

AXL F BK EC

Axioline F bus coupler for EtherCAT®

Data sheet
8479_en_07

© PHOENIX CONTACT 2014-10-27



1 Description

Valid from firmware version 1.10.

The bus coupler represents the link between an EtherCAT® network and the Axioline F system.

You can connect up to 63 Axioline F devices to an existing EtherCAT® system with the help of the bus coupler.

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

EtherCAT® features

- 2 Ethernet-Ports
- Automatic addressing
- Rotary coding switch for assigning the ID for the “Explicit Device ID” mechanism
- Detail of the station as a modular EtherCAT® device using a Modular Device Profile (MDP)
- Detail of the station as a block device is possible
- Acyclic data communication (mailbox protocols)

- Cyclic (synchronous) data communication
 - Supports the EtherCAT® cycle time of $< 100 \mu\text{s}$
 - Synchronism between EtherCAT® and local bus
 - Distributed clocks (jitter $\ll 1 \mu\text{s}$) for specific data acquisition

Features of Axioline F

- Up to 63 additional Axioline F devices can be connected
- Typical cycle time of the Axioline F local bus is around $10 \mu\text{s}$
- Runtime in the bus coupler is negligible (goes to $0 \mu\text{s}$)
- Firmware can be updated
- Diagnostic and status indicators

Abbreviations used

| | |
|-----|--------------------------------------|
| CoE | CAN application layer over EtherCAT® |
| DC | Distributed clocks |
| FoE | File access over EtherCAT® |



This data sheet is only valid in association with the UM EN AXL F SYS INST user manual.



Make sure you always use the latest documentation.
It can be downloaded from the product at phoenixcontact.net/products.
Here you will also find the current ESI file.

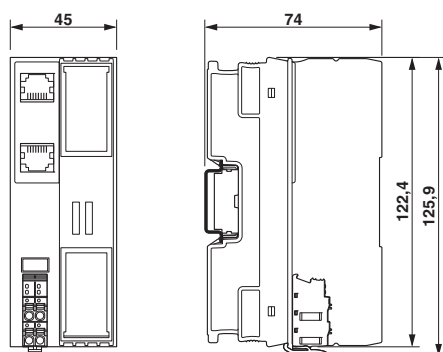
| | | |
|----------|--|----|
| 2 | Table of contents | |
| 1 | Description | 1 |
| 2 | Table of contents | 2 |
| 3 | Ordering data | 3 |
| 4 | Technical data | 4 |
| 5 | Internal circuit diagram | 6 |
| 6 | Connecting EtherCAT® and supply | 7 |
| 7 | Connection example..... | 8 |
| 8 | Configuration via rotary encoding switch | 8 |
| 9 | Local status and diagnostic indicators | 9 |
| 10 | Reset button | 11 |
| 11 | Service interface..... | 11 |
| 12 | Parameter data..... | 12 |
| 13 | Substitute value behavior | 12 |
| 14 | Synchronizing the application..... | 12 |
| 15 | Object dictionary..... | 14 |
| 16 | Process data..... | 22 |
| 17 | Diagnostics strategy | 23 |
| 18 | Firmware update..... | 26 |

3 Ordering data

| Description | Type | Order No. | Pcs. / Pkt. |
|---|-----------------------------------|-----------|-------------|
| Axioline F bus coupler for EtherCAT® (including bus base module and connector) | AXL F BK EC | 2688899 | 1 |
| Accessories | | | |
| Axioline F bus base module for housing type BK (Replacement item) | AXL BS BK | 2701422 | 5 |
| Axioline F short power connector (for e.g., AXL F BK ...) (Replacement item) | AXL CN S/UL | 2701421 | 5 |
| RJ45 connector, shielded, with bend protection sleeve, 2 pieces, gray for straight cables, for assembly on site. For connections that are not crossed, it is recommended that you use the connector set with gray bend protection sleeve. (Connector/Adapter) | FL PLUG RJ45 GR/2 | 2744856 | 1 |
| RJ45 connector, shielded, with bend protection sleeve, 2 pieces, green for crossed cables, for assembly on site. For connections that are not crossed, it is recommended that the connector set with green bend protection sleeves is used. (Connector/Adapter) | FL PLUG RJ45 GN/2 | 2744571 | 1 |
| Crimping pliers, for assembling the RJ45 plugs FL PLUG RJ45..., for assembly on site (Tools) | FL CRIMPTOOL | 2744869 | 1 |
| Zack marker strip for Axioline F (device labeling), in 2 x 20.3 mm pitch, unprinted, 25-section, for individual labeling with B-STIFT 0.8, X-PEN, or CMS-P1-PLOTTER (Marking) | ZB 20,3 AXL UNPRINTED | 0829579 | 25 |
| Zack marker strip, flat, in 10 mm pitch, unprinted, 10-section, for individual labeling with M-PEN 0.8, X-PEN, or CMS-P1-PLOTTER (Marking) | ZBF 10/5,8 AXL UNPRINTED | 0829580 | 50 |
| Insert label, Roll, white, unlabeled, can be labeled with: THERMOMARK ROLL, THERMOMARK X, THERMOMARK S1.1, Mounting type: snapped into marker carrier, Lettering field: 35 x 18.7 mm (Marking) | EMT (35X18,7)R | 0801831 | 1 |
| Documentation | | | |
| User manual, English, Starting up the Axioline F bus coupler for EtherCAT® using TwinCAT® | UM EN AXL F BK EC | - | - |
| User manual, English, Axioline F: System and installation | UM EN AXL F SYS INST | - | - |
| User manual, English, Axioline F: Diagnostic registers, and error messages | UM EN AXL F SYS DIAG | - | - |
| User manual, English, AXL F BK EC bus coupler: Access to PDI objects and startup parameterization | AH EN AXL F BK EC - TUNNEL | - | - |
| Application note, English, Firmware update on the AXL F BK EC bus coupler with TwinCAT® | AH EN FIRMWARE UPDATE AXL F BK EC | - | - |

4 Technical data

Dimensions (nominal sizes in mm)



| | |
|--------------------|---|
| Width | 45 mm |
| Height | 125.9 mm |
| Depth | 74 mm |
| Note on dimensions | The depth is valid when a TH 35-7.5 DIN rail is used (according to EN 60715). |

