ECAT-2092T

EtherCAT
Two-Channel Incremental Encoder Counter

with Latch and Compare Function

User Manual

(Version 1.1)

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Revision

Revision	Date	Description	Author
1	18.02.2019	Initial version	M. K.
1.1	09.07.2019	Modifying the open collector jumper pictures and drawings	M.K.

Contents

1 Product Overview

1.1 Introduction

The EtherCAT slave ECAT-2092T is an incremental encoder counter which provides two independent high-speed counter channels. 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 HR for each encoder channel llows the latching and clearing of each encoder counter.

The ECAT-2092T 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 and auto incremental 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.

1.2 Technical Data

Features:

- EtherCAT slave
- 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 and auto-increment compare
- 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/Csignal 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 Logic low: 0 V ~ 2 V
	12 V (set by jumper)	Logic high: 5 V ~ 12 V Logic low: 0 V ~ 2 V
	24 V (set by jumper)	Logic high: 5 V ~ 24 V 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 Logic low: 0 V ~ 2 V
	12 V (set by jumper)	Logic high: 5 V ~ 12 V Logic low: 0 V ~ 2 V
	24 V (set by jumper)	Logic high: 5 V ~ 24 V Logic low: 0 V ~ 2 V
Compare Trigger Output		
Channel	2	
Trigger pulse width	15 ~ 50 µs	
Load voltage	5 ~ 48 V	
Max load current	100 mA	
LED Indicators		
Diagnostic LED	Power, EtherCAT status, signal status of each encoder input	
Communication Interface		
Connector	2 x RJ-45	
Protocol	EtherCAT	

Item	Specification
Distance between stations	Max. 100 m (100BASE-TX)
Data transfer medium	Ethernet/EtherCAT Cable (Min. CAT 5), Shielded
Power	
Input voltage range	20 V_{DC} ~ 30V_{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 A; Power: 1 KV Class A
Surge (IEC 61000-4-5)	1 KV Class A
Mechanism	
Installation	DIN-Rail
Dimensions (LxWxH) [mm]	110mm x 90mm x 33mm (without connectors)
Case material	UL 94V-0 housing
Environment	
Operating temperature	-25℃ ~ 70℃
Storage temperature	-30℃ ~ 80℃
Relative humidity	10 ~ 90%, No condensation

Table 1: Technical data

1.4 Dimensions

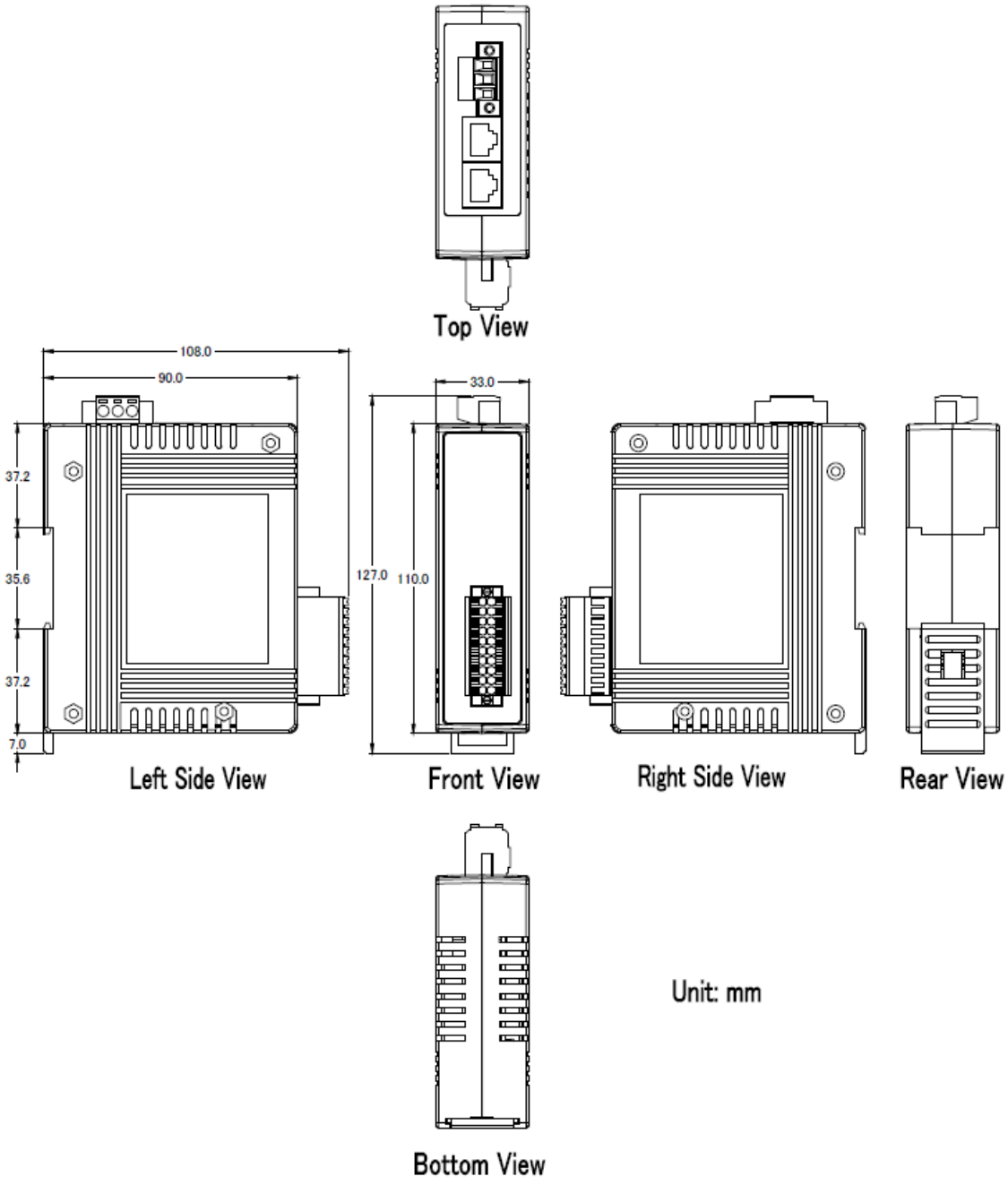


Figure 1: Dimensions of the ECAT-2092T

2 Scope of Delivery

The shipping package includes the following items:

- 1 x ECAT-2092T
- 1 x 20-pin plug-in connector
- 1 x 3-pin plug in connector (for power supply)
- 1 x Quick Start manual

Figure 2: ECAT-2092T 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/ecat-2092t.html

- Manual:
  ftp://ftp.icpdas.com/pub/cd/fieldbus_cd/ethercat/slave/motion/ecat-2092t/manual/

- XML EtherCAT Slave Information (ESI) file:
  ftp://ftp.icpdas.com/pub/cd/fieldbus_cd/ethercat/slave/motion/ecat-2092t/esi/

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

- Technical support:
  service@icpdas.com

3 LED Definition

The ECAT-2092T provides on the front side several diagnostic LEDs which indicates the signal status of each encoder channel.
Furthermore there are three LEDs to show the EtherCAT network status. The exact meaning of each LED is described in the following tables:

Figure 3: ECAT-2092T LEDs

EtherCAT LED	Color	State	Description
RUN	red		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 Outputs remain in safe state
		On	Device is in OP state
IN	green		Indicates the communication status of the EtherCAT port IN
		Off	No connection
		Flashing	Link and activity (e.g. data exchange with the master)
		On	Link without any activity
OUT	green		Indicates the communication status of the EtherCAT port OUT. Further EtherCAT slave can be connected to the port OUT
		Off	No EtherCAT slaves are connected to port OUT
		Flashing	Link and activity (e.g. data exchange connected slaves)
		On	Link without any activity

Table 2: EtherCAT status indicator

Control LED	Color	Description
*	red	- Power indicator
* * * * * * * * 0 1 2 3 4 5 6 7	green	- LED 0: A0 Channel status - LED 1: B0 Channel status - LED 2: C0 Channel status (index input) - LED 3: I0 Channel status (external latch input HR) - LED 4: A1 Channel status - LED 5: B1 Channel status - LED 6: C1 Channel status - LED 7: I1 Channel status (external latch input HR)

Table 3: Diagnostic LEDs

4 Wiring

4.1 Connection Interfaces

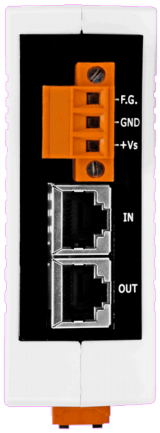


Figure 4: ECAT-2092T side view with power supply and EtherCAT connection

Name	Signal	Description
F.G	Frame ground	
GND	Power supply: Ground 0V (from negative power contact)	Feeding for ECAT-2092T
+Vs	Power supply: +24 V_{DC} (from positive power contact)	
IN	EtherCAT signal input	Incoming EtherCAT cable
OUT	EtherCAT signal output	Outgoing EtherCAT cable

Table 4: ECAT-2092T power supply and EtherCAT interfaces

Figure 5: ECAT-2092T 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 HR0+	
I0-	Input	Latch input HR0-	
T0+	Output	Compare trigger output (DO0)	
T0-		External ground for DO0	
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 HR0+	
I1-	Input	Latch input HR0-	
T1+	Output	Compare trigger output DO1	
T1-		External ground for DO1	

