

# AXL E EC DI8 DO4 2A M12 6M

**Axioline E EtherCAT® device, metal housing,  
8 inputs, 4 outputs, 24 V DC,  
M12 fast connection technology**



Data sheet  
8538\_en\_05

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## 1 Description

The Axioline E device is designed for use within an EtherCAT® network. It is used to acquire and output digital signals.

The device is designed for use in systems manufacturing. It is suitable for use without a control cabinet under harsh industrial conditions. The Axioline E device can be used on tool platforms, directly on welding robots or in conveying technology, for example.

### EtherCAT® features

- Connection to EtherCAT® network using M12 connectors (D-coded)
- Transmission speed 100 Mbps
- 2 Ethernet-Ports
- Automatic addressing
- Identification:
- Rotary coding switch for assigning the ID for the "Explicit Device ID" mechanism
- Configured Second Station Alias

- Hot Connect
- Acyclic data communication (CoE and FoE mailbox protocols)
- Supports the EtherCAT® cycle time of min. 100 µs
- Supports distributed clocks (jitter << 1 µs)
- Specification: ETG.1000 V1.02
- Device description by means of ESI
- Firmware can be updated

### Axioline E features

- Connection of digital sensors and actuators to M12 connectors (A-coded)
- Diagnostic and status indicators
- Short-circuit and overload protection of the sensor supply
- IP65/67 degree of protection



This data sheet is only valid in association with the corresponding user manual. Make sure you always use the latest documentation. It can be downloaded via the product at [phoenixcontact.net/products](https://phoenixcontact.net/products).



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



Firmware v2.2.x.x is required on the device for the functions described in the data sheet. If necessary, update the firmware (see section "Firmware update").

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### 3 Ordering data

| Description   | Type                       | Order No. | Pcs./Pkt. |
|---|----------------------------|-----------|-----------|
| Axioline E, Digital I/O device, EtherCAT®, M12 fast connection technology, digital inputs: 8, 24 V DC, connection method: 4-wire, digital outputs: 4, 24 V DC, 2 A, connection method: 3-wire, metal housing, degree of protection: IP65/67 | AXL E EC DI8 DO4 2A M12 6M | 2701529   | 1         |

| Accessories  | Type          | Order No. | Pcs./Pkt. |
|--|---------------|-----------|-----------|
| An M12 screw plug for the unoccupied M12 sockets of the sensor/actuator cable, boxes and flush-type connectors (Protection and sealing elements)   | PROT-M12      | 1680539   | 5         |
| Mounting plate for Axioline E metal devices (Mounting)   | AXL E MP 60   | 2701761   | 1         |
| Snap-in markers, Sheet, white, unlabeled, can be labeled with: THERMOMARK PRIME, THERMOMARK CARD, BLUEMARK ID, BLUEMARK ID COLOR, BLUEMARK CLED, TOPMARK NEO, TOPMARK LASER, mounting type: snapped into marker carrier, lettering field size: 7 x 10 mm (Marking) | UCT-EM (7X10) | 0830765   | 10        |

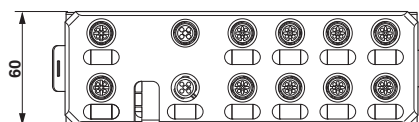
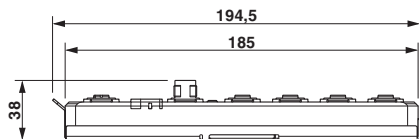
| Documentation  | Type                           | Order No. | Pcs. / Pkt. |
|--|--------------------------------|-----------|-------------|
| User manual, English:<br>Axioline E: system and installation   | UM EN AXL E SYS INST           | -         | -           |
| Application note, English:<br>Updating the firmware of Axioline E-EtherCAT® devices with TwinCAT®                              | AH EN FIRMWARE UPDATE AXL E EC | -         | -           |
| Application note, English:<br>Measures to protect network-capable devices with Ethernet connection against unauthorized access | AH EN INDUSTRIAL SECURITY      | -         | -           |
| Application note, English:<br>Wiring of Axioline E devices   | AH EN AXL E CABLE / WIRING     | -         | -           |

#### Additional ordering data

For additional accessories, visit [phoenixcontact.net/products](http://phoenixcontact.net/products).

## 4 Technical data

### Dimensions (nominal sizes in mm)



|                    |   |
|--------------------|---|
| Width              | 60 mm   |
| Height             | 185 mm  |
| Depth              | 38 mm   |
| Note on dimensions | The height is 194.5 mm including the mounting plate.<br>With fixing clips pulled out, the height is 212 mm.<br>The depth is 38 mm including the mounting plate<br>(30.5 mm without the mounting plate). |

### General data

|                                 |                  |
|---------------------------------|------------------|
| Housing material                | Zinc die-cast    |
| Weight                          | 750 g            |
| Ambient temperature (operation) | -25 °C ... 60 °C |



#### CAUTION: Risk of burns

If the device is used at an ambient temperature above 50°C, the contact temperature of metal surfaces may exceed 70°C.

|  |   |
|--|---|
| Ambient temperature (storage/transport)  | -25 °C ... 85 °C                                  |
| Permissible humidity (operation)         | 5 % ... 95 %                                      |
| Permissible humidity (storage/transport) | 5 % ... 95 %                                      |
| 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                     | IP65/IP67   |
| Protection class                         | III, IEC 61140, EN 61140, VDE 0140-1              |

### Connection data

|                   |               |
|-------------------|---------------|
| Connection method | M12 connector |
|-------------------|---------------|

### Interface: EtherCAT®

|                               |                                |
|-------------------------------|--------------------------------|
| Number                        | 2                              |
| Designation connection point  | Copper cable                   |
| Connection method             | M12 fast connection technology |
| Note on the connection method | D-coded                        |

**Interface: EtherCAT®**

|                     |                                  |
|---------------------|----------------------------------|
| Number of positions | 4                                |
| Transmission speed  | 100 Mbps (with auto negotiation) |
| Cycle Time          | < 100 µs                         |

**EtherCAT®**

|                    |  |
|--------------------|--|
| Equipment type     | EtherCAT® slave  |
| Mailbox protocols  | CANopen® over EtherCAT®, File access over EtherCAT®                          |
| Type of addressing | Auto-increment addressing<br>Fixed position addressing<br>Logical addressing |
| Specification      | ETG.1000 V1.02   |

**Supply: Module electronics and sensors (U<sub>S</sub>)**

|                              |  |
|------------------------------|--|
| Connection method            | M12 connector (T-coded)  |
| Number of positions          | 4  |
| Supply voltage               | 24 V DC  |
| Nominal supply voltage range | 18 V DC ... 31.2 V DC (including all tolerances, including ripple) |
| Current consumption          | typ. 140 mA ±15 % (at 24 V DC)<br>max. 12 A                        |

**Supply: Actuators (U<sub>A</sub>)**

|                              |  |
|------------------------------|--|
| Connection method            | M12 connector (T-coded)  |
| Number of positions          | 4  |
| Supply voltage               | 24 V DC  |
| Nominal supply voltage range | 18 V DC ... 31.2 V DC (including all tolerances, including ripple) |
| Current consumption          | typ. 30 mA ±15 % (at 24 V DC)<br>max. 12 A                         |