General data

| | |
|--|---|
| Color | traffic grey A RAL 7042 |
| Weight | 177 g (with connector and bus base module) |
| Ambient temperature (operation) | -25 °C ... 60 °C (Mounting position: wall mounting on horizontal DIN rail) -25 °C ... 55 °C (Mounting position: any) |
| Ambient temperature (storage/transport) | -40 °C ... 85 °C |
| Permissible humidity (operation) | 5 % ... 95 % (non-condensing) |
| Permissible humidity (storage/transport) | 5 % ... 95 % (non-condensing) |
| Air pressure (operation) | 70 kPa ... 106 kPa (up to 3000 m above sea level) |
| Air pressure (storage/transport) | 70 kPa ... 106 kPa (up to 3000 m above sea level) |
| Degree of protection | IP20 |
| Protection class | III, IEC 61140, EN 61140, VDE 0140-1 |
| Mounting position | Any (observe temperature derating) |

Connection data

| | |
|--|---|
| Designation | Axioline F connector |
| Connection method | Push-in technology |
| Conductor cross section solid / stranded | 0.2 mm ² ... 1.5 mm ² / 0.2 mm ² ... 1.5 mm ² |
| Conductor cross section [AWG] | 24 ... 16 |
| Stripping length | 8 mm |

Interface EtherCAT®

| | |
|----------------------|--|
| Number | 2 |
| Connection method | RJ45 socket, auto negotiation and autocrossing |
| Transmission speed | 100 MBit/s (Full duplex) |
| Cycle Time | 100 µs |
| Transmission physics | Ethernet in RJ45 twisted pair |
| Transmission length | max. 100 m |

Interface Axioline F local bus

| | |
|--------------------|-----------------|
| Connection method | Bus base module |
| Transmission speed | 100 MBit/s |

Interface Service

| | |
|-------------------|------------------|
| Number | 1 |
| Connection method | Micro USB type B |

System limits

| | |
|-----------------------------|-------------------------------------|
| Amount of process data | 1024 Byte (for each data direction) |
| Number of supported devices | max. 63 (per station) |



NOTE: Electronics may be damaged when overloaded

Observe the logic current consumption of each device when configuring an Axioline F station. It is specified in every module-specific data sheet. The current consumption can differ depending on the individual module. The permissible number of devices that can be connected therefore depends on the specific station structure.

EtherCAT®

| | |
|--------------------|--|
| Mailbox protocols | CAN application layer over EtherCAT®, File access over EtherCAT® |
| Type of addressing | Auto-increment addressing Fixed position addressing Logical addressing Explicit device ID |
| Specification | ETG.1000 V1.02 |

Supply of the bus coupler

| | |
|--------------------------------------|--|
| Supply of communications power U_L | 24 V DC |
| Maximum permissible voltage range | 19.2 V DC ... 30 V DC (including all tolerances, including ripple) |
| Current supply at U_{Bus} | 2 A |
| Current consumption from U_L | typ. 105 mA (without I/Os and $U_L = 24 V$) max. 570 mA (with 2 A at U_{Bus} for the I/Os and $U_L = 24 V$) |
| Power consumption at U_L | typ. 2.5 W (without I/Os) max. 13.7 W (with 2 A load at U_{Bus} for the I/Os) |



NOTE: Electronics may be damaged when overloaded

Provide external fuses for the 24 V U_L area. The power supply unit must be able to supply four times the nominal current of the external fuse to ensure that it blows in the event of an error.

Error messages to the higher level control or computer system

Emergency messages

Messages via object 10F3_{hex} Diagnosis history

Mechanical tests

| | |
|--|-----|
| Vibration resistance in acc. with EN 60068-2-6/IEC 60068-2-6 | 5g |
| Shock in acc. with EN 60068-2-27/IEC 60068-2-27 | 30g |
| Continuous shock according to EN 60068-2-27/IEC 60068-2-27 | 10g |

Conformance with EMC Directive 2004/108/EC

Noise immunity test in accordance with EN 61000-6-2

| | |
|--|--|
| Electrostatic discharge (ESD) EN 61000-4-2/IEC 61000-4-2 | Criterion B; 6 kV contact discharge, 8 kV air discharge |
| Electromagnetic fields EN 61000-4-3/IEC 61000-4-3 | Criterion A; Field intensity: 10 V/m |
| Fast transients (burst) EN 61000-4-4/IEC 61000-4-4 | Criterion B, 2 kV |
| Transient surge voltage (surge) EN 61000-4-5/IEC 61000-4-5 | Criterion B; DC supply lines: $\pm 0.5 kV/\pm 0.5 kV$ (symmetrical/asymmetrical); field-bus cable shield: $\pm 1 kV$ |

Conformance with EMC Directive 2004/108/EC

Conducted interference EN 61000-4-6/IEC 61000-4-6

Criterion A; Test voltage 10 V

Noise emission test according to EN 61000-6-3

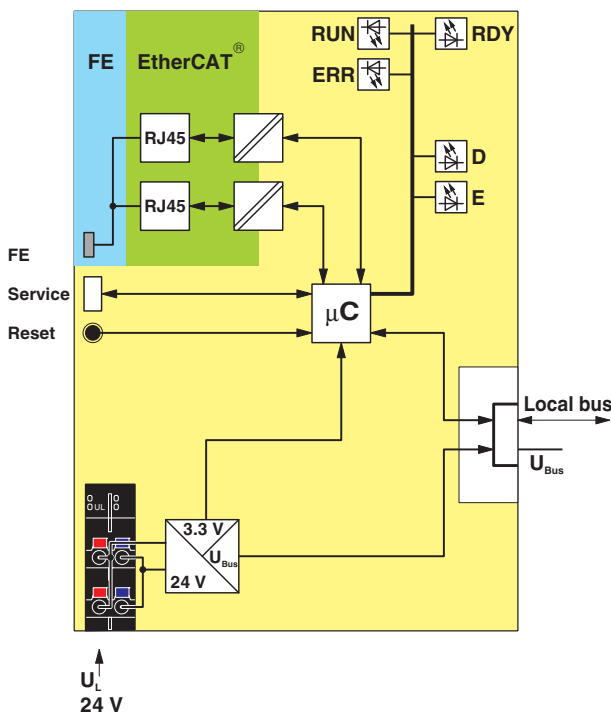
Radio interference properties EN 55022

Class B

Approvals

For the latest approvals, please visit phoenixcontact.net/products.