Table 5: Connection interfaces of the encoder

4.2 Internal I/O Structure

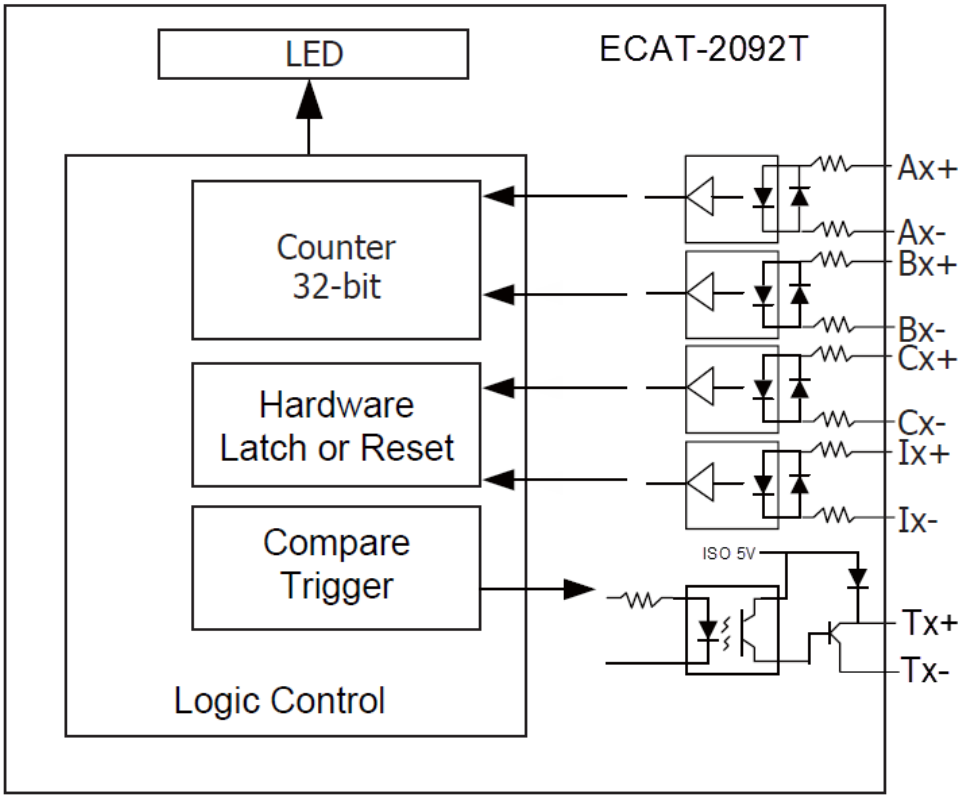


Figure 6: DIO circuit

4.3 Jumper Settings

The ECAT-2092T 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 ECAT-2092T does not provide an internal power supply for the encoder therefore the encoder has to be connected to an external power supply.

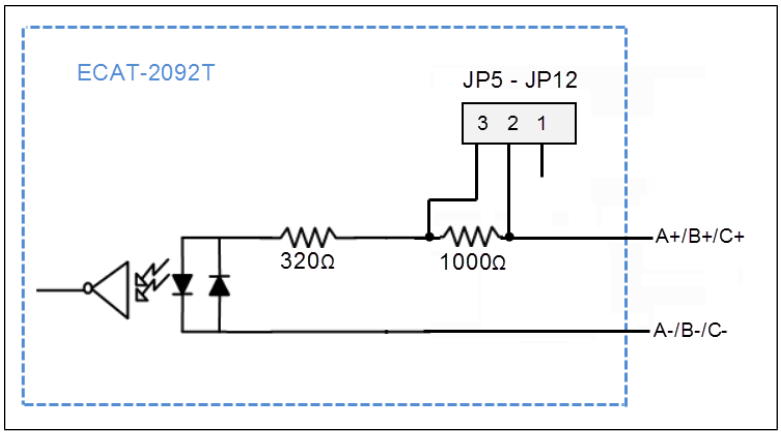


Figure 7: Encoder channel circuit

For single-ended encoder connection the ECAT-2092T 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 6 lists for each encoder signal input the corresponding jumper position. Figure 8 and Figure 9 shows the basic wiring diagram for open collector connection.

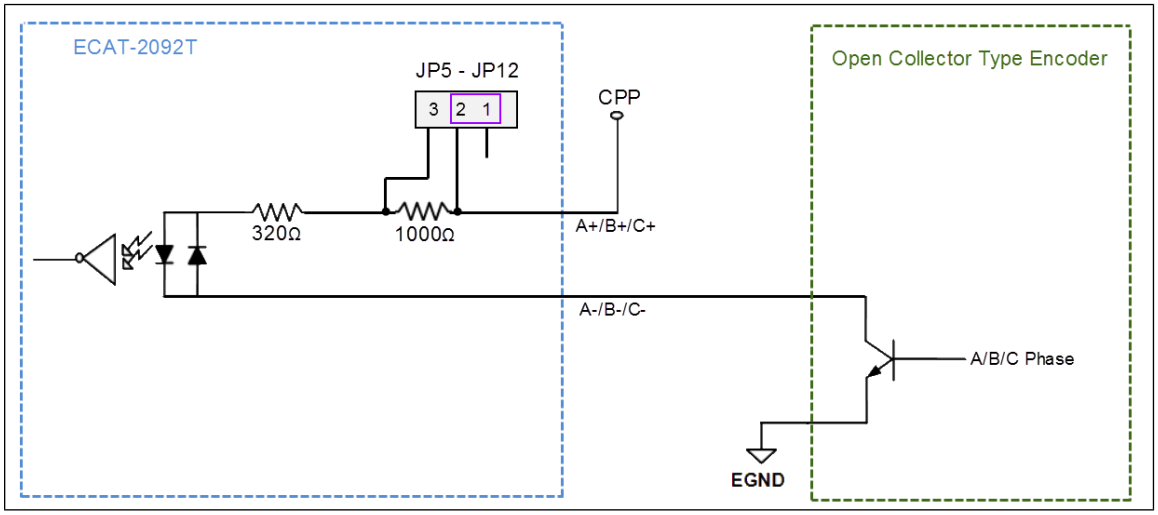


Figure 8: Open collector wiring diagram (Source Digital Input)

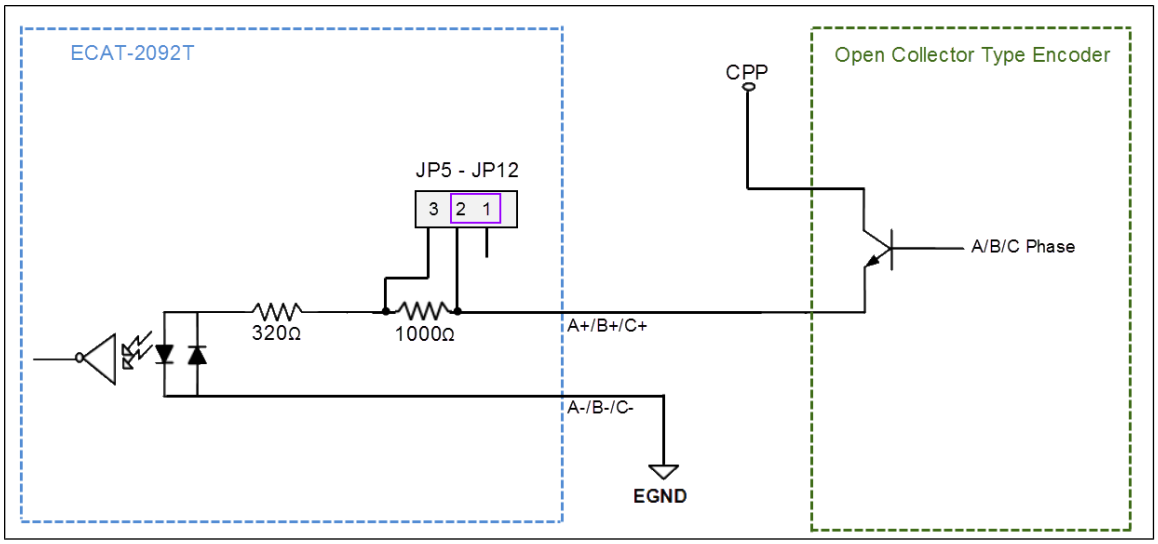


Figure 9: Open collector wiring diagram (Sink Digital Input)

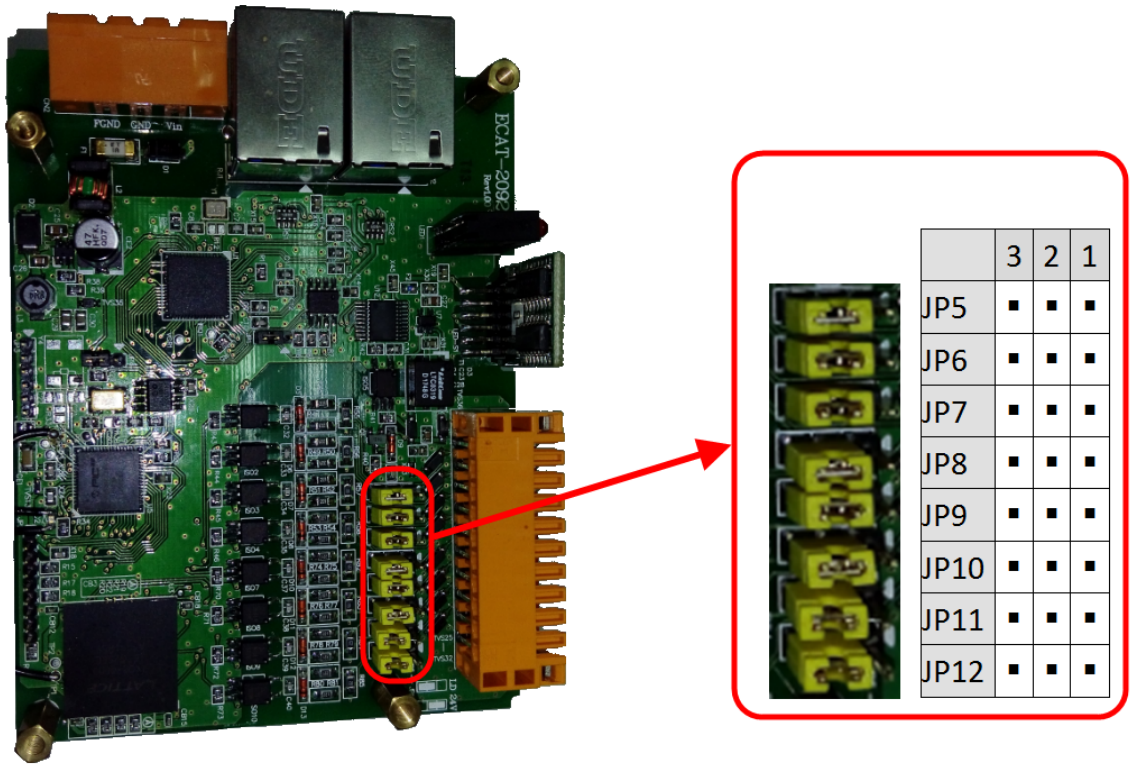


Figure 10: Jumper location

Jumper No	Channel	Jumper position 2-3	Jumper position 1-2
JP5	Encoder input A0	Differential channel	Open collector channel
JP6	Encoder input B0	Differential channel	Open collector channel
JP7	Encoder input Z0 (C0)	Differential channel	Open collector channel