**Digital inputs**

|  |                                   |
|--|-----------------------------------|
| Number of inputs   | 8                                 |
| Connection method  | M12 connector, double occupancy   |
| Connection technology  | 4-wire                            |
| Description of the input                                       | EN 61131-2 types 1 and 3          |
| Nominal input voltage  | 24 V DC                           |
| Nominal input current  | typ. 3 A                          |
| Sensor current per channel                                     | typ. 75 mA (from U <sub>S</sub> ) |
| Total sensor current   | max. 0.6 A (per device)           |
| Input voltage range "0" signal                                 | 0 V DC ... 5 V DC                 |
| Input voltage range "1" signal                                 | 11 V DC ... 30 V DC               |
| Input filter time  | < 1000 µs                         |
| Permissible conductor length to the sensor                     | 30 m                              |
| Overload protection, short-circuit protection of sensor supply | yes                               |

| <b>Digital outputs</b>                                    |  |
|---|--|
| Number of outputs   | 4  |
| Connection method   | M12 connector, (A-coded)   |
| Connection technology                                     | 3-wire   |
| Nominal output voltage                                    | 24 V DC (from voltage $U_A$ )  |
| Output voltage range                                      | 18 V DC ... 31.2 V DC  |
| Maximum output current per channel                        | 2 A  |
| Nominal load, ohmic                                       | 48 W (48 $\Omega$ , with nominal voltage)  |
| Nominal load, inductive                                   | 48 VA (1.2 H, 48 $\Omega$ , with nominal voltage)  |
| Signal delay  | max. 150 $\mu$ s (when switched on)<br>max. 200 $\mu$ s (when switched off)                        |
| Switching frequency                                       | max. 5500 per second (with at least 50 mA load current)<br>max. 1 per second (with inductive load) |
| Limitation of the voltage induced on circuit interruption | -28 V ... -17 V  |
| Output voltage when switched off                          | max. 1 V   |
| Output current when switched off                          | max. 20 $\mu$ A  |
| Behavior with overload                                    | Auto restart   |
| Reverse voltage resistance to short pulses                | Reverse voltage proof  |
| Overcurrent shut-down                                     | min. 2.2 A   |
| Overload protection, short-circuit protection of outputs  | yes  |

| <b>Electrical isolation/isolation of the voltage areas</b>  |                         |
|---|-------------------------|
| <b>Test section</b>   | <b>Test voltage</b>     |
| 24 V supply (communications power and sensor supply, digital inputs)/bus connection (Ethernet 1)                    | 500 V AC, 50 Hz, 1 min. |
| 24 V supply (communications power and sensor supply, digital inputs)/bus connection (Ethernet 2)                    | 500 V AC, 50 Hz, 1 min. |
| 24 V supply (communications power and sensor supply, digital inputs)/FE   | 500 V AC, 50 Hz, 1 min. |
| Bus connection (Ethernet 1)/FE  | 500 V AC, 50 Hz, 1 min. |
| Bus connection (Ethernet 2)/FE  | 500 V AC, 50 Hz, 1 min. |
| Bus connection (Ethernet 1)/bus connection (Ethernet 2)   | 500 V AC, 50 Hz, 1 min. |
| 24 V supply (actuator supply, digital outputs)/24 V supply (communications power and sensor supply, digital inputs) | 500 V AC, 50 Hz, 1 min. |
| 24 V supply (actuator supply, digital outputs)/bus connection (Ethernet 1)  | 500 V AC, 50 Hz, 1 min. |
| 24 V supply (actuator supply, digital outputs)/bus connection (Ethernet 2)  | 500 V AC, 50 Hz, 1 min. |
| 24 V supply (actuator supply, digital outputs)/FE   | 500 V AC, 50 Hz, 1 min. |

**Mechanical tests**

|   |  |
|---|--|
| Vibration resistance according to<br>EN 60068-2-6/IEC 60068-2-6 | 5g                                       |
| Shock according to<br>EN 60068-2-27/IEC 60068-2-27              | 30g, 11 ms period, half-sine shock pulse |
| Continuous shock according to<br>EN 60068-2-27/IEC 60068-2-27   | 10g                                      |

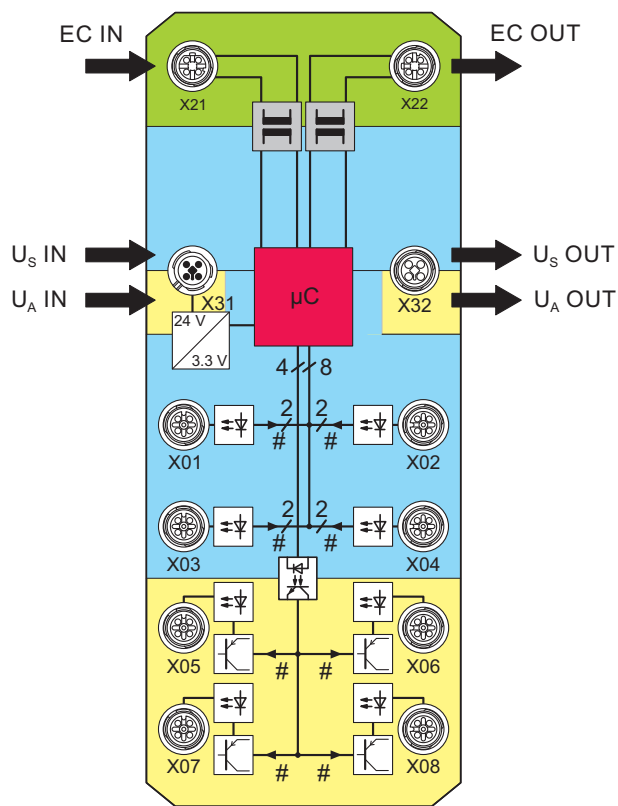
**Conformance with EMC Directive 2014/30/EU****Noise immunity test in accordance with EN 61000-6-2**

|   |  |
|---|--|
| Electrostatic discharge (ESD)<br>EN 61000-4-2/IEC 61000-4-2 | Criterion B, 6 kV contact discharge, 8 kV air discharge                                |
| Electromagnetic fields<br>EN 61000-4-3/IEC 61000-4-3        | Criterion A, Field intensity: 10 V/m   |
| Fast transients (burst)<br>EN 61000-4-4/IEC 61000-4-4       | Criterion B, 2 kV  |
| Transient overvoltage (surge)<br>EN 61000-4-5/IEC 61000-4-5 | Criterion B, DC supply lines: $\pm 0.5$ kV/ $\pm 0.5$ kV<br>(symmetrical/asymmetrical) |
| Conducted interference EN 61000-4-6/IEC 61000-4-6           | Criterion A; Test voltage 10 V   |
| <b>Noise emission test as per EN 61000-6-4</b>              | Class A  |

**Approvals**

For the latest approvals, please visit [phoenixcontact.net/products](http://phoenixcontact.net/products).

