# EC4-ENC2IT

# EtherCAT SubDevice Slim Two-Channel Incremental Encoder Counter Module

**with Compare Trigger and Latch Function**

# User Manual

**(Version 1.0)**




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Revision

| Revision | Date | Description | Author |
|---|---|---|---|
| 1 | 09.12.2024 | Initial version | Eric Chen |

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# 1 Product Overview




## 1.1 Introduction

The EC4-ENC2IT is an incremental encoding counter module with two independent high-speed counter channels, based on a slim design. It reads the pulse train generated by an incremental encoder and can be used in positioning feedback applications. Each channel has two counter (A, B) and one index inputs (C). The inputs can either be single-ended or differential signals. Three counting modes are supported: clockwise/counterclockwise, pulse/direction and quadrant counting mode. Each 32-bit counter and the trigger level (falling/rising edge) can be configured and set by software.

In addition to the encoder inputs A, B and C, a latch input I for each encoder channel allows the latching and clearing of each encoder counter. Encoder position are latched at rising and falling input signal and are recorded in two separate register.

The EC4-ENC2IT supports position compare: Each encoder channel is equipped with one 32-bit compare register which compares the counter position with the compare position and generates an output signal when the counter reaches or passes the compare position. The compare function supports single, auto incremental and array position compare. The pulse width of the compare output can be set.

Each channel has got an adjustable input signal filter for filtering out electrical noises.



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## 1.2 Technical Data

Features:

- On the fly processing: EtherCAT
- Two channels, 32-bit incremental encoder counters
- Encoder counting mode: CW/CCW , Pulse/Direction, A/B Phase
- Maximum counting rate: 4 MHz
- Encoder Input: A, B, C differential or single-ended signals
- Two digital input for counter latching
- Two digital output for position compare signal trigger: single, auto-increment and array compare
- Up to 200 compare values per encoder channel are supported for the array compare mode
- Position difference value for velocity calculation
- Encoder digital input filter
- Input level: 5V, 12V/24V with internal resistor
- Polarity setting by software for active high or active low encoder input
- A/B/C/I signal isolation voltage: 2500V optical isolation

## 1.3 Specification

| Item | Specification | |
|---|---|---|
| **Encoder Input** | | |
| Number of encoder inputs | 2x encoder counter (A, B, C, differential or single-ended | |
| Counter resolution | 32 bit | |
| Encoder mode | A/B Phase, CW/CCW, Pulse/Dir | |
| Maximum input pulse frequency | A/B Phase | 4 MHz |
| | CW/CCW | 4 MHz |
| | Pulse/Dir | 4 MHz |
| Programmable digital filter | 1 ~ 250 µs | |
| Input level | 5V (default) | Logic high: 4 V ~ 5 V<br>Logic low: 0 V ~ 2 V |
| | 12 V (set by jumper) | Logic high: 5 V ~ 12 V<br>Logic low: 0 V ~ 2 V |
| | 24 V (set by jumper) | Logic high: 5 V ~ 24 V<br>Logic low: 0 V ~ 2 V |
| A/B/C signal photo-isolation | 2500 $V_{DC}$ | |
| **External Latch Input** | | |
| Channel | 2 | |
| Input level | 5V (default) | Logic high: 4 V ~ 5 V<br>Logic low: 0 V ~ 2 V |
| | 12 V (set by jumper) | Logic high: 5 V ~ 12 V<br>Logic low: 0 V ~ 2 V |
| | 24 V (set by jumper) | Logic high: 5 V ~ 24 V<br>Logic low: 0 V ~ 2 V |



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| Item | Specification |
|---|---|
| **Compare Trigger Output** | |
| Channel | 2 |
| Trigger pulse width | 2 ~ 32767 µs |
| Load voltage | 5 ~ 48 V |
| Max load current | 100 mA |
| **LED Indicators** | |
| Diagnostic LED | Power, EtherCAT status |
| **EtherCAT** | |
| Cycle time | 200 µs |
| Distributed clocks | Yes |
| **Power** | |
| Input voltage range | +24 $V_{DC}$ |
| Power consumption | Maximum 4.5W |
| **EMS Protection** | |
| ESD (IEC 61000-4-2) | ±4 KV Contact for each channel |
| EFT (IEC 61000-4-4) | Signal: 1 KV Class B; Power: 1 KV Class B |
| **Mechanism** | |
| Casing | Plastic |
| Dimensions (mm) | 25 × 108 × 90 (W × L × D) |
| Installation | DIN-Rail or Wall Mounting |
| **Environment** | |
| Operating temperature | -25℃ ~ 70℃ |
| Storage temperature | -30℃ ~ 80℃ |
| Relative humidity | 10 ~ 90%, No condensation |

**Table 1: Technical data**



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## 1.4 Dimensions

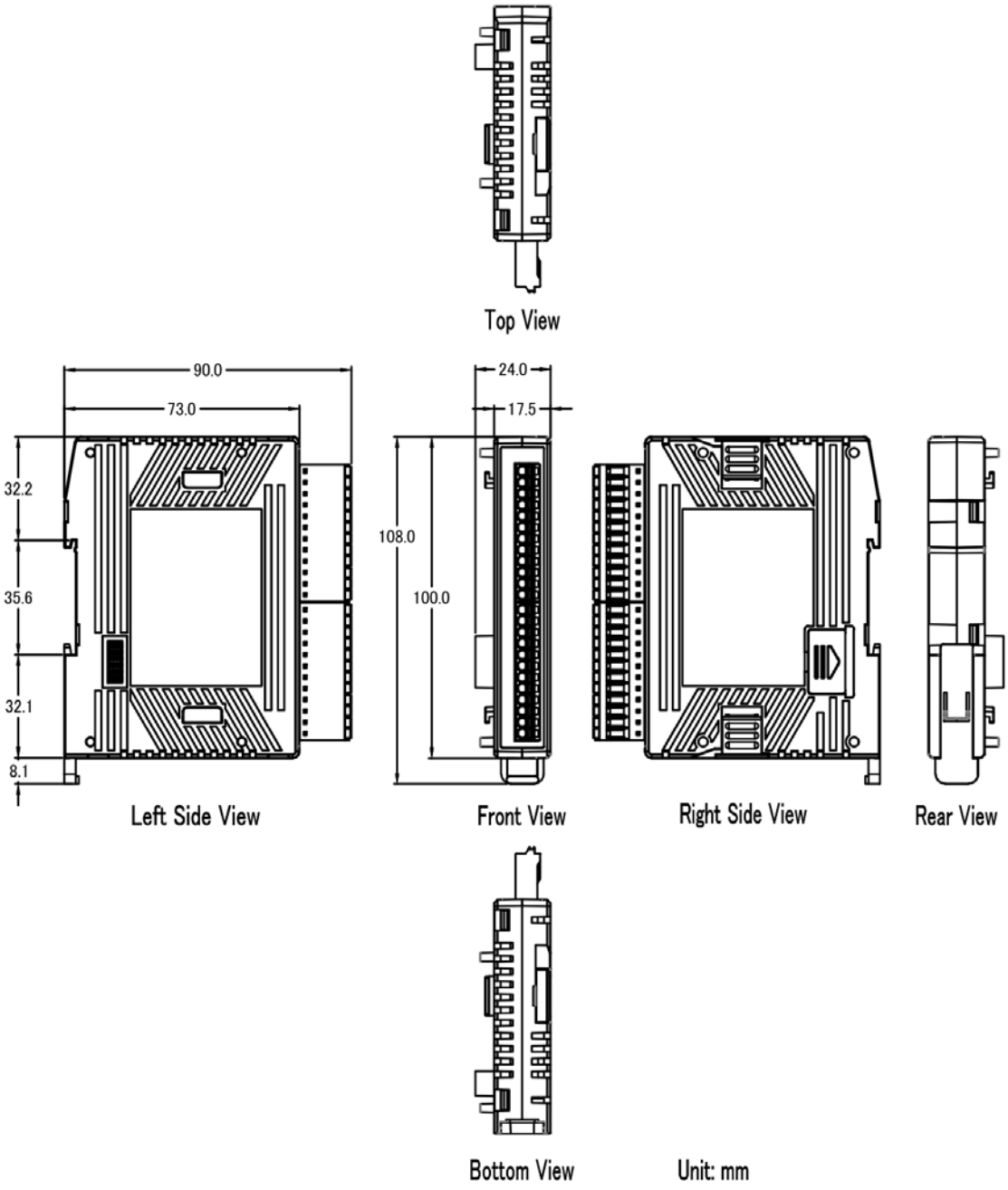



**Figure 1: Dimensions of the EC4-ENC2IT**



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# 2 Scope of Delivery

The shipping package includes the following items:

- 1 x EC4-ENC2IT
- 2 x 12-pin plug-in connector
- 1 x Quick Start manual



Figure 2: EC4-ENC2IT module and Quick Start manual

Note:

If any of these items are missing or damaged, please contact your local distributor. Please keep the original retail box with all retail packaging (Styrofoam, inner boxes, fasteners, etc.) in case you need to return the product.

More Information:

- Product website:
  http://www.icpdas.com/root/product/solutions/industrial_communication/fieldbus/ethercat/motion/EC4-ENC2IT.html

- Manual:
  ftp://ftp.icpdas.com/pub/cd/fieldbus_cd/ethercat/slave/motion/EC4-ENC2IT/manual/

- XML EtherCAT Slave Information (ESI) file:
  ftp://ftp.icpdas.com/pub/cd/fieldbus_cd/ethercat/slave/motion/EC4-ENC2IT/esi/

- FAQ:
  http://www.icpdas.com/root/product/solutions/industrial_communication/fieldbus/ethercat/ethercat_faqs.html

- Technical support:
  service@icpdas.com



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# 3 LED Definition

The EC4-ENC2A provides on the front side two diagnostic LEDs which indicates the power and EtherCAT network status. The exact meaning of the EtherCAT LED is described in the following tables:

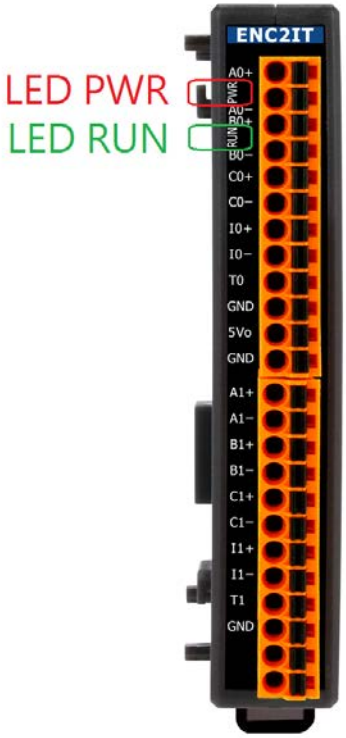



**Figure 3: EC4-ENC2IT LEDs**

| EtherCAT LED | Color | State | Description |
|---|---|---|---|
| RUN | green | | This LED indicates the operation state of the EtherCAT slave: |
| | | Off | Device is in INIT state |
| | | Flashing | Device is in PREOP state |
| | | Single flash | Device is in SAFEOP state<br>Outputs remain in safe state |
| | | On | Device is in OP state |

**Table 2: EtherCAT status indicator**



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# 4 Wiring

## 4.1 Connection Interfaces




Figure 4: EC4-ENC2IT front view with encoder inputs

| Name | Signal | Signal Description | |
|---|---|---|---|
| A0+ | Input | Encoder input A0+ | Encoder Channel 0 |
| A0- | Input | Encoder input A0- | |
| B0+ | Input | Encoder input B0+ | |
| B0- | Input | Encoder input B0- | |
| C0+ | Input | Encoder input C0+ | |
| C0- | Input | Encoder input C0- | |
| I0+ | Input | Latch input I0+ | |
| I0- | Input | Latch input I0- | |
| T0 | Output | Compare trigger output (DO0) | |
| GND | | External ground for DO0 | |
| 5Vo | Output | Power supply to encoder | |
| A1+ | Input | Encoder input A1+ | Encoder Channel 1 |
| A1- | Input | Encoder input A1- | |
| B1+ | Input | Encoder input B1+ | |
| B1- | Input | Encoder input B1- | |
| C1+ | Input | Encoder input C1+ | |
| C1- | Input | Encoder input C1- | |
| I1+ | Input | Latch input I1+ | |
| I1- | Input | Latch input I0- | |
| T1 | Output | Compare trigger output DO1 | |
| GND | | External ground for DO1 | |

Table 3: Connection interfaces of the encoder



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## 4.2 Internal I/O Structure

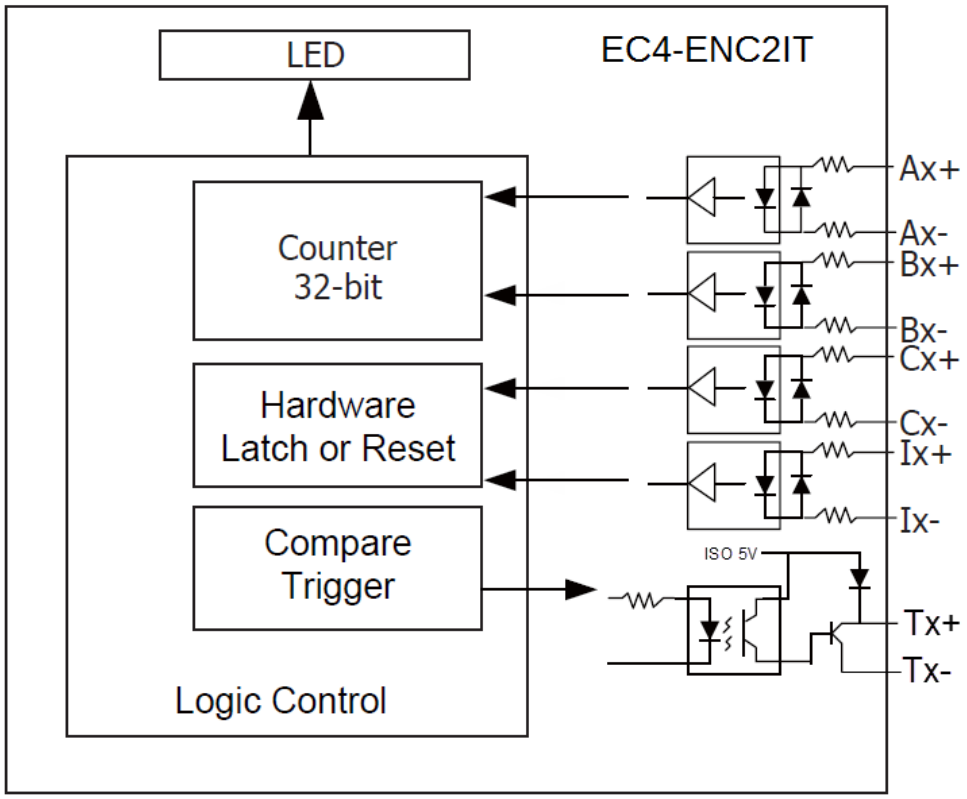



Figure 5: DIO circuit

## 4.3 Jumper Settings

The EC4-ENC2IT can accept encoder inputs from either differential or single-ended signals. By default it is set to support differential encoder signals as they are preferred due to their excellent noise immunity. For open collector type encoder the internal resistor needs to be enabled. The EC4-ENC2IT does not provide an internal power supply for the encoder therefore the encoder has to be connected to an external power supply.

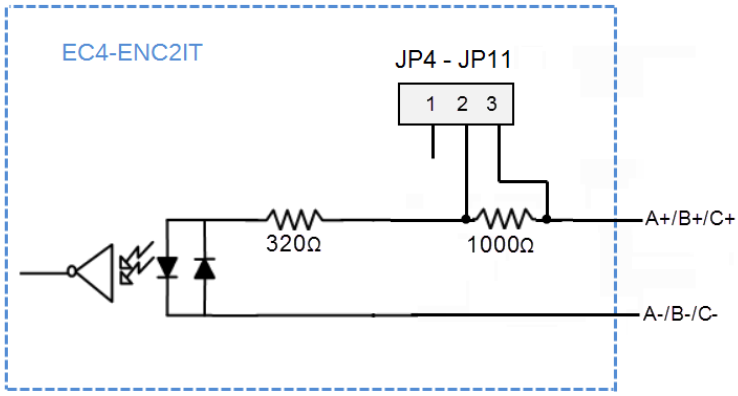



Figure 6: Encoder channel circuit



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For single-ended encoder connection the EC4-ENC2IT provides an internal 1k Ohm resistor for each signal input. The internal resistor can be selected by setting the jumper of the corresponding encoder channel to the position 1-2. The housing needs to be opened in order to set the jumper. For enabling the internal resistor Table 4 lists for each encoder signal input the corresponding jumper position. Figure 7 and Figure 8 shows the basic wiring diagram for open collector connection.

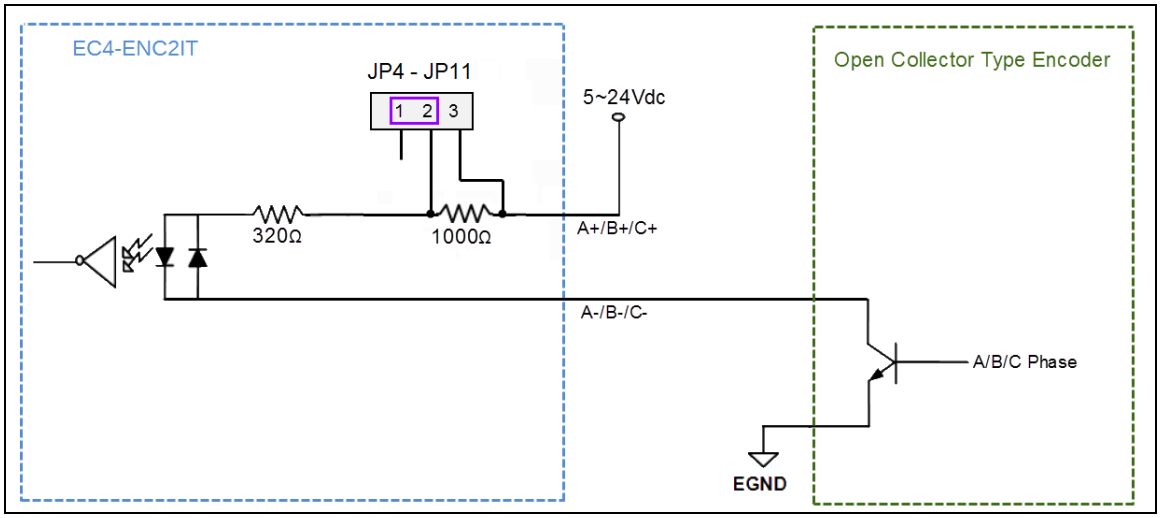



**Figure 7: Open collector wiring diagram (Source Digital Input)**

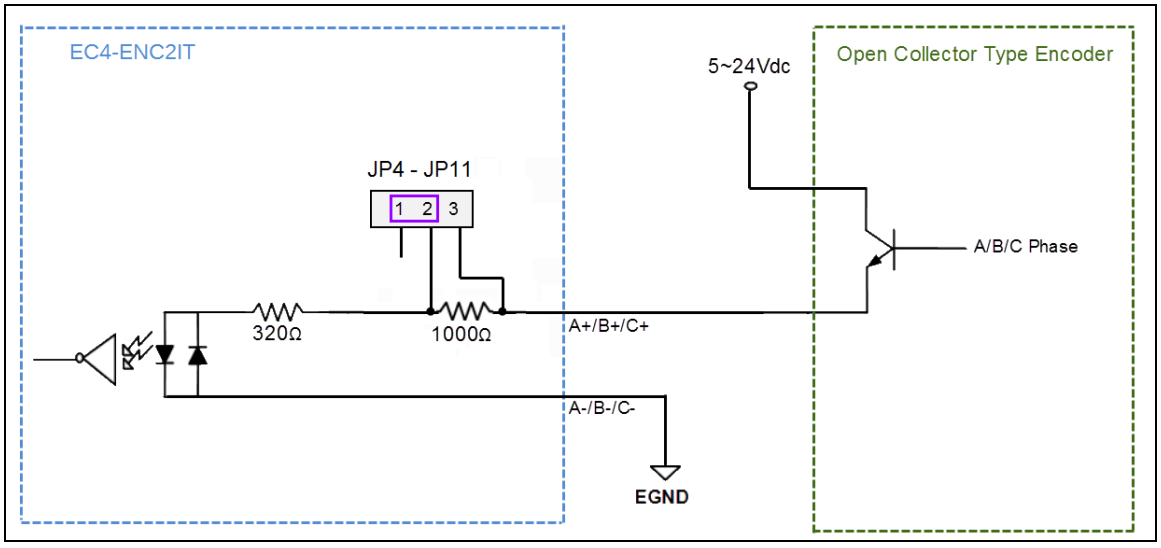



**Figure 8: Open collector wiring diagram (Sink Digital Input)**



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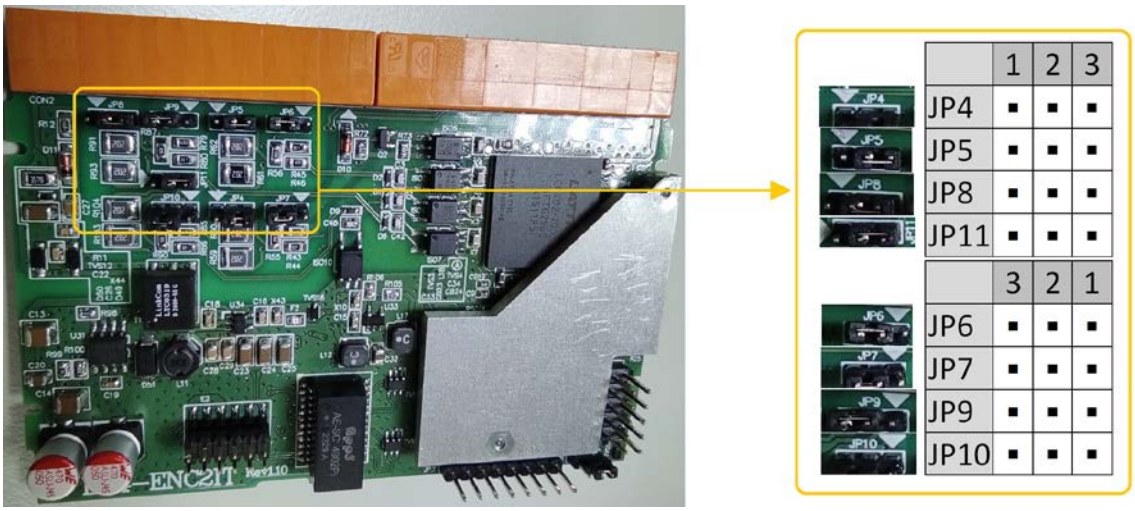



Figure 9: Jumper location

| Jumper No | Channel | Jumper position 2-3 | Jumper position 1-2 |
|---|---|---|---|
| JP4 | Encoder input A0 | Differential channel | Open collector channel |
| JP5 | Encoder input B0 | Differential channel | Open collector channel |
| JP6 | Encoder input Z0 (C0) | Differential channel | Open collector channel |
| JP7 | Extern latch input I0 (HR0) | Differential channel | Open collector channel |
| JP8 | Encoder input A1 | Differential channel | Open collector channel |
| JP9 | Encoder input B1 | Differential channel | Open collector channel |
| JP10 | Encoder input Z1 (C1) | Differential channel | Open collector channel |
| JP11 | Extern latch input I1 (HR1) | Differential channel | Open collector channel |

Table 4: Jumper definitions for the encoder channels

The input levels for the open collector with the internal resistor of 1 K ohm is as follows

- Input 12 V:
  - Logic High: 5 V ~ 12 V
  - Logic Low: 0 V ~ 2 V
- Input 24V:
  - Logic High: 5 V ~ 24 V
  - Logic Low: 0 V ~ 2 V



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## 4.4 Digital Input Wiring

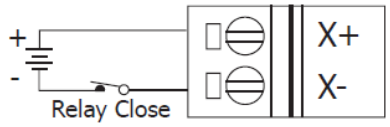
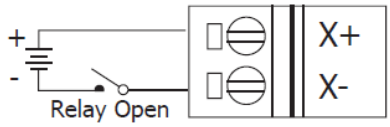
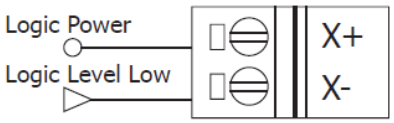
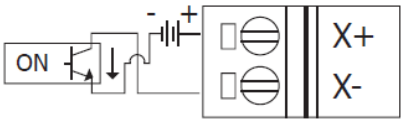
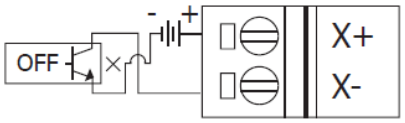
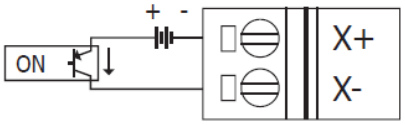
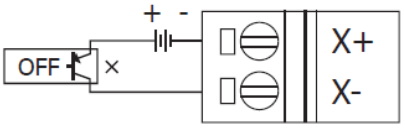
| Input Type | ON State LED ON Readback as 1 | OFF State LED OFF Readback as 0 |
|---|---|---|
| Relay Contact | Relay ON | Relay OFF |
| |  |  |
| TTL/CMOS Logic | Voltage > 4 V | Voltage < 0.8 V |
| |  |  |
| NPN Output | Open Collector ON | Open Collector OFF |
| |  |  |
| PNP Output | Open Collector ON | Open Collector OFF |
| |  |  |

**Figure 10: Encoder counter (A/B), index (C) and external latch (I) input wiring**



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## 4.5 Compare Trigger Output Wiring

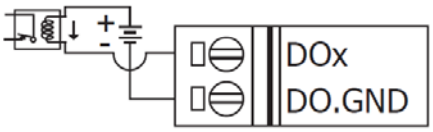
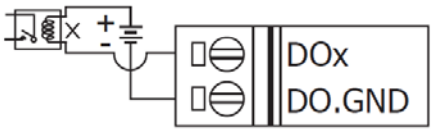
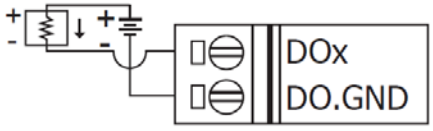
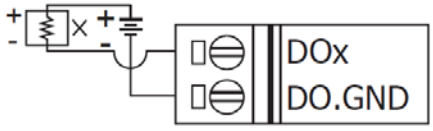
| Output Type | ON State Readback as 1 | OFF State Readback as 0 |
|---|---|---|
| Drive Relay | Relay ON | Relay OFF |
| |  |  |
| Resistance Load | | |
| |  |  |

**Figure 11: Compare trigger output wiring**



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# 5 Basics Communication

## 5.1 EtherCAT Cabling

The cable length between two EtherCAT devices must not exceed 100 m.