Jumper No	Channel	Jumper position 2-3	Jumper position 1-2
JP8	Extern latch input I0 (HR0)	Differential channel	Open collector channel
JP9	Encoder input A1	Differential channel	Open collector channel
JP10	Encoder input B1	Differential channel	Open collector channel
JP11	Encoder input Z1 (C1)	Differential channel	Open collector channel
JP12	Extern latch input I1 (HR1)	Differential channel	Open collector channel

Table 6: 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

4.4 Digital Input Wiring

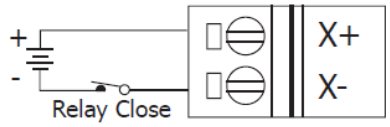
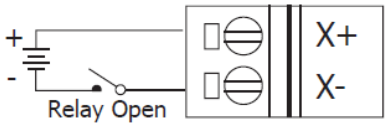
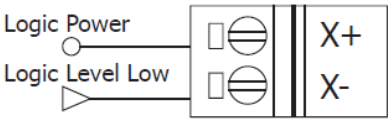
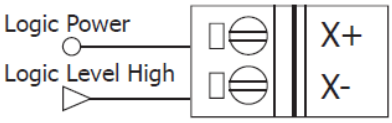
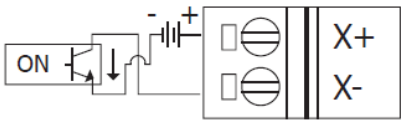
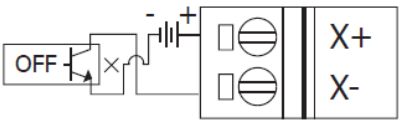
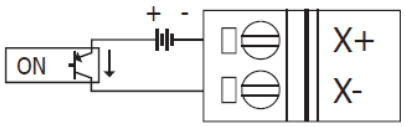
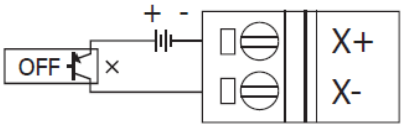
Input Type	ON State LED ON Readback as 1	OFF State LED OFF Readback as 0
Relay Contact	Relay ON	Relay OFF
		
TTL/CMOS Logic	Voltage > 4 V	Voltage < 0.8 V
		
NPN Output	Open Collector ON	Open Collector OFF
		
PNP Output	Open Collector ON	Open Collector OFF
		

Figure 11: Encoder counter (A/B), index (C) and external latch (HR) input wiring

4.5 Compare Trigger Output Wiring

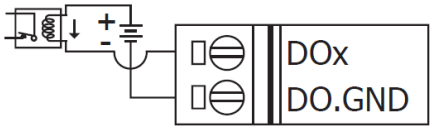
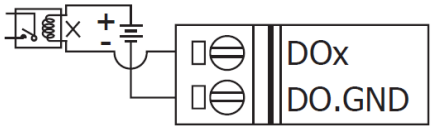
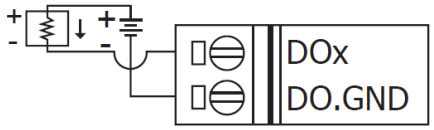
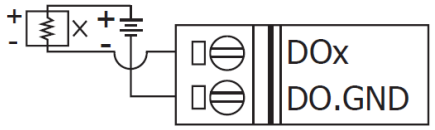
Output Type	ON State Readback as 1	OFF State Readback as 0
Drive Relay	Relay ON	Relay OFF
		
Resistance Load		
		

Figure 12: Compare trigger output wiring

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 ECAT-2092T supports four states:

- Init (state after Reset)
- Pre-Operational
- Safe-Operational
- Operational

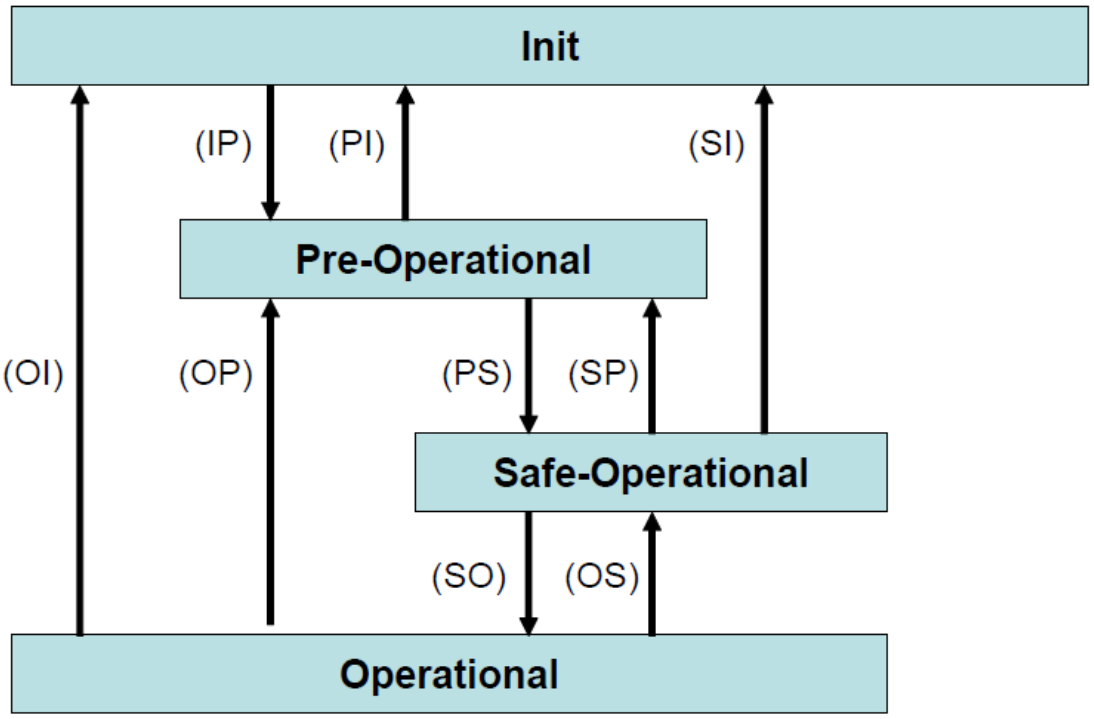


Figure 13: EtherCAT state machine

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 ECAT-2092T 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 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 ECAT-2092T supports three type of Op modes: Free Run mode, SM-Synchron and Distributed Clock (DC) mode.

5.3 Synchronization Modes

ECAT-2092T 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.

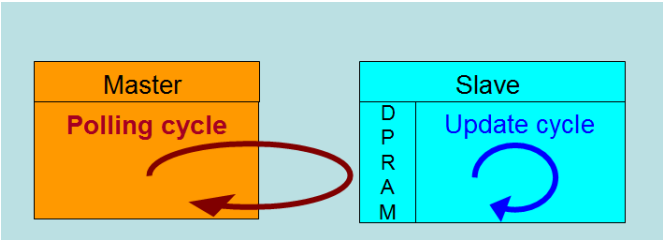


Figure 14: Master-slave cycle in Free Run mode

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

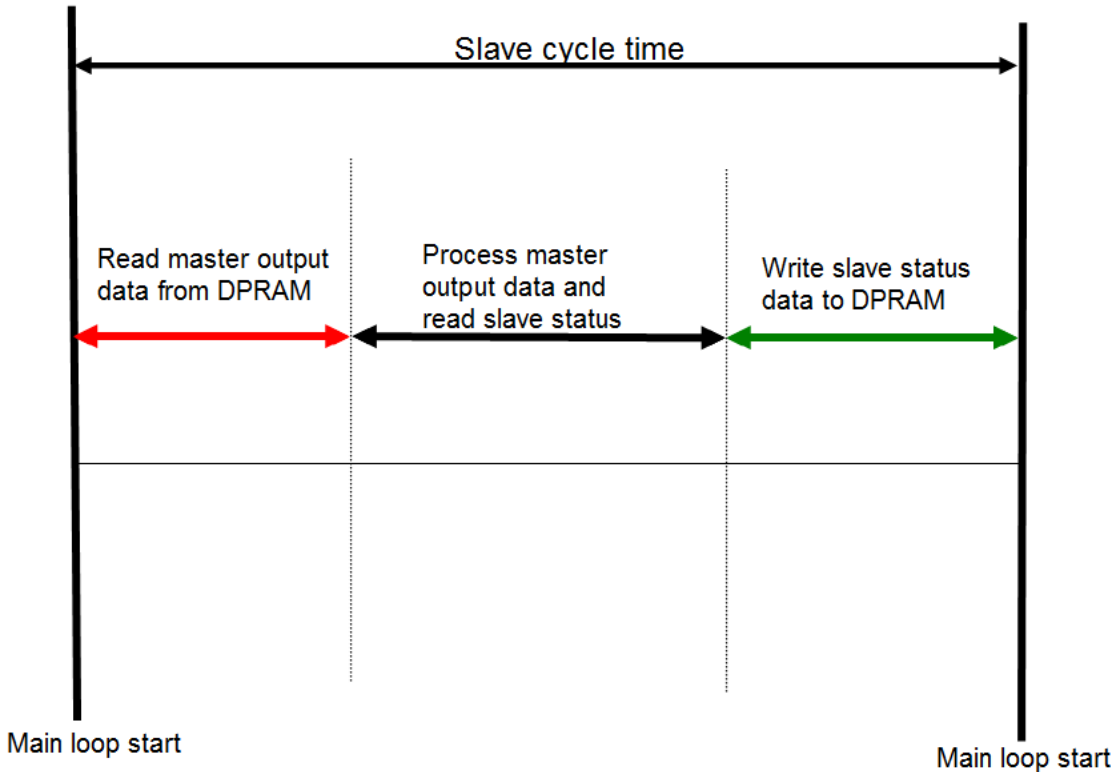
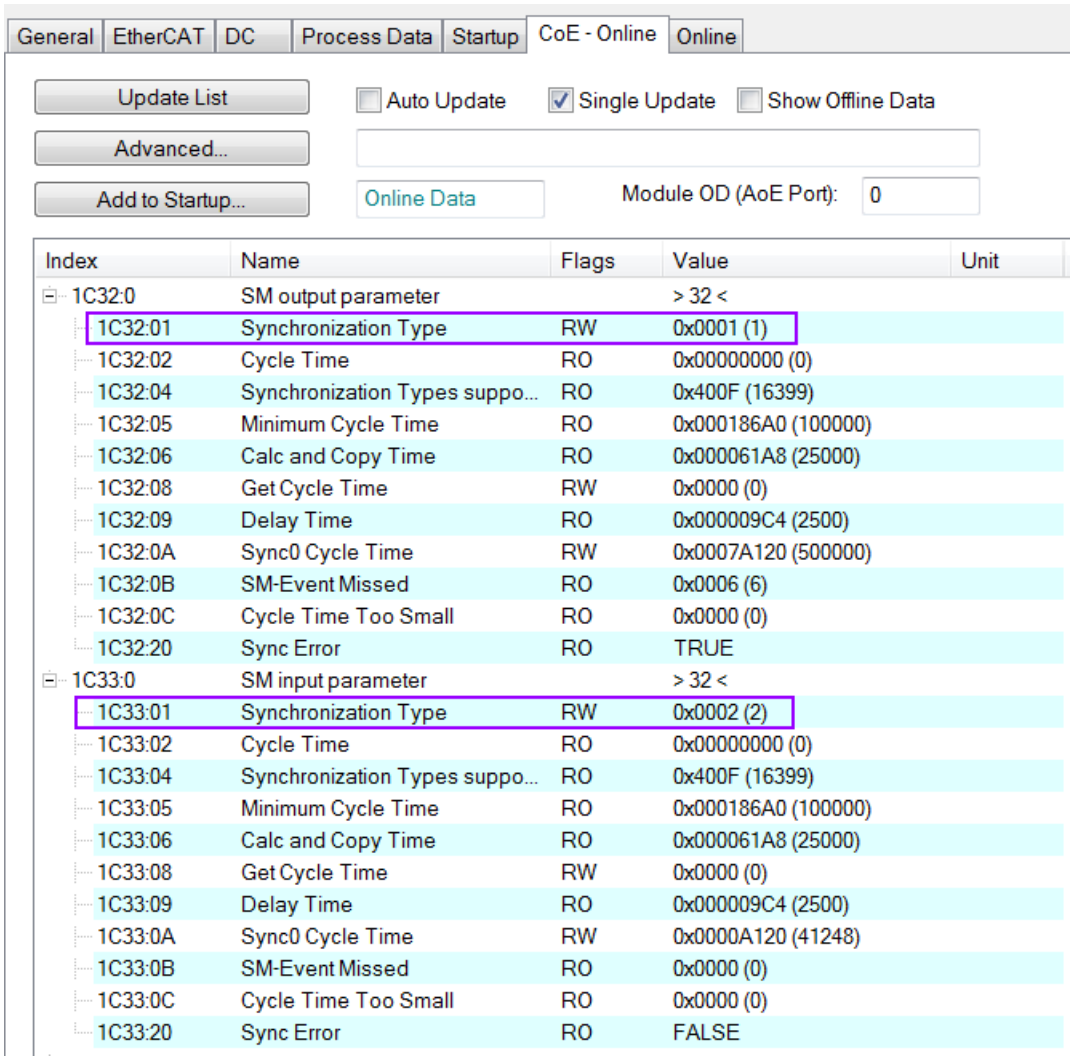