### 5 Internal circuit diagram



Key:

Green area: Network  
 Blue area:  $U_S$   
 Yellow area:  $U_A$









-  Transmitter with electrical isolation
-  Power supply unit with electrical isolation
-  Microcontroller
-  Digital input
-  Digital output
-  LED
-  Optocoupler
-  Transistor

Figure 1 Internal wiring of connections

### 6 Abbreviations used

- CoE CAN application protocol over EtherCAT®
- FoE File access over EtherCAT®
- EoE Ethernet over EtherCAT®
- AoE ADS (Automation Device Specification) over EtherCAT®

## 7 Pin assignment

### 7.1 EtherCAT® and power supply connection

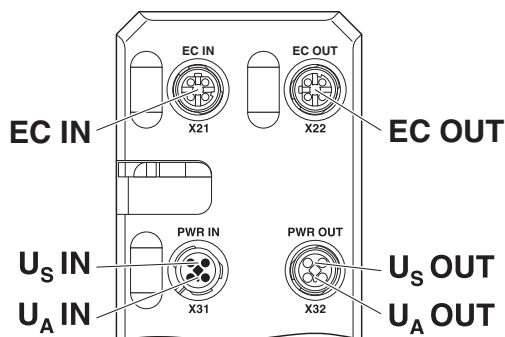


Figure 2 Connections for EtherCAT® and voltage supply

| Designation              | Meaning                                 |
|--------------------------|---|
| EC IN (X21)              | EtherCAT® IN                            |
| EC OUT (X22)             | EtherCAT® OUT                           |
| U <sub>S</sub> IN (X31)  | Power supply IN (logic and sensors)     |
| U <sub>A</sub> IN (X31)  | Power supply IN (actuators)             |
| U <sub>S</sub> OUT (X32) | Power supply OUT for additional devices |
| U <sub>A</sub> OUT (X32) | Power supply OUT for additional devices |



Ground the device by means of the mounting screws of the fixing clips or the mounting plate or the DIN rail.

### 7.2 EtherCAT® pin assignment

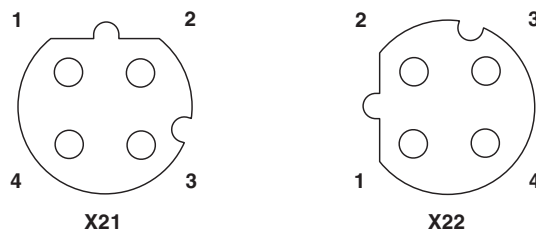


Figure 3 Pin assignment, D-coded

| Pin | EC IN (X21) | EC OUT (X22) |
|-----|-------------|--------------|
| 1   | TX+         | TX+          |
| 2   | RX+         | RX+          |
| 3   | TX-         | TX-          |
| 4   | RX-         | RX-          |



The shield is connected to FE in the device.



The thread is used for additional shielding.

### 7.3 Pin assignment of the power supply U<sub>S</sub>/U<sub>A</sub>

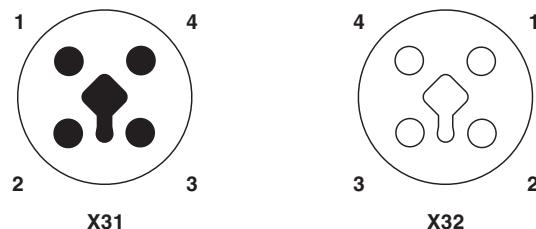


Figure 4 Pin assignment of the power supply, T-coded

| Pin | IN                         | OUT                        | Conductor colors |
|-----|----------------------------|----------------------------|------------------|
| 1   | +24 V DC (U <sub>S</sub> ) | +24 V DC (U <sub>S</sub> ) | Brown            |
| 2   | GND (U <sub>A</sub> )      | GND (U <sub>A</sub> )      | White            |
| 3   | GND (U <sub>S</sub> )      | GND (U <sub>S</sub> )      | Blue             |
| 4   | +24 V DC (U <sub>A</sub> ) | +24 V DC (U <sub>A</sub> ) | Black            |

7.4 Connecting inputs and outputs

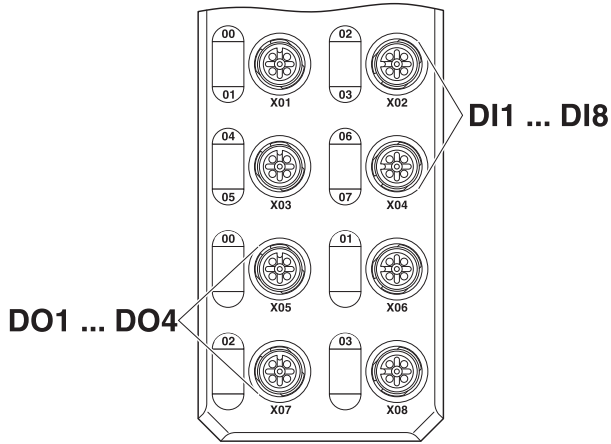


Figure 5 Input and output connections

| Designation               | Meaning         |
|---------------------------|-----------------|
| DI1 ... DI8 (X01 ... X04) | Inputs 1 ... 8  |
| DO1 ... DO4 (X05 ... X08) | Outputs 1 ... 4 |

7.5 Pin assignment of the inputs and outputs

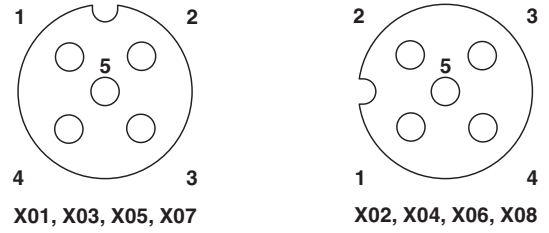


Figure 6 Pin assignment of the inputs and outputs, A-coded

| Pin | Input socket       | Output socket     |
|-----|--------------------|-------------------|
| 1   | +24 V DC ( $U_S$ ) | Not used          |
| 2   | Input 2, 4, 6, 8   | Not used          |
| 3   | GND                | GND               |
| 4   | Input 1, 3, 5, 7   | Output 1, 2, 3, 4 |
| 5   | FE                 | FE                |

## 8 Connection example

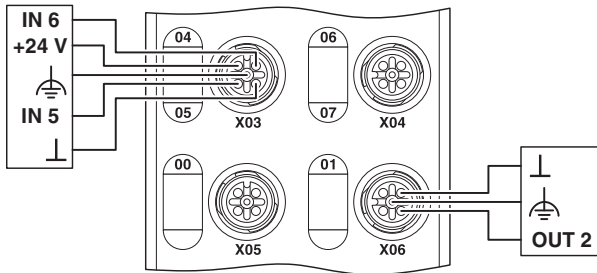


Figure 7 Example of connection of sensors and actuators

## 9 Connection notes



**NOTE: Data corruption or loss**

Implement the FE connection using mounting screws, in order to ensure immunity to interference.



**NOTE: Device damage**

To ensure IP65/67 degree of protection, cover unused sockets with protective caps.



**NOTE: Damage to the electronics**

Only supply the sensors with the voltage  $U_S$  provided at the terminal points.



**NOTE: Damage to the electronics**

Observe the correct polarity of the supply voltages  $U_S$  and  $U_A$  in order to prevent damage to the device.