5 Internal circuit diagram



Key:







- FE Functional earth ground
- Service Service interface
- Reset Reset button
- Local bus Axioline F local bus (hereinafter referred to as local bus)
- RJ45 RJ45 interface
-  RJ45
-  Power supply unit with electrical isolation
-  Microcontroller
-  Power supply unit
-  LED
-  Electrically isolated areas

Figure 1 Internal wiring of the terminal points

6 Connecting EtherCAT® and supply

6.1 Connecting EtherCAT®

Connect EtherCAT® to the bus coupler via an 8-pos. RJ45 connector.

The EtherCAT® connections are directional.

| Designation | Direction | Note |
|-------------|-----------|---------------------------------------|
| X1 | IN | Connecting the cable from the master. |
| X2 | OUT | |

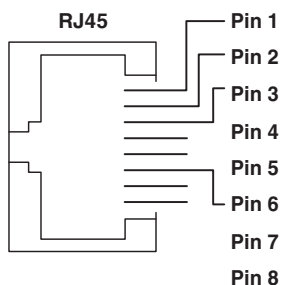


Figure 2 Pin assignment of the Ethernet socket (RJ45)

For the pin assignment, please refer to the following table:

| Pin | Assignment |
|-----|-------------------------|
| 1 | TxD + (transmit data +) |
| 2 | TxD - (transmit data -) |
| 3 | RxD+ (receive data +) |
| 4 | Reserved |
| 5 | Reserved |
| 6 | RxD- (receive data -) |
| 7 | Reserved |
| 8 | Reserved |



Auto crossover
Both Ethernet interfaces are provided with the auto crossover function.



Shielding
The shielding ground of the connected twisted pair cables is electrically connected with the socket. When connecting network segments, avoid ground loops, potential transfers, and voltage equalization currents via the braided shield.



Observe bending radii
The housing dimensions specified under "Dimensions" refer to the bus coupler with I/O connectors without Ethernet connection. When installing the bus coupler in a control box, observe the bending radii of the Ethernet cables and the connectors used (e.g., FL CAT5 FLEX: 30 mm for fixed installation and FL CAT5 HEAVY: 30 mm without outer sheath and 45 mm with outer sheath). If required, use angled RJ45 connectors to maintain these bending radii.

6.2 Connecting the supply voltage - terminal point assignment

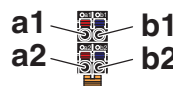


Figure 3 Terminal point assignment

| Terminal point | Color | Assignment |
|-----------------------------|-------|--|
| Supply voltage input | | |
| a1, a2 | Red | 24 V DC (U _L) Supply of the logic voltage (internally jumpered) |
| b1, b2 | Blue | GND Reference potential of the supply voltage (internally jumpered) |

7 Connection example

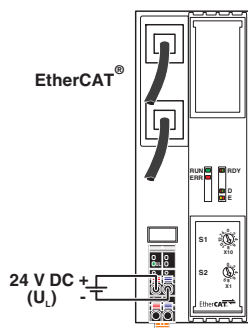


Figure 4 Connection of the cables

8 Configuration via rotary encoding switch

You can configure the address assignment using the rotary coding switch.

After modifying the switch position, restart the bus coupler, as the modification to the switch position does not take effect during operation.

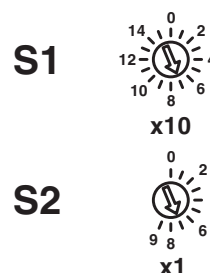


Figure 5 Rotary encoding switch

The code results from the sum of $S1 \times 10$ plus $S2 \times 1$. The image shows code 77 ($7 \times 10 + 7$).

| S1 | S2 | Code | Function |
|----------|---------|------------|-----------------------------|
| 0 ... 15 | 1 ... 9 | 01 ... 159 | Device Identification Value |
| Other | | | Reserved |

8.1 Device identification value

Switch position 01 ... 159

The devices are automatically assigned addresses as standard.

Set the EtherCAT[®] explicit device identification manually with this switch position.

8.2 Reserved/invalid switch position

The device starts with the previous settings, e.g., with the settings that were valid before the device was restarted.

9 Local status and diagnostic indicators

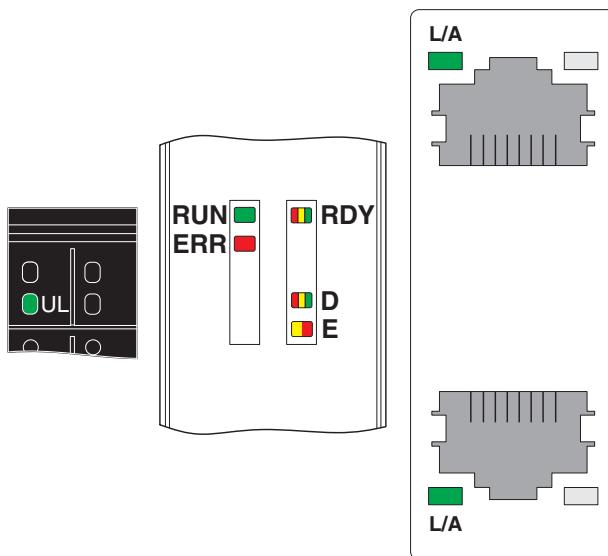


Figure 6 Local status and diagnostic indicators

| Designation | Color | Meaning | State | Description |
|-------------|--------------------------|-------------|--------------------------|--|
| UL | Green | U_{Logic} | ON | Communications power supply present. |
| | | | OFF | Communications power supply not present. |
| RUN | Green | RUN | OFF | Bus coupler in Init state |
| | | | Flashing slowly (2.5 Hz) | Bus coupler in Pre-Operational state |
| | | | Single pulse | 200 ms on, 1000 ms off; bus coupler in Safe-Operational state |
| | | | ON | Bus coupler in Operational state |
| | | | Flashing (10 Hz) | Bus coupler in Bootstrap state |
| | | | ON | Critical internal error |
| ERR | Red | Error | OFF | No error |
| | | | Flashing slowly (2.5 Hz) | Configuration error; a state transition initiated by the master cannot be executed |
| | | | Single pulse | 200 ms on, 1000 ms off; local application error |
| | | | Double pulse | 200 ms on, 200 ms off, 200 ms on, 1000 ms off; watchdog timeout |
| | | | ON | Critical internal error |
| RDY | Green/ yellow/ red | Ready | Green ON | Device is ready for operation. |
| | | | Flashing green/yellow | Communications power undervoltage or surge voltage Overtemperature |
| | | | Yellow ON | Firmware/bus coupler is booting |
| | | | Yellow flashing | Firmware update is being performed. |
| | | | Yellow/red | Firmware update has failed. |
| | | | Red ON | Rotary encoding switches are set to an invalid/reserved position |
| | | | OFF | Device is not ready to operate. |