**Cables and connectors**
For connecting EtherCAT devices only Ethernet connections (cables + plugs) that meet the requirements of at least category 5 (CAT5) according to EN 50173 or ISO/IEC 11801 should be used. EtherCAT uses 4 wires for signal transfer.
The pin assignment is compatible with the Ethernet standard (ISO/IEC 8802-3).

## 5.2 EtherCAT State Machine

The state of the EtherCAT master and slave is controlled via the EtherCAT State Machine (ESM) . The state determines which functions are accessible or executable in the EtherCAT slave. State changes are typically initiated by requests of the master and acknowledged by the slave after the successful initialization. In case of an internal error, the slave automatically changes to a lower state.

The EC4-ENC2IT supports four states:
- Init (state after Reset)
- Pre-Operational
- Safe-Operational
- Operational



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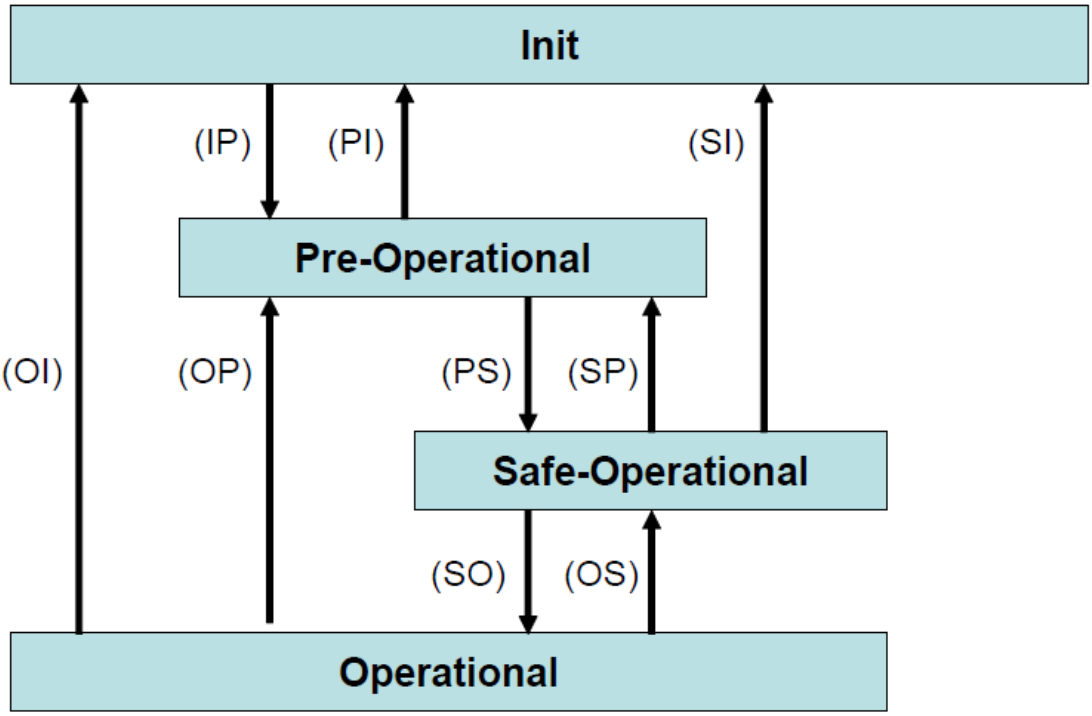



Figure 12: EtherCAT state machine

**Init**

After switch-on the EtherCAT slave is in the initial state. Only ESC register communication is possible, but no mailbox or process data communication. The slave initializes the service object data with default value or with values previously stored to the local memory. The EtherCAT master assigns the station address and configures the sync manager channels 0 and 1 for acyclic mailbox communication.

**Pre-Operational (Pre-Op)**

In Pre-Op state acyclic mailbox communication is possible, but not process data communication. In this state the EtherCAT master does the following configurations:

- Sets the sync manager 2 and 3 of the EC4-ENC2IT for process data communication (from sync manager channel 2)
- Configurates the Fieldbus Memory Management Unit
- PDO mapping or the sync manager PDO assignment
- The user has the option to save motion control related configuration data (0x8000 - 0x8020) to a non-volatile memory.

**Safe-Operational (Safe-Op)**

In Safe-Op state both mailbox and process data communication are enabled, but the slave keeps its outputs in a safe state, while the input data are updated cyclically. The slave will ignore the output data sent by the master and just return the current input



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data (e.g. digital input, encoder value, etc.)

The sync manager watchdog expires when the master application does not provide new output process data within the configured watchdog time. In this case the slave will automatically go from operational state to ERROR-SAFEOP state.

**Operational (Op)**
Here both the process data object (PDO) and service data object (SDO) are fully enabled. Master sends cyclic output data and read input data. The EC4-ENC2IT supports three type of Op modes: Free Run mode, SM-Synchron and Distributed Clock (DC) mode.

## 5.3 Synchronization Modes

EC4-ENC2IT devices support three different modes:

- Free Run: The master cycle time and slave cycle time are independent and not synchronized.
- SM-Synchron: The master cycle time interval is not deterministic and can vary. Master and slave process data handling are synchronized. The slave only starts processing data once it received a new datagram from the master.
- Distributed Clock (DC): The cycle time and interval is fixed and deterministic. Both the master and slave cycle time are synchronized. The slave processes data at a fixed and deterministic time interval (DC cycle time). The slave expect the master to exchange process data at a fixed time interval. If the master does not send/read data within the set time interval then an synchronization error will be generated by the slave.

### 5.3.1 Free Run Mode

The slave operates autonomously based on its own cycle and is not synchronized with the EtherCAT cycle. The master cycle time and the slave cycle time are fully independent which means each slave device reads/writes its own process data according to its local time, independent of the master's cycle time.

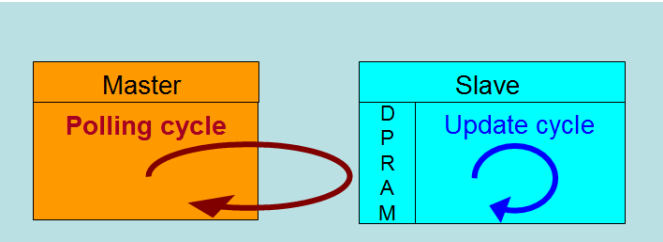



**Figure 13: Master-slave cycle in Free Run mode**



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The following diagram shows the process timing of the slave in Free Run mode in detail:

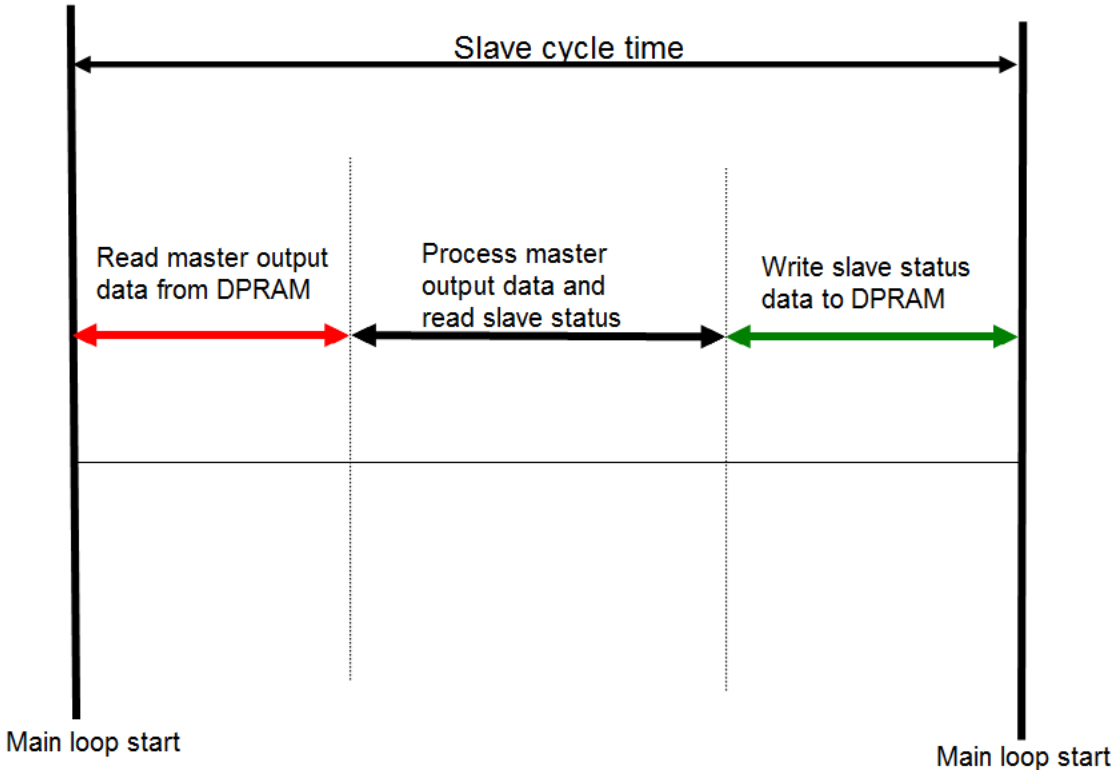


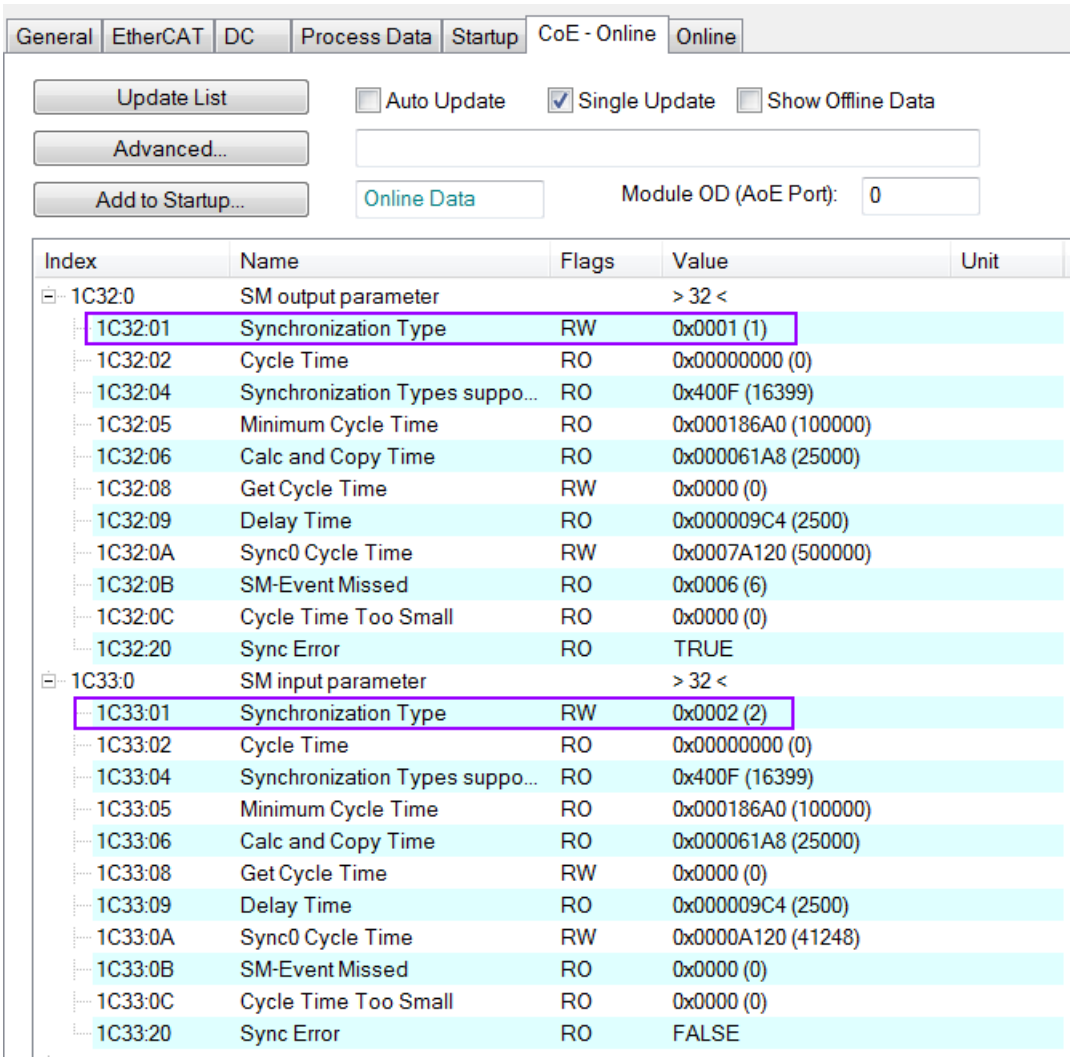

Figure 14: Slave processing sequence in Free-run mode

The slave firmware checks in each cycle time the memory of the EtherCAT slave chip (ESC) whether new output data has been received from the master. Newly received data will be processed. In the next step the encoder input status are being read from the FPGA chip. In the final step the read status are being written to the DPRAM, so that the master can retrieve the data ESC DPRAM in the next cycle time.
Free Run synchronization parameter has to be set in PREOP mode:
0x1C32.1 = 0
0x1C33.1 = 0

The setting of the Free Run synchronization parameter can be done in TwinCAT by clicking on the "CoE online" tab of the EC4-ENC2IT slave. Make sure the slave is set into PreOP mode before modifying the synchronization parameters



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| Index | Name | Flags | Value | Unit |
|---|---|---|---|---|
| 1C32:0 | SM output parameter | | > 32 < | |
| 1C32:01 | Synchronization Type | RW | 0x0001 (1) | |
| 1C32:02 | Cycle Time | RO | 0x00000000 (0) | |
| 1C32:04 | Synchronization Types suppo... | RO | 0x400F (16399) | |
| 1C32:05 | Minimum Cycle Time | RO | 0x000186A0 (100000) | |
| 1C32:06 | Calc and Copy Time | RO | 0x000061A8 (25000) | |
| 1C32:08 | Get Cycle Time | RW | 0x0000 (0) | |
| 1C32:09 | Delay Time | RO | 0x000009C4 (2500) | |
| 1C32:0A | Sync0 Cycle Time | RW | 0x0007A120 (500000) | |
| 1C32:0B | SM-Event Missed | RO | 0x0006 (6) | |
| 1C32:0C | Cycle Time Too Small | RO | 0x0000 (0) | |
| 1C32:20 | Sync Error | RO | TRUE | |
| 1C33:0 | SM input parameter | | > 32 < | |
| 1C33:01 | Synchronization Type | RW | 0x0002 (2) | |
| 1C33:02 | Cycle Time | RO | 0x00000000 (0) | |
| 1C33:04 | Synchronization Types suppo... | RO | 0x400F (16399) | |
| 1C33:05 | Minimum Cycle Time | RO | 0x000186A0 (100000) | |
| 1C33:06 | Calc and Copy Time | RO | 0x000061A8 (25000) | |
| 1C33:08 | Get Cycle Time | RW | 0x0000 (0) | |
| 1C33:09 | Delay Time | RO | 0x000009C4 (2500) | |
| 1C33:0A | Sync0 Cycle Time | RW | 0x0000A120 (41248) | |
| 1C33:0B | SM-Event Missed | RO | 0x0000 (0) | |
| 1C33:0C | Cycle Time Too Small | RO | 0x0000 (0) | |
| 1C33:20 | Sync Error | RO | FALSE | |

Figure 15: SyncManager setting for Free-Run mode

### 5.3.2 SM-Synchron

In this mode both the master and the slave are synchronized but the data exchange cycle interval is not deterministic. The slave waits for the master to send a data telegram before starting to process the input and output data. In this mode the process data handling is being initiated by the master which determines the cycle time.

Once the output data sent by the master arrives at the slave it immediately starts processing the output data. In the next step the encoder input data will be written to the internal process data image of the slave. The input process data image will be read by the master in the next cycle.
SyncManager synchronization parameter:
0x1C32.1 = 0x1
0x1C33.1 = 0x22



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By setting the operation mode of TwinCAT to "SM-Synchron" the SyncManager synchronization parameter are set by default to the above values.

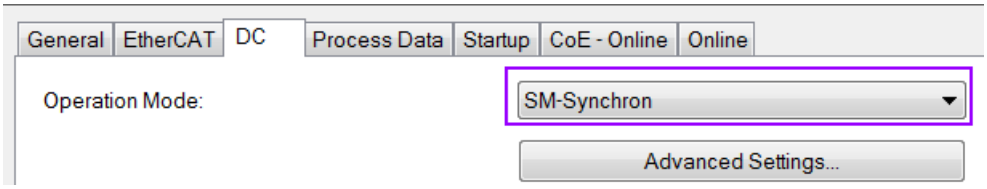



Figure 16: SM-Synchron mode selection

### 5.3.3 Distributed Clocks (DC Mode)

DC clock synchronization enables all EtherCAT devices (master and slaves) to share the same EtherCAT system time. The EtherCAT slaves in the network can be synchronized to each other. This enables the master to simultaneously set the output (e.g. digital output, pulse output) or to synchronously read inputs (e.g. digital input, encoder counter) of different slaves in the EtherCAT network.

For system synchronization all slaves are synchronized to one reference clock. Normally the first EtherCAT slave closest to the master with Distributed Clocks capability becomes the clock base for the master as well as for other DC slaves.

The EtherCAT slave is synchronized with the SYNC0 or SYNC1 event of the distributed clock system. After the EtherCAT network has been set into DC communication mode by the master, the ESC (EtherCAT slave chip) of each slave generates fixed time hardware interrupt which triggers the slave firmware to process the PDO data received from the master. The master cycle time and the ESC hardware interrupt time interval are fully synchronized to the first slave in the network that is used as a reference clock with the SYNC0 signal.

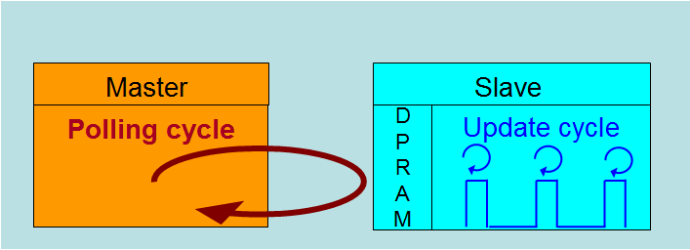



Figure 17: Master-slave cycle in DC mode



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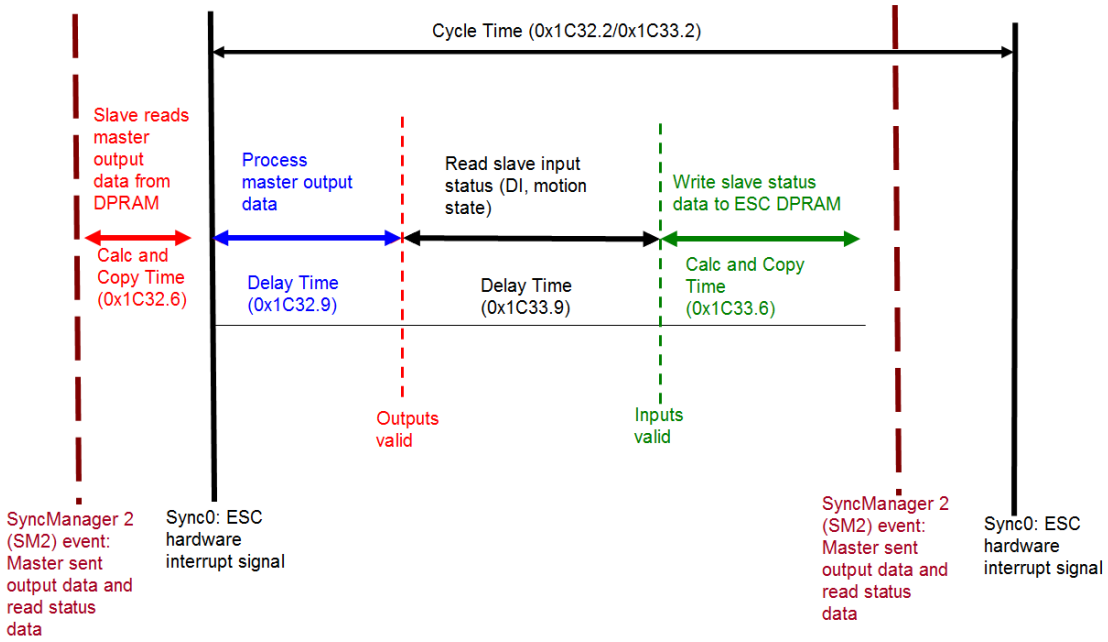



**Figure 18: Internal slave processing sequence in DC mode**

Once the slave receives process data (RxPDOs) from the master the SM2 event is triggered which causes the firmware to read the data from the ESC memory. The ESC interrupts the firmware at fixed time interval to process the data received from the master and write the status data to the ESC memory. Every time when the master fails to sent process data within the DC cycle time the internal sync error counter is being increase by three counts. This error counter is being decreased by one count for every successful DC cycle. Once the error counter reached the maximum count (default 4) a sync error will be generated and the slave goes into Safe OP mode (Sync Error 0x1C32:20 TRUE). The maximum count value can be set by changing the default value of the "Sync Error Counter Limit" (0x10F1:02).

| Index | Name | Flags | Value |
|---|---|---|---|
| 10F1:0 | Error Settings | | > 2 < |
| 10F1:01 | Local Error Reaction | RW | 0x00000001 (1) |
| 10F1:02 | Sync Error Counter Limit | RW | 0x0004 (4) |

**Figure 19: Sync error counter limit object**

The setting of the sync manager for the output and input data is available at the TwinCAT "CoE online" tab.



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| Index | Name | Flags | Value |
|---|---|---|---|
| 1C32:0 | SM output parameter | | > 32 < |
| 1C32:01 | Synchronization Type | RW | 0x0002 (2) |
| 1C32:02 | Cycle Time | RO | 0x00000000 (0) |
| 1C32:04 | Synchronization Types supported | RO | 0x401F (16415) |
| 1C32:05 | Minimum Cycle Time | RO | 0x001E8480 (2000000) |
| 1C32:06 | Calc and Copy Time | RO | 0x0007A120 (500000) |
| 1C32:08 | Get Cycle Time | RW | 0x0001 (1) |
| 1C32:09 | Delay Time | RO | 0x000927C0 (600000) |
| 1C32:0A | Sync0 Cycle Time | RW | 0x005B8D80 (6000000) |
| 1C32:0B | SM-Event Missed | RO | 0x0000 (0) |
| 1C32:0C | Cycle Time Too Small | RO | 0x0000 (0) |
| 1C32:20 | Sync Error | RO | FALSE |

**Figure 20: SyncManager 2 parameters**

SyncManager parameter description (time unit: nanosecond):

- Calc and Copy Time (0x1C32.6 / 0x1C33.6): Required time to copy the process data from the ESC to the local memory and calculate the output value.
- Delay Time (0x1C32.9 / 0x1C33.9): Delay from receiving the trigger to set the output or latch the input.
- Cycle Time (0x1C32.2 / 0x1C33.2 ): The current cycle time for the application. When using DC synchronization the value is read from register 0x9A0:0x9A3.
- 0x1C32.5 / 0x1C33.5 (Min Cycle Time): Minimum cycle time for the application. It is the total execution time of all slave application related operations.



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# 6 Project Integration

In this chapter the integration of the EC4-ENC2IT device into a TwinCAT controlled EtherCAT network is being described. In general the EC4-ENC2IT is a standard EtherCAT slave which can be controlled by any standard EtherCAT master (e.g. Acontis, CODESYS, etc.).

## 6.1 ESI File

A ESI file describes the properties and functions supported by the EC4-ENC2IT. By using the ESI file an easy and abstract integration of an EtherCAT device in a project tool is realized. With the help of the ESI file a detailed knowledge of EtherCAT is not required to configure the device. The TwinCAT EtherCAT master/System Manager needs the device description files in order to generate device configuration in online or offline mode.

### 6.1.1 Import of ESI File

Copy the XML description file "EC4-ENC2IT.xml" of the EC4-ENC2IT device into the TwinCAT system directory and restart the TwinCAT system.
For TwinCat 3.1 copy the ESI file "EC4-ENC2IT.xml" in the following directory:
C:\TwinCAT\3.1\Config\Io\EtherCAT

| Software | Default directory path |
|---|---|
| Beckhoff EtherCAT Configuration | C:\EtherCAT Configurator\EtherCAT |
| Beckhoff TwinCAT 3.x | C:\TwinCAT\3.x\Config\Io\EtherCAT |
| Beckhof TwinCAT 2.x | C:\TwinCAT\Io\EtherCAT |

**Table 5: ESI file target directory**

## 6.2 Device Setup and Configuration

In this manual only the online configuration of the slave module will be discussed. For offline configuration procedure please consult the TwinCAT user manual.