**NOTE: Malfunction**

When connecting the sensors and actuators, observe the assignment of the connections to the EtherCAT<sup>®</sup> input and output data.



Secure the device to a level surface or to a profile. Do not use this device to bridge gaps, in order to prevent forces being transmitted via the device.



Use standard M5 screws with toothed lock washer and self-locking nuts. Observe the maximum torque of the screws.

## 10 Identification

In the case of EtherCAT® devices, a distinction is made between address assignment and identification.

**Addresses** are used for direct communication between the EtherCAT® master and the relevant slave. In doing so, the master assigns each slave a unique 16-bit address.

**Identifications** are used to uniquely identify a slave in an EtherCAT® network.

Identifications for AXL E EC devices are:

- Device Identification Value
- Configured Second Station Alias

### 10.1 Configuration via rotary encoding switch (Device Identification Value)

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

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

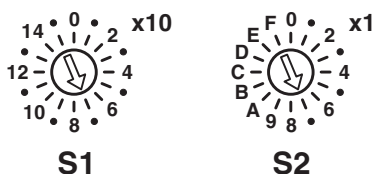


Figure 8 Rotary encoding switch

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

| S1       | S2       | Code       | Function                    |
|----------|----------|------------|-----------------------------|
| 0 ... 15 | 0 ... 09 | 01 ... 159 | Device Identification Value |
| Other    |          |            | Reserved                    |

#### Switch position 01 ... 159

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



The device is ready for operation after powering up, as soon as the RDY LED lights up green.  
A connection to the device cannot be established in the firmware startup phase.  
As soon as the RDY LED lights up green, a new switch position can be selected on the rotary coding switch and the device can be restarted.

#### Reserved/invalid switch position

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

#### 10.2 Configured Second Station Alias

For information on how to use the “Configured Second Station Alias” identification, please consult your configuration software.

#### 10.3 Hot Connect

The Hot Connect functionality allows preconfigured sections to be removed from or added to the data traffic before the start or during operation of the system. This can be carried out by disconnecting/connecting the communication line or by switching a device on/off, for example. This is called “flexible topology” or “Hot Connect”.

## 11 Local status and diagnostic indicators

### 11.1 Indicators for EtherCAT® and power supply

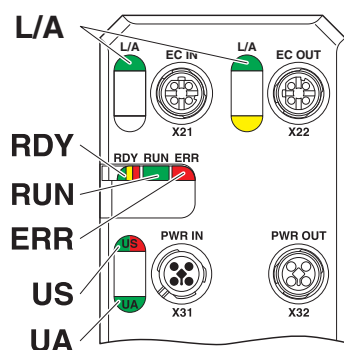


Figure 9 Indicators for EtherCAT® and power supply

| Designation | Color                              | Meaning       | State                        | Description   |
|-------------|------------------------------------|---------------|------------------------------|---|
| L/A         | Green                              | Link/Activity | Green on                     | Connection is present at EC IN/EC OUT.  |
|             |                                    |               | Off                          | Connection is not present at EC IN/EC OUT.  |
| RDY         | Green/<br>yellow/<br>red           | Ready         | Green on                     | Device is ready for operation.  |
|             |                                    |               | Yellow flashing              | Firmware update is being performed.   |
|             |                                    |               | Flashing<br>green/<br>yellow | Over- or undervoltage at $U_S$  |
|             |                                    |               |                              | Temperature of the device is in the critical area.                                    |
|             |                                    |               |                              | Failure of the actuator supply $U_A$  |
|             |                                    |               |                              | Surge voltage/undervoltage of the actuator supply $U_A$                               |
|             |                                    |               | Red on                       | Rotary encoding switches are set to an invalid/reserved position.                     |
| Off         | Device is not ready for operation. |               |                              |   |
| RUN         | Green                              | RUN           | Off                          | Device is in the Init state.  |
|             |                                    |               | Flashing slowly (2.5 Hz)     | Device is in the Pre-Operational state.   |
|             |                                    |               | Single pulse                 | 200 ms on, 1000 ms off; device is in the Safe-Operational state.                      |
|             |                                    |               | Green on                     | Device is in the Operational state.   |
|             |                                    |               | Flashing (10 Hz)             | Device is in the Bootstrap state.   |
| ERR         | Red                                | Error         | On                           | Critical error in the device  |
|             |                                    |               | Flashing slowly (2.5 Hz)     | Configuration error, a state transition initiated by the master cannot be executed.   |
|             |                                    |               | Single pulse                 | Local application error   |
|             |                                    |               | Double pulse                 | Watchdog timeout. The EtherCAT® watchdog for monitoring the process data has elapsed. |
|             |                                    |               | Off                          | No error  |

| Designation | Color         | Meaning                        | State    | Description  |
|-------------|---------------|--------------------------------|----------|--|
| US          | Green/<br>red | <b>U</b> <sub>Sensors</sub>    | Green on | Communications power/sensor voltage is present.                |
|             |               |                                | Off      | Communications power/sensor voltage is not present or too low. |
|             |               |                                | Red on   | Sensor voltage overload  |
| UA          | Green         | <b>U</b> <sub>Actuatores</sub> | On       | Actuator voltage is present.                                   |
|             |               |                                | Off      | Actuator voltage is not present.                               |

11.2 Input and output indicators

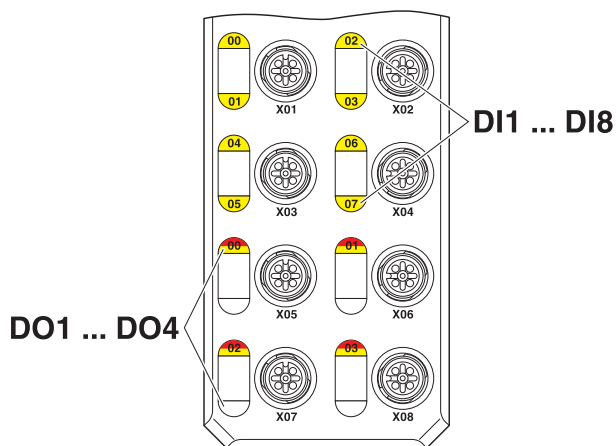


Figure 10 Input and output indicators

| Designation | Color      | Meaning               | State     | Description                              |
|-------------|------------|-----------------------|-----------|--|
| 00 ... 07   | Yellow     | Status of the inputs  | On        | Input is set.                            |
|             |            |                       | Off       | Input is not set.                        |
| 00 ... 03   | Yellow/red | Status of the outputs | Yellow on | Output is set.                           |
|             |            |                       | Red on    | Output is short circuited or overloaded. |
|             |            |                       | Off       | Output is not set.                       |



The numbering of the LEDs is as follows: the first number specifies the byte, the second number specifies the bit.

## 12 EtherCAT®

The CAN application layer over EtherCAT® (CoE) mailbox protocol is the basis of the 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.

The objects implemented on the device are described in the “EtherCAT® object dictionary” section.