Figure 15: Slave processing sequence in Free-run mode

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 ECAT-2092T slave. Make sure the slave is set into PreOP mode before modifying the synchronization parameters



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 16: 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

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

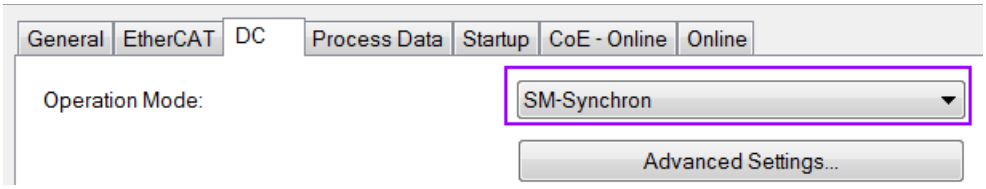


Figure 17: SM-Synchron mode selection

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.

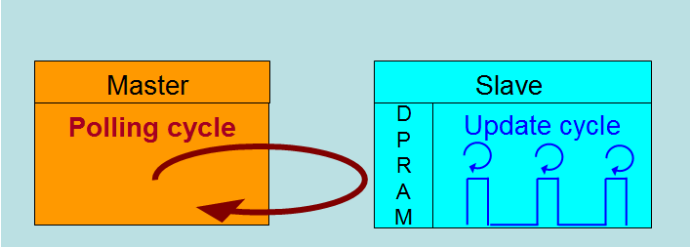


Figure 18: Master-slave cycle in DC mode

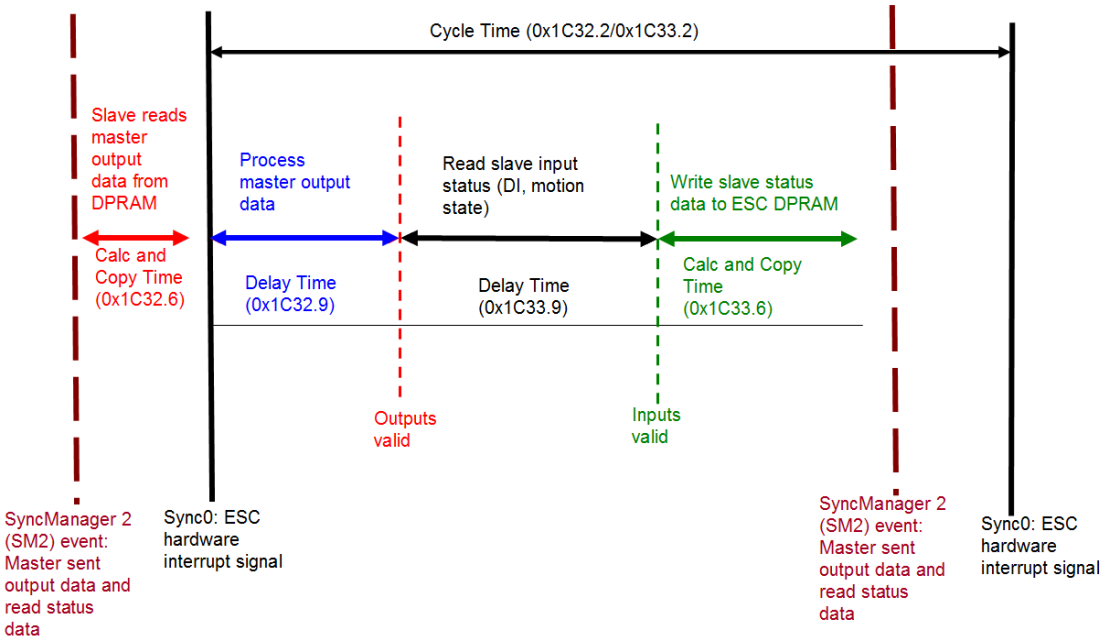


Figure 19: Internal slave processing sequence in DC mode

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 20: 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.

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 21: 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.

6 Project Integration

In this chapter the integration of the ECAT-2092T device into a TwinCAT controlled EtherCAT network is being described. In general the ECAT-2092T 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 ECAT-2092T. 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 "ECAT-2092T.xml" of the ECAT-2092T device into the TwinCAT system directory and restart the TwinCAT system.
For TwinCat 3.1 copy the ESI file "ECAT-2092T.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 7: 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 ECAT-2092T 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

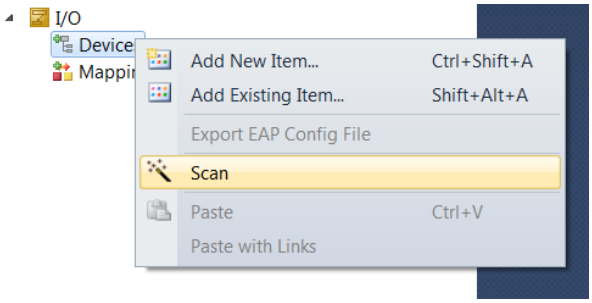
configuration tool

- The ECAT-2092T devices has to be connected to a power supply and ready for communication
- Set the TwinCAT in CONFIG mode.

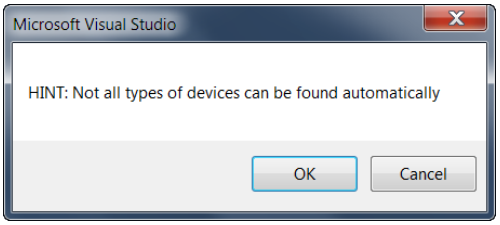
6.2.1 Scanning of the EtherCAT Device

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 ECAT-2092T device.



Step 2: Select "OK"



Step 3: Select the Ethernet device (Ethernet chip) to which the ECAT-2092T is connected to. Confirm the selection with "OK".

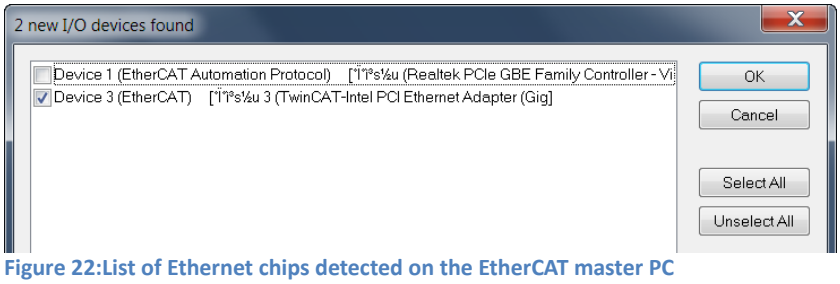
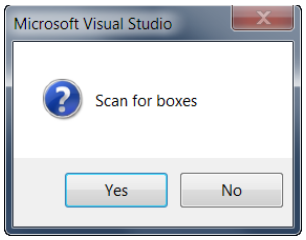
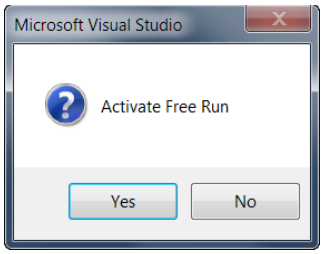


Figure 22:List of Ethernet chips detected on the EtherCAT master PC

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



Step 5: Set the ECAT-2092T 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:

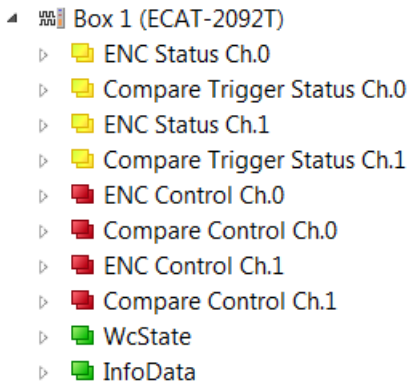


Figure 23: Default parameter selection for the ECAT-2092T

6.2.2 Encoder Counter Configuration

The configuration of the ECAT-2092T 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.