The following conditions must be met before a configuration can be set up:

- The EC4-ENC2IT slave devices must be connected via EtherCAT cables to the EtherCAT master. In this manual TwinCAT 3.1 version is being used as the EtherCAT master and configuration tool



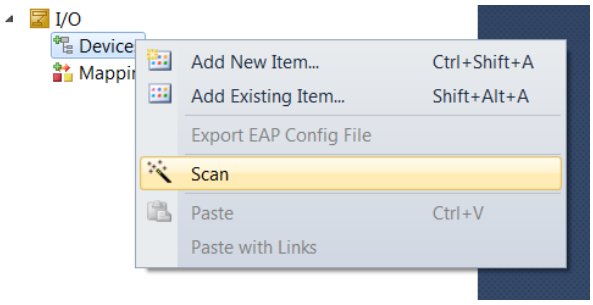
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- The EC4-ENC2IT devices has to be connected to a power supply and ready for communication
- Set the TwinCAT in CONFIG mode.

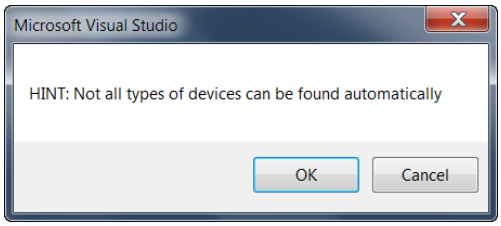
### 6.2.1 Scanning of the EtherCAT Device

After the TwinCAT has been set into CONFIG mode the online device search can be started.

**Step 1:** Right-click the “Devices” in the configuration tree to open the scan dialog. Click "Scan" to search the EC4-ENC2IT device.




**Step 2:** Select "OK"




**Step 3:** Select the Ethernet device (Ethernet chip) to which the EC4-ENC2IT is connected to. Confirm the selection with "OK".

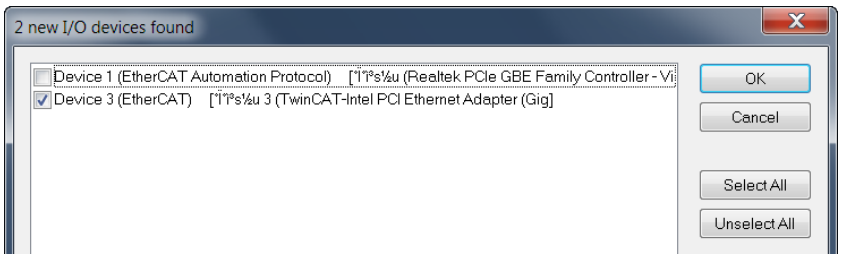
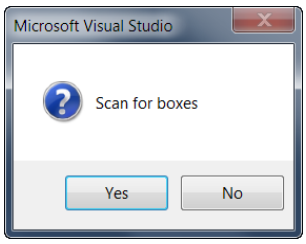



**Figure 21:List of Ethernet chips detected on the EtherCAT master PC**

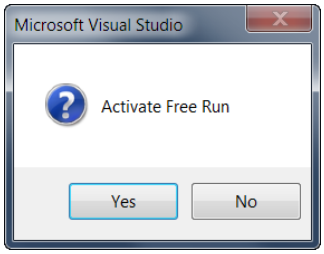
**Step 4:** Start the scan process by clicking "Yes"



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**Step 5:** Set the EC4-ENC2IT into Free-Run mode by clicking "Yes"




By default the counter and compare trigger process data for both encoder channels are displayed in the tree view:

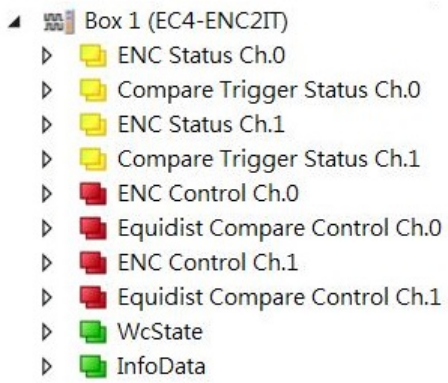



**Figure 22: Default parameter selection for the EC4-ENC2IT**

### 6.2.2 Encoder Counter Configuration

The configuration of the EC4-ENC2IT device such as the encoder mode, filter setting etc. only needs to be done once before the actual encoder counting starts. These parameters have to be accessed via the CANopen over EtherCAT (CoE) protocol and are listed in the "CoE online" tab. The CoE protocol has a lower priority than the cyclic process data object (PDO) communication. Therefore the CoE parameters will not be updated in every cycle but only when the master has spare time.

Encoder relevant CoE parameter are listed in the "Encoder setting" objects (Index 0x8000, 0x8010)



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For each channel the following configuration procedure has to be done:

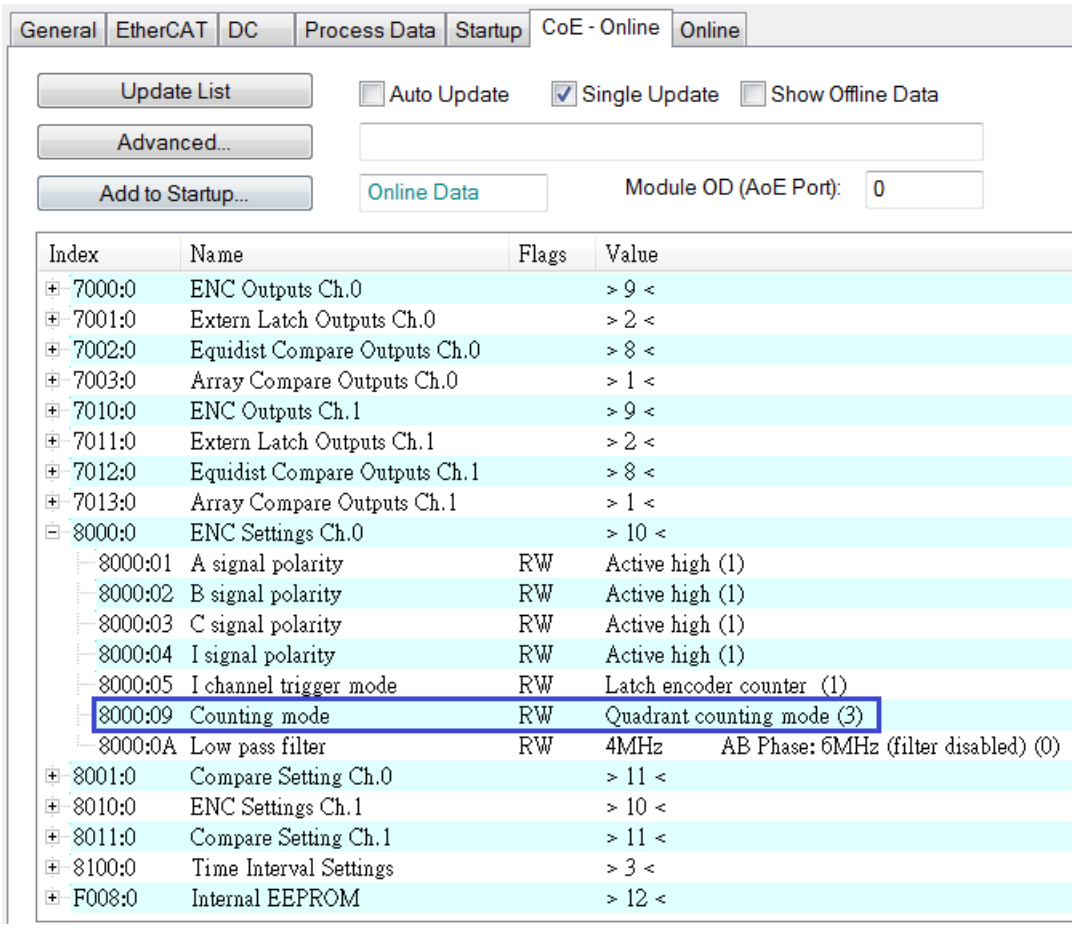
- Counting mode setting
- A/B/C signal polarity setting. The input signal may be active low or active high.
- Low pass filter clock cycle setting
- For external latch (if selected):
  - External latch "I" signal polarity setting: The input signal may be active low (falling edge trigger) or active high (rising edge trigger).
    NOTE: The "I" signal polarity can not be set for each channel individually. Both channel need to be set to the same polarity.
  - Extern latch mode setting: An latch signal can either latch the counter value or set the counter value to zero
- For compare trigger (if selected):
  - The pulse width setting of the triggered DO signal.
  - Compare DO trigger signal
  - The compare mode: equidistance incremental compare or non-equidistance compare (array of compare value) type.
  - For non-equidistance compare type:
    - List of compare position values
    - Number of compare position
    - Activate/Deactivate "I" digital input channel for enabling/disabling the position compare function

**Example of setting the encoder counting mode for each channel:**

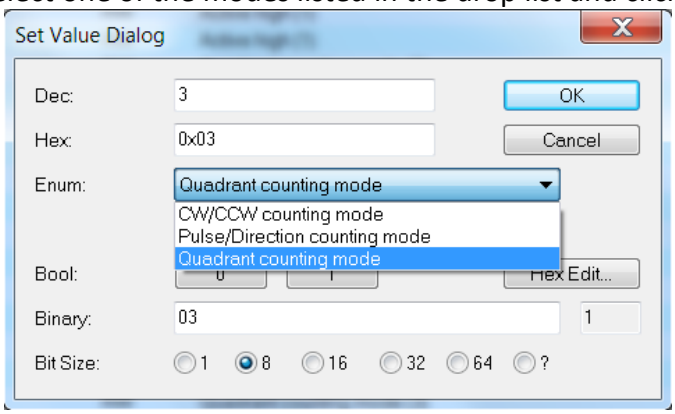
**Step 1:** Go to "ENC Setting Ch.0" of a channel. Extend the index tree and double click "Counting mode" with the index 8000:09 for channel 0.



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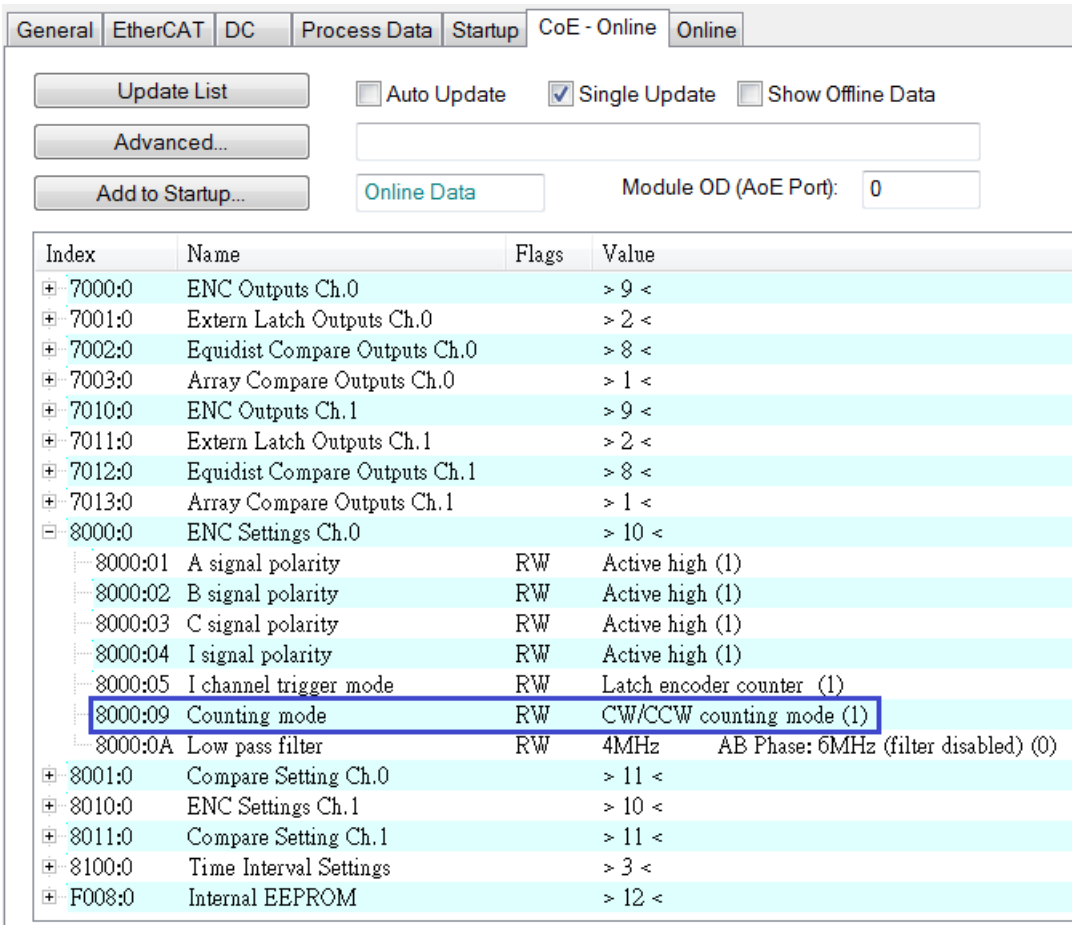

**Step 2:** Select one of the modes listed in the drop list and click "OK"




**Step 3:** Once the setting has been successfully sent to the slave it will be displayed in the CoE online parameter list. In the figure below "CW/CCW counting mode" has been selected for channel 0. This value needs only to be set once and therefore does not have to be sent in every cycle time.



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All the relevant encoder configurations have to be set first before the process data is being used by the application program. Once the parameters are set, the encoder counter is basically ready for operation.

If required, the configuration can be permanently save to an internal non-volatile memory of the EC4-ENC2IT. After powering on the device it will immediately be initialized according configuration setting. The procedure for saving the configuration data is being described in chapter 8.2.

### 6.2.3 EtherCAT Slave Process Data Assignment

The user has to select the process data which has to be transferred between the EtherCAT master and slave during each cycle (Process Data Objects, PDOs). The process data exist of two parts:

- TxPDO: Data which is being read by the master (e.g. encoder status) .
- RxPDO: Data or parameters which is being sent to the slave (e.g. reset encoder position).



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Once the parameters of the process data image has been defined by the user the master will exchange the in- and output data in every cycle.

For TwinCAT the ESI file predefines PDO assignment which allows the user to quickly select the process data objects required for his application. The following list the available predefined PDO assignment categories:

- Counter + Equidist compare trigger (default selection)
- Counter + Array compare trigger
- Counter + Extern latch + Index latch
- Counter
- Counter + Extern latch + Equidist compare trigger
- Counter + Extern latch + Array compare trigger
- Counter + Index latch + Extern latch + Equidist compare trigger
- Counter + Index latch + Extern latch + Array compare trigger
- Counter + Index latch + Extern latch + Equidist compare trigger + Array compare trigger
- Counter + Index latch + Extern latch + Equidist compare trigger + Array compare trigger + Vel

By selecting one of the motion mode from the list box (Figure 23) all the relevant parameters are automatically assigned and mapped to the process data objects (TxPDO, RxPDO). If required, additional objects can be assigned to the process data by selecting the object listed under "PDO Assignment (0x1C12)" and "PDO Assignment (0x1C13)".

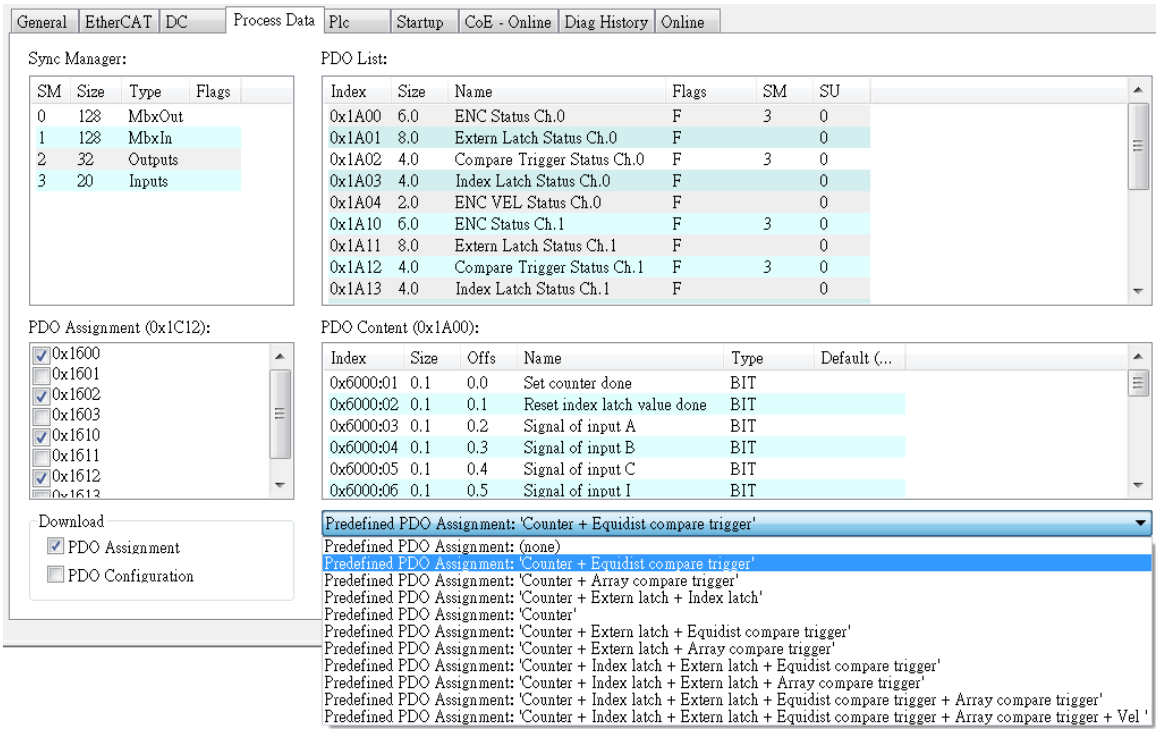



**Figure 23: Predefined PDO assignment selection**



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The limitation of using the predefined PDO assignments is that for both encoder channel the same process data is being selected. Therefore if the projects requires that different process data objects have to be transmitted for each for each channel then the process data objects have to be selected manually. In TwinCAT the supported process data objects are listed in the "PDO Assignment (0x1C12)" and "PDO Assignment (0x1C13)" boxes. The variable of which a PDO is made up are described in Object Description and Parameterization in chapter 9.
The following section describes the procedure for selecting the PDO manually.

PDO selection procedure:

1. Click the "Process Data" tab of the EC4-ENC2IT slave
2. For RxPDO selection: click in the "Sync Manager" window the "Outputs" line and in the "PDO Assignment (0x1C12)" window select for each encoder channel the required RxPDO (see Figure 24). If the variables listed in the RxPDO are not required for the application then deselect the PDO in order to reduce the process data image size.
3. For TxPDO selection: click in the "Sync Manager" window the "Inputs" line and in the "PDO Assignment (0x1C13)" window select for each encoder channel the required TxPDO. The process data contains status variables for the encoder, latch and compare function, and signal status information.

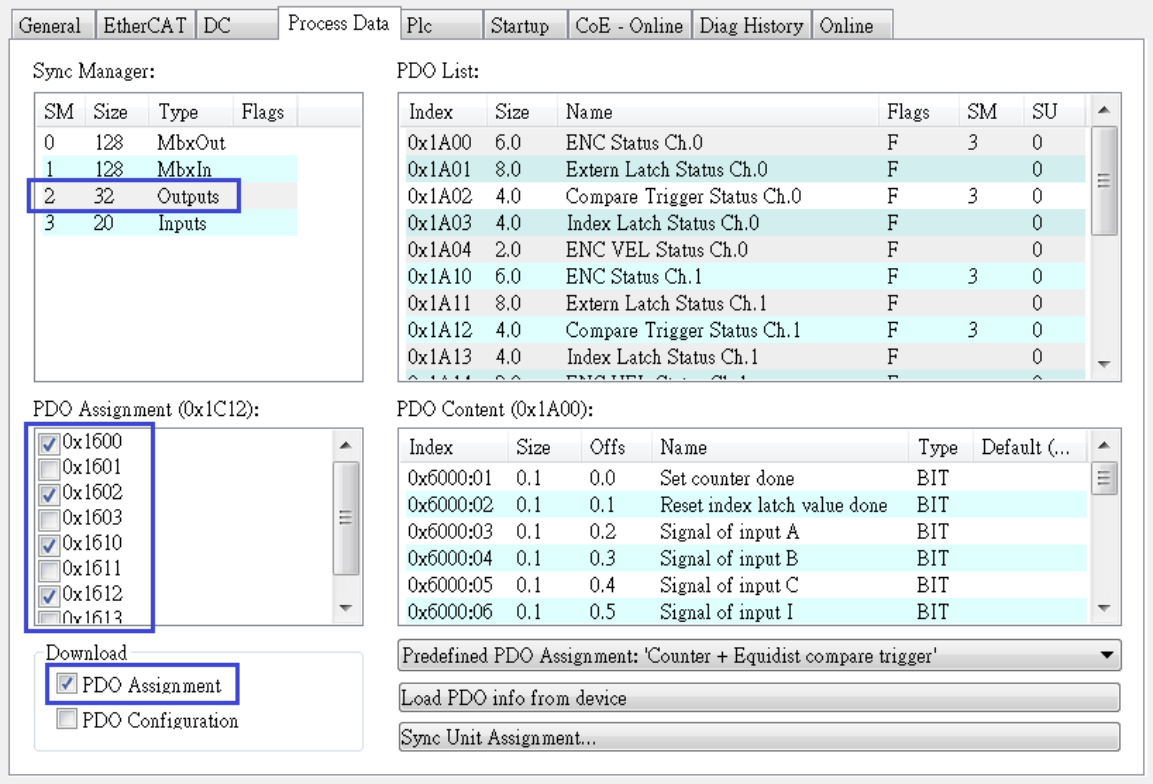



**Figure 24: Predefined PDO assignment selection**



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Download the new PDO assignment to the Sync manager of the slave by clicking "Restart TwinCAT (Config Mode)" in the drop down menu. Make sure the check box next "PDO Assignment" is enabled.

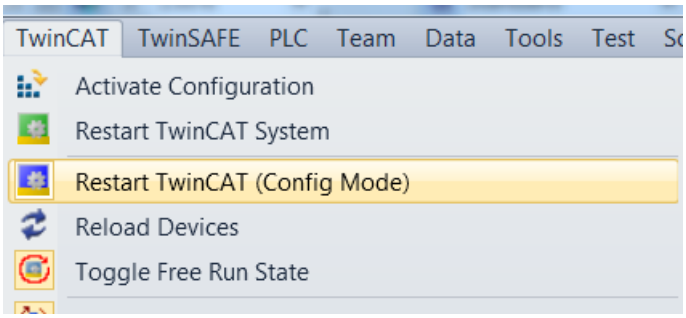



**Figure 25: Download PDO assignment and restart TwinCAT**

The device is now ready to be set into Free-Run or DC mode.



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# 7 Parameter Description

## 7.1 Configuration Parameters

### 7.1.1 Counting Mode

The EC4-ENC2IT encoder counter supports three modes:

- Pulse/Direction counting mode
- Clockwise/Counterclockwise mode
- Quadrant counting mode

The encoder counter mode has to be set via CoE (0x80n0:09, n= 0;1), see Figure 26:

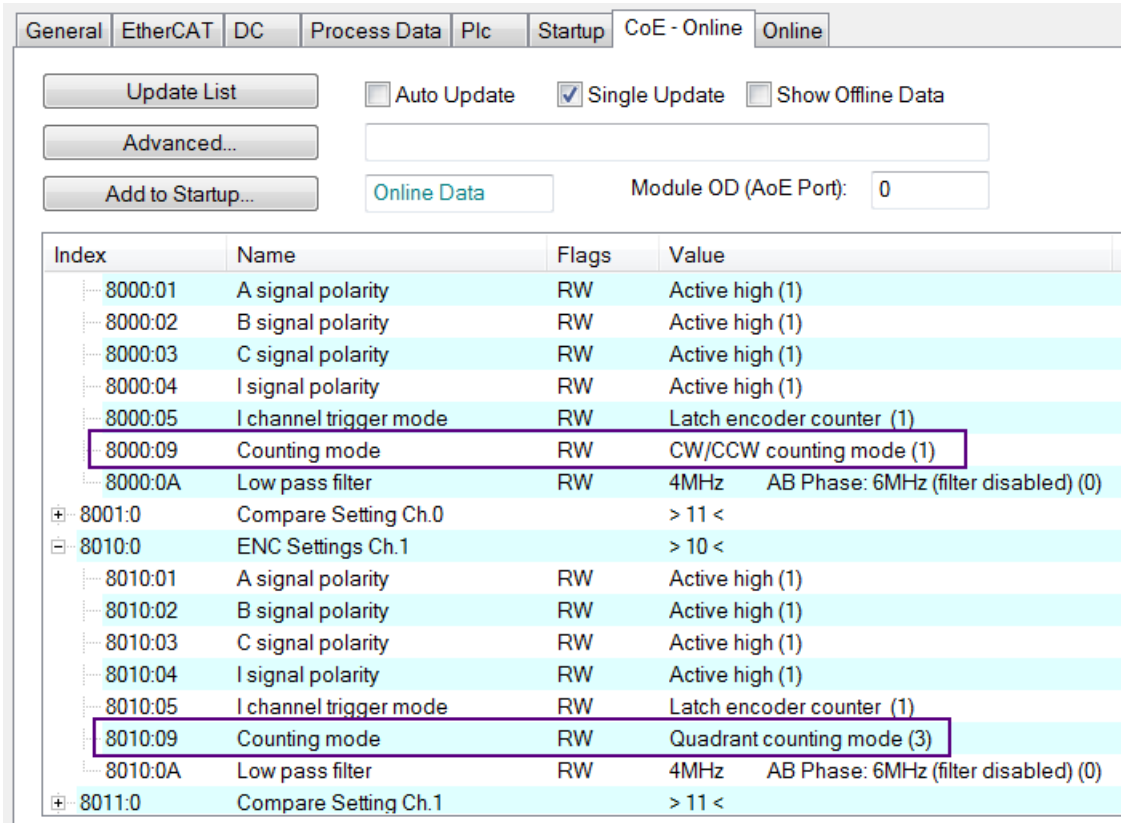



Figure 26:Configuration parameters set via CoE

In the **pulse/direction counting mode** (Figure 27) one input signal line is being used to indicate the position and a second one indicates the direction of motion, either forward or reverse. The "A" signal serves as the counter input and the "B" signal serves as the direction input (B = high: enables up count; B = low: enables down count). The EC4-ENC2IT counts the rising or falling edges of the "A" signal pulses and the "B" signal



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determines the direction of the count and decides whether to increment or decrement the counter. On every active input signal "A" the position counter is incremented by one when the direction input "B" signal is high and decremented by one when the direction input "B" is low.