| Designation | Color | Meaning | State | Description |
|-------------|--------------------------|---------------|--|--|
| D | Green/ yellow/ red | Diagnostics | Green ON | Run: Data exchange; status and data from the higher-level system is transmitted. |
| | | | Green flashing | Active: configuration is active, data exchange with invalid process data, PDI channel can be used. |
| | | | Yellow ON | Ready: Device is ready to operate, no data is exchanged. |
| | | | Yellow flashing | Access from Startup+ in I/O check mode |
| | | | Flashing yellow/red | Bus error during active I/O check |
| | | | Red flashing | Local bus error on startup |
| | | | Red ON | General local bus error |
| | | | | Communication error |
| | | | | Local bus device has been removed or configured device is missing. |
| | | | | Reset at a local bus device |
| | | | Serious device error at a local bus device (local bus device can no longer be reached) | |
| E | Yellow/ red | Error | Yellow ON | I/O warning at a local bus device |
| | | | Red ON | I/O error at a local bus device |
| L/A | Green | Link/Activity | Green ON | Connection present at EC IN/EC OUT. |
| | | | Green flashing | Transmission or reception of Ethernet telegrams at EC IN / EC OUT. |
| | | | OFF | Connection not present at EC IN/EC OUT. |

10 Reset button

The reset button is located beneath the top marking label on the bus coupler.

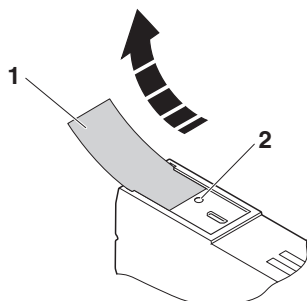


Figure 7 Reset button

- 1 Labeling field
- 2 Reset button

The reset button has the following functions:

- Restarting the bus coupler
- Resetting of the default settings

10.1 Restarting the bus coupler

The bus coupler is restarted when the button is pressed during operation.

The outputs of the station are set to the parameterized substitute values.

The process image of the inputs is not re-read.

10.2 Restoring the default settings

If you wish to restore the default settings, proceed as follows:

- Disconnect the power to the module.
- Press and hold the reset button.
- Switch on the power.
- When the RDY LED flashes red/green, release the button.

During the reset process the RDY LED lights up yellow.

When the bus coupler is fully started and ready to operate, the RDY LED lights up green.

11 Service interface

The service interface is located beneath the top marking field on the bus coupler.

The service interface is used for later applications.

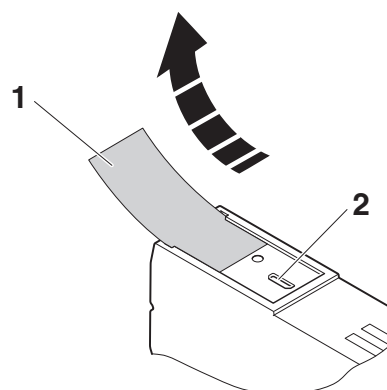


Figure 8 Service interface

- 1 Labeling field
- 2 Service interface

12 Parameter data

The CAN application layer over EtherCAT® (CoE) mailbox protocol is the basis of the Modular Device Profile and enables parameterization of EtherCAT® devices via the object dictionary. The object dictionary is accessed via COE using Service Data Object (SDO) services.

Axioline F modules are parameterized via objects intended for this purpose in the CoE object dictionary. Each Axioline F module has two tunnel objects, via which the parameters can be set (object 20nn_{hex}) and read (object 30nn_{hex}). These tunnel objects can be used to parameterize the Axioline F modules in EtherCAT® system startup via the EtherCAT® engineering functionality of the StartUp or Init commands.

In the event of an error in the local bus, you can parameterize whether the local bus continues to run in the remaining system or whether it enters the stop state.

The objects implemented on the bus coupler are described in the "Object dictionary" section.

13 Substitute value behavior

If EtherCAT® communication fails or an error occurs in the local bus, all Axioline F station outputs are set to the parameterized substitute values.

14 Synchronizing the application

There are two modes for synchronizing the application which can be selected in the engineering system.

1. SM Synchronous
2. DC Synchronous

14.1 SM Synchronous

In this mode, the EtherCAT® communication system and the local bus operate asynchronously. The local bus is in Auto-Run mode and runs with the minimum possible cycle time for the current module configuration.

14.2 DC Synchronous

In this mode, the bus cycle of the local bus is synchronized to the EtherCAT® cycle.

The implemented distributed clock unit is used to synchronize the processes in a temporal manner.



If you want to use the DC Synchronous mode of the bus coupler, make sure that there is at least one module in the Axioline F station that supports local bus synchronization.

If you set DC Synchronous mode and there is no module in the Axioline F station that supports local bus synchronization, the bus coupler refuses the change in state from PRE-OP to SAFE-OP with AL status code 0028_{hex} (SyncMode not supported).

The LEDs indicate this state:

| LED | State | Meaning |
|-------------------------|--------------------------|--|
| Bus coupler | | |
| RUN | Flashing slowly (2.5 Hz) | Bus coupler in Pre-Operational state |
| ERR | Flashing slowly (2.5 Hz) | Configuration error; a state transition initiated by the master cannot be executed |
| D | Green flashing | Active: configuration is active, data exchange with invalid process data, PDI channel can be used. |
| Local bus device | | |
| D | Green flashing | Active |

Implementing DC Synchronous mode

In synchronous operation, the time points for outputting and reading process data from the individual I/O modules of the Axioline F station are synchronized with the higher-level network. This synchronization is by means of EtherCAT® Distributed Clocks (DC).

A requirement for this is that bus-synchronous operation is supported by the module. All modules that do not support bus-synchronous operation continue running asynchronously, as in SM Synchronous mode.

For information on which modules support bus-synchronous operation and the minimum cycle time that is possible, please refer to the module-specific documentation.

In general, with a preselected DC cycle time, only the I/O modules whose update rate (plus local bus cycle time) is less than the DC cycle time are operated synchronously. Only then do these I/O modules supply a new value in every DC cycle.