## 13 EtherCAT® object dictionary (CoE objects)

The device object dictionary contains objects which can be addressed via SDO services. The device supports standard objects and manufacturer-specific objects. The standard objects are described in ETG.1000.6 (Application Layer Protocol Specification). The manufacturer-specific objects are listed below.

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

| Index (hex)                        | Object name  | Data type   | Rights |
|------------------------------------|--|-------------|--------|
| <b>Device Identity Objects (1)</b> |  |             |        |
| 1000                               | Device Type  | UINT32      | RO     |
| 1008                               | Manufacturer Device Name   | STRING      | RO     |
| 1009                               | Manufacturer Hardware Version  | STRING      | RO     |
| 100A                               | Manufacturer Software Version  | STRING      | RO     |
| 1018                               | Identity   | IDENTITY    | RO     |
| <b>Sync Manager Objects</b>        |  |             |        |
| 1C00                               | Sync Manager Communication Type                                      | UINT8       | RO     |
| 1C10                               | Sync Manager 0 PDO Assignment (Mail out control register)            | UINT16      | RO     |
| 1C11                               | Sync Manager 1 PDO Assignment (Mail out control register)            | UINT16      | RO     |
| 1C12                               | Sync Manager 2 PDO Assignment (Process data output control register) | UINT16      | RO     |
| 1C13                               | Sync Manager 3 PDO Assignment (Process data input control register)  | UINT16      | RO     |
| 1C32                               | Sync Parameter of SM2  | SYNC_PAR    | RO     |
| 1C33                               | Sync Parameter of SM3  | SYNC_PAR    | RO     |
| <b>Device Identity Objects (2)</b> |  |             |        |
| 2001                               | Component Name   | STRING      | RO     |
| 2002                               | Vendor Name  | STRING      | RO     |
| 2003                               | Vendor URL   | STRING      | RO     |
| 2004                               | Order Number   | STRING      | RO     |
| 2005                               | Manufacturing Date   | STRING      | RO     |
| 2006                               | QS Date  | STRING      | RO     |
| 2007                               | Installation Location  | STRING      | R/W    |
| 2008                               | Operational Hours  | UINT32      | RO     |
| 2009                               | Service Date   | STRING      | RO     |
| 200A                               | Equipment Ident  | STRING      | R/W    |
| <b>Safe State Objects</b>          |  |             |        |
| 2100                               | Safe State Mode  | UINT8       | R/W    |
| 2102                               | Safe State Values  | UINT8       | R/W    |
| <b>Reset Objects</b>               |  |             |        |
| 2F00                               | Reset to Factory Settings  | UINT8       | R/W    |
| <b>PDO Mapping Objects</b>         |  |             |        |
| 1600                               | RxPDO Mapping Digital Outputs  | PDO Mapping | RO     |
| 1A00                               | TxPDO Mapping Digital Inputs   | PDO Mapping | RO     |
| 1A01                               | RxPDO Mapping IO Status  | PDO Mapping | RO     |
| 4000                               | Digital Inputs   | UINT8       | RO     |
| 4001                               | IO Status  | UINT32      | RO     |
| 5000                               | Digital Outputs  | UINT8       | RO     |

### 13.1 Device Identity Object (device rating plate)

The device has objects for identification. They contain information about the manufacturer and device and make up the device rating plate.

The objects that form the device rating plate are described below.

| Index (hex) | Subindex | Object name                   | Data type | Rights | Meaning/value  |
|-------------|----------|-------------------------------|-----------|--------|--|
| 1000        | -        | Device Type                   | UINT32    | RO     | 00000000 <sub>hex</sub> (0)  |
| 1008        | -        | Manufacturer Device Name      | STRING    | RO     | Product name   |
| 1009        | -        | Manufacturer Hardware Version | STRING    | RO     | Hardware version, version ID   |
| 100A        | -        | Manufacturer software version | STRING    | RO     | Firmware version, version ID   |
| 1018        | Identity |                               |           |        |  |
|             | 00       | Number of Entries             | UINT8     | RO     | Number of object subindices  |
|             | 01       | Vendor ID                     | UINT32    | RO     | 00000084 <sub>hex</sub> (132)  |
|             | 02       | Product Code                  | UINT32    | RO     | Order No.  |
|             | 03       | Revision Number               | UINT32    | RO     | Device revision, version ID  |
|             | 04       | Serial number                 | UINT32    | RO     | Serial number  |
| 2001        | -        | Component Name                | STRING    | RO     | Digital EtherCAT <sup>®</sup> I/O devices                              |
| 2002        | -        | Vendor Name                   | STRING    | RO     | Phoenix Contact  |
| 2003        | -        | Vendor URL                    | STRING    | RO     | www.phoenixcontact.com   |
| 2004        | -        | Order Number                  | STRING    | RO     | Order No.  |
| 2005        | -        | Manufacturing Date            | STRING    | RO     | YYYY-MM-DD T HH:MM:SS Z<br>(date and time of manufacture)              |
| 2006        | -        | QS Date                       | STRING    | RO     | YYYY-MM-DD T HH:MM:SS Z<br>(date and time of final manufacturing test) |
| 2007        | -        | Installation Location         | STRING    | R/W    | User-defined device installation location                              |
| 2008        | -        | Operational Hours             | UINT32    | RO     | Operating hours counter  |
| 2009        | -        | Service Date                  | STRING    | RO     | YYYY-MM-DD T HH:MM:SS Z<br>(date and time of a service)                |
| 200A        | -        | Equipment Ident               | STRING    | R/W    | User-defined device name   |

### 13.2 Sync Manager Objects

The EtherCAT<sup>®</sup> protocol provides two types of communication, these are:

- Mailbox mode
- and buffered mode.

The mailbox mode is used for acyclic transmission of commands to slaves. If a slave receives a mailbox message, this must be processed first before anything else can be processed.

In contrast, the buffered mode enables the master and slave to use a shared data area. The master and slave can read or write data in this area (buffer) at any time.

The sync manager manages the data exchange for both processes to ensure there are no data collisions.

A detailed description of all registers can be found in the "EtherCAT<sup>®</sup> Slave Controller" description from the EtherCAT<sup>®</sup> user organization ([www.EtherCAT.org](http://www.EtherCAT.org)).

### 13.3 Safe State Objects (substitute value behaviors)

The device monitors the cyclic communication to the EtherCAT® master (controller) and responds to potential errors, such as communication abortions/failures.

If EtherCAT® communication fails (an EtherCAT® state other than operational), all device outputs are set to the parameterized substitute values.

| Index (hex) | Subindex                 | Object name                         | Data type | Rights | Meaning/value   |
|-------------|--------------------------|-------------------------------------|-----------|--------|---|
| 2100        | -                        | Safe State Mode                     | UINT8     | R/W    | <b>00<sub>hex</sub> = Set all outputs to "0" (default).</b>   |
|             |                          |                                     |           |        | 01 <sub>hex</sub> = Set all outputs to "1".   |
|             |                          |                                     |           |        | 02 <sub>hex</sub> = All outputs keep the last value.  |
|             |                          |                                     |           |        | 03 <sub>hex</sub> = Set substitute value sample (-> object 2102 is active.)   |
| 2102        | <b>Safe State Values</b> |                                     |           |        |   |
|             | 00                       | Number of Entries                   | UINT8     | RO     | Number of object subindices   |
|             | 01                       | Failsafe Values output bits 0 ... 3 | UINT8     | R/W    | Substitute value sample (for all outputs) is only valid if 03 <sub>hex</sub> (substitute value sample) was previously set in object 2100. |



The CoE objects for configuring the substitute value behavior can only be set in the EtherCAT® "pre-operational" state.