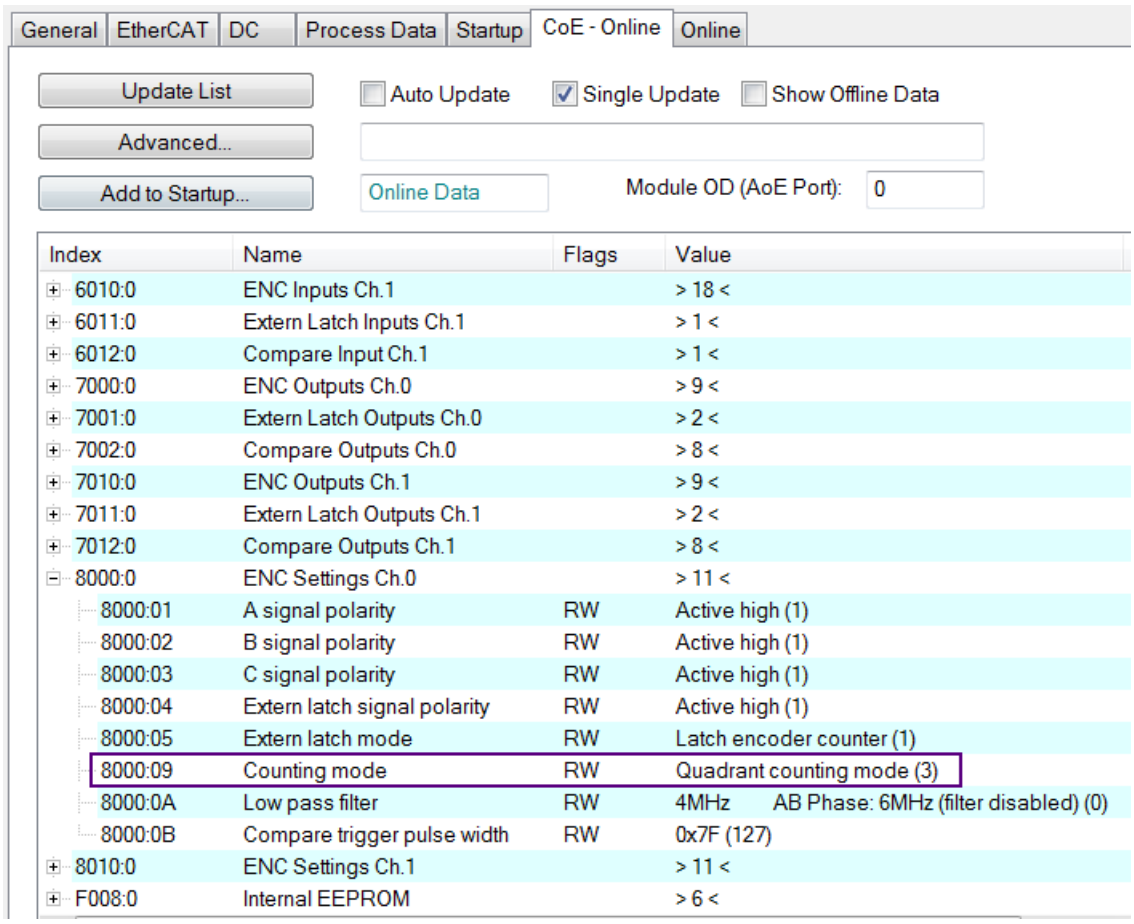
Encoder relevant CoE parameter are listed in the "Encoder setting" objects (Index 0x8000, 0x8010)

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

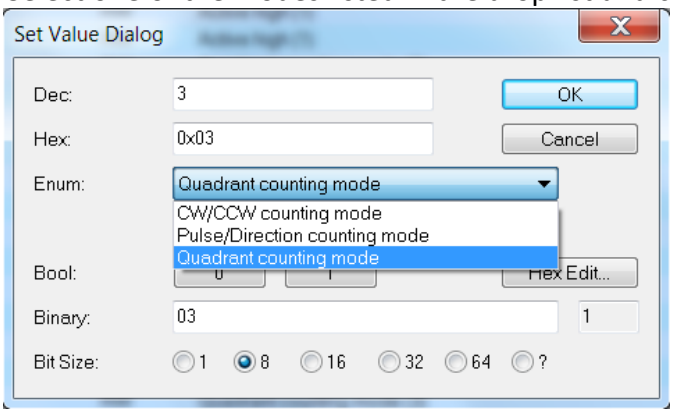
- Counting mode setting
- A/B/C signal polarity setting. The input signal may be active low or active high.
- Low pass filter clock cycle setting
- For external latch (if selected):
  - External latch HR signal polarity setting: The input signal may be active low (falling edge trigger) or active high (rising edge trigger).
    NOTE: The HR 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.

Example of setting the encoder counting mode for each channel:

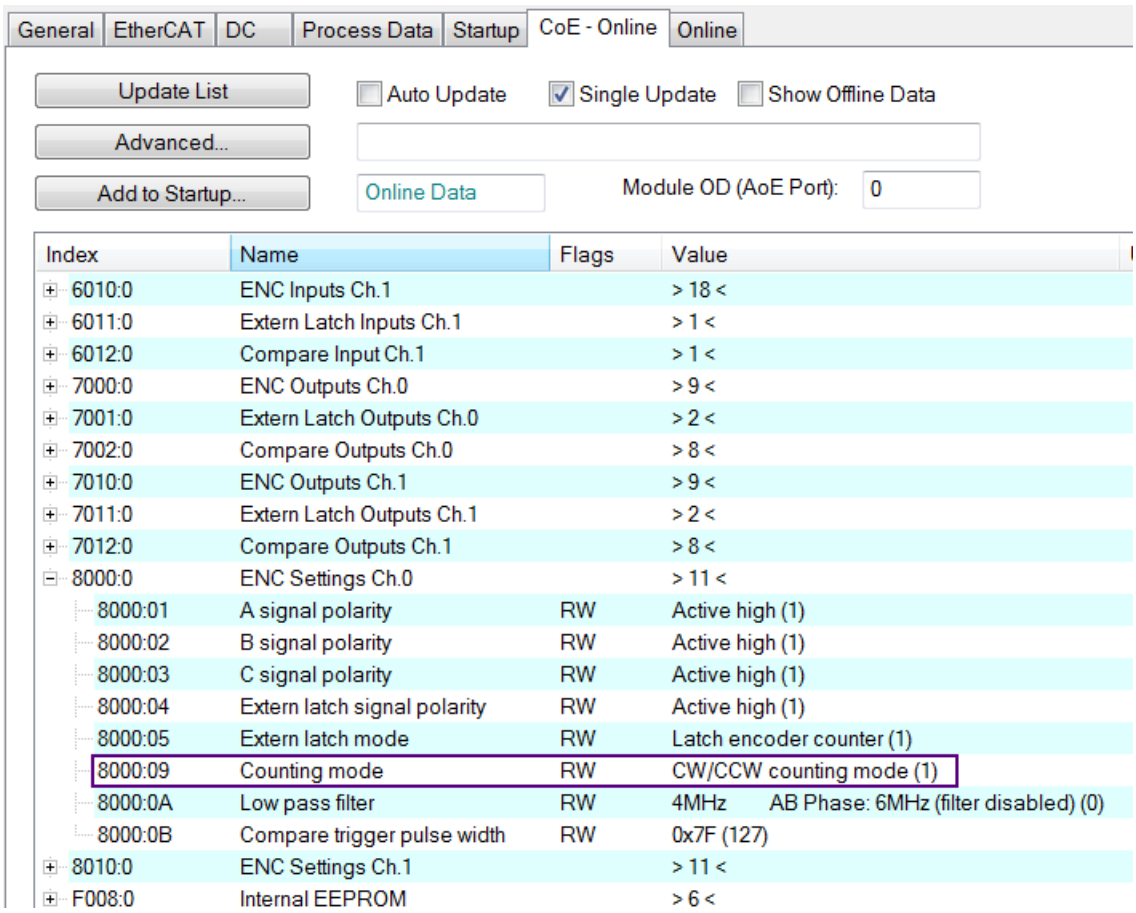
Step 1: Go to "ENC Setting Ch.0" of a channel. Extend the index tree and double click "Counting mode" with the index 8000:09 for channel 0.



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.



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 ECAT-2092T. 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 7.4.

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).

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 + Compare trigger (default selection)
- Counter + Extern latch + Index latch
- Counter
- Counter + Extern latch + Compare trigger
- Counter + Index latch + Extern latch + Compare trigger

By selecting one of the motion mode from the list box (Figure 24) 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)".