Object F102_{hex} can be used to specify which modules of the local bus operate bus-synchronously (see “Objects for the status of bus-synchronous operation”).

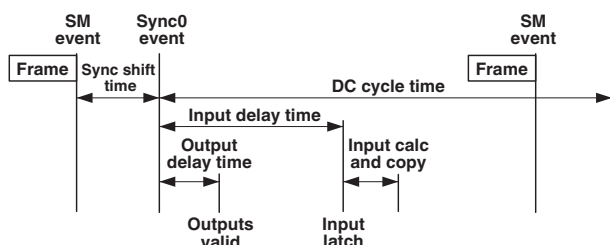


Figure 9 Synchronization model

The figure shows the synchronization model of the Axioline F bus coupler for EtherCAT®.

The so-called “DC Sync0 event” is used for synchronization. After the “Sync0 event” has occurred and a fixed delay time (output delay time) has elapsed, the process data is output. The inputs are likewise read after a fixed delay (input delay time).

The delay times depend on the Axioline F modules used as well as the size of the Axioline F station. They are calculated by the bus coupler during startup and are then constant.



Please observe the following when parameterizing the bus coupler for operation in DC Synchronous mode:

Select “Sync shift time”, i.e., the interval between “SM event” and “Sync0 event”, between 10% and 30% of the cycle time as far as possible.

The shortest EtherCAT® bus cycle must not be shorter than the maximum synchronization time of the modules located in the local bus that can be synchronized.

15 Object dictionary

The bus coupler object dictionary contains objects which can be addressed via SDO services. These are defined in the ETG standards. Objects with a module-specific design are subsequently described in detail.

The objects are addressed using a combination of index and subindex. Subindex 0 lists the number of subindices.

The following applies for the tables below:

| | |
|--------|---|
| Length | Length of the elements in bytes |
| Rights | Access rights |
| R | Read |
| W | Write |
| nn | Module number in an Axioline F station, beginning with 01 |

15.1 CoE standard objects

| Index (hex) | Name | Defined in standard |
|-------------|------------------------------|---------------------|
| 1000 | Device type | ETG.1000.6 |
| 1008 | Device name | ETG.1000.6 |
| 1009 | HardwareVersion | ETG.1000.6 |
| 100A | Software Version | ETG.1000.6 |
| 1018 | Identify | ETG.1000.6 |
| 10F1 | Error settings | ETG.1020 |
| 10F3 | Diagnosis history | ETG.1020 |
| 10F8 | Timestamp | ETG.1020 |
| 1C00 | SyncManager type | ETG.1000.6 |
| 1C12 | RxPDO assign | ETG.1000.6 |
| 1C13 | TxPDO assign | ETG.1000.6 |
| 1C32 | SM output parameter | ETG.1020 |
| 1C33 | SM input parameter | ETG.1020 |
| F000 | Modular device profile | ETG.5000.1 |
| F030 | Configured module ident list | ETG.5000.1 |
| F050 | Detected module ident list | ETG.5000.1 |

ETG.1000.6 Application Layer protocol specification

ETG.1020 EtherCAT[®] Protocol Enhancements

ETG.5000.1 Modular Device Profile Part 1

15.2 Module-specific CoE objects

In the table below, nn is the number of the module that is to be addressed. The numbering starts with 01.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning | |
|-------------|-----------|--------------------------|----------------|---------------------|--------|--|---|
| 6nn0 | 01 | Inputs | Octet string | Depending on module | R | nn module input process data | |
| 7nn0 | 01 | Outputs | Octet string | Depending on module | R | nn module output process data | |
| 16nn | 01 | RxPDO mapping | | 4 | R | Bit 31 ... 16 | Index of the associated input data object (e.g., 6010 _{hex}) |
| | | | | | | Bit 15 ... 8 | Subindex of the associated input data object |
| | | | | | | Bit 7 ... 0 | Subindex length of the associated input data object |
| 1Ann | 01 | TxPDO mapping | | 4 | R | Bit 31 ... 16 | Index of the associated output data object (e.g., 7010 _{hex}) |
| | | | | | | Bit 15 ... 8 | Subindex of the associated output data object |
| | | | | | | Bit 7 ... 0 | Subindex length of the associated output data object |
| 9nn0 | | Module nn identification | Record | | | Identification of module nn | E.g., module 1: 9010 _{hex} , module 2: 9020 _{hex} etc. |
| | 0A | Module ident | Unsigned 32 | 4 | R | Unique number for module identification (connection to device description) | |
| | 0B | Slot | Unsigned 16 | 2 | R | Location of the module in the Axioline F station, beginning with 1 | |
| Ann0 | | DiagState | Record | | | Diagnostics | Read access to PDI object 0018 _{hex} in the Axioline F nn module via the PDI channel |
| | 01 | No | Unsigned 16 | 2 | R | Error number | See data sheet on the module. |
| | 02 | Prio | Unsigned 8 | 1 | R | Priority | See data sheet on the module. |
| | 03 | Channel/group/module | Unsigned 8 | 1 | R | Channel/group/module | See data sheet on the module. |
| | 04 | Code | Unsigned 16 | 2 | R | Error code | See data sheet on the module. |
| | 05 | MoreFollows | Unsigned 8 | 1 | R | More follows | See data sheet on the module. |
| | 06 | Text | Visible String | 51 | R | Text | See data sheet on the module. |

15.3 CoE objects for identification (device rating plate)

PDI objects are stored on each Axioline F module for identification purposes. They contain information about the manufacturer and module and make up the device rating plate.

This information can be accessed using the bus coupler via EtherCAT®.

The following tables describe the detail on the device rating plate on objects in EtherCAT®.