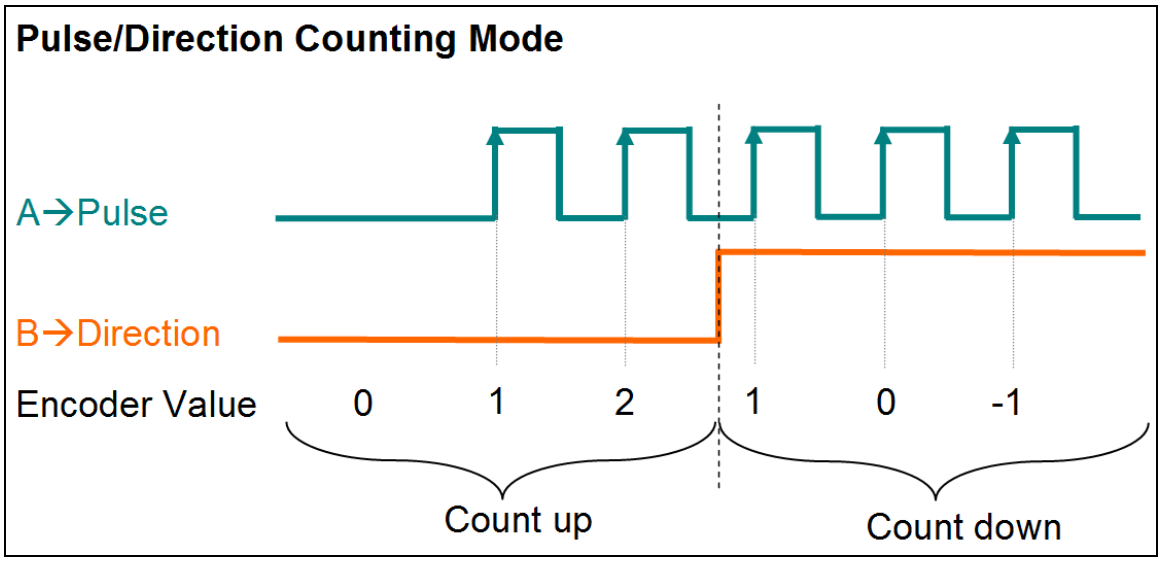



Figure 27: Pulse/Direction counting mode

In **clockwise/counterclockwise mode** (Figure 28) the "A" signal indicates a positive increments (clockwise signal) and the "B" signal a negative increments (counterclockwise signal). Therefore the encoder counter increases by one when the "A" signal is going high, while decreases by one when the "B" signal is going high.

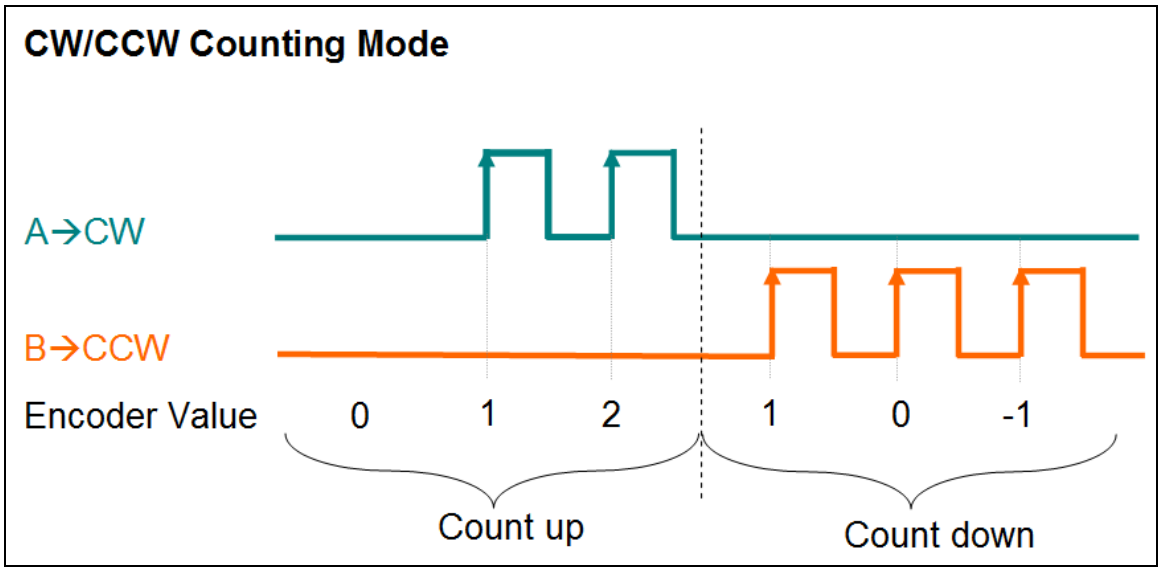



Figure 28: Clockwise/ Counterclockwise counting mode



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In the **quadrant counting mode** (Figure 29) the encoder counter increments when signal "A" leads signal "B" and decrements when signal "B" leads signal "A". For example if the last input signal for both "A" and "B" was off and in the next cycle "A" is on and "B" is off then the direction is clockwise and the counter increments by one, but if "A" is off and "B" is on then the direction is counterclockwise and the counter decrements by one. Both the rising and falling edges of "A" signal and "B" signal are counted.

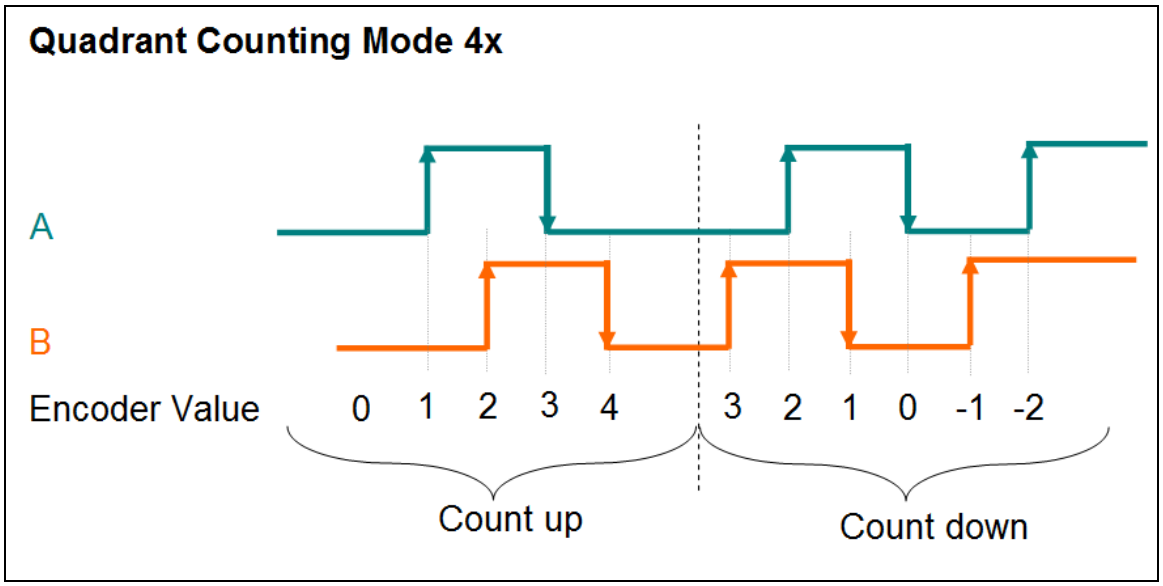



Figure 29: Quadrant counting mode

## 7.1.2 Signal Polarity Setting

### *7.1.2.1 Encoder Input Signal*

The polarity of the encoder A,B,C signal indicates the active level of the signal. The active level of the encoder A, B and C signals has to be set via CoE:

- "A" signal 0x80n0:01
- "B" signal 0x80n0:02
- "C" signal 0x80n0:03

n - represents the channel number (n= 0;1)

By changing the signal polarity of "A" and/or "B" the direction of counting may change. For example:

- By changing the signal "B" polarity which indicates the direction for the pulse/direction counting mode (Figure 27) the counting direction will change.
- By changing the polarity of signal "A" for the quadrant counting mode (Figure 29) results in a change of counting direction.
- Changing the signal polarity for the clockwise/counterclockwise mode will not



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change the counting direction

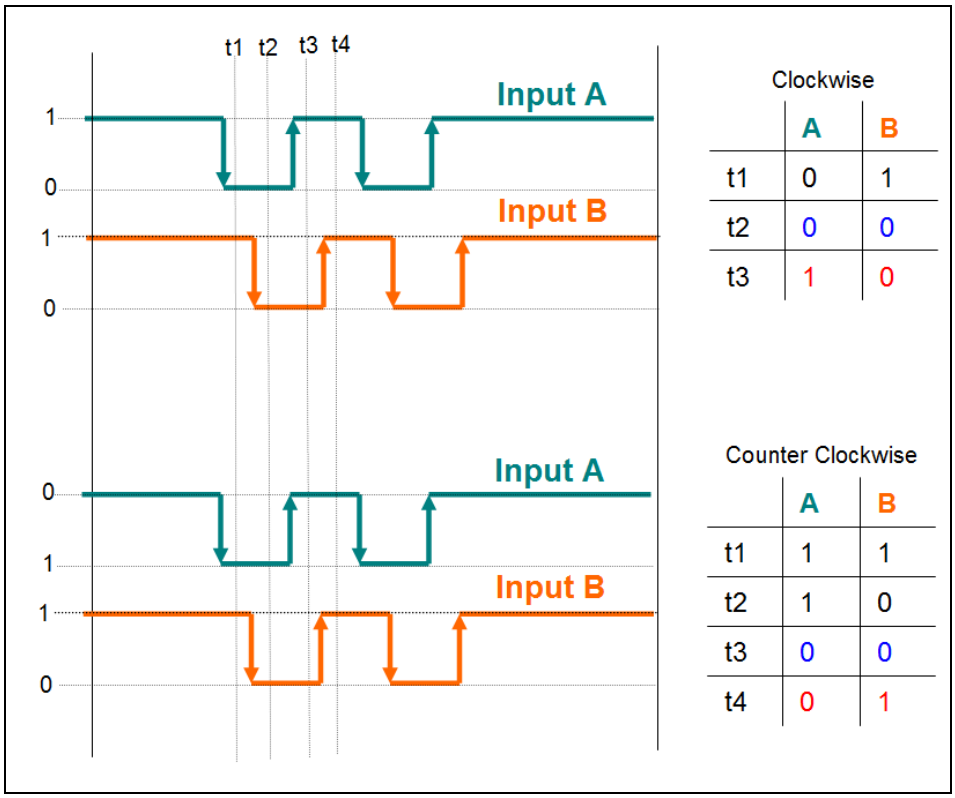



**Figure 30: Polarity change of input signal "A" inverts the counting direction**

#### *7.1.2.2 Extern Latch Input Signal*

The polarity of the extern latch signal (I) indicates whether a falling or rising edge will trigger a position latch or clear encoder counter action. The latch trigger edge has to be set as follows:

- Rising edge -->Active high
- Falling edge --> Active low

The trigger level of the extern latch signal has to be set via CoE (0x80n0:05, n= 0;1).
For position compare the input channel (I) can be used to directly enable/disable the compare output trigger.

NOTE: The trigger level for extern latch can not be set for each channel individually. Both channel need to be set to the same trigger level.



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### 7.1.3 Extern Latch Mode

Two latch modes are being supported (Table 6):

- Latch current encoder position
- Reset encoder counter to zero

| Latch Mode | Description |
|---|---|
| Latch encoder counter | The rising and falling edge signal at the I digital input channel triggers an encoder position latch.<br>Both captured positions, latched at the positive and negative edge, can be accessed via process data (0x60n1:01 and 0x60n1:02, n= 0;1) |
| Reset encoder counter | A positive trigger signal will immediately reset the encoder counter (0x60n0:11, n= 0;1) to zero.<br><br>Attention:<br>If the compare trigger function with auto-increment has been enabled and the encoder counter has been reset to zero via the I digital input channel then it is important to reset the compare function in order to update the compare position register. |

**Table 6: Latch mode**

The latch mode has to be set via CoE (0x80n0:05, n= 0;1).

Application for the latch function:

- Position capture
- Position measurement: the value difference between the rising and falling latched position indicates the distance the encoder counter moved between the rising and falling input signal (Figure 31).
- Homing



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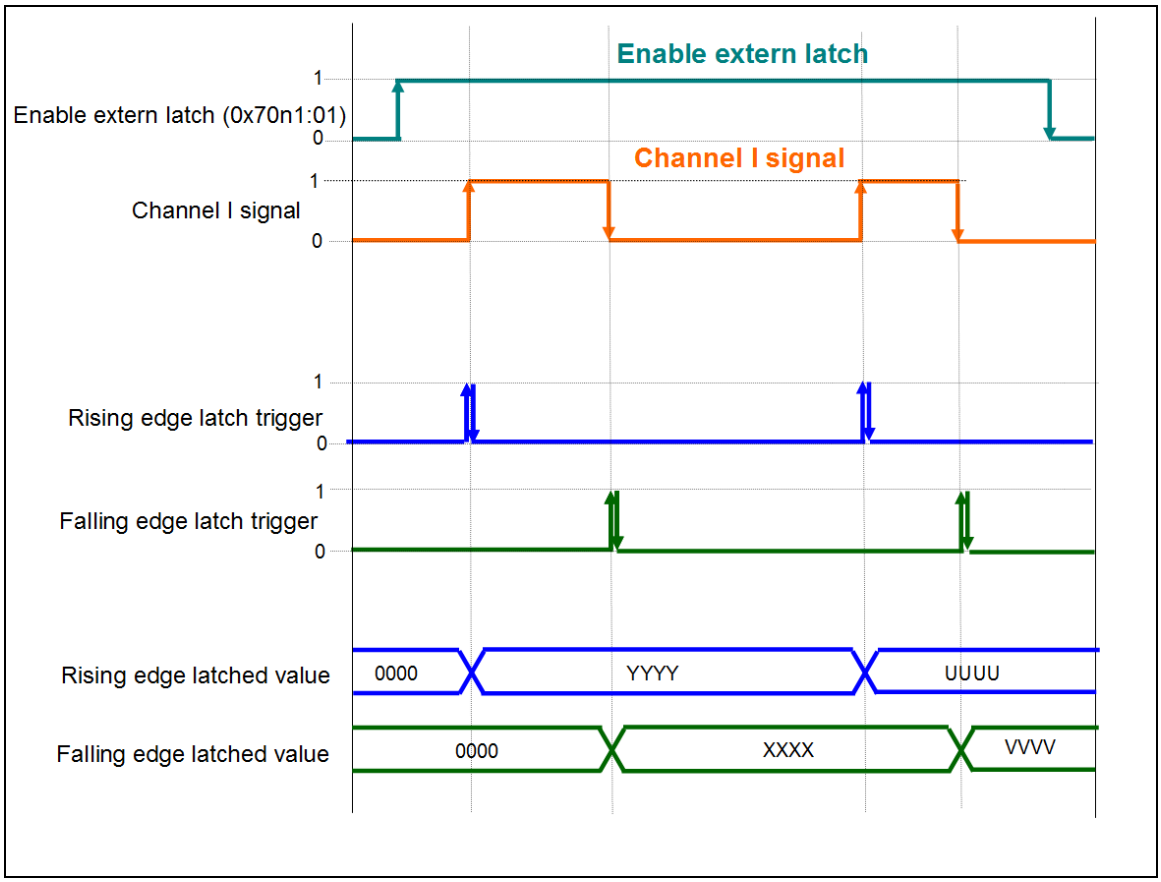



Figure 31: Rising and falling edge latch

### 7.1.4 Low Pass Filter Setting

Filters are for screening out noise from multiple inputs. The filter clock is used for sampling the input signal: if – and only if – two consecutive samples have the same value, the input is considered stable and the value is output from the filter. Table 7 list the filter clocks frequencies available for the EC4-ENC2IT.

| Low pass filter number | Maximum Input Frequency | |
|---|---|---|
| | Pulse/Direction counting mode<br>Clockwise/Counterclockwise mode | Quadrant counting mode |
| 0 | 4MHz (filter disabled) | 6MHz (filter disabled) |
| 1 | 4MHz | 1MHz |
| 2 | 2MHz | 500KHz |
| 3 | 1MHz | 250KHz |
| 4 | 640KHz | 160KHz |
| 5 | 320KHz | 80KHz |
| 6 | 160KHz | 40Hz |
| 7 | 80KHz | 20KHz |
| 8 | 40KHz | 10KHz |

Table 7: Filter clock frequencies



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The filter clock has to be set via CoE (0x80n0:0A, n= 0;1)

Make sure that the period of the filter clock is less than half of the pulse width of measured input signal (Table 8: H>2T ) otherwise the encoder counter may not count all the pulses of the incoming pulse train.

| Filter Setting | Filtering Status | |
|---|---|---|
| H > 2T | Correct | All input signals will pass the filter |
| T < H < 2T | Incorrect | Some valid input signals will be not pass the input filter and therefore are not being detected |
| H < T | Incorrect | The input signal will be filtered |
| H = the HIGH width of the input signal<br>T = the period of the filtering clock | | |

**Table 8: Low pass filter setting**

### 7.1.5 Position Compare Configuration

The compare trigger function generates an digital output pulse when the encoder counter reaches the compare position. Position compare operations and its pulse output trigger is directly executed by hardware and therefore without any time delay. The EC4-ENC2IT supports three types of compare:

- Single position compare
- Fixed distance auto-increment compare: The next compare position will be automatically set by incrementing the current compare position with a fixed distance.
- Position compare array: Each compare position can be individually set. Up to 200 compare values are supported for each encoder channel.

The position compare setting and configuration has to be done via the SDO 0x80n1 (n= 0;1). Only one compare type can be selected for each axis. For all three position compare types the trigger pulse width and the signal type have to be set.

#### *7.1.5.1 Compare Trigger Pulse Width*

The pulse width of the output signal can be set via CoE (0x80n1:01, n= 0;1). The unit is microseconds and valid values are 1 to 32767 (Table 9).



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| Pulse Width Setting | Actual Pulse Width (µSec) |
|---|---|
| 1 | 1 |
| ... | ... |
| 50 (default) | 50 |
| ... | ... |
| 32766 | 32766 |
| 32767 | 32767 |

**Table 9: Compare trigger pulse output width setting**

#### *7.1.5.2 Compare DO Trigger Signal Type*

Set the active level of the signal output generated by the DO channel when a position compare event is being triggered via CoE (0x80n1:02, n= 0;1). The default value is "Normal" (0).

#### *7.1.5.3 Compare Mode*

Two types of position compare modes are supported: Equidistant compare and array compare. For enabling single position compare and fixed distance auto-increment compare select "Equidist Compare Control Ch.n" (0x16n2, n=0; 1). Select "Array Compare Control Ch.n" (0x16n3, n=0; 1) for activating position compare array mode which uses an array or list of position values which have to be entered by the user via the CoE (0x2nxx:01, n=0; 2). EC4-ENC2IT can only support one of the two modes at a time.

The compare mode can be enabled in two ways:

1. Via PDO by setting the "Enable compare" variable of the PDO 0x16n2 (n= 0;1) or the PDO 0x16n3 (n= 0;1) to TRUE and in addition
2. via digital input (I)

In order to use the digital input (I) for activating the compare output trigger the "Activate compare via DI" parameter has to be enabled via CoE (0x80n1:03, n= 0;1). It is always necessary to first switch the device into compare mode by setting the "Enable compare" variable to TRUE even if the digital input (I) is being used for activating the compare mode. Therefore the digital input can only be used for switching the compare mode on or off after the compare mode of the specified channel has been activated.



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### *Number of Compare Position*

For the "Array Compare Control" mode a maximum number of 200 position per axis is being supported. The "Max number of compare positions" variable (SDO 0x80n1:0A, n= 0;1) allows the user to set the number of compare positions to be used for the compare operation. The compare position has to be set before the compare operation starts via the service data object 0x2nxx (n=0; 2):

- Channel 0: 0x2000 to 0x20C7
- Channel 1: 0x2200 to 0x22C7

The EC4-ENC2IT will only trigger a compare output if the encoder value reaches the position value in the exact same order as they are listed in the 0x2nxx objects. The first trigger position is always determined by the "Position" variable set in object 0x2n00, the second by 0x2n01, the third by 0x2n02, etc. For each object the "DO trigger" variable can be individually set. The variable has to be set to TRUE in order for the EC4-ENC2IT to trigger a digital output when the encoder counter reaches the position value. " Array compare start index" (80n1:0A) variable starts always from the first position 0x2n00 (n=0; 2).

For example:
If the variable "Array compare end index" (0x8001:0B) is set to 10 for channel 0 then the positions stored in the objects 0x2000 to 0x200A will be used for the compare operation (Figure 32). The EC4-ENC2IT will only trigger a DO signal at a compare position if the "DO trigger" variable in the 0x2xxx objects is set to TRUE. The encoder counter has to sequentially arrive at the position 0x2000 to 0x200A, that means the counter first has to reach the 0x2000 position before the next position 0x2001 will be activated for position compare. If the encoder counter reaches the 0x2001 value before 0x2000 value then the 0x2001 position will not be triggered. In Figure 32 the "DO trigger" variables in 0x2002, 0x2006 and 0x2007 are disable and therefore no DO signal will be triggered once the encoder counter passes the compare position.
When the encoder position has reached the last compare position (here point 0x200A) then the next compare position will start again with the position stored in 0x2000.

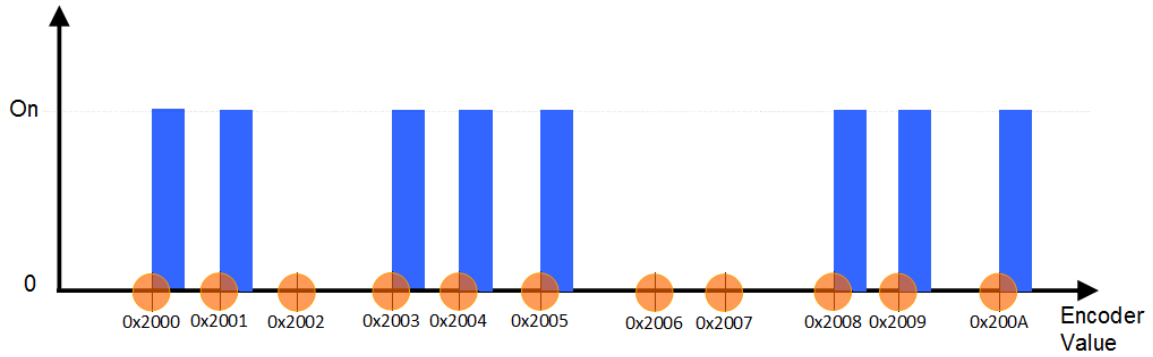



**Figure 32: Array of compare positions for channel 0**



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### 7.1.6 Velocity Calculation Setting

The time interval parameters of 0x8100 have to be set first (see 9.8 for details) before starting the velocity calculation.

First, set the global time interval multiplier " Basic Multiplier " (0x8100: 01) of each channel, whose unit is 0.5 milliseconds. When it is necessary to extend or shorten the time interval of all channels, it can be adjusted by changing the value of this parameter.

Second, set the time interval multiplier "CHn Multiplier " (0x8100 : 02+n, n = 0, 1) of individual channels, then the time interval Vel_dT of each channel is configured as:

$Vel_dT = T_{basic} \times T_{chn} \times 0.5 \times 10^{-3}$ sec, n= 0, 1.

Whereby $T_{basic}$ represents "Basic Multiplier", $T_{chn}$ represents "CHn Multiplier".

After that, the velocity V can be calculated from the variable Vel_dP, and the unit is pulses/sec:

V = Vel_dP / Vel_dT

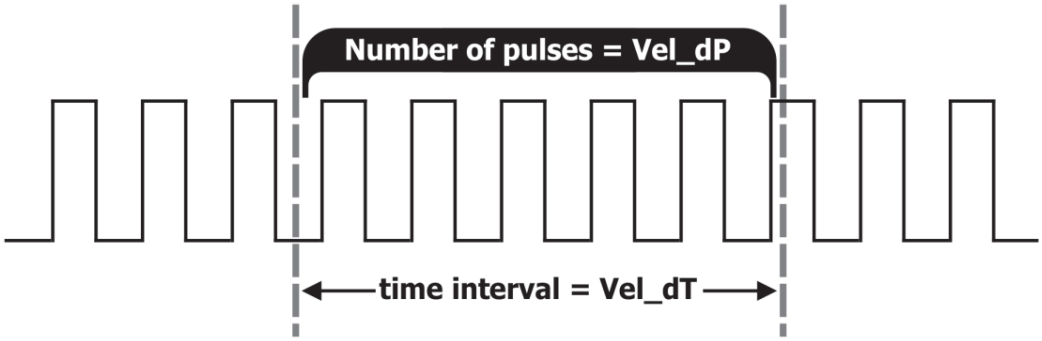



Figure 33: Variables for velocity calculation

### 7.1.7 Repeat Signal

Set whether to extend the signal (encoder input A,B,C ) of channel 0 to channel 1 via CoE (0x3000). The default value is "Disable" (0).
The usage of this function is to let the two channels refer to the same signal source, and then set the comparison trigger output respectively.