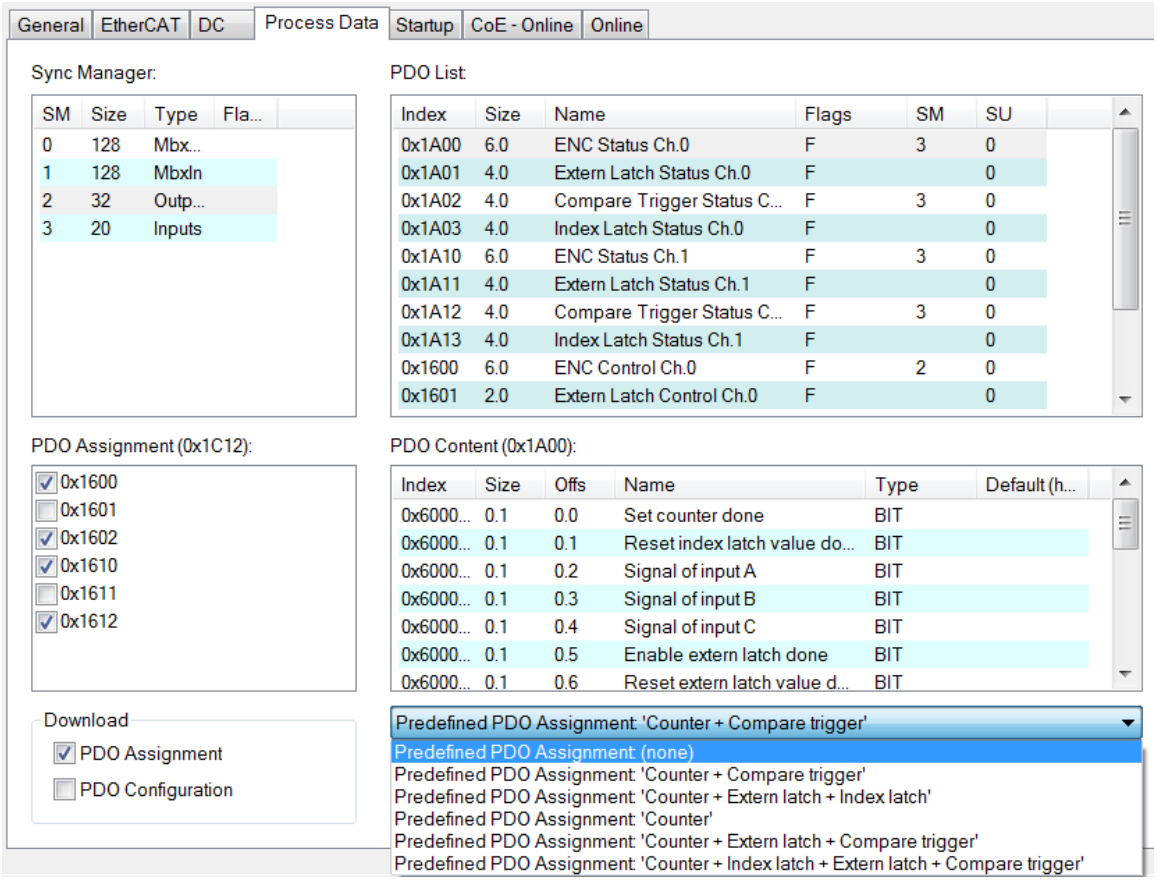


Figure 24: Predefined PDO assignment selection

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 8.
The following section describes the procedure for selecting the PDO manually.

PDO selection procedure:

1. Click the "Process Data" tab of the ECAT-2092T 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 25). 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.

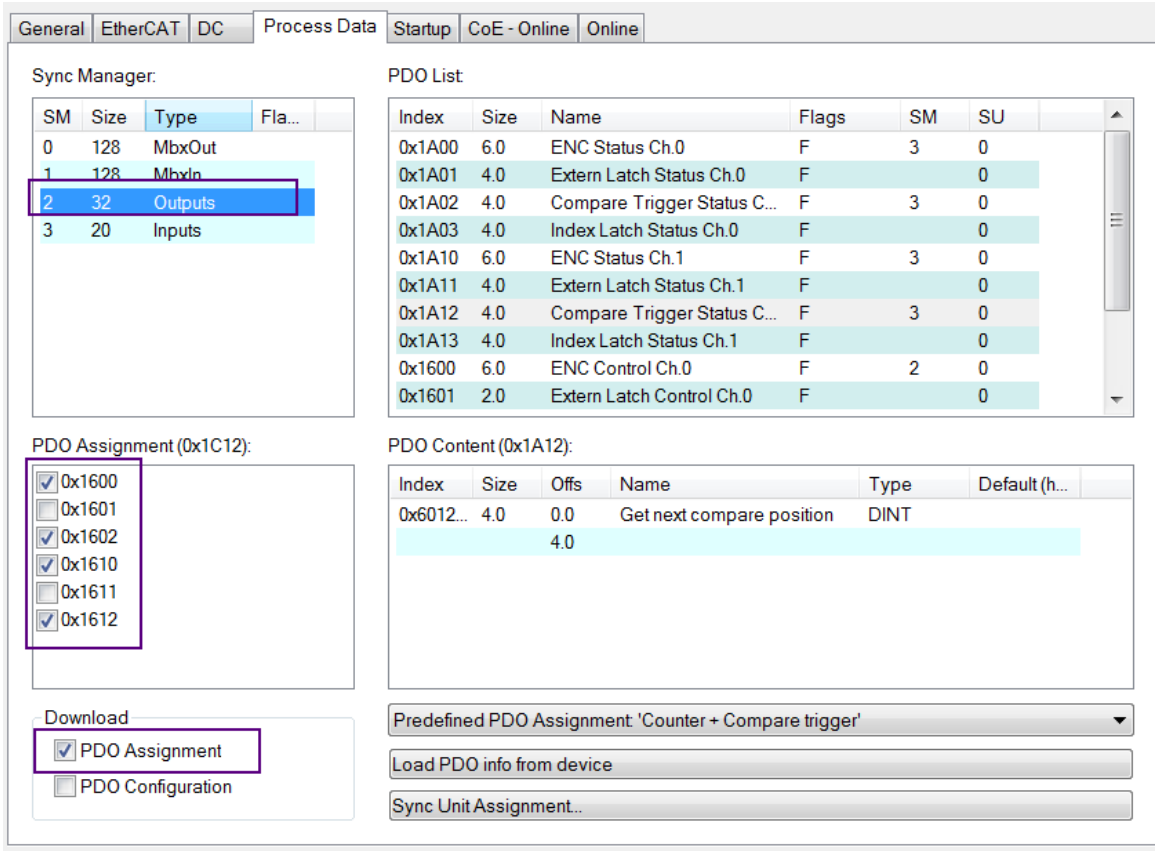


Figure 25: Predefined PDO assignment selection

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.

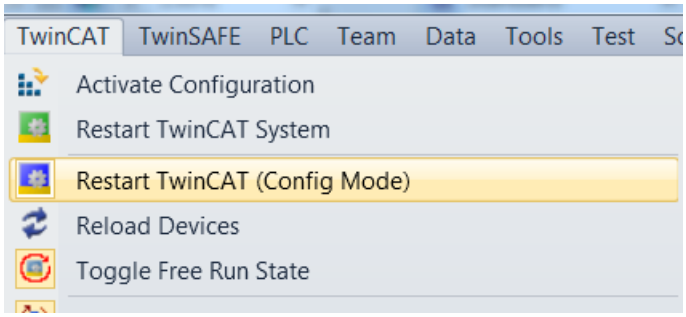


Figure 26: Download PDO assignment and restart TwinCAT

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

7 Parameter Description

7.1 Configuration Parameters

7.1.1 Counting Mode

The ECAT-2092T 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 27:

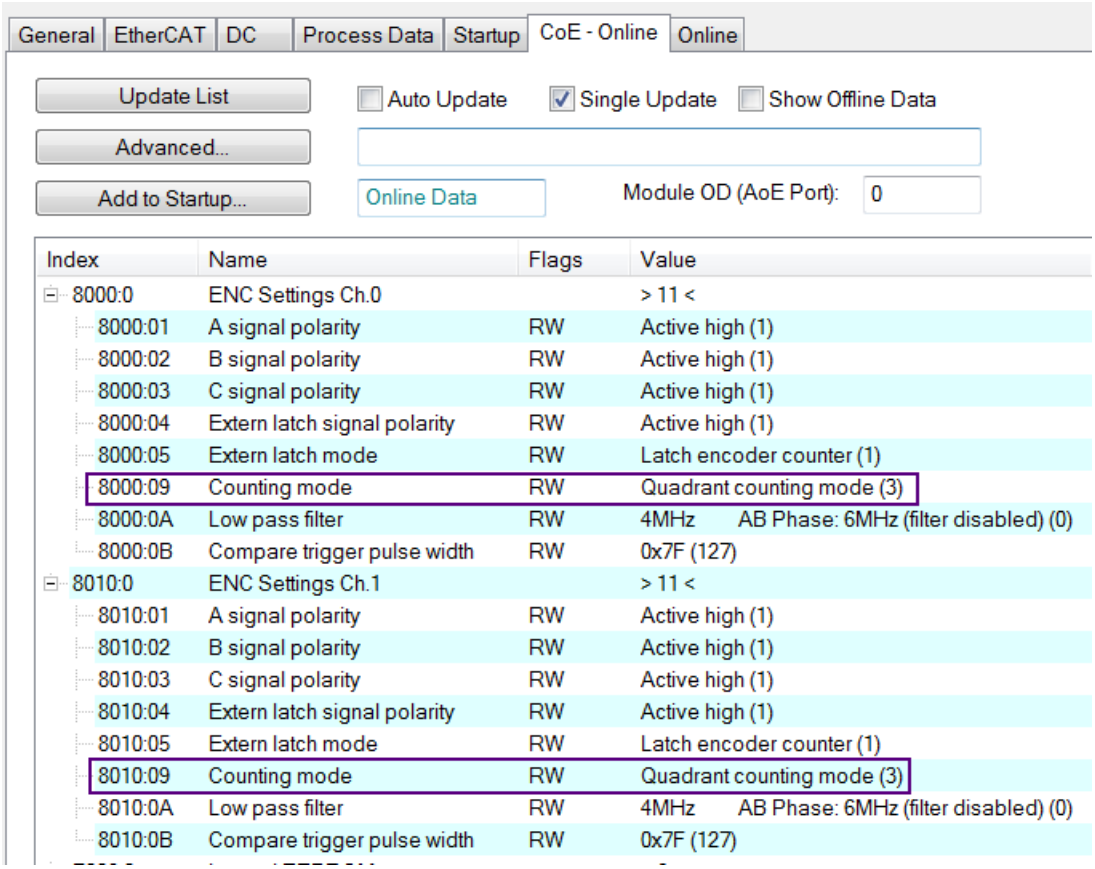


Figure 27:Configuration parameters set via CoE

In the **pulse/direction counting mode** (Figure 28) 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 ECAT-2092T counts the rising or falling edges of the "A" signal pulses and the "B" signal 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.

