIe	4x SFP module with mPCIe interface to carry max. 4 SFP+ transceivers	Please contact *STAR ELECTRONICS GmbH & Co. KG*
BusCable 200 2SPE2m 2SPE2m OABR	2 pole SPE male to 2 pole SPE male, 2 m	3-00343H02
BusCable 500 2SPE2m 2SPE2m OABR	2 pole SPE male to 2 pole SPE male, 5 m	3-00343I02
BusCable 250 2SPE2m 9SUBDf OABR	2 pole SPE male to 9 pin D-Sub female connector, 2.5 m	3-00343G02
BusCable 250 2SPE2m 2HMTDf OABR	2 pole SPE male to 2 pole H-MTD female, 2,5m	3-00343N01
BusCable 250 2SPE2m 2HMTDm OABR	2 pole SPE male to 2 pole H-MTD male, 2,5m	3-00343O01
BusCable 250 2SPE2m 2HMTDfw OABR	2 pole SPE male to 2 pole H-MTD female waterproof, 2,5m	3-00343P01
BusCable 250 2SPE2m 2HMTDmw OABR	2 pole SPE male to 2 pole H-MTD male waterproof, 2,5m	3-00343Q01
Customer specific parts		Please contact *STAR ELECTRONICS GmbH & Co. KG*

8 Appendix

8.1 Appendix A: Guideline for handling ESD sensitive Products

- Any tester, equipment, or tool used at any production step or for any manipulation of semi-conductor devices must have its shield connected to ground.
- The product itself and the carrier system of the product respectively must be placed on a conductive table top or covered by an antistatic surface (superficial resistivity equal to or higher than 0.5MΩ/cm²), grounded through a ground cable (conductive cable from protected equipment to ground isolated through a 1MΩ resistor placed in series).
- All manipulation of finished goods has to be made at such a grounded worktable.
- The worktable must be free of all non-antistatic objects.
- An antistatic floor covering grounded through a conductive ground cable (with serial resistor between 0.9MΩ and 1.5MΩ) should be used.
- It is recommended that you wear an antistatic wrist or ankle strap, connected to the antistatic floor covering or to the grounded equipment.
- If no antistatic wrist or ankle strap is worn, touch the surface of the grounded worktable before each manipulation of the ESD sensitive product.
- It is recommended that antistatic gloves or finger coats be worn.
- It is recommended that nylon clothing be avoided while performing any manipulation of parts.

8.2 Appendix B:

8.2.1 Acronyms and Abbreviations

Item	Definition
BD	Bus driver
BP	Bus plus
BM	Bus minus
ECU	Electronic Control Unit
EMC	Electromagnetic Compatibility
ESD	Electro Static Discharge
FR	FlexRay
NC	Not Connected
PCB	Printed Circuit Board
PL	Physical Layer

8.2.2 List of Tables

8.2.3 List of Figures

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