### 13.4 Reset Object

The device can be reset to its factory settings.

To do so, use the following object:

| Index (hex) | Subindex | Object name               | Data type | Rights | Meaning/value  |
|-------------|----------|---------------------------|-----------|--------|--|
| 2F00        | -        | Reset to Factory Settings | UINT8     | R/W    | <b>00<sub>hex</sub> = Normal operation (default)</b> |
|             |          |                           |           |        | 01 <sub>hex</sub> = Reset device                     |
|             |          |                           |           |        | Other = Reserved                                     |



The reset is carried out once the device is restarted.

### 13.5 PDO Mapping Objects

In addition to the cyclical I/O process data, the device has other status and diagnostic data which is included in the cyclic process image. This data has a total length of 4 bytes (object 1A01<sub>hex</sub>).

#### PDO Mapping Register

| Index (hex)     | Subindex                             | Object name       | Data type | Rights | Meaning/value                                 |   |
|-----------------|--------------------------------------|-------------------|-----------|--------|---|---|
| 1600            | <b>RxPDO Mapping Digital Outputs</b> |                   |           |        |   |   |
|                 | 00                                   | Number of Entries | UINT8     | RO     | 02 <sub>hex</sub> (2)                         |   |
|                 | 01                                   |                   | UINT32    | RO     | Bit 31 ... bit 16                             | Index of the output data object (5000 <sub>hex</sub> )  |
|                 |                                      |                   |           |        | Bit 15 ... bit 8                              | Subindex of the output data object (01 <sub>hex</sub> ) |
| Bit 7 ... bit 0 |                                      |                   |           |        | Subindex length of the output data object (8) |   |
| 1A00            | <b>TxPDO Mapping Digital Inputs</b>  |                   |           |        |   |   |
|                 | 00                                   | Number of Entries | UINT8     | RO     | 02 <sub>hex</sub> (2)                         |   |
|                 | 01                                   |                   | UINT32    | RO     | Bit 31 ... bit 16                             | Index of the input data object (4000 <sub>hex</sub> )   |
|                 |                                      |                   |           |        | Bit 15 ... bit 8                              | Subindex of the input data object (01 <sub>hex</sub> )  |
| Bit 7 ... bit 0 |                                      |                   |           |        | Subindex length of the input data object (8)  |   |
| 1A01            | <b>TxPDO Mapping IO Status</b>       |                   |           |        |   |   |
|                 | 00                                   |                   | UINT8     | RO     | 01 <sub>hex</sub> (1)                         |   |
|                 | 01                                   |                   | UINT32    | RO     | Bit 31 ... bit 16                             | Index of the IO status object (4001 <sub>hex</sub> )    |
|                 |                                      |                   |           |        | Bit 15 ... bit 8                              | Subindex of the IO status object (01 <sub>hex</sub> )   |
| Bit 7 ... bit 0 |                                      |                   |           |        | Subindex length of the IO status object (32)  |   |

#### PDO Register

| Index (hex) | Subindex               | Object name                     | Data type | Rights | Meaning/value         |   |
|-------------|------------------------|---------------------------------|-----------|--------|-----------------------|---|
| 4000        | <b>Digital Inputs</b>  |                                 |           |        |                       |   |
|             | 00                     | Number of Entries               | UINT8     | RO     | 02 <sub>hex</sub> (2) |   |
|             | 01                     | Digital Inputs bit 0 ... bit 7  | UINT8     | RO     | Bit 7 ... bit 0       | Digital input 8 (X04.2) ... digital input 1 (X01.4)   |
| 4001        | <b>IO Status</b>       |                                 |           |        |                       |   |
|             | 00                     | Number of Entries               | UINT8     | RO     | 01 <sub>hex</sub> (1) |   |
|             | 01                     |                                 | UINT32    | RO     | Bit 31 ... bit 16     | Reserved  |
|             |                        |                                 |           |        | Bit 5                 | Undervoltage of sensor supply                         |
|             |                        |                                 |           |        | Bit 4                 | Surge voltage of sensor supply                        |
|             |                        |                                 |           |        | Bit 3                 | Undervoltage of actuator supply                       |
|             |                        |                                 |           |        | Bit 2                 | Short circuit/overload of the actuator supply         |
|             |                        |                                 |           |        | Bit 1                 | Output surge voltage                                  |
| Bit 0       |                        |                                 |           |        | Output short circuit  |   |
| 5000        | <b>Digital Outputs</b> |                                 |           |        |                       |   |
|             | 00                     | Number of Entries               | UINT8     | RO     | 02 <sub>hex</sub> (2) |   |
|             | 01                     | Digital Outputs bit 0 ... bit 3 | UINT8     | RO     | Bit 3 ... bit 0       | Digital output 4 (X08.4) ... Digital output 1 (X05.4) |

## 14 Process data

### 14.1 TxPDO Mapping Digital Inputs

| Input process data |     |    |     |    |     |    |     |    |
|--------------------|-----|----|-----|----|-----|----|-----|----|
| Byte               | 0   |    |     |    |     |    |     |    |
| Bit                | 7   | 6  | 5   | 4  | 3   | 2  | 1   | 0  |
| IN                 | 07  | 06 | 05  | 04 | 03  | 02 | 01  | 00 |
| Connection         | X04 |    | X03 |    | X02 |    | X01 |    |
| Pin                | 2   | 4  | 2   | 4  | 2   | 4  | 2   | 4  |
| DI                 | 8   | 7  | 6   | 5  | 4   | 3  | 2   | 1  |

Key:

Bit: Process data assignment

IN: LED marking

DI: Device input

### 14.2 RxPDO Mapping Digital Outputs

| Output process data |   |   |   |   |     |     |     |     |
|---------------------|---|---|---|---|-----|-----|-----|-----|
| Byte                | 0 |   |   |   |     |     |     |     |
| Bit                 | 7 | 6 | 5 | 4 | 3   | 2   | 1   | 0   |
| OUT                 | - | - | - | - | 4   | 3   | 2   | 1   |
| Connection          | - | - | - | - | X08 | X07 | X06 | X05 |
| Pin                 | - | - | - | - | 4   | 4   | 4   | 4   |
| DO                  | - | - | - | - | 4   | 3   | 2   | 1   |

Key:

Bit: Process data assignment

OUT: LED marking

DO: Device output

### 14.3 TxPDO Mapping IO Status

| Bit 31 ... bit 6 | Bit 5  | Bit 4    | Bit 3                             | Bit 2    | Bit 1    | Bit 0                  |
|------------------|--|----------|-----------------------------------|----------|----------|------------------------|
| Reserved         | Supply of the module electronics and sensors ( $U_S$ ) |          | Supply of the actuators ( $U_A$ ) |          | Outputs  |                        |
|                  | Undervoltage   | Overload | Undervoltage/Short-circuit        | Reserved | Reserved | Overload/Short-circuit |

## 15 EtherCAT® State Machine: AL Objects

The device has a state machine, called the EtherCAT® State Machine (ESM).