Detail of manufacturer-specific information

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning (code in hex) | |
|-------------|-----------|--------------------------|----------------|--------|--------|---|-------------|
| 9nn1 | | Manufacturer information | | | | Detail of manufacturer-specific information from the PDI objects for identification (device rating plate) | |
| | 01 | VendorName | Visible String | 15 | R | 0001 | Vendor name |
| | 02 | Vendor ID | Visible String | 6 | R | 0002 | Vendor ID |
| | 03 | VendorText | Visible String | 48 | R | 0003 | Vendor text |
| | 04 | VendorURL | Visible String | 29 | R | 0012 | Vendor URL |

Detail of module-specific information

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning (code in hex) | |
|-------------|-----------|-----------------------|----------------|---------|--------|---|--|
| 9nn2 | | Information on module | | | | Detail of module-specific information from the PDI objects for identification (device rating plate) | |
| | 01 | ProductName | Visible String | Max. 58 | R | 0007 | Product name |
| | 02 | Serial number | Visible String | 11 | R | 0008 | Serial number |
| | 03 | ProductText | Visible String | Max. 58 | R | 0009 | Product text |
| | 04 | OrderNumber | Visible String | 8 | R | 000A | Order No. |
| | 05 | HW BuildDate | Visible String | 10 | R | 000B.1 | Hardware version, date of version |
| | 06 | HW Version | Visible String | Max. 40 | R | 000B.2 | Hardware version, version ID |
| | 07 | FW BuildDate | Visible String | 10 | R | 000C.1 | Firmware version, date of version |
| | 08 | FW Version | Visible String | Max. 40 | R | 000C.2 | Firmware version, version ID |
| | 09 | PDI BuildDate | Visible String | 10 | R | 000D.1 | Parameter channel version, date of version |
| | 0A | PDI Version | Visible String | Max. 40 | R | 000D.2 | Parameter channel version, version ID |
| | 0B | DeviceType | Octet string | 8 | R | 0037 | Module identification |

15.4 Objects for access to PDI objects (tunnel objects)

Parameter and diagnostic data as well as other information is transmitted via the PDI channel of the Axioline F station.

You can access the PDI objects of the modules of a station via EtherCAT®. Objects 20nn_{hex} and 30nn_{hex} are used, with which a tunnel method can be implemented.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning | |
|-----------------------|-----------------------|--|--------------|--------|--------|--|---|
| 20nn | | Axioline F module nn PDI write tunnel object | Record | | | Write access to the PDI objects in Axioline F module nn via the PDI channel Mapping to PDI write service (service code 01 _{hex}) at slot nn | |
| | 01 | Command | Octet string | 250 | R/W | Data for the PDI write request | |
| | | | | | | Byte 0 | Subslot |
| | | | | | | Byte 1, 2 | PDI object index |
| | | | | | | Byte 3 | PDI object subindex |
| | | | | | | Byte 4 | Length of the data to be written |
| | | | | | | Byte 5 ... n | User data (max. 245 bytes) |
| | 02 | Status | Unsigned 8 | 1 | R | Status of the last write access | |
| | | | | | | 01 _{hex} | Last access completed successfully (positive confirmation received) |
| | | | | | | 03 _{hex} | Last access not completed successfully (negative confirmation received) |
| | 03 | Response | Octet string | 9 | R | Result of the last write access | |
| | | | | | | Data for PDI write response | |
| | | | | | | Byte 0 | Subslot |
| | | | | | | Byte 1, 2 | PDI object index |
| | | | | | | Byte 3 | PDI object subindex |
| Byte 4 | | | | | | Length (= 0) | |
| Positive confirmation | | | | | | | |
| Byte 5 ... 8 | | | | | | 0 | |
| Negative confirmation | | | | | | | |
| Byte 5 | | | | | | Error class | |
| Byte 6 | Error code | | | | | | |
| Byte 7, 8 | Additional error code | | | | | | |

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning | |
|-----------------------|-----------------------|--------------------------------------|--------------|--------|--------|--|---|
| 30nn | | Axioline F module nn PDI read tunnel | Record | | | Read access to PDI objects in Axioline F module nn via the PDI channel Mapping to PDI read service (service code 00 _{hex}) at slot nn | |
| | 01 | Command | Octet string | 4 | R/W | Data for PDI read request | |
| | | | | | | Byte 0 | Subslot |
| | | | | | | Byte 1, 2 | PDI object index |
| | | | | | | Byte 3 | PDI object subindex |
| | 02 | Status | Unsigned 8 | 1 | R | Status of the last read access | |
| | | | | | | 01 _{hex} | Last access completed successfully (positive confirmation received) |
| | | | | | | 03 _{hex} | Last access not completed successfully (negative confirmation received) |
| | 03 | Response | Octet string | 250 | R | Result of the last read access Data for PDI read response | |
| | | | | | | Byte 0 | Subslot |
| | | | | | | Byte 1, 2 | PDI object index |
| | | | | | | Byte 3 | PDI object subindex |
| | | | | | | Byte 4 | Length |
| | | | | | | Positive confirmation | |
| | | | | | | Byte 5, 6 | 0 |
| Byte 7 ... n | | | | | | Data for PDI read response | |
| Negative confirmation | | | | | | | |
| Byte 5 | | | | | | Error class | |
| Byte 6 | | | | | | Error code | |
| Byte 7, 8 | Additional error code | | | | | | |

15.5 Objects for Axioline F bus diagnostics

CoE object F100_{hex} can be used to request the status information of the Axioline F master.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning |
|-------------|-----------|--------------------------------|-------------|--------|--------|--|
| F100 | | Axioline Bus Coupler Diag Info | Record | | | Read access to diagnostic information of the Axioline F master |
| | 01 | Axioline Bus State | Unsigned 16 | 2 | R | Current state of the Axioline F local bus |
| | 02 | Axioline Error_Code | Unsigned 16 | 2 | R | Error code according to the current bus state |
| | 03 | Axioline Add_Error Info | Unsigned 16 | 2 | R | Additional error information |

“Axioline Bus State” mirrors the diagnostic status register. For more detailed information on this, please refer to the UM EN AXL F SYS DIAG user manual.

“Axioline Error_Code” indicates the error code of module errors. For the meaning of the error code, please refer to the data sheet for the module in question or the UM EN AXL F SYS DIAG user manual.

“Axioline Add_Error Info” indicates the position of the module in question.

The data for object F100_{hex} is additionally provided in the cyclic input data of the Axioline F station (see also “Process data of the bus coupler”).

15.6 Objects for the status of bus-synchronous operation

This object contains information about which local bus modules operate bus-synchronously.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning |
|-------------|-----------|---|------------|--------|--------|--|
| F102 | | Axioline modules used for synchronization | Record | | | During operation in DC Synchronous mode, indicates which Axioline F modules are operated bus-synchronously |
| | 01 | | Unsigned 8 | 1 | R | Position of the modules that are operated bus-synchronously in the local bus starting with 1; n ≤ 63 |
| | ... | | Unsigned 8 | 1 | R | |
| | n | | Unsigned 8 | 1 | R | |

15.7 Objects for bus coupler configuration

The bus coupler has objects which are used for the configuration of the bus coupler. Write access to these objects is only possible in the PREOP state.