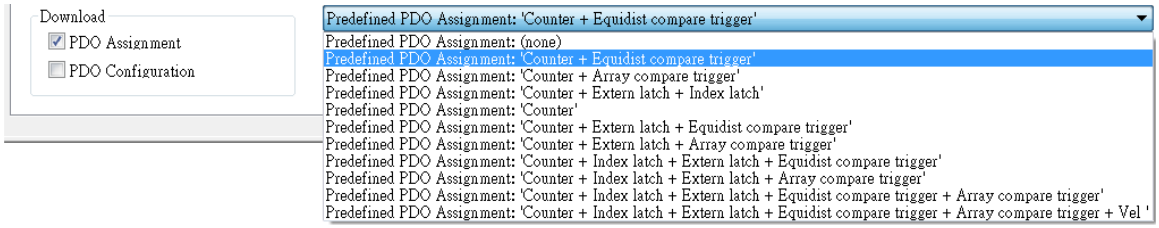


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## 7.2 Process Data Parameter

### 7.2.1 Counter

If the EC4-ENC2IT is being used for reading the encoder counter only then the following PDOs have to be selected: 0x16n0 and 0x1An0 (n= 0;1). By using TwinCAT the required PDO can be selected with one click by selecting the "Counter" from the predefined PDO assignment drop box.




The following table list and describes the parameter defined in the process data objects 0x16n0 and 0x1An0:

| 0x16n0 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Reset index latch value | 0x70n0:02 | Requires 0x1An3 to be assigned to the process data. Will be discussed in a later section) |
| Set counter | 0x70n0:04 | If "Set counter" changes its value from FALSE to TRUE then the encoder counter of the EC4-ENC2IT will be set to the value of "Set counter value" (0x70n0:09) . The "Set counter done" (0x60n0:01) will change from FALSE to TRUE to indicate that the counter has successfully been set to the new value. |
| Set counter value | 0x70n0:09 | The new value to the assigned to the encoder counter. Has to be set by the user. |

**Table 10: 0x16n0 - Process data sent to the EC4-ENC2IT**

| 0x1An0 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Set counter done | 0x60n0:01 | Indicates whether the "Encoder counter value" (0x60n0:11) has been assigned a new value. The user has to set the "Set counter" (0x70n0:04) from FALSE to TRUE in order to reset the encoder value to zero. |
| Reset index latch value done | 0x60n0:02 | Requires the 0x1An3 object to be added to the process data (will be discussed in the following section) |
| Signal of input A | 0x60n0:03 | Shows whether the "A" signal is high or low |
| Signal of input B | 0x60n0:04 | Shows whether the "B" signal is high or low |
| Signal of input C | 0x60n0:05 | Shows whether the "C" signal is high or low |



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| 0x1An0 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| | | |
| Signal of input I | 0x60n0:06 | Shows whether the "I" signal is high or low |
| Enable extern latch done | 0x60n0:07 | Requires the 0x16n1 and 0x1An1 to be added to the process data (will be discussed in the next section) |
| Reset extern latch value done | 0x60n0:08 | Requires the 0x16n1 and 0x1An1 to be added to the process data (will be discussed in the next section) |
| Enable equidist compare done | 0x60n0:09 | Requires the 0x16n2 and 0x1An2 to be added to the process data |
| Enable array compare done | 0x60n0:0A | Requires the 0x16n3 and 0x1An2 to be added to the process data |
| Enable compare via DI done | 0x60n0:0B | Position compare has been enabled via the digital input channel (I) |
| Next compare position active | 0x60n0:0C | Indicates whether the "Get next compare position" (0x1An2, n= 0; 1) value is active as the next compare position. |
| Sync error | 0x60n0:0F | This variable informs the user whether a synchronization error occurred in Distributed Clock (DC) mode during the previous cycle.<br>The master has to make sure that within each fixed time interval a datagram is being sent to the slave otherwise a synchronization error will be displayed |
| TxPDO Toggle | 0x60n0:10 | The slaves toggles this parameter each time TxPDO data has been updated |
| Actual counter value | 0x60n0:11 | Current encoder counter value |
| Index latched counter value | 0x60n0:12 | Requires the 0x1An3 object to be added to the process data |

**Table 11: 0x1An0 - Process data received from the EC4-ENC2IT**

The following flow diagram (Figure 34) shows the procedure for setting the encoder counter value.



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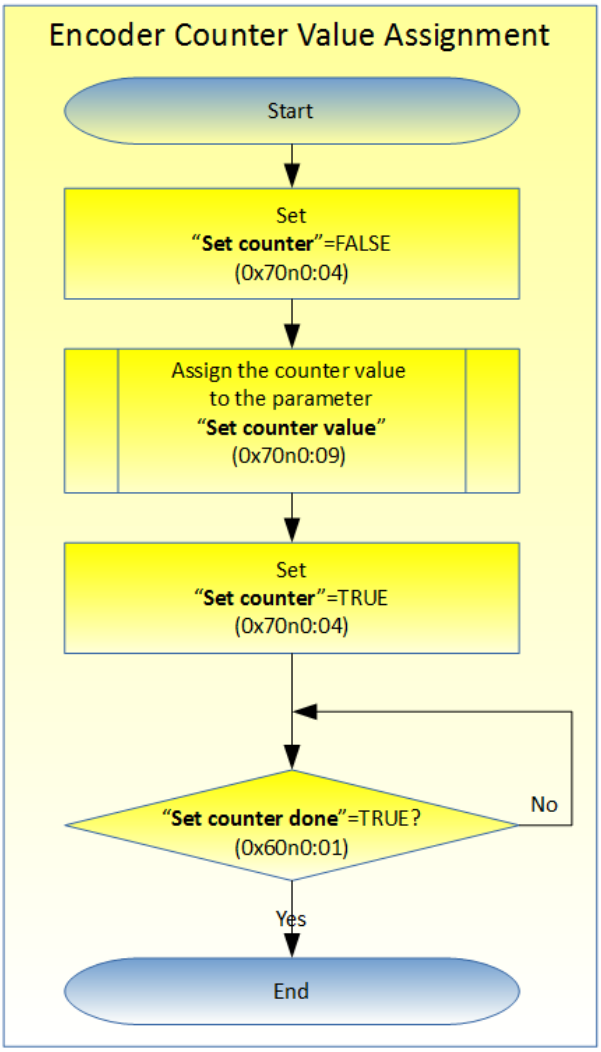



Figure 34: Encoder counter setting

### 7.2.2 Position Compare Trigger

The compare trigger function supports three modes: Single position compare, auto-increment position compare and array position compare.

- Single position compare: The user has to set one compare position at which a digital output signal will be triggered. The DO trigger will always be generate once the encoder counter reaches this position, regardless from which direction. The compare position can be altered by software at any time by following the procedure described in the first column of Table 15.
- Auto-increment position compare: Here the compare position will automatically be incremented by hardware once the current compare position has been reached. The compare function will trigger a signal output and increment the compare position if the current compare position has been approached from the configured direction. It



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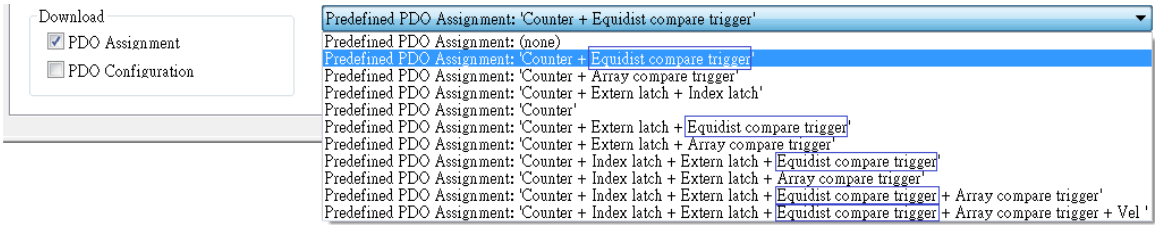
is important to reset the compare function by disabling/enabling it after the encoder counter has been set to a different value by the user.

- Array position compare: The position compare array type allows the operator to assign for each channel up to 200 position compare values in sequential order. The values has to be set via CoE (0x2nxx:01, n=0; 2). The compare function will trigger a digital output once the encoder counter has reached the position in the sequential order of the position array. Each value in the array can be individually enabled/disabled for triggering a digital output.

#### 7.2.2.1 Equidistant Compare Mode

This mode supports two types: Single position compare and auto-increment position compare

Process data required for doing equidistant position compare control: 0x16n0, 0x16n2, 0x1An0, 0x1An2 (n= 0;1). By using TwinCAT one of the predefined PDO Assignments which contains the "Equidist compare trigger" has to be selected.




The main variables of the process data objects 0x16n0 and 0x1An0 have already been described in the previous section therefore only the equidistant compare position parameters will be listed in the following tables.

| 0x16n2 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Enable compare | 0x70n2:01 | The compare function will be activated if the "Enable compare" parameter changes its value from FALSE to TRUE. It is necessary to first set the following variables before enabling the compare function:<br>▪ "Set auto increment compare direction"<br>▪ "Set first compare position"<br>▪ "Set auto increment compare value"<br>Once the compare function has been activated the "Enable equidist compare done" (0x60n0:08) value changes to TRUE.<br><br>If the encoder counter (0x60n0:11) has been reset or assigned a new value then the compare function needs to be reset by assigning FALSE/TRUE to the "Enable compare" variable. |



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| 0x16n2 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Set auto increment compare direction | 0x70n2:02 | Indicates the direction at which the encoder counter has to approach the compare value.<br>This variable is valid only if incremental-compare has been activated ("Set auto increment compare value" != 0)<br><br>Valid values:<br>▪ 0: positive direction<br>▪ 1: negative direction |
| Set first compare position | 0x70n2:07 | Position at which the first compare output signal will be triggered<br>EC4-ENC2IT supports two compare mode:<br>▪ Single compare position: In this mode the "Set first compare position" variable sets the position at which a compare output trigger will occur.<br>▪ Auto-increment compare: Here the "Set first compare position" indicates the first position at which a compare trigger event will be generated. The hardware will automatically set the next compare position by adding/subtracting the "Set auto increment compare value" (0x70n2:08) value to/from the "Set first compare position" value.<br><br>The user can always confirm the next compare position by reading the variable "Get next compare position" (0x60n2:01). This position is only valid if the "Next compare position active" (0x600n:0C) is true. |
| Set auto increment compare value | 0x70n2:08 | The value of this variable will be automatically added to the current compare position once it has been reached from the direction setup in "Set auto increment compare direction"<br><br>Disable auto-increment compare function by setting this variable to zero. |

**Table 12: 0x16n2 - Process data sent to the EC4-ENC2IT**

| 0x1An0 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Enable equidist compare done | 0x60n0:08 | Indicates whether the compare function has been activated (TRUE) or not (FALSE). |
| Enable compare via DI done | 0x60n0:0B | Indicates whether the position compare has been activated via digital input channel (I).<br>This parameter will turn true if the following three conditions are met:<br>• Use the digital input (I) for enabling compare "Activate compare via DI"= Enabled (0x80n1:03, n= 0;1)<br>• Compare mode has been enabled: "Enable equidist compare done" (0x60n0:09, n= 0;1) is TRUE<br>• Channel (I) has a digital input signal |

**Table 13: 0x1An0 - Process data received from the EC4-ENC2IT**



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| 0x1An2 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Get next compare position | 0x60n2:01 | Shows the value at which the next compare output will be triggered. This position is only valid if the "Next compare position active" (0x600n:0C) is TRUE. |

Table 14: 0x1An2 - Process data received from the EC4-ENC2IT

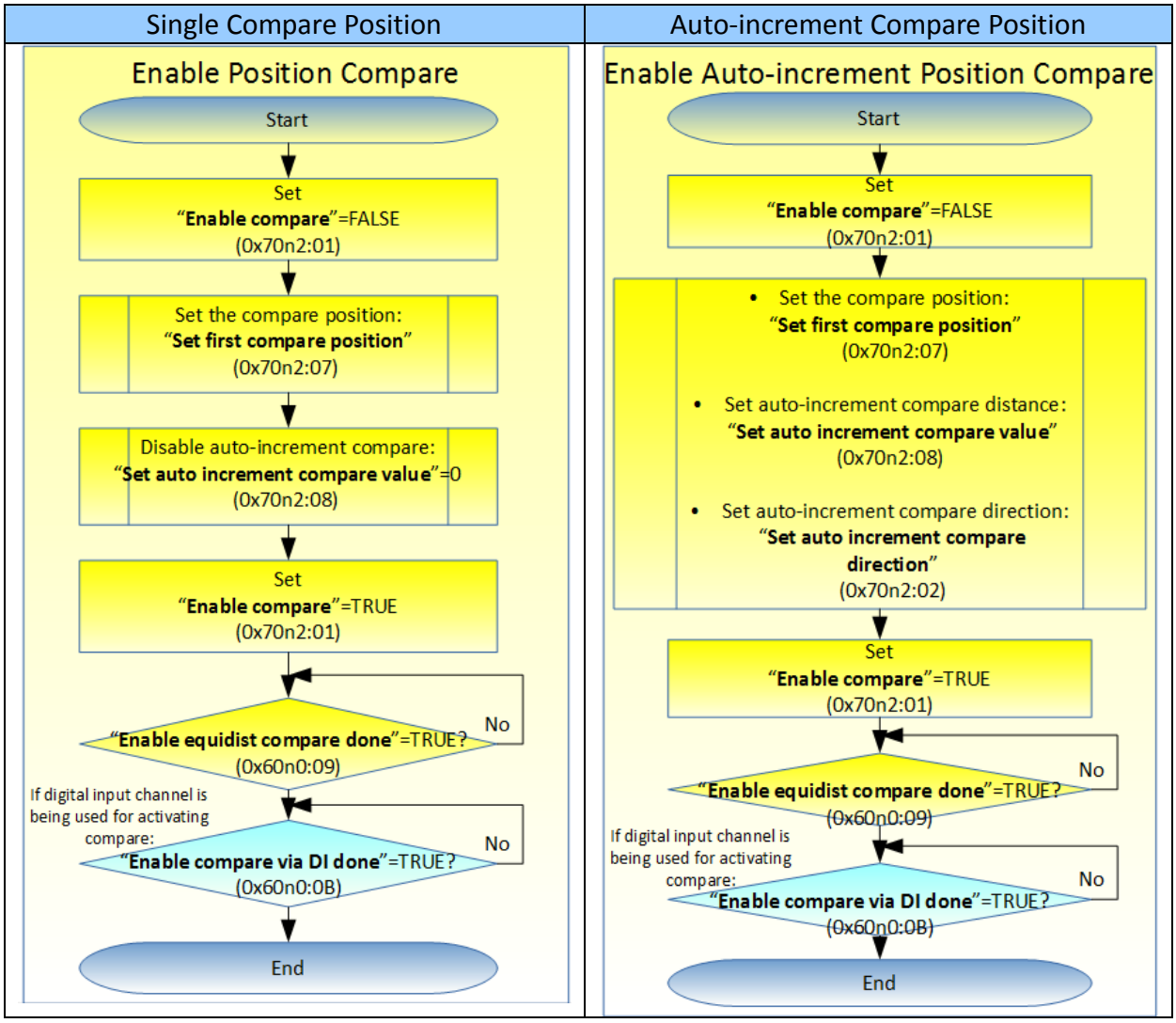


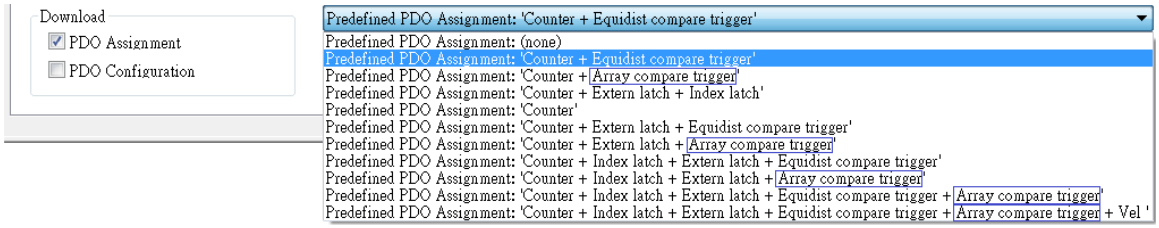

Table 15: Procedure for activating the equidistant compare function



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### 7.2.2.2 Array Compare Mode

Process data required for doing array position compare control: 0x16n0, 0x16n3, 0x1An0, 0x1An2 (n= 0;1). By using TwinCAT one of the predefined PDO Assignments which contains the "Array compare trigger" has to be selected.




The following tables describe the PDO parameters used for the array compare mode.

| 0x16n3 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Enable compare | 0x70n3:01 | The compare function will be activated if the "Enable compare" parameter changes its value from FALSE to TRUE.<br><br>The position compare values have to be set via CoE (0x2nxx:01, n=0; 2) before the "Enable compare" is set to TRUE.<br>Once the compare function has been activated the "Enable array compare done" (0x60n0:0A) value changes to TRUE. |

**Table 16: 0x16n3 - Process data sent to the EC4-ENC2IT**

| 0x1An0 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Enable array compare done | 0x60n0:09 | Indicates whether the compare function has been activated (TRUE) or not (FALSE). |
| Enable compare via DI done | 0x60n0:0B | Indicates whether the position compare has been activated via digital input channel (I).<br>This parameter will turn true if the following three conditions are met:<br>• Use the digital input (I) for enabling compare "Activate compare via DI"= Enabled (0x80n1:03, n= 0;1)<br>• Compare mode has been enabled: "Enable array compare done" (0x60n0:0A, n= 0;1) is TRUE<br>• Channel (I) has a digital input signal |

**Table 17: 0x1An0 - Process data received from the EC4-ENC2IT**



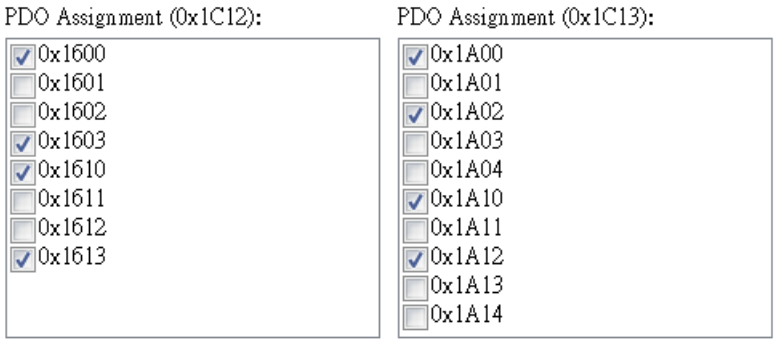
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| 0x1An2 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Get next compare position | 0x60n2:01 | Shows the value at which the next compare output will be triggered. This position is only valid if the "Next compare position active" (0x600n:0C) is TRUE. |

Table 18: 0x1An2 - Process data received from the EC4-ENC2IT

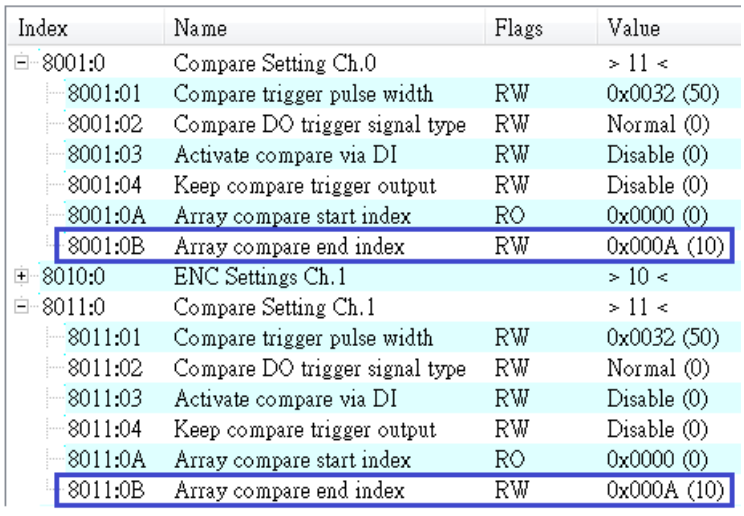
Procedure for configuring and activating the "Array compare" mode:

**Step 1:** Select the following PDO: 0x16n0, 0x16n3, 0x1An0, 0x1An2 (n= 0;1)




TwinCAT provides a function to directly select all necessary PDOs by clicking the "Predefined PDO Assignment" drop list as described above.

**Step 2:** Configure the compare properties via the SDO (0x80n1, n= 0;1). For array compare it is important to set the "Array compare end index" variable (SDO 0x80n1:0B, n= 0;1). This sets the quantity of position compare values to be used for the compare operation (Figure 35).



| Index | Name | Flags | Value |
|---|---|---|---|
| 8001:0 | Compare Setting Ch.0 | | > 11 < |
| 8001:01 | Compare trigger pulse width | RW | 0x0032 (50) |
| 8001:02 | Compare DO trigger signal type | RW | Normal (0) |
| 8001:03 | Activate compare via DI | RW | Disable (0) |
| 8001:04 | Keep compare trigger output | RW | Disable (0) |
| 8001:0A | Array compare start index | RO | 0x0000 (0) |
| 8001:0B | Array compare end index | RW | 0x000A (10) |
| 8010:0 | ENC Settings Ch.1 | | > 10 < |
| 8011:0 | Compare Setting Ch.1 | | > 11 < |
| 8011:01 | Compare trigger pulse width | RW | 0x0032 (50) |
| 8011:02 | Compare DO trigger signal type | RW | Normal (0) |
| 8011:03 | Activate compare via DI | RW | Disable (0) |
| 8011:04 | Keep compare trigger output | RW | Disable (0) |
| 8011:0A | Array compare start index | RO | 0x0000 (0) |
| 8011:0B | Array compare end index | RW | 0x000A (10) |

Figure 35: Compare mode and number of compare position



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**Step 3:** Assign an array of position values to the 0x2nxx:01 objects (n=0; 2) via CoE. Each object stores one position value and a "DO trigger" flag which indicates whether a digital output will be triggered if the encoder value reaches this position value. The first compare value has to be stored in object 0x2n00, the second in object 0x2n01, the third in object 0x2n02, etc.. The sequence of the position values are important as the EC4-ENC2IT always considers the value stored in object 0x2n00 as the first compare position and it remains in the compare register until the encoder counter reaches this position before using the object 0x2n01 value as the next compare position.

Example:
In Figure 36 the compare values for encoder channel 0 are set to 150, 250, 350, 500, 600, 750, 900, 1000, 1200, 1300 and 1450. The "DO Trigger" flag for objects 0x2002:02, 0x2006:02 and 0x2007:02 are disabled therefore no digital output will be triggered for these positions (Figure 37).



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| Index | Name | Flags | Value |
|---|---|---|---|
| 2000:0 | Ch.0 Compare Pos.0 | | > 2 < |
| 2000:01 | Position | RW | 150 |
| 2000:02 | DO trigger | RW | Enable (1) |
| 2001:0 | Ch.0 Compare Pos.1 | | > 2 < |
| 2001:01 | Position | RW | 250 |
| 2001:02 | DO trigger | RW | Enable (1) |
| 2002:0 | Ch.0 Compare Pos.2 | | > 2 < |
| 2002:01 | Position | RW | 350 |
| 2002:02 | DO trigger | RW | Disable (0) |
| 2003:0 | Ch.0 Compare Pos.3 | | > 2 < |
| 2003:01 | Position | RW | 500 |
| 2003:02 | DO trigger | RW | Enable (1) |
| 2004:0 | Ch.0 Compare Pos.4 | | > 2 < |
| 2004:01 | Position | RW | 600 |
| 2004:02 | DO trigger | RW | Enable (1) |
| 2005:0 | Ch.0 Compare Pos.5 | | > 2 < |
| 2005:01 | Position | RW | 750 |
| 2005:02 | DO trigger | RW | Enable (1) |
| 2006:0 | Ch.0 Compare Pos.6 | | > 2 < |
| 2006:01 | Position | RW | 900 |
| 2006:02 | DO trigger | RW | Disable (0) |
| 2007:0 | Ch.0 Compare Pos.7 | | > 2 < |
| 2007:01 | Position | RW | 1000 |
| 2007:02 | DO trigger | RW | Disable (0) |
| 2008:0 | Ch.0 Compare Pos.8 | | > 2 < |
| 2008:01 | Position | RW | 1200 |
| 2008:02 | DO trigger | RW | Enable (1) |
| 2009:0 | Ch.0 Compare Pos.9 | | > 2 < |
| 2009:01 | Position | RW | 1300 |
| 2009:02 | DO trigger | RW | Enable (1) |
| 200A:0 | Ch.0 Compare Pos.10 | | > 2 < |
| 200A:01 | Position | RW | 1450 |
| 200A:02 | DO trigger | RW | Enable (1) |

**Figure 36: User defined compare positions**

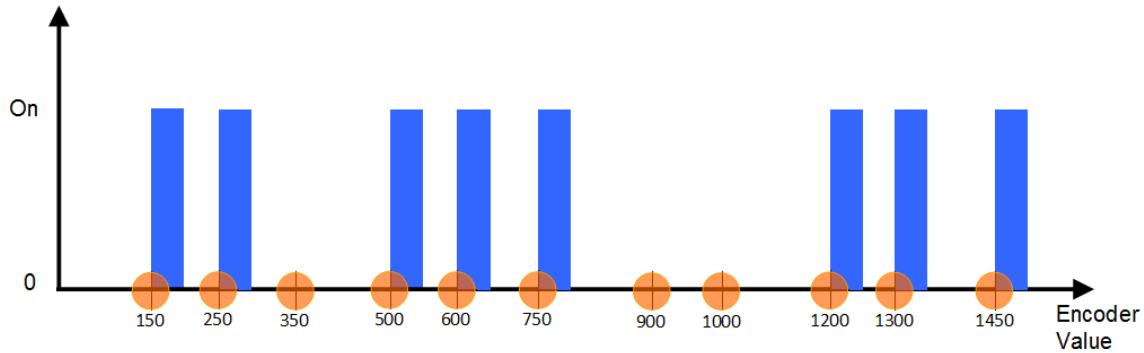



**Figure 37: Compare position with DO trigger settings**



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**Step 4:** Set the slave in Op mode and enable the compare function by setting the "Enable compare" (0x70n3:01, n=0;1) variable to TRUE (Figure 38).