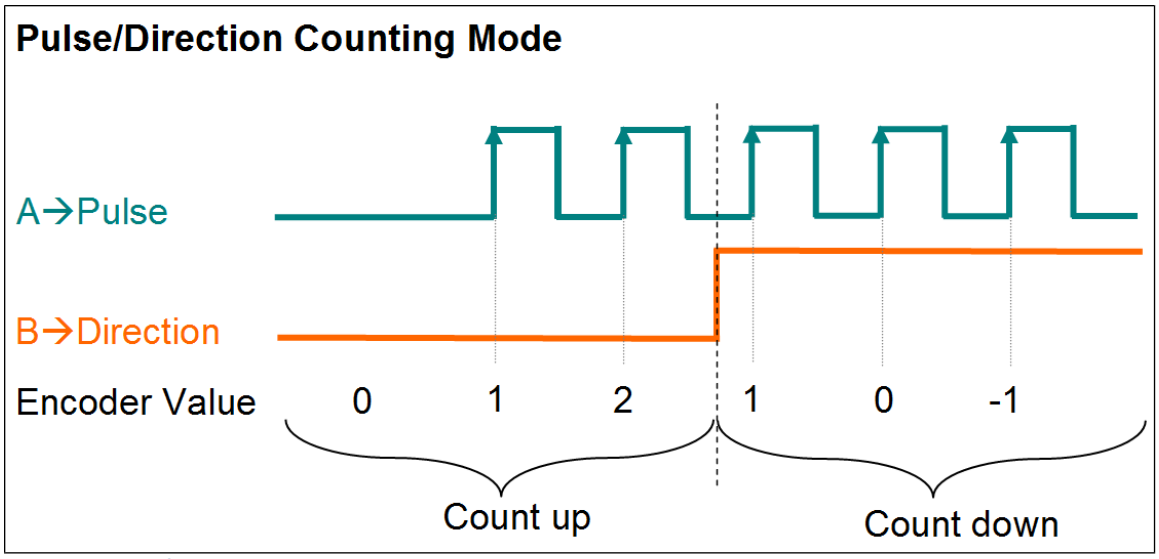


Figure 28: Pulse/Direction counting mode

In **clockwise/counterclockwise mode** (Figure 29) 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.

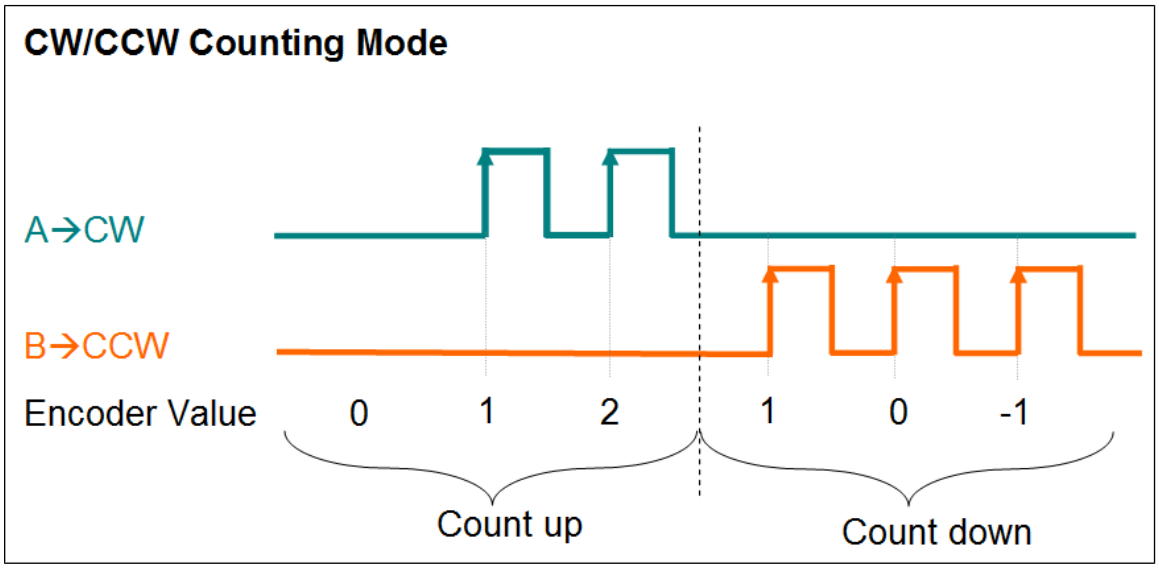


Figure 29: Clockwise/ Counterclockwise counting mode

In the **quadrant counting mode** (Figure 30) 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.

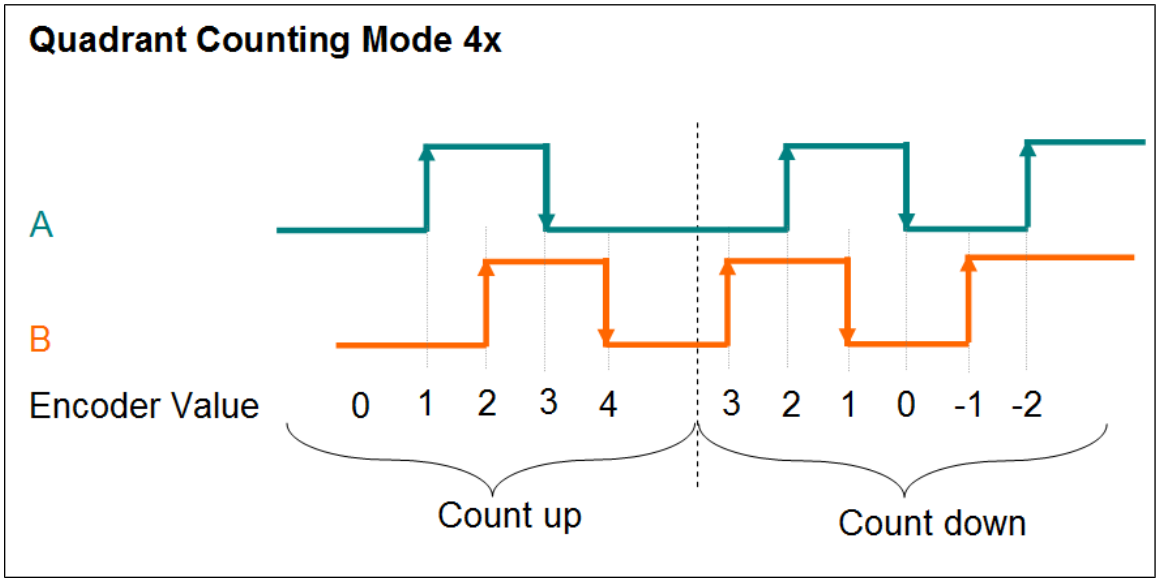


Figure 30: Quadrant counting mode

7.1.2 Signal Polarity Setting

7.1.2.1 Encoder Input Signal

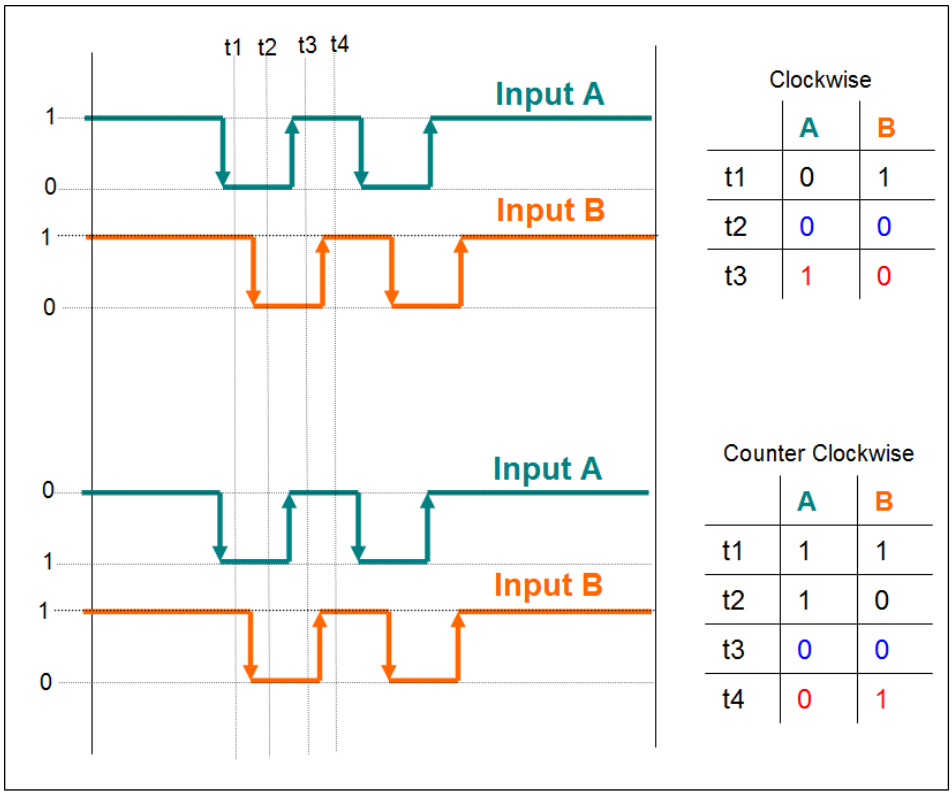
The polarity of the encoder A,B,C signal indicates the active level of the signal. The active level of the encoder A, B and C signals has to be set via CoE:

- "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 28) the counting direction will change.
- By changing the polarity of signal "A" for the quadrant counting mode (Figure 31) results in a change of counting direction.
- Changing the signal polarity for the clockwise/counterclockwise mode will not change the counting direction



Clockwise

	A	B
t1	0	1
t2	0	0
t3	1	0

Counter Clockwise

	A	B
t1	1	1
t2	1	0
t3	0	0
t4	0	1

Figure 31: 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 (HR) 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).

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.

7.1.3 Extern Latch Mode

Two latch modes are being supported (Table 8):

- Latch current encoder position
- Reset encoder counter to zero

Latch Mode	Description

Latch encoder counter	An extern trigger signal will latch the current encoder position. The latched value can be accessed via process data (0x60n1:01, n= 0;1)
Reset encoder counter	A positive trigger signal will immediately reset the encoder counter (0x60n0:11, n= 0;1) to zero. Attention: If the compare trigger function with auto-increment has been enabled when the encoder counter has been reset to zero then it is important to reset the compare function in order to update the compare position register.

Table 8: Latch mode

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

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 9 list the filter clocks frequencies available for the ECAT-2092T.

Low pass filter number	Maximum Input Frequency	
	Pulse/Direction counting mode 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 9: Filter clock frequencies

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 10: 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 T = the period of the filtering clock		

Table 10: Low pass filter setting

7.1.5 Compare Trigger Pulse Width

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 pulse width of the output signal can be set via CoE (0x80n0:0B, n= 0;1). Valid value are 1 to 127.