The contents of the objects are stored retentively in the bus coupler and are therefore still available after the bus coupler is restarted.

When reset to the default settings, these objects return to their default values.

Object F800_{hex} can be used to configure the byte sequence of the transmitted process data.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning | |
|-------------|-----------|-----------------|-----------|--------|--------|--|-------------------------|
| F800 | | Endian settings | Record | | | Byte sequence setting for a process data length of 16, 32 or 64 bits. The EtherCAT® standard specifies Little Endian format, Axioline F uses Big Endian. | |
| | 01 | Swap Word | Bit | 1 | R | Byte sequence for a process data length of 16 bits | |
| | | | | | | True | Little endian (default) |
| | | | | | | False | Big endian |
| | 02 | Swap DWord | Bit | 2 | R | Byte sequence for a process data length of 32 bits | |
| | | | | | | True | Little endian (default) |
| | | | | | | False | Big endian |
| | 03 | Swap LWord | Bit | 2 | R | Byte sequence for a process data length of 64 bits | |
| | | | | | | True | Little endian (default) |
| | | | | | | False | Big endian |

Object F801_{hex} can be used to specify the bus coupler response in the event of a bus error.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning | |
|-------------|-----------|------------------------------|-----------|--------|--------|---|--|
| F801 | | Leave OP on Axioline busfail | Record | | | Parameterization of the response to an Axioline F bus error | |
| | 00 | | Bit | 0.1 | W | True | In the event of an Axioline F bus error, the bus coupler switches to the SAFEOP ERR state, in addition a diagnosis is entered. |
| | | | | | | False | (default) In the event of an Axioline F bus error, the bus coupler remains in the OP state, only a diagnosis is entered. |

Object F802_{hex} can be used to check the connected module configuration.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning | | | | |
|-------------|---|-------------------------------|-----------|--------|--------|--|------|---|-------|--|
| F802 | | Validate module configuration | Record | | | Validation of the module configuration | | | | |
| | 00 | | Bit | 0.1 | W | <table border="1"> <tr> <td>True</td> <td>(default) During the transition from PREOP to SAFEOP, the bus coupler checks the module configuration.</td> </tr> <tr> <td>False</td> <td>The bus coupler does not check the module configuration.</td> </tr> </table> | True | (default) During the transition from PREOP to SAFEOP, the bus coupler checks the module configuration. | False | The bus coupler does not check the module configuration. |
| True | (default) During the transition from PREOP to SAFEOP, the bus coupler checks the module configuration. | | | | | | | | | |
| False | The bus coupler does not check the module configuration. | | | | | | | | | |

In order for the module configuration to be checked, the master must write object F030hex with the expected module configuration during the state transition from PREOP to SAFEOP. If this is not done, validation is not carried out. When the object is written, it must be done so correctly and consistently. The contents of object F030 are reset on a state transition from SAFEOP to PREOP.

By writing to object F803_{hex}, the cycle time of the Axioline F local bus can be changed.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning |
|-------------|-----------|---------------------------|-------------|--------|--------|--|
| F803 | | Axioline F bus cycle time | Record | | | Current Axioline F bus cycle time in nanoseconds |
| | 00 | | Unsigned 32 | 4 | R | Current bus cycle time in nanoseconds |
| | | | | | W | Changing the bus cycle time 0: sets the minimum possible cycle time |

16 Process data

16.1 Process data of the bus coupler

In addition to the cyclic IN and OUT process data, which is defined by the connected AxioLine F modules, the bus coupler itself has data which is inserted in the cyclic process image. This data has a total length of 8 bytes.

In accordance with the EtherCAT[®] standard, this data appears before the IN process data of the first AxioLine F module in the process image (SyncManager 3 bytes 0 ... 8). The objects for the corresponding PDO mapping can be found in 1AFF_{hex}.

Process data byte 0 and 1 (word 0) are assigned the “New diag message bit” (index 10F3_{hex}, subindex 04) of the “Diagnosis history” object.

Process data words 1 ... 3 contain status and diagnostic information for the AxioLine F bus coupler and can also be called via acyclic services using CoE. They appear in the form of object F100_{hex}.

| Word 0, byte 0 | | | | | | | |
|----------------|---|---|---|---|---|---|-----------------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | | | | | | | New Diagnosis Message |

| Word 0, byte 1 | | | | | | | |
|----------------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | | | | | | | |

| Word 1 | | | |
|--------------------|--|--------|--|
| Byte 3 | | Byte 2 | |
| AxioLine bus state | | | |

| Word 2 | | | |
|---------------------|--|--------|--|
| Byte 5 | | Byte 4 | |
| AxioLine Error_Code | | | |

| Word 3 | | | |
|-------------------------|--|--------|--|
| Byte 7 | | Byte 6 | |
| AxioLine Add_Error Info | | | |

“AxioLine Bus State” mirrors the diagnostic status register. For more detailed information on this, please refer to the UM EN AXL F SYS DIAG user manual.

“AxioLine Error_Code” indicates the error code of module errors. For the meaning of the error code, please refer to the data sheet for the module in question or the UM EN AXL F SYS DIAG user manual.

“AxioLine Add_Error Info” indicates the position of the module in question.

16.2 Process data of the local bus modules

The IN and OUT process data of the modules appear according to their process data description (PDI objects 003B_{hex} and 003C_{hex} on the module).

For mapping, object F800_{hex} can be used to configure whether process data with a length of 16, 32, and 64 bits is to be transmitted in Big Endian format (AxioLine F standard) or in Little Endian format. The configuration is stored retentively in the bus coupler.

17 Diagnostics strategy

17.1 Mechanisms

Different mechanisms are used to diagnose the bus coupler.

| Mechanism | Diagnostics | |
|---|--|---|
| EtherCAT [®] state machine | EtherCAT [®] system diagnostics | |
| EtherCAT [®] hardware watchdog | | |
| Emergency messages | Errors are indicated to the master | |
| Diagnostic objects in the CoE object dictionary | Advanced diagnostics, e.g., of I/O errors | |
| | 10F1 | Error settings |
| | F100 | Axioline Bus Coupler Diag Info |
| | F101 | Axioline bus error counters |
| | F102 | Axioline modules used for synchronization |
| | F802 | Validate module configuration |
| Diagnosis history object | 16 diagnostic messages could not be stored | |
| | 10F3 | Diagnosis history |

17.2 EtherCAT[®] state machine

An error is indicated as follows:

- Error bit in the “AL status” register is set.
- An error code is written in the “AL status code” register by the slave.