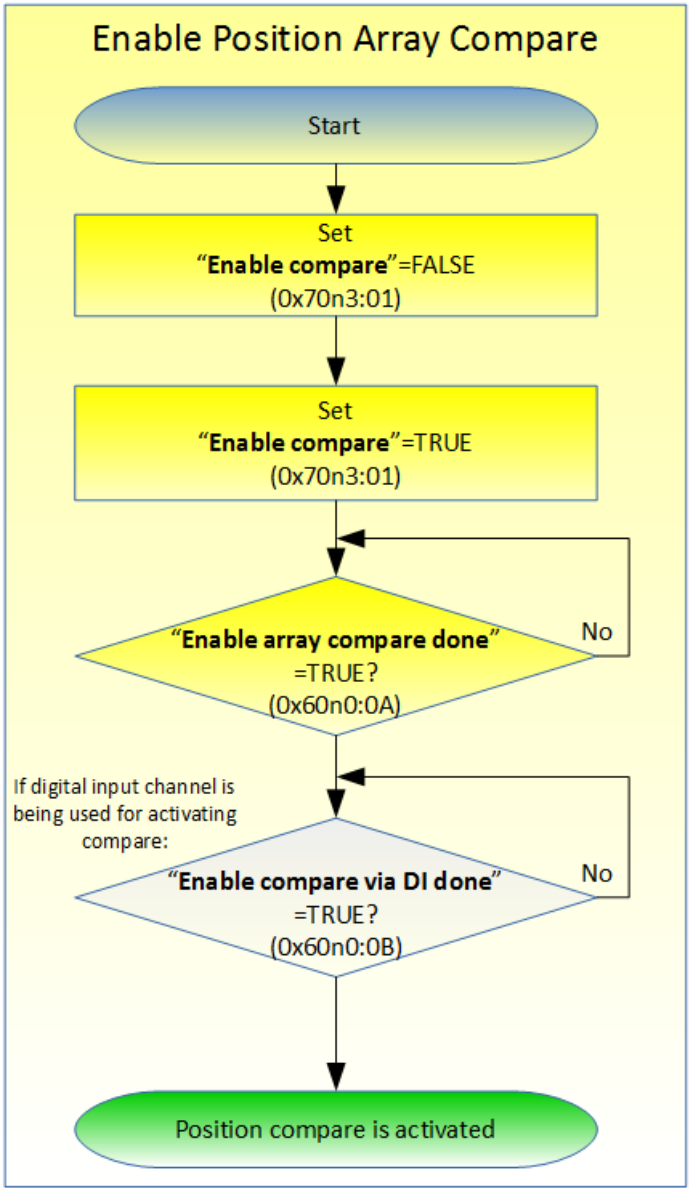



**Figure 38:Procedure for activating the array compare function**



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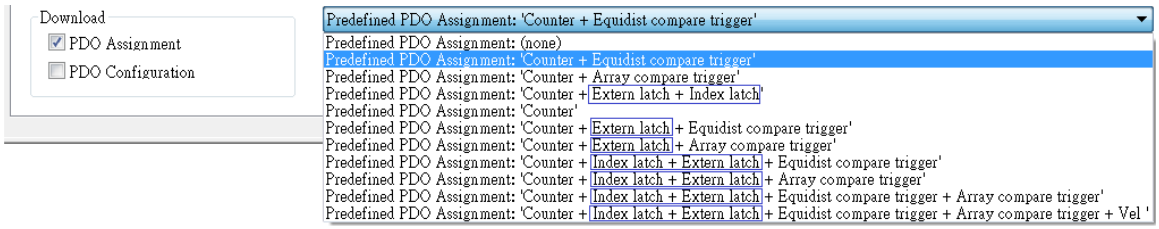
### 7.2.3 Index and Extern Latch

The EC4-ENC2IT has got two latch inputs for each encoder channel: Index "C" and extern "I" latch.

- Index latch: The index latch is always enabled and can not be disabled. A index signal triggers a hardware latch of the current encoder counter. The EC4-ENC2IT allows the index latched value to be reset to zero. Assign the 0x1An3 object to the process data for reading the latched counter value.
- Extern latch: The extern latch function supports two modes:
  - Reset encoder counter: The encoder counter is reset to zero once the extern "I" signal has been triggered
  - Latch encoder counter: This mode captures and stores two latch values. A rising and falling edge input signal at the "I" channel triggers a hardware latch of the current encoder value.

  The extern latch function is by default disabled and has to be enabled prior to the latch operation.
  Assign the objects 0x1An1 and 0x16n1 to the process data.

TwinCAT allows the selection of the latch object by selecting one of the predefined PDO assignment which contains the "Index latch" or "Extern latch" keywords from the list box:




The following tables describes the status and assignment parameters of both index and extern latch.

| 0x16n0 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Reset index latch value | 0x70n0:02 | When this variable turns from FALSE to TRUE then the index latch value will be cleared (set to zero). The status variable "Reset index latch value done" (0x60n0:02) will become TRUE once the action has been finished. |

**Table 19: 0x16n0 - Process data sent to the EC4-ENC2IT**



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| 0x16n1 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Enable extern latch | 0x70n1:01 | If this variable turns from FALSE to TRUE then the extern latch will be activated. The status variable "Enable extern latch done" (0x60n0:06) will become TRUE once the extern latch has been enabled.<br>If this variable turns from FALSE to TRUE then both latch parameters "Rising edge latched value" (0x60n1:01) and "Falling edge latched value" (0x60n1:02) are reset to zero. |
| Reset extern latch value | 0x70n1:02 | If this variable turns from FALSE to TRUE then the extern latch parameters "Rising edge latched value" (0x60n1:01) and "Falling edge latched value" (0x60n1:02) will be reset to zero. The status variable "Reset extern latch counter done" (0x60n0:07) will be TRUE once the extern latch register has been reset. |

**Table 20: 0x16n1 - Process data sent to the EC4-ENC2IT**

| 0x1An0 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Reset index latch value done | 0x60n0:02 | Indicates whether the index latch value has been reset to zero. This parameter shows the response of the slave to the "Reset index latch value" (0x70n0:02) input.<br><br>The parameter is FALSE if<br>▪ the "Reset index latch value" (0x70n0:02) is set to FALSE<br>▪ the firmware is busy resetting the index latch value<br><br>The parameter is TRUE if the "Reset index latch value" (0x70n0:02) has been set to TRUE and the index value has successfully been set to zero |
| Enable extern latch done | 0x60n0:07 | Indicates whether the extern "I" latch has been enabled. This parameter shows the response of the slave to the "Enable extern latch" (0x70n1:01) input. |
| Reset extern latch counter done | 0x60n0:08 | Indicates whether the extern latch register has been reset to zero. This parameter shows the response of the slave to the "Reset extern latch value" (0x70n1:02) input. |

**Table 21: 0x1An0 - Process data received from the EC4-ENC2IT**



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| 0x1An1 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Rising edge latched value | 0x60n1:01 | ▪ Encoder value latched by the rising edge of the external signal at channel "I".<br>▪ The trigger level has to be set for both encoder channel together ("I signal polarity", 0x80n0:04 )<br>▪ The value is valid only if<br>• the extern latch function has been enabled ("Enable extern latch done", 0x60n0:06)<br>• the extern latch has been set to "Latch encoder counter" mode. This has to be set via "Extern latch mode" (0x80n0:05) |
| Falling edge latched value | 0x60n2:01 | ▪ Encoder value latched by the falling edge of the external signal at channel "I".<br>▪ The trigger level has to be set for both encoder channel together ("I signal polarity", 0x80n0:04 )<br>▪ The value is valid only if<br>• the extern latch function has been enabled ("Enable extern latch done", 0x60n0:06)<br>• the extern latch has been set to "Latch encoder counter" mode. This has to be set via "Extern latch mode" (0x80n0:05) |

**Table 22: 0x1An1 - Process data received from the EC4-ENC2IT**

| 0x1An3 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Index latched counter value | 0x60n0:12 | Encoder value latched by the index signal "C". The encoder value will be latched at a rising or falling edge of the index input signal. The trigger edge can be set for each channel individually ("C signal polarity", 0x80n0:03) |

**Table 23: 0x1An3 - Process data received from the EC4-ENC2IT**



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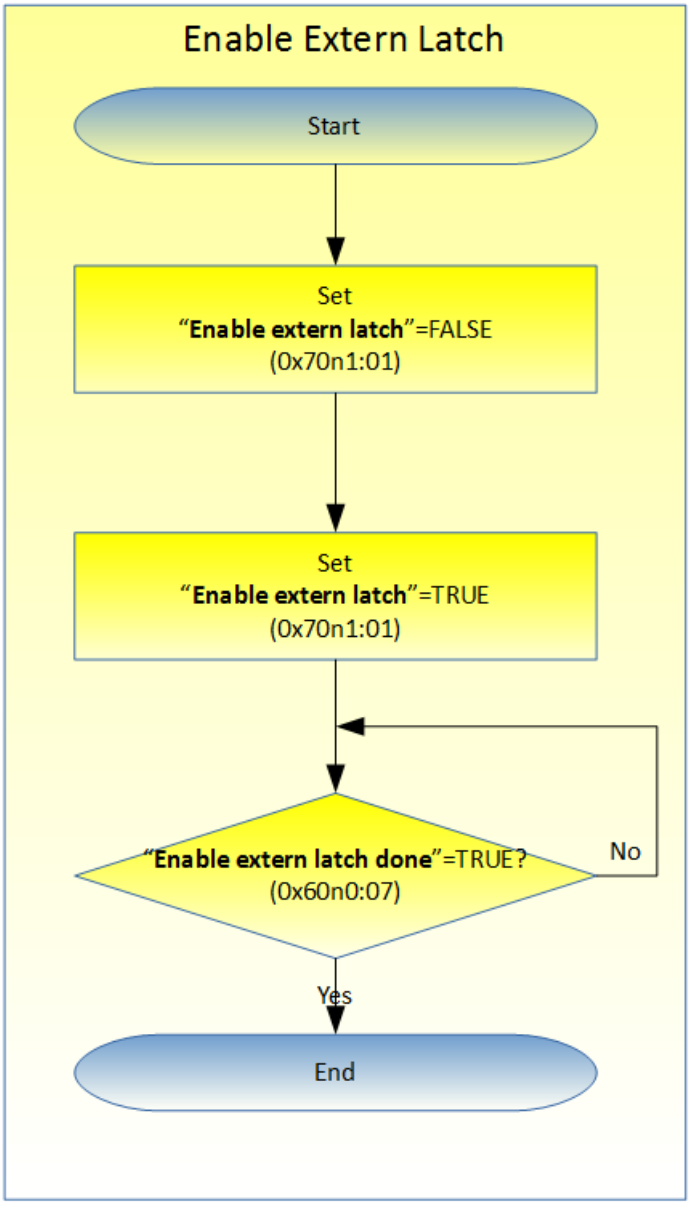



Figure 39: Activating external "I" latch



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The following table (Table 24) shows the procedure for resetting the index and extern latch value to zero.

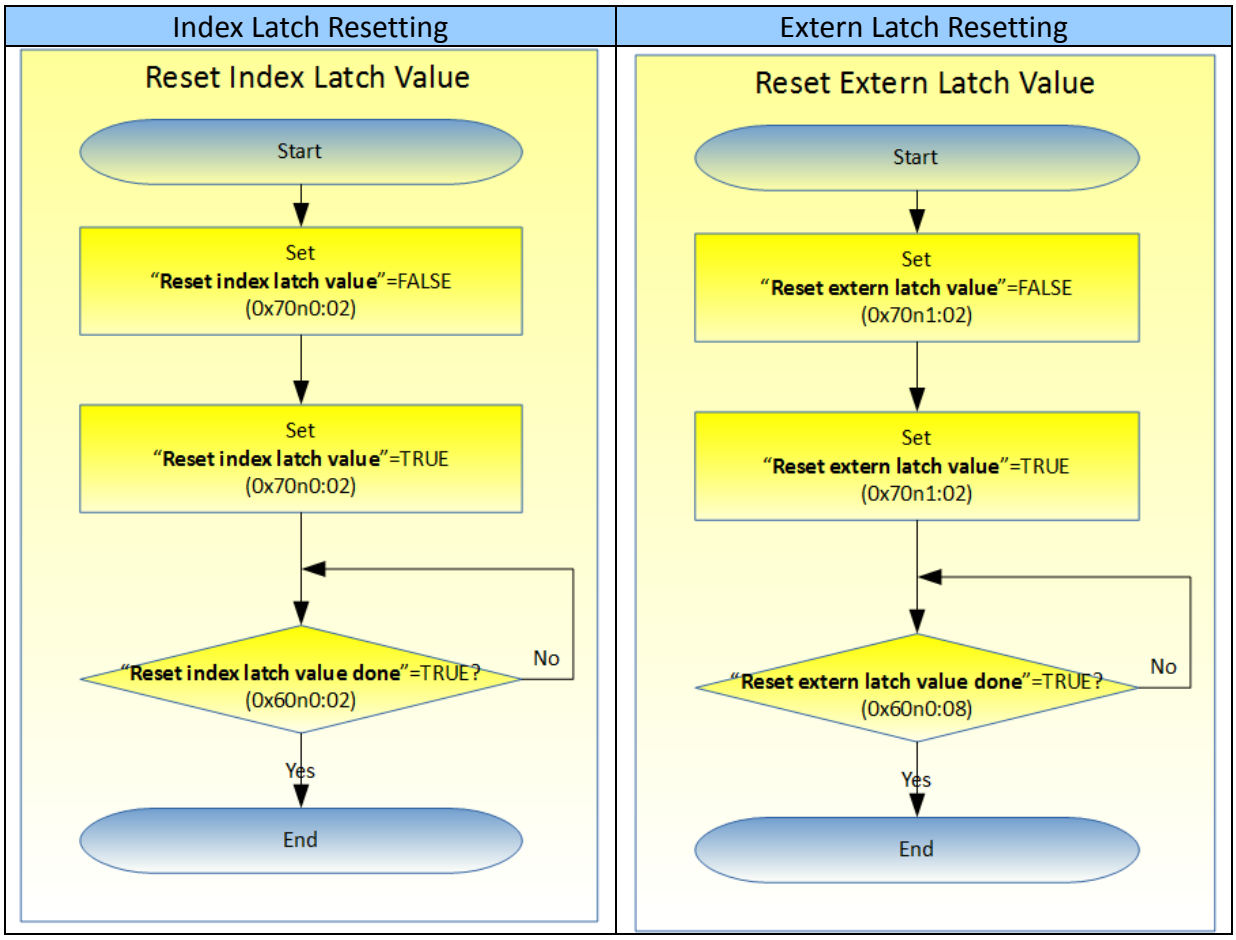


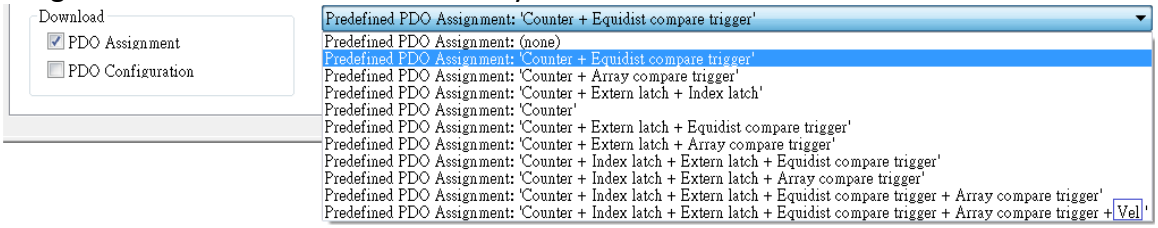

**Table 24: Resetting latch register procedure**



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### 7.2.4 Velocity Calculation

The EC4-ENC2IT provides velocity calculation functionality for each encoder channel. TwinCAT allows the selection of the velocity status object by selecting a predefined PDO assignment which contains the "Vel" keywords from the list box:

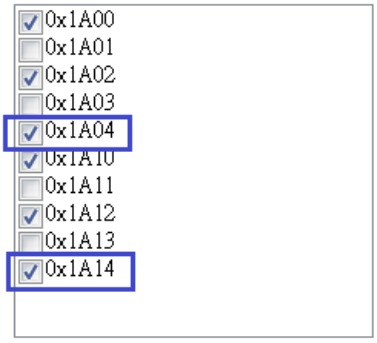



Alternatively, the user can add the velocity status object to the process data by selecting the PDO object: 0x1An4, (n= 0;1) in PDO Assignment (0x1C13).

PDO List:

| Index | Size | Name | Flags | SM | SU |
|---|---|---|---|---|---|
| 0x1A00 | 6.0 | ENC Status Ch.0 | F | 3 | 0 |
| 0x1A01 | 8.0 | Extern Latch Status Ch.0 | F | | 0 |
| 0x1A02 | 4.0 | Compare Trigger Status Ch.0 | F | 3 | 0 |
| 0x1A03 | 4.0 | Index Latch Status Ch.0 | F | | 0 |
| 0x1A04 | 2.0 | ENC VEL Status Ch.0 | F | | 0 |
| 0x1A10 | 6.0 | ENC Status Ch.1 | F | 3 | 0 |
| 0x1A11 | 8.0 | Extern Latch Status Ch.1 | F | | 0 |
| 0x1A12 | 4.0 | Compare Trigger Status Ch.1 | F | 3 | 0 |
| 0x1A13 | 4.0 | Index Latch Status Ch.1 | F | | 0 |
| 0x1A14 | 2.0 | ENC VEL Status Ch.1 | F | | 0 |

PDO Assignment (0x1C13):




The following tables describe the PDO parameter used for velocity calculation.

| 0x1An4 (n= 0;1) | | |
|---|---|---|
| Parameter | Object | Description |
| Vel_dP | 0x60n3:01 | Position difference per time interval for velocity calculation |

**Table 25: 0x1An4 - Process data received from the EC4-ENC2IT**

Vel_dP is the position difference per time interval described in chapter 7.1.6.
If the time interval basic multiplier "Basic Multiplier" (0x8100: 01) and the time interval multiplier "CHn Multiplier" (0x8100: 02+n, n = 0, 1) of a channel are both default values, the Vel_dP of the channel is the position difference per 1 millisecond.



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# 8 CoE Interface

## 8.1 General Description

The CoE interface (CANopen over EtherCAT) is used for parameter management of EtherCAT devices. The CoE interface displays all the objects and parameters which are required for operating and diagnosing the EC4-ENC2IT device. Some parameters are fixed and can not be modified, they for example indicate the operating status of the device or the device properties. Encoder configuration parameters need to be set before the actual motion control starts. These parameter setting are determined by the encoder type and the setup of the system.

CoE parameters has to be accessed via the CAN over EtherCAT protocol. The EtherCAT master accesses the local CoE lists of the slaves via CAN over EtherCAT. The user does not need to understand the CoE protocol when using the TwinCAT System Manager for CoE parameter configuration.

The CoE parameters describe a wide range of features such as manufacturer ID, device name, process data settings and configuration parameters.

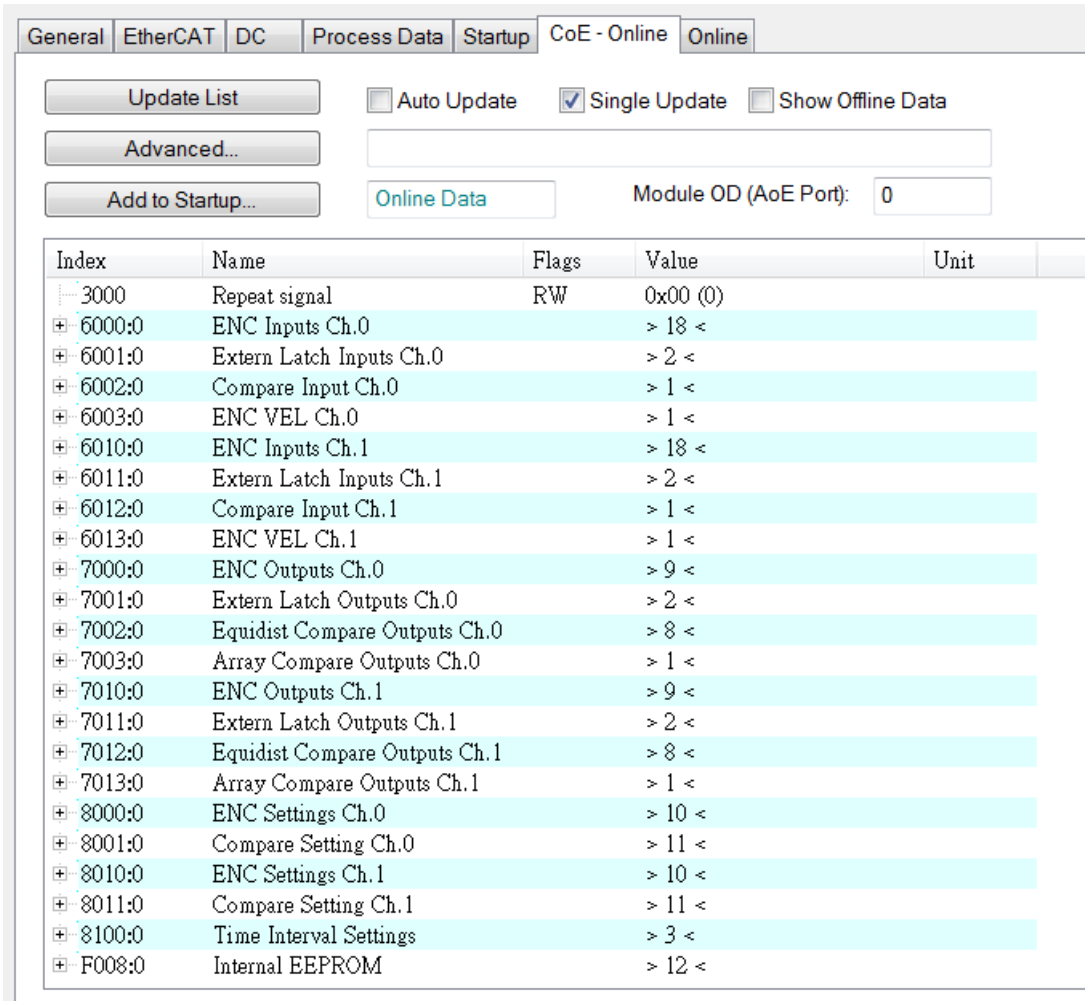
The relevant ranges of the CoE list are:

- 0x1000: Stores fixed information of the device, including name, manufacturer, serial number etc.. In addition stores information about the current and available process data configurations.
  - 0x1600: RxPDO mapping
  - 0x1A00: TxPDO mapping
- 0x2000: Stores the compare position values for the array compare mode
- 0x3000: Set whether to extend the signal of channel 0 to channel 1
- 0x8000: Stores all the configuration data which are required for the encoder counter.
- 0x6000: Input PDOs ("input" from the perspective of the EtherCAT master)
- 0x7000: Output PDOs ("output" from the perspective of the EtherCAT master)

The Figure 40 shows part of the CoE objects available for the EC4-ENC2IT device, ranging from 0x3000 to 0xF008. The parameters of the objects can be accessed by expanding the tree in the "CoE-Online" tab. The objects and their properties are described in chapter 9.



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| Index | Name | Flags | Value | Unit |
|---|---|---|---|---|
| 3000 | Repeat signal | RW | 0x00 (0) | |
| 6000:0 | ENC Inputs Ch.0 | | > 18 < | |
| 6001:0 | Extern Latch Inputs Ch.0 | | > 2 < | |
| 6002:0 | Compare Input Ch.0 | | > 1 < | |
| 6003:0 | ENC VEL Ch.0 | | > 1 < | |
| 6010:0 | ENC Inputs Ch.1 | | > 18 < | |
| 6011:0 | Extern Latch Inputs Ch.1 | | > 2 < | |
| 6012:0 | Compare Input Ch.1 | | > 1 < | |
| 6013:0 | ENC VEL Ch.1 | | > 1 < | |
| 7000:0 | ENC Outputs Ch.0 | | > 9 < | |
| 7001:0 | Extern Latch Outputs Ch.0 | | > 2 < | |
| 7002:0 | Equidist Compare Outputs Ch.0 | | > 8 < | |
| 7003:0 | Array Compare Outputs Ch.0 | | > 1 < | |
| 7010:0 | ENC Outputs Ch.1 | | > 9 < | |
| 7011:0 | Extern Latch Outputs Ch.1 | | > 2 < | |
| 7012:0 | Equidist Compare Outputs Ch.1 | | > 8 < | |
| 7013:0 | Array Compare Outputs Ch.1 | | > 1 < | |
| 8000:0 | ENC Settings Ch.0 | | > 10 < | |
| 8001:0 | Compare Setting Ch.0 | | > 11 < | |
| 8010:0 | ENC Settings Ch.1 | | > 10 < | |
| 8011:0 | Compare Setting Ch.1 | | > 11 < | |
| 8100:0 | Time Interval Settings | | > 3 < | |
| F008:0 | Internal EEPROM | | > 12 < | |

Figure 40: "CoE - Online " tab

## 8.2 Save Data to Memory

In this section the procedure of saving configuration parameters to the non-volatile memory of the EC4-ENC2IT is being discussed.