The EtherCAT® master sends state change requests to the AL Control Register of the slave. The slave displays the current state in the AL Status Register and make additional error codes available in the AL status code register in the event of errors.

### 15.1 AL Control and AL Status Register

If the master writes to the AL Control Register, then the corresponding state transition is triggered in the device state machine by the slave. The AL Status Register reflects the current state of the slave.

| Index (hex)      | Object name                       | Data type | Rights | Meaning/value    |   |
|------------------|-----------------------------------|-----------|--------|------------------|---|
| 0120             | AL Control                        | UINT16    | R/W    | Bit 0 ... bit 3  | <b>State (AL Status requested by master)</b>                                      |
|                  |                                   |           |        |                  | 01 <sub>hex</sub> = Init (I)  |
|                  |                                   |           |        |                  | 02 <sub>hex</sub> = Pre-Operational (P)   |
|                  |                                   |           |        |                  | 03 <sub>hex</sub> = Bootstrap (B)   |
|                  |                                   |           |        |                  | 04 <sub>hex</sub> = Safe-Operational (S)  |
|                  |                                   |           |        |                  | 08 <sub>hex</sub> = Operational (O)   |
|                  |                                   |           |        | Bit 4            | <b>Acknowledge (Master acknowledge bit)</b>                                       |
|                  |                                   |           |        |                  | 00 <sub>hex</sub> = Parameter Change of the AL Status Register will be unchanged. |
|                  |                                   |           |        |                  | 01 <sub>hex</sub> = Parameter Change of the AL Status Register will be reset.     |
|                  |                                   |           |        | Bit 5 ... bit 7  | Reserved  |
|                  | 00 <sub>hex</sub> = Shall be zero |           |        |                  |   |
| 0130             | AL Status                         | UINT16    | RO     | Bit 0 ... bit 3  | <b>AL Status (AL Status requested by master)</b>                                  |
|                  |                                   |           |        |                  | 01 <sub>hex</sub> = Init (I)  |
|                  |                                   |           |        |                  | 02 <sub>hex</sub> = Pre-Operational (P)   |
|                  |                                   |           |        |                  | 03 <sub>hex</sub> = Bootstrap (B)   |
|                  |                                   |           |        |                  | 04 <sub>hex</sub> = Safe-Operational (S)  |
|                  |                                   |           |        |                  | 08 <sub>hex</sub> = Operational (O)   |
|                  |                                   |           |        | Bit 4            | <b>Change (Error flag, Master acknowledge bit)</b>                                |
|                  |                                   |           |        |                  | 00 <sub>hex</sub> = Confirmation of state in AL Control Register                  |
|                  |                                   |           |        |                  | 01 <sub>hex</sub> = A change has happened or an error occurred.                   |
|                  |                                   |           |        | Bit 5 ... bit 7  | Reserved  |
| Bit 8 ... bit 15 | <b>Application specific</b>       |           |        |                  |   |
|                  | Reserved                          |           |        |                  |   |
| 0134             | AL Status Code                    | UINT16    | RO     | Bit 0 ... bit 15 | All Status Code (send by slave)   |

## 16 Diagnostic strategy

### 16.1 Mechanisms

Different mechanisms are used to diagnose the devices.

| Mechanism  | Diagnosis                                      |
|--|--|
| EtherCAT <sup>®</sup> state machine                | EtherCAT <sup>®</sup> -<br>system diagnostics  |
| EtherCAT <sup>®</sup> hardware<br>watchdog         |  |
| Emergency messages                                 | Signaling errors to the<br>master              |
| Diagnostic objects in the<br>CoE object dictionary | Extended diagnosis, e. g.<br>peripheral errors |
| 4001 <sub>hex</sub>                                | IO status value*                               |

\* see chapter 14 „Process data“ ,  
table TxPDO Mapping IO Status

### 16.2 AL Status Code Register

If the state transition requested by the master is not possible, then the slave sets an error flag in the AL Status Register (bit 4) and writes an error code to the AL Status Code Register.

The AL status code is mapped in the EtherCAT<sup>®</sup> master CoE objects A0XX. XX stands for the slave address.

The following codes are implemented on the device:

| AL status code (hex) | Bedeutung                                   |
|----------------------|---|
| 0000                 | No error                                    |
| 0001                 | Unspecified error                           |
| 0011                 | Invalid requested state change              |
| 0012                 | Unknown requested state                     |
| 0015                 | Invalid Mailbox Configuration for Bootstrap |
| 0016                 | Invalid mailbox configuration               |
| 0017                 | Invalid Sync Manager Configuration          |
| 001A                 | Multiple synchronisation error:             |
| 001B                 | SyncManager watchdog                        |
| 001D                 | Invalid output configuration                |
| 001E                 | Invalid input configuration                 |
| 002B                 | No valid inputs and outputs                 |
| 002C                 | Fatal synch error                           |
| 0032                 | PLL error                                   |

| AL Status (AL Status request by master)  |
|--|
| 01 <sub>hex</sub> = Init (I)             |
| 02 <sub>hex</sub> = Pre-Operational (P)  |
| 03 <sub>hex</sub> = Bootstrap (B)        |
| 04 <sub>hex</sub> = Safe-Operational (S) |
| 08 <sub>hex</sub> = Operational (O)      |

## 17 Emergency messages

Emergency messages are messages that are actively sent from the device to the EtherCAT<sup>®</sup> master if certain events/problems occur. They are an unverified service which is based on CoE. In this way, all errors can be indicated to the master by the slave. This takes the form of messages which are specified in ETG.1000.6.

An emergency message is structured as follows:

| CoE emergency message |                |                 |
|-----------------------|----------------|-----------------|
| 2 bytes               | 1 byte         | 5 bytes         |
| Error code            | Error register | Diagnostic data |

The following emergency messages are supported by the device:

| Error code (hex) | Error register                 | Diagnostic data (hex) | Localization | Meaning                                   |
|------------------|--------------------------------|-----------------------|--------------|---|
| 2301             | Bit 2 set (02 <sub>dec</sub> ) | 00, 07, 01, 00, 00    | Device level | Overload/Short-circuit of an output       |
| 3001             | Bit 2 set (02 <sub>dec</sub> ) | 00, 01, 00, 00, 00    | Device level | Overload U <sub>S</sub>                   |
| 3002             | Bit 2 set (02 <sub>dec</sub> ) | 00, 02, 00, 00, 00    | Device level | Overvoltage U <sub>S</sub>                |
| 3003             | Bit 2 set (02 <sub>dec</sub> ) | 00, 03, 00, 00, 00    | Device level | Undervoltage U <sub>S</sub>               |
| 3004             | Bit 2 set (02 <sub>dec</sub> ) | 00, 04, 00, 00, 00    | Device level | Overvoltage U <sub>A</sub>                |
| 3005             | Bit 2 set (02 <sub>dec</sub> ) | 00, 05, 00, 00, 00    | Device level | Undervoltage/Short-circuit U <sub>A</sub> |
| 4001             | Bit 4 set (08 <sub>dec</sub> ) | 00, 06, 00, 00, 00    | Device level | Overtemperature device                    |



The device sends emergency messages for an incoming and outgoing error. Once the problem has been solved, an emergency message with the error code 0000<sub>hex</sub> (reset error) is sent by the slave. The value of the corresponding bit in the error register is then 0. The diagnostic data value does not change.