The following codes are implemented on the bus coupler:

| AL Status Code [hex] | Meaning |
|----------------------|--|
| 0000 | No error: There is no error. |
| 0011 | Invalid requested state change: The state change requested is invalid. |
| 0012 | Unknown requested state: The state requested does not exist. |
| 0016 | Invalid mailbox configuration: Error when configuring the SyncManager for mailbox communication. |
| 001B | SyncManager watchdog: The hardware watchdog which monitors the SyncManager process data has expired. |
| 001D | Invalid output configuration: Error in the SyncManager configuration for output process data. |
| 001E | Invalid input configuration: Error in the SyncManager configuration for input process data. |
| 0028 | SyncMode not supported: There is no module in the Axioline F station that supports local bus synchronization. |

17.3 Emergency messages

Emergency messages are an unverified service based on CoE. As such, all errors can be indicated to the master by the slave, taking the form of messages which are specified in ETG.1000.6.

Detail of Axioline F bus and I/O errors on a CoE emergency message:

| | | | | | | |
|-----------------------|---------------------|-------------------|-------------|------------|----------|--------|
| CoE emergency message | 2 bytes | 1 byte | 5 bytes | | | |
| | Error code | Error reg | Data | | | |
| Axioline F bus errors | 2 bytes | 1 byte | 2 bytes | 2 bytes | 1 byte | |
| | 1000 _{hex} | 80 _{hex} | Slot number | Error code | | 0 |
| Axioline F I/O errors | 2 bytes | 1 byte | 2 bytes | 1 byte | 1 byte | 1 byte |
| | Error code | 80 _{hex} | Slot number | Location | Priority | 0 |

CoE emergency message

| Error code (hex) | Meaning |
|------------------|---------------------------------------|
| 00xx | Error reset or no error |
| 10xx | Generic error |
| 20xx | Current |
| 21xx | Current, device input side |
| 22xx | Current inside the device |
| 23xx | Current, device output side |
| 30xx | Voltage |
| 31xx | Mains voltage |
| 32xx | Voltage inside the device |
| 33xx | Output voltage |
| 40xx | Temperature |
| 41xx | Ambient temperature |
| 42xx | Device temperature |
| 50xx | Device hardware |
| 60xx | Device software |
| 61xx | Internal software |
| 62xx | User software |
| 63xx | Data set |
| 70xx | Additional modules |
| 80xx | Monitoring |
| 81xx | Communication |
| 82xx | Protocol error |
| 8210 | PDO not processed due to length error |
| 8220 | PDO length exceeded |
| 90xx | External error |
| A0xx | ESM transition error |
| F0xx | Additional functions |
| FFxx | Device specific |

The errors which could occur in the Axioline F system are separated into two groups with different message designs.

Axioline F I/O errors

For the error codes for Axioline F I/O errors, please refer to the data sheets for the I/O modules.

Axioline F bus errors

The error codes for Axioline F bus errors have the emergency error code 1000_{hex} (generic error) as standard.

The Axioline F error code is displayed in the “Emergency message” data area.



For the meaning of the error codes for the Axioline F bus errors and Axioline F I/O errors, please refer to the AXL F SYS DIAG user manual.

17.4 Diagnosis history 10F3_{hex}

The object 10F3_{hex} is implemented as a ring memory in Overwrite mode. The last 16 diagnostic messages are always stored; older messages are deleted.

The error codes of the Axioline F bus and I/O errors are stored in the object's diagnostic messages.

The following table shows the design of a diagnostic message from the Axioline F bus coupler for EtherCAT® as well as detailing specific Axioline F information.

| Index (hex) | Sub-index | Object name | Data type | Length | Rights | Meaning |
|-------------|-----------|-----------------------------|-------------|--------|--------|--|
| 10F3 | | Diagnosis history | Record | | | Diagnostic statistics |
| | 01 | Maximum messages | Unsigned 8 | 1 | R | Maximum number of messages |
| | 02 | Newest message | Unsigned 8 | 1 | R | Newest message |
| | 03 | Newest acknowledged message | Unsigned 8 | 1 | R/W | Newest acknowledged message |
| | 04 | New message available | Bit | 0.1 | R | New message present |
| | 05 | Flags | Unsigned 16 | 2 | R/W | Setting for the behavior of the object. See ETG.1020 |

17.5 Diagnostic objects in the CoE object dictionary

The Diagnosis History Object enables a diagnosis station-wide.

For module-specific diagnostics, the module diagnostics objects (PDI object 0018_{hex}) are displayed in the CoE object dictionary of the bus coupler (CoE objects A000_{hex} to A3F0_{hex}).

18 Firmware update

It is possible to carry out a firmware update via EtherCAT®.

The File Access over EtherCAT® (FoE) mechanism is used for this, which is provided via your engineering system.

For detailed instructions for the firmware update with Twin-CAT®, please refer to application note AH EN FIRMWARE UPDATE AXL F BK EC.

The application note can be downloaded at phoenixcontact.net/products.

Changes in the firmware versions

Firmware 1.10

Full implementation of DC Synchronous mode

Addition of the following CoE objects (hex):

| | |
|------|---|
| 10F1 | Error settings |
| 10F8 | Timestamp |
| F100 | Axioline Bus Coupler Diag Info |
| F101 | Axioline bus error counters |
| F102 | Axioline modules used for synchronization |
| F800 | Endian settings |
| F801 | Leave OP on Axioline busfail |
| F802 | Validate module configuration |
| F803 | Axioline F bus cycle time |

Modified object

| | |
|------|-------------------|
| 10F3 | Diagnosis history |
|------|-------------------|

The data for object F100_{hex} is additionally provided in the cyclic input data of the Axioline F station (see also “Process data of the bus coupler”).



NOTE: Access to incorrect data when using a project that has not been adapted

The data of object F100_{hex} is mapped in the process image before the IN process data of the first Axioline F module.

If an existing project is used without adapting it, you will access incorrect data due to the shift of the IN process data.

Therefore, adapt an existing project accordingly.



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.