### 8.2.1 Save Configuration Data

The CoE objects 0x80n0, 0x80n1 (n=0;1) contain all the parameters needed to configure the EC4-ENC2IT. The 0x80n0 objects main purpose is the encoder counter and the latch channel configuration and the 0x80n1 objects is for position compare setting. TwinCAT allows the user to set the configuration parameters via the System Manager (Figure 40) or from a TwinCAT PLC via ADS (TcEtherCAT.lib library).

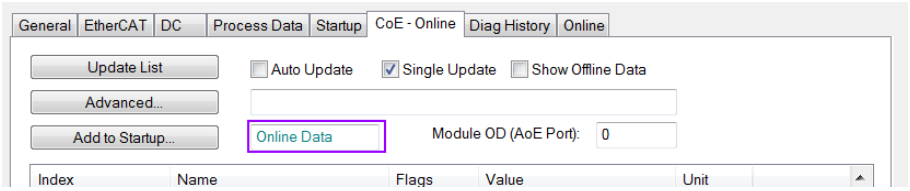


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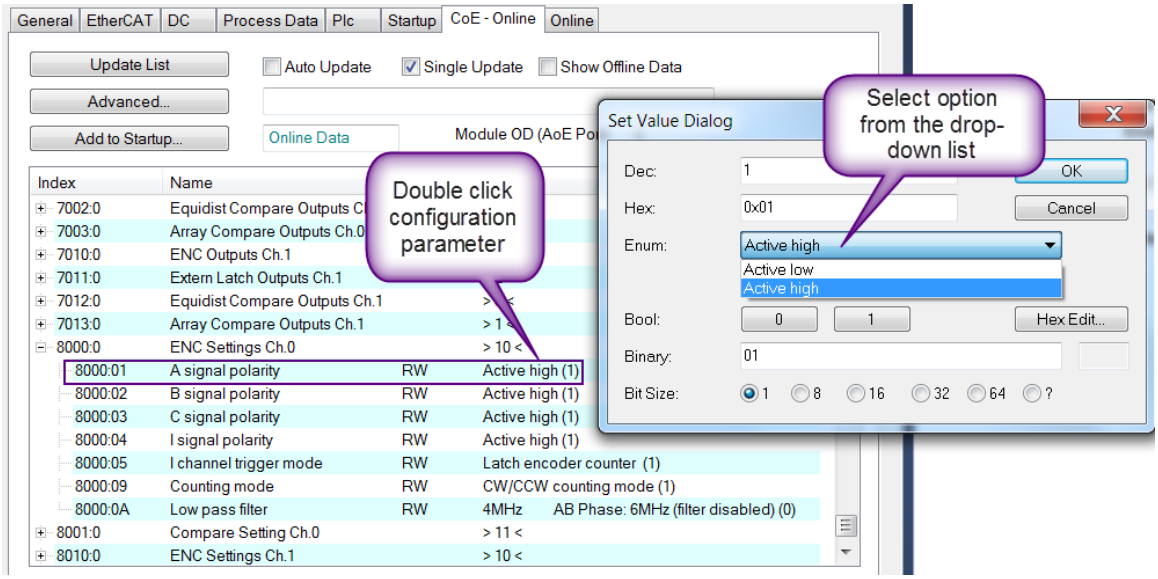
If the CoE parameters of the EC4-ENC2IT are set online, then the device does not automatically store the data to its non-volatile memory, and therefore the data will be lost once the device is switched off. The 0xF008 object provides functions to store the configuration data permanently to the non-volatile memory of the EC4-ENC2IT and the setting will be immediately available immediately after a restart.

Procedure for storing configuration data to the local EC4-ENC2IT memory:

**Step 1:** Make sure the TwinCAT System Manager is connected to the EC4-ENC2IT and the "CoE-Online" tab is showing that the slave is online.



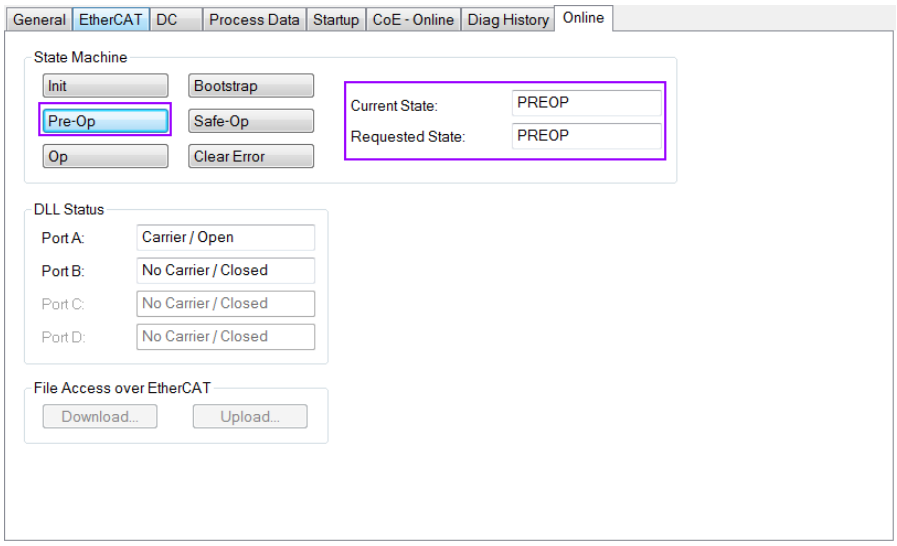

**Step 2:** Do all the necessary configuration by entering the correct parameter values for the configuration objects (0x80n0, 0x80n1 (n=0;1)). The setting is being done by double clicking the configuration parameter and selecting an option from the shown drop list box . In the following picture the signal polarity of the A signal of encoder channel 0 is being set.




**Step 3:** After all the configurations have been done set the slave into Pre-Op mode. Data can only be stored to the local device if it is in Pre-Op mode. On the "Online" tab click the "Pre-OP" button to put the slave into Pre-OP mode.



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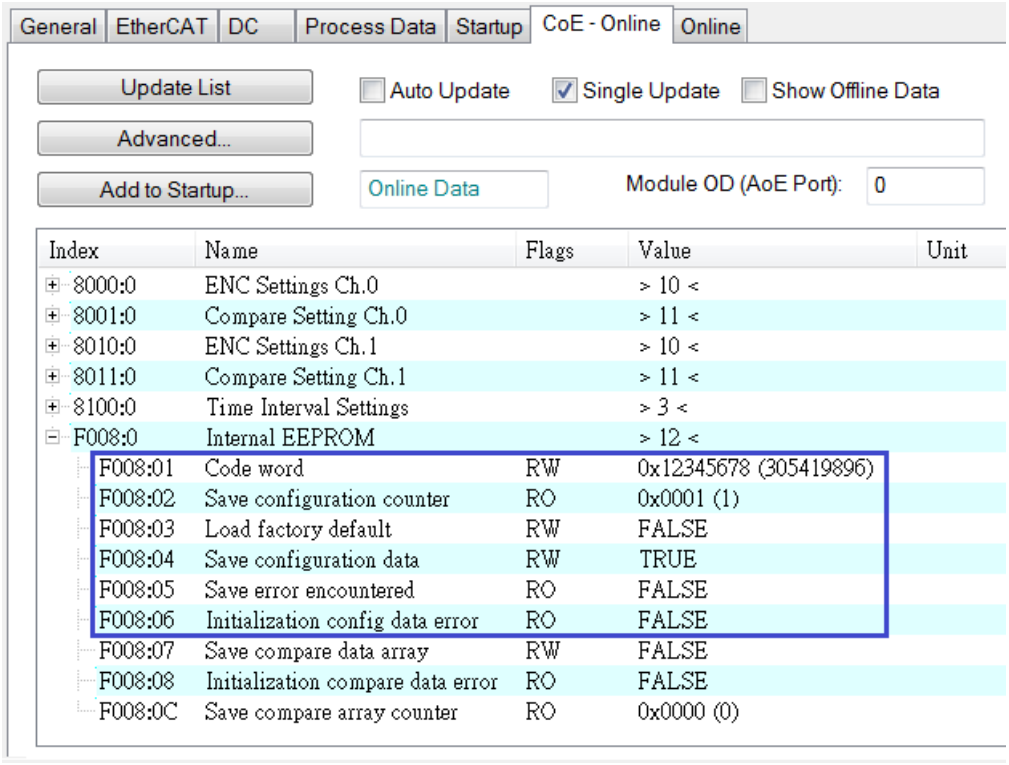

**Step 4:** The parameters of the 0xF008 object handles the save procedure.

1. Scroll to the end of the "CoE-Online" list and expand the tree view of the 0xF008 object
2. Enter the value 0x12345678 for the "Code Word"
3. Set the "Save configuration data" from FALSE to TRUE in order to save the configuration data (0x80n0, 0x80n1 (n=0;1)) to the internal EEPROM. The parameter "Save error encountered" (F008:05) indicates whether an error occurred during the save process.
4. In order for the configuration data to be loaded after a device restart set the "Load factory default" to FALSE. It is always possible to return to the factory default setting by setting this value back to TRUE.
5. The "Save configuration counter" (F008:02) shows how often configuration data has been stored to the local memory in the lifetime of the device.
6. If the EC4-ENC2IT has not been correctly initialized with the saved configuration data after the module has been switch on then the "Initialization config data error" (F008:06) flag shows TRUE.

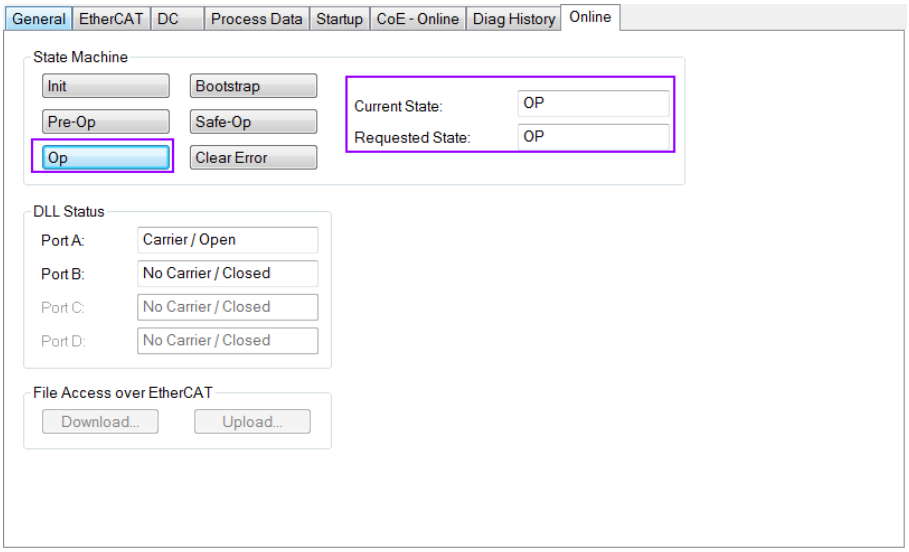
   ATTENTION:
   The local memory only supports a limited number of save operations. Depending on the memory version once the save operation exceeds 10000 cycles it can no longer be guaranteed that data are reliably saved or are still readable. Therefore the "Save configuration data" (F008:04) and the "Load factory default" (F008:03) should not be continuously set from the controlling application program.



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**Step 5:** Set the EC4-ENC2IT back into OP mode.




## 8.2.2 Save Position Compare Values

The position compare value are being used for the array compare mode. The position values have to set via the CoE (0x2nxx:01, n=0; 2). Up to 200 position per encoder



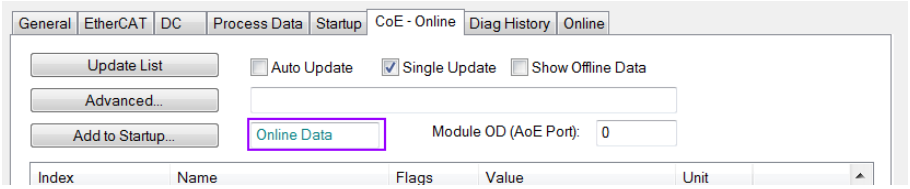
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channel are supported. The EtherCAT master has to sent these values to the EC4-ENC2IT every time when the module is switch on which may take some time especially when large quantity of position compare value have to be set. In order to reduce the download time the module allows the user to directly store the value on the internal EEPROM. The module compare register will be immediately initialize with these values after it is switch on and it is ready for compare operation. With this method the value only have to be sent once which reduces the initialization time.

In the following the procedure for saving the position compare values with the help of the TwinCAT System Manager will be explained.

Procedure for storing the 0x2nxx:01 (n=0; 2) object data to the local EC4-ENC2IT memory:

**Step 1:** Make sure the TwinCAT System Manager is connected to the EC4-ENC2IT device and the "CoE-Online" tab is showing that the slave is online.




**Step 2:** Write the position compare values to the "Position" (0x2nxx:01, n=0; 2) parameter and set the "DO trigger" (0x2nxx:02, n=0; 2) flag.

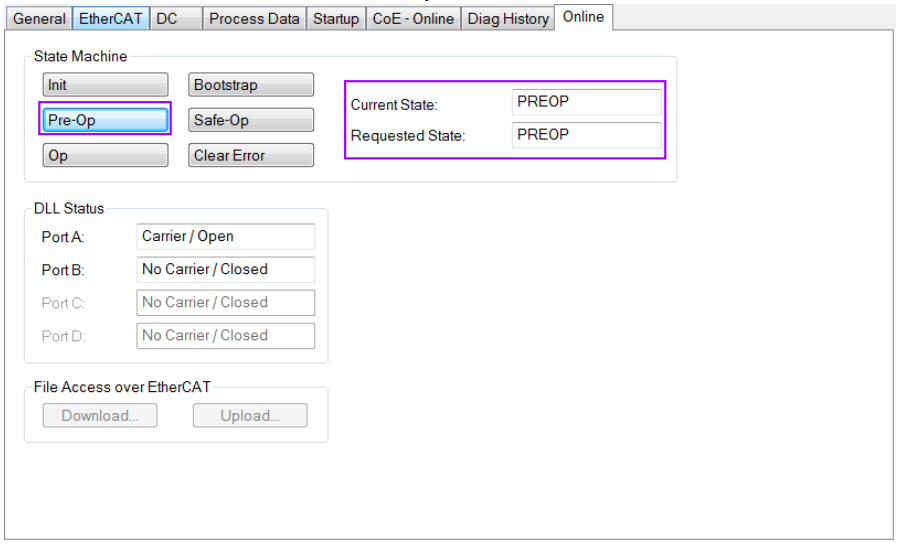
| Index | Name | Flags | Value |
|---|---|---|---|
| 2000:0 | Ch.0 Compare Pos.0 | | > 2 < |
| 2000:01 | Position | RW | 150 |
| 2000:02 | DO trigger | RW | Enable (1) |
| 2001:0 | Ch.0 Compare Pos.1 | | > 2 < |
| 2001:01 | Position | RW | 250 |
| 2001:02 | DO trigger | RW | Enable (1) |
| 2002:0 | Ch.0 Compare Pos.2 | | > 2 < |
| 2002:01 | Position | RW | 350 |
| 2002:02 | DO trigger | RW | Disable (0) |
| 2003:0 | Ch.0 Compare Pos.3 | | > 2 < |
| 2003:01 | Position | RW | 500 |
| 2003:02 | DO trigger | RW | Enable (1) |
| 2004:0 | Ch.0 Compare Pos.4 | | > 2 < |
| 2004:01 | Position | RW | 600 |
| 2004:02 | DO trigger | RW | Enable (1) |
| 2005:0 | Ch.0 Compare Pos.5 | | > 2 < |
| 2005:01 | Position | RW | 750 |
| 2005:02 | DO trigger | RW | Enable (1) |

**Step 3:** After all the configurations have been done set the slave into Pre-Op mode. Data can only be stored to the local device if it is in Pre-Op mode. On the "Online"



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tab click the "Pre-OP" button to put the slave into Pre-OP mode.




**Step 4:** The parameters of the 0xF008 object handles the save procedure.

1. Scroll to the end of the "CoE-Online" list and expand the tree view of the 0xF008 object
2. Enter the value 0x12345678 for the "Code Word"
3. Set the "Save compare data array" (F008:07) from FALSE to TRUE in order to save the position compare object data (0x2nxx:01, n=0; 2) to the internal EEPROM.

   ATTENTION:
   In every save operation 200 objects for each encoder channel will be save. The save operation need some time and may exceed the timeout of the EtherCAT master. In this case it is necessary for the master to reconnect to the slave and reload the SDO to show the correct SDO data.

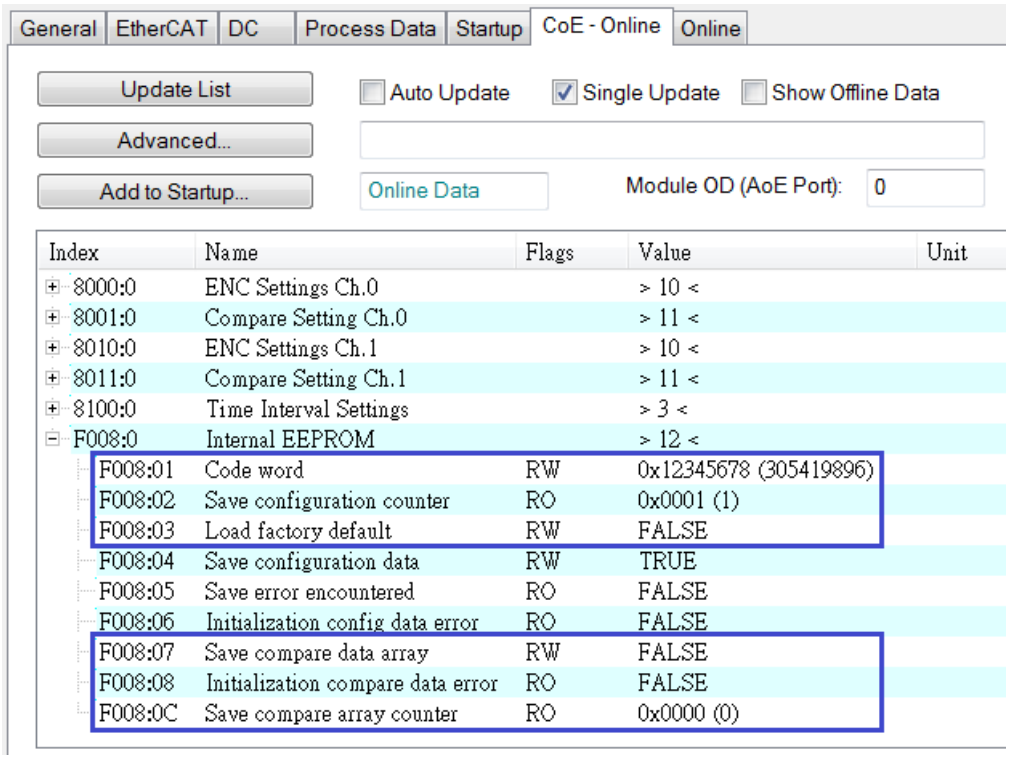
4. In order for the configuration data to be loaded after a device restart set the "Load factory default" to FALSE. It is always possible to return to the factory default setting by setting this value back to TRUE.
5. The "Save compare array counter" (F008:0C) shows how often configuration data has been stored to the local memory in the lifetime of the device.
6. If during power on the 0x2nxx:01 (n=0; 2) objects could not be correctly initialized with the saved position compare data then the "Initialization compare data error" (F008:08) flag shows TRUE.

   ATTENTION:
   The local memory only supports a limited number of save operations. Depending on the memory version once the save operation exceeds 10000 cycles it can no longer be guaranteed that data are reliably saved

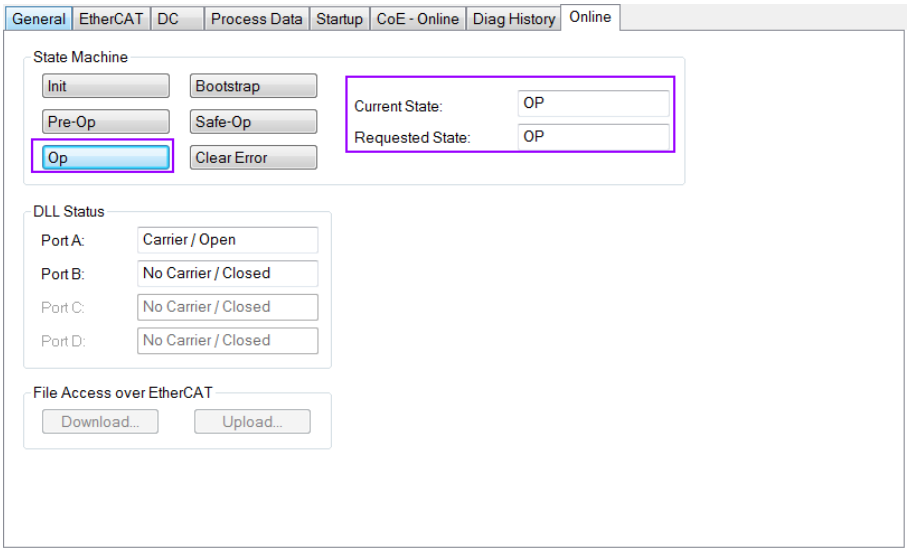


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or are still readable. Therefore the " Save compare data array " (F008:07) and the "Load factory default" (F008:03) should not be continuously set from the controlling application program.




**Step 5:** Set the EC4-ENC2IT back into OP mode.






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# 9 Object Description and Parameterization

## 9.1 Standard Objects

Index 1000 Device type

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1000:0 | Device type | Device type of the EtherCAT slave | UINT32 | RO | 0x00000020 |

Index 1008 Device name

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1008:0 | Device name | Device name of the EtherCAT slave | STRING | RO | EC4-ENC2IT |

Index 1009 Hardware version

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1009:0 | Hardware version | Hardware version of this device | STRING | RO | 1.0.0 (or greater) |

Index 100A Software version

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 100A:0 | Software version | Software version of the EtherCAT slave | STRING | RO | 1.0 .0 (or greater) |

Index 1018 Identity

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1018:0 | Identity | | UINT8 | RO | 0x04 |
| 1018:01 | Vendor ID | Vendor ID of the EtherCAT slave | UINT32 | RO | 0x00494350 |
| 1018:02 | Product code | Product code of the EtherCAT slave | UINT32 | RO | 0x00040E20 |
| 1018:03 | Revision | Revision number of the EtherCAT slave | UINT32 | RO | 0x00000010 |
| 1018:04 | Serial number | Serial number of the EtherCAT slave (not supported) | UINT32 | RO | 0x00000000 |

Index 10F1 Error settings

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 10F1:0 | Error settings | | UINT8 | RO | 0x02 |
| 10F1:01 | Local error reaction | Not implemented | UINT32 | RW | 0x00000001 |
| 10F1:02 | Sync error counter limit | For DC mode only:<br>The Sync Error Counter is incremented with every missing Sync Management Event by three and decremented by one if an event is | UINT16 | RW | 0x0004 |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | received. If the Sync Error Counter exceeds this limit the system changes into the SAFEOP state with the 'Synchronization Lost' error. The Sync Error Counter is reset when the error was acknowledged. | | | |

## 9.2 RxPDO Mapping Objects

"n" represents the channel number (0 to 1)

Index 0x16n0 ENC Control Ch.n (RxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 16n0:0 | ENC Control Ch.n | Encoder control | UINT8 | RO | 0x09 |
| 16n0:01 | Control__Gap1 | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 16n0:02 | Control__Reset index latch value | Set index latch to zero (1 Bit) | UINT32 | RO | 0x70n00201 |
| 16n0:03 | Control__Gap3 | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 16n0:04 | Control__Set counter | Set encoder counter (1 Bit) | UINT32 | RO | 0x70n00401 |
| 16n0:05 | Control__Gap5 | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 16n0:06 | Control__Gap6 | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 16n0:07 | Control__Gap7 | Empty (2 Bit) | UINT32 | RO | 0x00000002 |
| 16n0:08 | Control__Gap8 | Empty (8 Bit) | UINT32 | RO | 0x00000008 |
| 16n0:09 | Control__Set counter value | Assign encoder counter value (32 Bit) | UINT32 | RO | 0x70n00920 |

Index 0x16n1 Extern Latch Control Ch.n (RxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 16n1:0 | Extern Latch Control Ch.n | Latch control | UINT8 | RO | 0x04 |
| 16n1:01 | Control__Enable extern latch | Enable the extern DI channel latch (1 Bit) | UINT32 | RO | 0x70n10101 |
| 16n1:02 | Control__Reset extern latch value | Set extern latch position to zero (1 Bit) | UINT32 | RO | 0x70n10201 |
| 16n1:03 | Control__Gap3 | Empty (6 Bit) | UINT32 | RO | 0x00000006 |
| 16n1:04 | Control__Gap4 | Empty (8 Bit) | UINT32 | RO | 0x00000008 |



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Index 0x16n2 Compare Control Ch.n (RxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 16n2:0 | Compare Control Ch.n | Compare control | UINT8 | RO | 0x08 |
| 16n2:01 | Control__Enable compare | Enable compare trigger (1 Bit) | UINT32 | RO | 0x70n20101 |
| 16n2:02 | Control__Set auto increment compare direction | Set direction of auto-increment compare (1 Bit) | UINT32 | RO | 0x70n20201 |
| 16n2:03 | Control__Gap3 | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 16n2:04 | Control__Gap4 | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 16n2:05 | Control__Gap5 | Empty (4 Bit) | UINT32 | RO | 0x00000004 |
| 16n2:06 | Control__Gap6 | Empty (8 Bit) | UINT32 | RO | 0x00000008 |
| 16n2:07 | Control__Set first compare position | First compare position (32 Bit) | UINT32 | RO | 0x70n20720 |
| 16n2:08 | Control__Set auto increment compare value | Auto increment compare value (32 Bit) | UINT32 | RO | 0x70n20820 |