### 17.1 Diagnostic messages

The following diagnostic messages are indicated by the EtherCAT<sup>®</sup> device:

| Diagnostic messages                       | Status bit process data | Network-specific diagnostic mapping (Emergency message) |
|---|-------------------------|---|
| Overtemperature device                    | -                       | Yes   |
| Undervoltage U <sub>S</sub>               | Bit 5                   | Yes   |
| Overload U <sub>S</sub>                   | Bit 4                   | Yes   |
| Overvoltage U <sub>S</sub>                | -                       | Yes   |
| Undervoltage/Short-circuit U <sub>A</sub> | Bit 3                   | Yes   |
| Overvoltage U <sub>A</sub>                | -                       | Yes   |
| Overload/Short-circuit of an output       | Bit 0                   | Yes   |



Channel diagnostics are always reported in groups of 4. The LED status can be found in chapter 11.

## 18 Synchronization

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

- SM Synchronous (process data update when an SM event occurs)
- DM Synchronous (process data update when a SYNC0 event occurs)

### 18.1 SM Synchronous

In this mode, the EtherCAT® communication system and the I/Os operate asynchronously. The I/Os are in Auto-Run mode and run with the minimum cycle time possible for the current device configuration. This mode is set by default in the device.

### 18.2 DC Synchronous

In this mode, the I/Os are synchronized with the EtherCAT® cycle.

The implemented Distributed Clocks unit is used for the time synchronization of processes.

In synchronous operation, the time points for outputting and reading the process data of the individual I/Os are synchronized with the higher-level network. EtherCAT® Distributed Clocks (DC) are used for this synchronization.

Figure 11 Synchronization model

The figure shows the synchronization model of the EtherCAT® device. The “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).



In order to activate DC Synchronous mode in TwinCAT®, it must be selected in the DC tab under Operation Mode and the slave must be started up again by means of the EtherCAT® master. TwinCAT® should be operated in Run mode.

## 19 Restoring the default settings

The following options are available for restoring the default settings:

- Write the value “1” to CoE object 2F00<sub>hex</sub>. After powering on again, the device is in the default settings.

## 20 Firmware started

Once you have connected the power, the firmware is started.

After completion of the boot process of the firmware, the RDY LED lights up green or flashes depending on the bus status.

## 21 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 TwinCAT®, please refer to application note AH EN FIRMWARE UPDATE AXL E EC.

The application note can be downloaded at [phoenixcontact.net/products](http://phoenixcontact.net/products).

## 22 Monitoring/substitute value behavior

The device monitors the connection for network communication.

In the event of a connection timeout, the device switches its outputs to the previously configured safe state.

For further information, please refer to “Safe State Objects”.

## 23 Device description file (ESI)

In the case of EtherCAT®, a device description file is required for various configuration tools.

This file is called EtherCAT® Slave Information (ESI).

A single ESI file is provided for all Axioline E EtherCAT® devices.

## 24 Data format

EtherCAT® uses Little Endian format. All variables, parameters, and data in this document are in Little Endian format (Intel), i.e., LSB/MSB.



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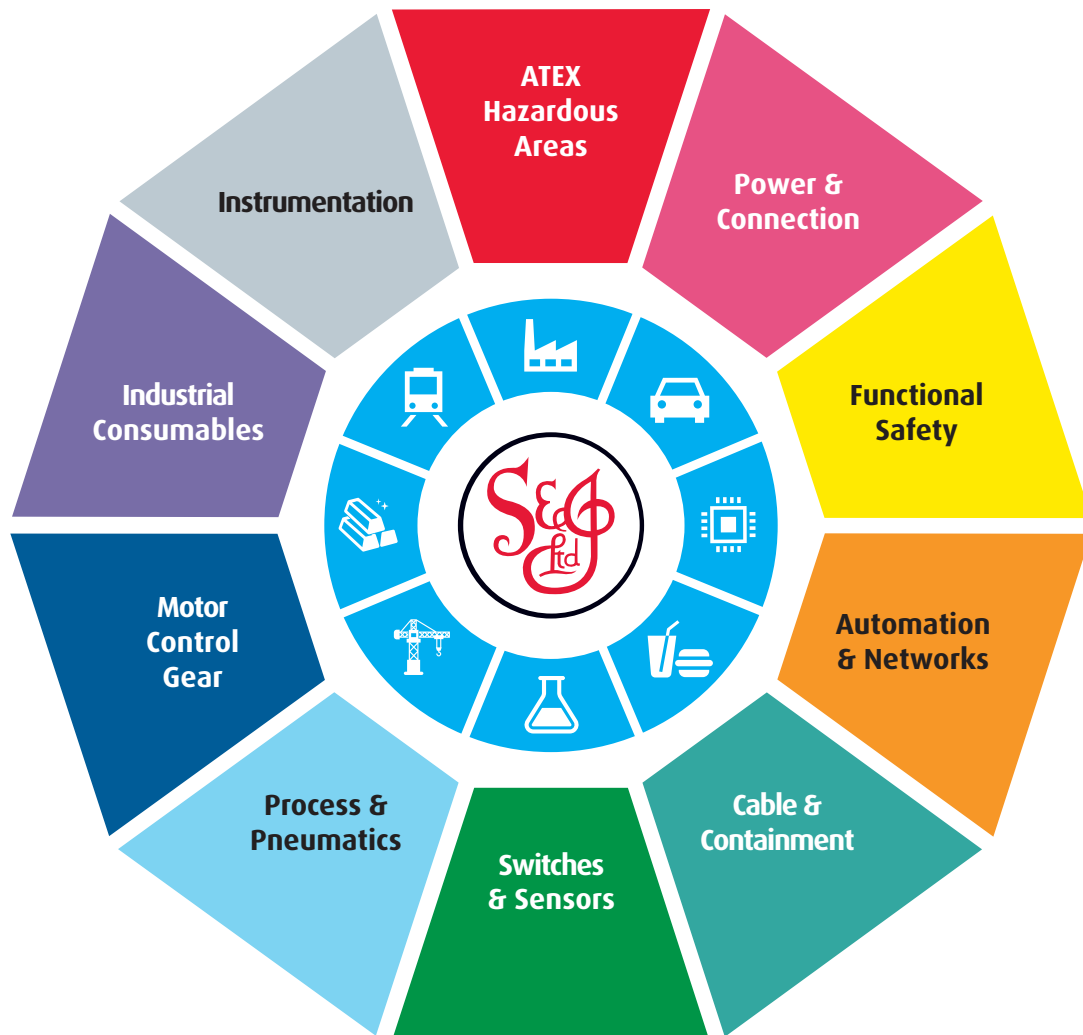
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