Index 0x16n3 Array Compare Control Ch.n (RxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 16n3:0 | Array Compare Control Ch.n | Array compare control | UINT8 | RO | 0x03 |
| 16n3:01 | Enable compare | Enable the extern array position compare (1 Bit) | UINT32 | RO | 0x70n30101 |
| 16n3:02 | Control__Gap2 | Empty (7 Bit) | UINT32 | RO | 0x00000007 |
| 16n3:03 | Control__Gap3 | Empty (8 Bit) | UINT32 | RO | 0x00000008 |

## 9.3 TxPDO Mapping Objects

"n" represents the channel number (0 to 1)

Index 0x1An0 ENC StatusCh.n (TxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1An0:0 | ENC StatusCh.n | Encoder status | UINT8 | RO | 0x11 |
| 1An0:01 | Status__Set counter done | Counter value setting finished (1 Bit) | UINT32 | RO | 0x60n00101 |
| 1An0:02 | Status__Reset index latch value done | Index latch value set to zero finished | UINT32 | RO | 0x60n00201 |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | (1 Bit) | | | |
| 1An0:03 | Status__Signal of input A | Channel A input signal (1 Bit) | UINT32 | RO | 0x60n00301 |
| 1An0:04 | Status__Signal of input B | Channel B input signal (1 Bit) | UINT32 | RO | 0x60n00401 |
| 1An0:05 | Status__Signal of input C | Channel C input signal (1 Bit) | UINT32 | RO | 0x60n00501 |
| 1An0:06 | Status__Signal of input I | Channel I input signal (1 Bit) | UINT32 | RO | 0x60n00601 |
| 1An0:07 | Status__Enable extern latch done | Extern latch has been enabled (1 Bit) | UINT32 | RO | 0x60n00701 |
| 1An0:08 | Status__Reset extern latch counter done | Extern latch counter has been set to zero (1 Bit) | UINT32 | RO | 0x60n00801 |
| 1An0:09 | Status__Enable equidist compare done | Equidistant position compare has been enabled (1 Bit) | UINT32 | RO | 0x60n00901 |
| 1An0:0A | Status__Enable array compare done | Array position compare has been enabled (1 Bit) | UINT32 | RO | 0x60n00A01 |
| 1An0:0B | Status__Enable compare via DI done | Equidistant or array position compare has been enabled via digital input channel I (1 Bit) | UINT32 | RO | 0x60n00B01 |
| 1An0:0C | Status__Next compare position active | The next compare position is valid (1 Bit) | UINT32 | RO | 0x60n00C01 |
| 1An0:0D | Status__GapD | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 1An0:0E | Status__GapE | Empty (1 Bit) | UINT32 | RO | 0x00000001 |
| 1An0:0F | Status__Sync error | Sync error (1 Bit) | UINT32 | RO | 0x60n00F01 |
| 1An0:10 | Status__TxPDO Toggle | TxPDO Toggle (1 Bit) | UINT32 | RO | 0x60n01001 |
| 1An0:11 | Status__Counter value | Encoder counter value (32 Bit) | UINT32 | RO | 0x60n01120 |

Index 0x1An1 Extern Latch Status Ch.n (TxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1An1:0 | Extern Latch Status Ch.n | Extern latch status | UINT8 | RO | 0x02 |
| 1An1:01 | Status__Rising edge latched value | Extern latched encoder position triggered by rising edge (32 Bit) | UINT32 | RO | 0x60n10120 |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1An1:02 | Status__Falling edge latched value | Extern latched encoder position triggered by falling edge (32 Bit) | UINT32 | RO | 0x60n10220 |

Index 0x1An2 Compare Trigger Status Ch.n (TxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1An2:0 | Compare Trigger Status Ch.n | Compare trigger status | UINT8 | RO | 0x01 |
| 1An2:01 | Status__Get next compare position | Shows the next compare position (32 Bit) | UINT32 | RO | 0x60n20120 |

Index 0x1An3 Index Latch Status Ch.n (TxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1An3:0 | Index Latch Status Ch.n | Index latch status | UINT8 | RO | 0x01 |
| 1An3:01 | Status__Index latched counter value | Index Latched encoder counter (32 Bit) | UINT32 | RO | 0x60n01220 |

Index 0x1An4 ENC VEL Status Ch.n (TxPDO-Map)

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1An4:0 | ENC VEL Status Ch.n | Encoder velocity status | UINT8 | RO | 0x01 |
| 1An4:01 | Status__Vel_dP | Position difference per time interval for velocity calculation (16 Bit) | UINT32 | RO | 0x60n30110 |

## 9.4 Sync Manager Objects

Index 0x1C00 Sync manager type

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C00:0 | Sync manager type | Using the sync managers | UINT8 | RO | 0x04 |
| 1C00:01 | SubIndex 001 | Sync-Manager Type Channel 1: Mailbox Write | UINT8 | RO | 0x01 |
| 1C00:02 | SubIndex 002 | Sync-Manager Type Channel 2: Mailbox Read | UINT8 | RO | 0x02 |
| 1C00:03 | SubIndex 003 | Sync-Manager Type Channel | UINT8 | RO | 0x03 |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | 3: Process Data Write (Outputs) | | | |
| 1C00:04 | SubIndex 004 | Sync-Manager Type Channel 4: Process Data Read (Inputs) | UINT8 | RO | 0x04 |

Index 0x1C12 RxPDO assign

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C12:0 | RxPDO assign | SyncManager 2 assignment: PDO Assign Outputs | UINT8 | RO | 0x08 |
| 1C12:01 | SubIndex 001 | Default assignment: ENC Control Channel 0 | UINT16 | RW | 0x1600 |
| 1C12:02 | SubIndex 002 | Default assignment: ENC Control Channel 0 | UINT16 | RW | 0x1602 |
| 1C12:03 | SubIndex 003 | Default assignment: ENC Control Channel 1 | UINT16 | RW | 0x1610 |
| 1C12:04 | SubIndex 004 | Default assignment: ENC Control Channel 1 | UINT16 | RW | 0x1612 |
| 1C12:05 | SubIndex 005 | -- | UINT16 | RW | 0x0000 |
| 1C12:06 | SubIndex 006 | -- | UINT16 | RW | 0x0000 |
| 1C12:07 | SubIndex 007 | -- | UINT16 | RW | 0x0000 |
| 1C12:08 | SubIndex 008 | -- | UINT16 | RW | 0x0000 |

Index 0x1C13 TxPDO assign

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C13:0 | TxPDO assign | SyncManager 3 assignment: PDO Assign Inputs | UINT8 | RO | 0x0A |
| 1C13:01 | SubIndex 001 | Default assignment: ENC Status Channel 0 | UINT16 | RW | 0x1A00 |
| 1C13:02 | SubIndex 002 | Default assignment: ENC Status Channel 0 | UINT16 | RW | 0x1A02 |
| 1C13:03 | SubIndex 003 | Default assignment: ENC Status Channel 1 | UINT16 | RW | 0x1A10 |
| 1C13:04 | SubIndex 004 | Default assignment: ENC Status Channel 1 | UINT16 | RW | 0x1A12 |
| 1C13:05 | SubIndex 005 | -- | UINT16 | RW | 0x0000 |
| 1C13:06 | SubIndex 006 | -- | UINT16 | RW | 0x0000 |
| 1C13:07 | SubIndex 007 | -- | UINT16 | RW | 0x0000 |
| 1C13:08 | SubIndex 008 | -- | UINT16 | RW | 0x0000 |
| 1C13:09 | SubIndex 009 | -- | UINT16 | RW | 0x0000 |
| 1C13:0A | SubIndex 010 | -- | UINT16 | RW | 0x0000 |



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Index 0x1C32 Sync Manager (SM) output parameter

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C32:0 | SM output parameter | Synchronization parameters for the outputs | UINT8 | RO | 0x20 |
| 1C32:01 | Synchronization Type | Current synchronization mode:<br>• 0: Free Run<br>• 1: Synchronous without SM 2 event<br>• 2: DC-Mode - Synchronous with SYNC0 Event<br>• 3: DC-Mode - Synchronous with SYNC1 event | UINT8 | RO | 0x0001 |
| 1C32:02 | Cycle Time | Cycle time (in ns):<br>• Free Run: Cycle time of the local timer<br>• Synchronous with SM 2 event: Master cycle time<br>• DC mode: SYNC0/SYNC1 Cycle Time | UINT8 | RO | 0x00000000 |
| 1C32:04 | Synchronization Types supported | Supported synchronization modes:<br>• Bit 0 = 1: free run is supported<br>• Bit 1 = 1: Synchron with SM 2 event is supported<br>• Bit 2-3 = 01: DC mode is supported<br>• Bit 4-5 = 10: Output shift with SYNC1 event (only DC mode) | UINT8 | RO | 0x8007 |
| 1C32:05 | Minimum Cycle Time | Minimum cycle time (in ns) | | RO | 0x00000000 |
| 1C32:06 | Calc and Copy Time | Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only) | | RO | 0x00000000 |
| 1C32:08 | Get Cycle Time | • 0: Measurement of the local cycle time is stopped<br>• 1: Measurement of the local cycle time is started<br>Set parameter to 1 in order to update the Cycle Time (1C32:02, 1C33:02) parameter with the maximum measured value | | RW | 0x0000 |
| 1C32:09 | Delay Time | Time between SYNC1 event and output (in ns, DC mode only) | | RO | 0x00000000 |
| 1C32:0A | Sync0 Cycle Time | | | RW | 0x00000000 |
| 1C32:0B | SM-Event Missed | Number of missed SM events in OPERATIONAL (DC mode only) | | RO | 0x0000 |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C32:0C | Cycle Time Too Small | Cycle was not completed in time or the next cycle began too early | | RO | 0x0000 |
| 1C32:20 | Sync Error | The synchronization was not correct in the last cycle (outputs were output too late; DC mode only) | | RO | FALSE |

Index 0x1C33 Sync Manager (SM) input parameter

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C33:0 | SM input parameter | Synchronization parameters for the inputs | UINT8 | RO | 0x20 |
| 1C33:01 | Synchronization Type | Current synchronization mode:<br>• 0: Free Run<br>• 1: Synchron with SM 3 Event (no outputs available)<br>• 2: DC - Synchron with SYNC0 Event<br>• 3: DC - Synchron with SYNC1 Event<br>• 34: Synchron with SM 2 Event (outputs available) | UINT8 | RO | 0x0022 |
| 1C33:02 | Cycle Time | Cycle time (in ns):<br>• Free Run: Cycle time of the local timer<br>• Synchronous with SM 2 event: Master cycle time<br>• DC mode: SYNC0/SYNC1 Cycle Time | UINT8 | RO | 0x00000000 |
| 1C33:04 | Synchronization Types supported | Supported synchronization modes:<br>• Bit 0 = 1: free run is supported<br>• Bit 1 = 1: Synchron with SM 2 event is supported<br>• Bit 2-3 = 01: DC mode is supported<br>• Bit 4-5 = 10: Output shift with SYNC1 event (only DC mode) | UINT8 | RO | 0x8007 |
| 1C33:05 | Minimum Cycle Time | Minimum cycle time (in ns) | | RO | 0x00000000 |
| 1C33:06 | Calc and Copy Time | Time between reading of the inputs and availability of the Inputs data for the master (in ns, only DC mode) | | RO | 0x00000000 |
| 1C33:08 | Get Cycle Time | • 0: Measurement of the local cycle time is stopped | | RW | 0x0000 |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | • 1: Measurement of the local cycle time is started<br>Set parameter to 1 in order to update the Cycle Time (1C32:02, 1C33:02) parameter with the maximum measured value | | | |
| 1C33:09 | Delay Time | Time between SYNC1 event and reading of the inputs (in ns, only DC mode) | | RO | 0x00000000 |
| 1C33:0A | Sync0 Cycle Time | | | RW | 0x00000000 |
| 1C33:0B | SM-Event Missed | Number of missed SM events in OPERATIONAL (DC mode only) | | RO | 0x0000 |
| 1C33:0C | Cycle Time Too Small | Cycle was not completed in time or the next cycle began too early | | RO | 0x0000 |
| 1C33:20 | Sync Error | The synchronization was not correct in the last cycle (outputs were output too late; DC mode only) | | RO | FALSE |

## 9.5 Position Compare Array

"n" represents the channel number (0; 1)
"k" represents the channel offset k= n*2
"xx" represents the position array index: any hex number between 0x00 to 0xC7
"y" represents the position array index: any decimal number between 0 to 199

Index 0x2kxx Ch.n Compare Pos.y

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 0x2kxx:0 | Ch.n Compare Pos.xx | Array compare position parameters | UINT8 | RO | 0x02 |
| 0x2kxx:01 | Position | The compare position at which to output a digital signal once the encoder counter reaches this position | INT32 | RO | 0x00000000 |
| 0x2kxx:02 | DO trigger | Indicates whether or not to trigger a digital output once the encoder counter reaches the compare position value | BOOLEAN | RO | 0x0 |



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## 9.6 Input Data

"n" represents the channel number (0 to 1)

Index 0x60n0 ENC Inputs Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 60n0:0 | Encoder input status Ch.n | Encoder status inputs | UINT8 | RO | 0x12 |
| 60n0:01 | Set counter done | Assigning the counter a new value has completed. Indicates whether the "Set counter" (70n0:04) action was successful | BOOLEAN | RO | |
| 60n0:02 | Reset index latch value done | Indicates that the index latch value has been set to zero | BOOLEAN | RO | |
| 60n0:03 | Signal of input A | Signal of input A | BOOLEAN | RO | |
| 60n0:04 | Signal of input B | Signal of input B | BOOLEAN | RO | |
| 60n0:05 | Signal of input C | Signal of input C | BOOLEAN | RO | |
| 60n0:06 | Signal of input I | Signal of input I | BOOLEAN | RO | |
| 60n0:07 | Enable extern latch done | Indicates whether the external latch has been enabled | BOOLEAN | RO | |
| 60n0:08 | Reset extern latch value done | Indicates whether the external latch counter has been reset | BOOLEAN | RO | |
| 60n0:09 | Enable equidist compare done | Indicates whether the equidistant position compare function has been enabled | BOOLEAN | RO | |
| 60n0:0A | Enable array compare done | Indicates whether the array position compare function has been enabled | BOOLEAN | RO | |
| 60n0:0B | Enable compare via DI done | Indicates whether the equidistant or array position compare function has been enabled via digital input channel I.<br><br>This parameter turns true when all three condition has been met:<br>• "Activate compare | BOOLEAN | RO | |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | via DI"= Enabled (0x80n1:03, n= 0;1)<br>• Either "Enable equidist compare done" (0x60n0:09) or "Enable array compare done" (0x60n0:0A) is TRUE<br>• Channel (I) has a digital input signal | | | |
| 60n0:0C | Next compare position active | Indicates whether the "Get next compare position" (0x60n2:01) is valid. | BOOLEAN | RO | |
| | | | | | |
| 60n0:0F | Sync error | The Sync error bit is only required for DC mode. It indicates whether a synchronization error has occurred during the previous cycle | BOOLEAN | RO | |
| 60n0:10 | TxPDO Toggle | The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated | BOOLEAN | RO | |
| 60n0:11 | Counter value | The encoder counter value | INT32 | RO | |
| 60n0:12 | Index Latched counter value | The index latched counter value. The trigger condition (falling or rising edge) has to be set via "C signal polarity" (80n0:03). A latch event is generated every time when the trigger condition has been met. | INT32 | RO | |

## Index 0x60n1 Extern Latch Inputs Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 60n1:0 | Extern Latch Inputs Ch.n | Extern latch status inputs | UINT8 | RO | 0x02 |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 60n1:01 | Rising edge latched value | Latched encoder position triggered by the rising edge of "I" signal | INT32 | RO | |
| 60n1:02 | Falling edge latched value | Latched encoder position triggered by falling edge of "I"signal | INT32 | RO | |

Index 0x60n2 Compare Trigger Input Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 60n2:0 | Compare Trigger Input Ch.n | Compare trigger status inputs | UINT8 | RO | 0x01 |
| 60n2:01 | Get next compare position | Indicates the next compare position at which an output will be triggered | INT32 | RO | |

Index 0x60n3 ENC VEL Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 60n3:0 | ENC VEL Ch.n | Encoder velocity | UINT8 | RO | 0x01 |
| 60n3:01 | Vel_dP | Position difference per time interval for velocity calculation | INT16 | RO | |

## 9.7 Output Data

"n" represents the channel number (0 to 1)

Index 0x70n0 ENC Outputs Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 70n0:0 | ENC Outputs Ch.n | | UINT8 | RO | 0x09 |
| 70n0:02 | Reset index latch value | Set index latch value to zero | BOOLEAN | RO | FALSE |
| 70n0:04 | Set counter | Assign encoder counter a new counter value.<br>• By setting this Boolean from FALSE to TRUE the counter register will be assigned the value of parameter 70n0:09 | BOOLEAN | RO | FALSE |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | ("Set counter value") | | | |
| 70n0:09 | Set counter value | Counter value which will be assigned to the encoder counter register (see 70n0:04 ) | INT32 | RO | 0 |

Index 0x70n1 Extern Latch Outputs Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 70n1:0 | Extern Latch Outputs Ch.n | | UINT8 | RO | 0x02 |
| 70n1:01 | Enable extern latch | Enable the external "I" signal latch<br>• By setting this Boolean from FALSE to TRUE the hardware "I" signal latch function is enabled. The encoder value (60n0:11) will be latched when the "I" input signal rises or falls<br>• By setting this variable to FALSE the extern latch function will be disabled and the latched counter value registers (60n1:01; 60n1:02) are reset to zero | BOOLEAN | RO | FALSE |
| 70n1:02 | Reset extern latch value | Set the extern latch value to zero<br>• By setting this Boolean from FALSE to TRUE both extern latch parameters (60n1:01; 60n1:02) are reset to zero | BOOLEAN | RO | FALSE |

Index 0x70n2 Compare Outputs Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 70n2:0 | Compare Outputs Ch.n | | UINT8 | RO | 0x08 |
| 70n2:01 | Enable compare | Enable the equidistant position compare output trigger function | BOOLEAN | RO | FALSE |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | • By setting this Boolean from FALSE to TRUE the compare function will be enabled<br>• By setting this variable to FALSE the extern latch function will be disabled<br>• It is suggested to first set all the compare parameters (70n2:02, 70n2:07, 70n2:08) before enabling the compare trigger function<br>• If the counter has been set to zero while the compare function is active, then the compare function has to be first disabled and then again enabled in order for the compare value to be reset | | | |
| 70n2:02 | Set auto increment compare direction | Set the auto-incremental direction for the compare value<br>• 0 - positive direction<br>• 1- negative direction | BOOLEAN | RO | FALSE |
| 70n2:07 | Set first compare position | The first compare position | INT32 | RO | 0 |
| 70n2:08 | Set auto increment compare value | The next compare position will be automatically calculated by adding the incremental value to the current compare position (70n2:07)<br>• Disable the auto-increment compare function by setting this parameter to zero | INT32 | RO | 0 |



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Index 0x70n3 Array Compare Outputs Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 70n3:0 | Array Compare Outputs Ch.n | | UINT8 | RO | 0x01 |
| 70n3:01 | Enable compare | Enable the array position compare output trigger function<br>• By setting this Boolean from FALSE to TRUE the compare function will be enabled<br>• By setting this variable to FALSE the extern latch function will be disabled<br>• It is important to first set all the compare position values via the CoE (0x2nxx:01, n=0; 2) before enabling the compare trigger function<br>• If the counter has been set to zero while the compare function is active, then the compare function has to be first disabled and then again enabled in order for the compare value to be reset | BOOLEAN | RO | FALSE |



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## 9.8 Configuration Data

ENC Parameter

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 3000 | Repeat signal | Extend channel 0 signal (encoder input A,B,C ) to channel 1:<br>• 0: Disable<br>• 1: Enable | UINT8 | RW | 0x00 |

Index 0x80n0 ENC Settings Ch.n

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 80n0:0 | ENC Settings Ch.n | Encoder settings | UINT8 | RO | 0x0A |
| 80n0:01 | A signal polarity | Polarity of A input signal | DT0803EN01 | RW | 0x01 ("Active high") |
| 80n0:02 | B signal polarity | Polarity of B input signal | DT0803EN01 | RW | 0x01 ("Active high") |
| 80n0:03 | C signal polarity | Polarity of C input signal | DT0803EN01 | RW | 0x01 ("Active high") |
| 80n0:04 | I signal polarity | Polarity of extern latch "I" input signal<br>NOTE:<br>The trigger level for extern latch can not be set for each channel individually. Both channel need to be set to the same trigger level. | DT0803EN01 | RW | 0x01 ("Active high") |
| 80n0:05 | I channel trigger mode | Extern latch setting:<br>• Reset encoder counter or<br>• Latch encoder counter | DT0804EN01 | RW | 0x01 ("Latch encoder counter ") |
| 80n0:09 | Counting mode | Counter mode selection:<br>• CW/CCW,<br>• Pulse/Direction,<br>• Quadrant | DT0801EN08 | RW | 0x03 ("Quadrant counting mode") |
| 80n0:0A | Low pass filter | Low pass filter setting | DT0802EN08 | RW | 0x00 ("4MHz<br>AB Phase:<br>6MHz (filter disabled)") |

"n" represents the channel number (0 to 1)

Index 0x80n1 ENC Settings Ch.n



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 80n1:0 | Compare Setting Ch.n | Compare settings | UINT8 | RO | 0x0B |
| 80n1:01 | Compare trigger pulse width | Pulse width of the compare trigger output | UINT16 | RW | 0x32 (50) |
| 80n1:02 | Compare DO trigger signal type | Do compare trigger output signal type (Active high or active low)<br>• Normal (0)<br>Depends on the external wiring: Can either be active high or active low.<br>• Reverse (1) | DT0806EN01 (BIT1) | RW | 0x00 ("Normal") |
| 80n1:03 | Activate compare via DI | "Enable" indicates that the DI channel is being used for enabling / disabling the compare mode | DT0805EN01 (BIT1) | RW | 0x00 ("Disable") |
| 80n1:04 | Keep compare trigger output | "Enable" indicates that the compare output can still be triggered when the EC4-ENC2IT is disconnected from master<br><br>NOTE:<br>After enabling this function, if the module is disconnected from master, the compare function can only be disabled via the digital input channel (I) | DT0805EN01 (BIT1) | RW | 0x00 ("Disable") |
| 80n1:0A | Array compare start index | • Used for position compare array:<br>• The start index is fixed at zero | UINT16 | R | 0x0000 |
| 80n1:0B | Array compare end index | Used for position compare array:<br>• Sets the number of compare positions to be used for the compare process<br>• The first compare position always has to be stored in the first object 0x2k00 (k=0 for channel 0, k=2 for channel 1) | UINT16 | RW | 0x0000 |

"n" represents the channel number (0 to 1)



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Index 0x8100 Time Interval Settings

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| 8100:0 | Time Interval Settings | | UINT8 | RO | 0x03 |
| 8100:01 | Basic Multiplier | The unit time is 0.5 ms<br>Base Time =<br>Basic Multiplier * 0.5 ms | UINT8 | RW | 0x02 |
| 8100:02 | Ch0 Multiplier | Ch0 Time Interval =<br>Base Time *<br>Ch0 Multiplier | UINT8 | RW | 0x01 |
| 8100:03 | Ch1 Multiplier | Ch1 Time Interval =<br>Base Time *<br>Ch0 Multiplier | UINT8 | RW | 0x01 |



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## 9.9 Configuration Parameters Storage

Index 0xF008 Internal EEPROM

| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| F008:0 | Internal EEPROM | Storing CoE parameters to the internal EEPROM. | UINT8 | RO | 0x05 |
| F008:01 | Code Word | Password for saving CoE configuration data to the EEPROM Password: 0x12345678 | UINT32 | RW | 0x00000000 |
| F008:02 | Save configuration counter | Shows the how often configuration data has been saved to the local non-volatile memory. Due to hardware restrictions a maximum number of 10000 save cycle times are supported. | UINT16 | RO | 0x0000 |
| F008:03 | Load factory default | Load factory default configuration immediately after power on.<br>• By setting this parameter to FALSE the user set configuration data (0x8000 to 0x8020) will be loaded after power on | BOOLEAN | RW | TRUE |
| F008:04 | Save configuration data | Save all configuration setting to local non-volatile memory.<br>• Set to TRUE in order to save the configuration data (0x8000 to 0x8011) to the memory of the EC4-ENC2IT | BOOLEAN | RW | FALSE |
| F008:05 | Save error encountered | Indicates whether data has been successfully written to memory | BOOLEAN | RO | FALSE |
| F008:06 | Initialization config data error | Indicates whether an error occurred while reading configuration | BOOLEAN | RO | FALSE |



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| Index (hex) | Name | Description | Data type | Flags | Default |
|---|---|---|---|---|---|
| | | data (0x8000 to 0x8011) from the internal EEPROM after the device has been switched on | | | |
| F008:07 | Save compare data array | Save all position compare array values to the local non-volatile memory.<br><br>Set this parameter to TRUE in order to save the compare array data (0x2000 to 0x22C7) to the memory of the EC4-ENC2IT.<br><br>ATTENTION:<br>The saving action does takes some time which can exceed the EtherCAT timeout. If an timeout occurs the TwinCAT does not update the 0xF008 object. In this case restart TwinCAT to force an update of the 0xF008 object members. | BOOLEAN | RW | FALSE |
| F008:08 | Initialization compare data error | Indicates whether an error occurred while reading compare array data (0x2000 to 0x22C7) from the internal EEPROM after the device has been switched on | BOOLEAN | RO | FALSE |
| F008:0C | Save compare array counter | Shows the how often compare array data has been saved to the local non-volatile memory. Due to hardware restrictions a maximum number of 10000 save cycle times are supported. | UINT16 | RO | 0x0000 |



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