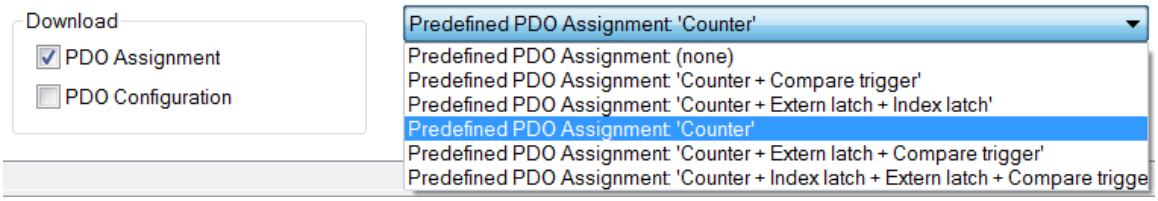
Pulse Width Setting	Actual Pulse Width (µSec)
127 (default)	50
110	40
96	30
87	20
80	15

Table 11: Compare trigger pulse output width setting

7.2 Process Data Paramater

7.2.1 Counter

If the ECAT-2092T 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 ECAT-2092T 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 12: 0x16n0 - Process data sent to the ECAT-2092T

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
Enable extern latch done	0x60n0:06	Requires the 0x16n1 and 0x1An1 to be added to the process data (will be discussed in the next section)
Reset extern latch value done	0x60n0:07	Requires the 0x16n1 and 0x1An1 to be added to the process data (will be discussed in the next section)
Enable compare done	0x60n0:08	Requires the 0x16n2 and 0x1An2 to be added to the process data
Sync error	0x60n0:0F	This variable informs the user whether a synchronization error occurred in Distributed Clock (DC) mode during the previous cycle. The master has to make sure that within each fixed time interval a datagram is being sent to the slave otherwise a

0x1An0 (n= 0;1)		
Parameter	Object	Description
		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 13: 0x1An0 - Process data received from the ECAT-2092T

The following flow diagram (Figure 32) shows the procedure for setting the encoder counter value.

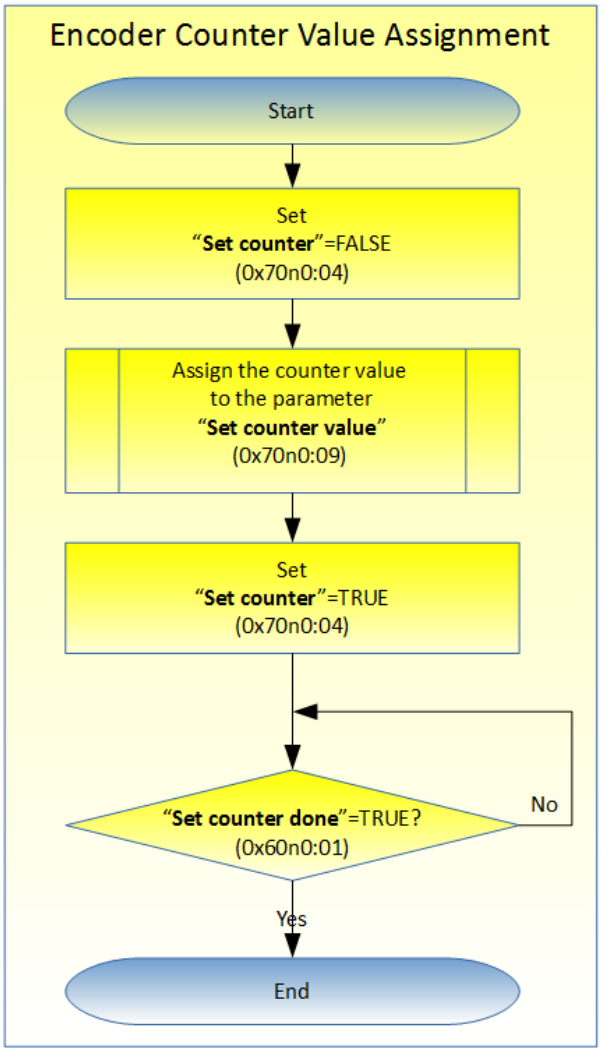


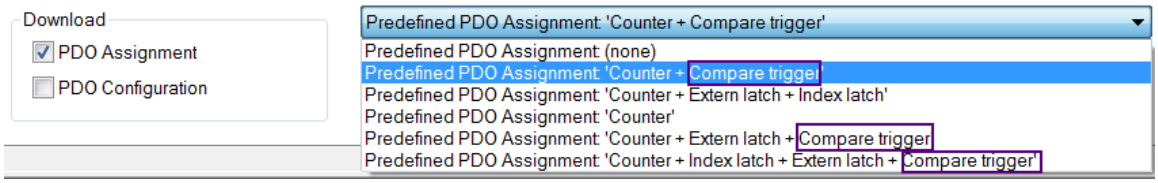
Figure 32: Encoder counter setting

7.2.2 Position Compare Trigger

The compare trigger function supports two modes: Single position compare and auto-increment 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 17.
- 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 is important to reset the compare function by disabling/enabling it when the encoder counter has been set to a different value by the user.

Process data required for doing position compare control: 0x16n0, 0x16n2, 0x1An0, 0x1An2 (n= 0;1). By using TwinCAT one of the predefined PDO Assignments which contains the "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 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: ▪ "Set auto increment compare direction" ▪ "Set first compare position" ▪ "Set auto increment compare value" Once the compare function has been activated the "Enable compare done" (0x60n0:08) value changes to TRUE. 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.

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. This variable is valid only if incremental-compare has been activated ("Set auto increment compare value" != 0) Valid values: ▪ 0: positive direction ▪ 1: negative direction
Set first compare position	0x70n2:07	Position at which the first compare output signal will be triggered ECAT-2092T supports two compare mode: ▪ Single compare position: In this mode the "Set first compare position" variable sets the position at which a compare output trigger will occur. ▪ 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. The user can always confirm the next compare position by reading the variable "Get next compare position" (0x60n2:01)
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" Disable auto-increment compare function by setting this variable to zero.

Table 14: 0x16n0 - Process data sent to the ECAT-2092T

0x1An0 (n= 0;1)		
Parameter	Object	Description
Enable compare done	0x60n0:08	Indicates whether the compare function has been activated (TRUE) or not (FALSE).

Table 15: 0x1An0 - Process data received from the ECAT-2092T

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.

Table 16: 0x1An2 - Process data received from the ECAT-2092T

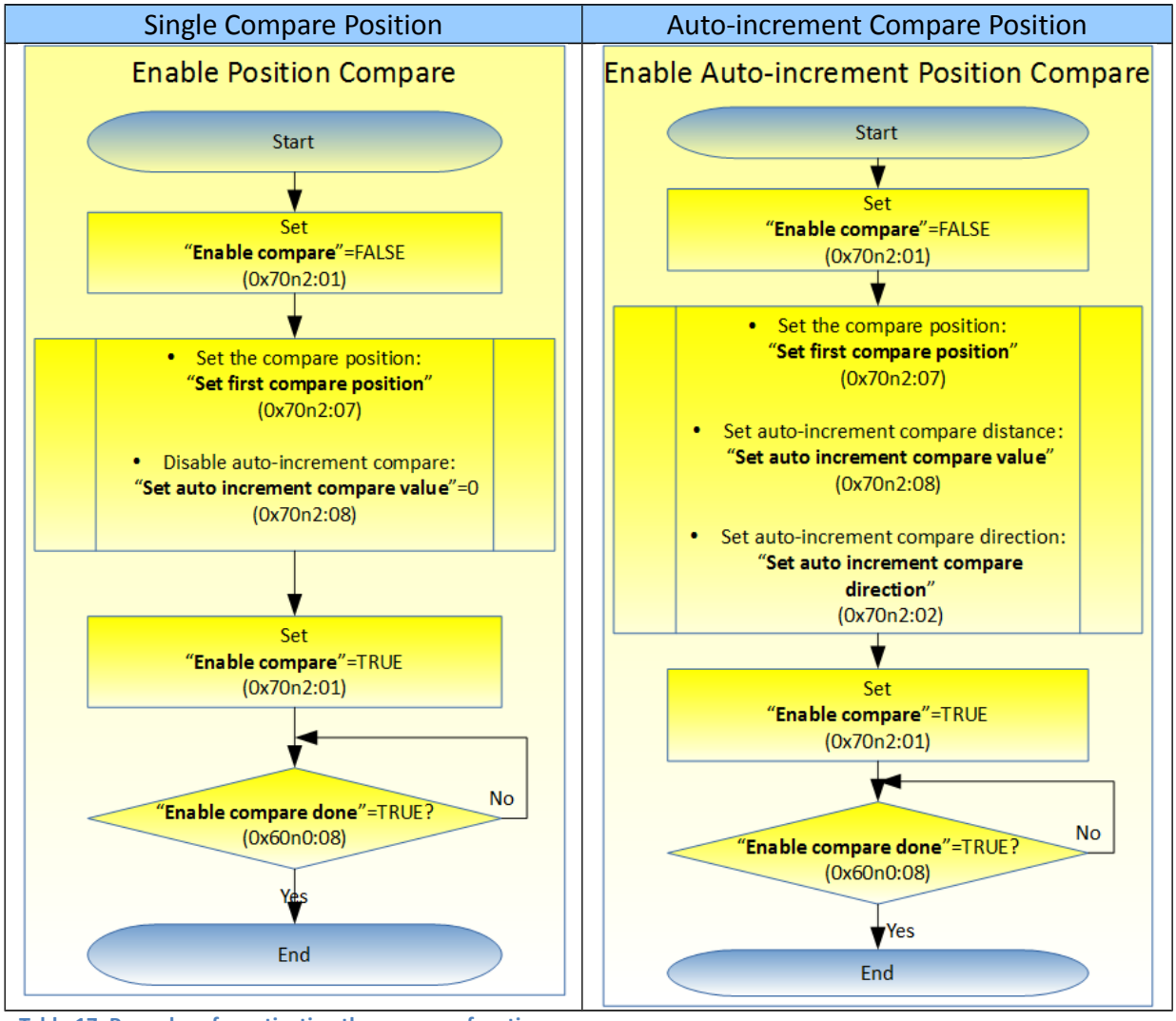


Table 17: Procedure for activating the compare function

7.2.3 Index and Extern Latch

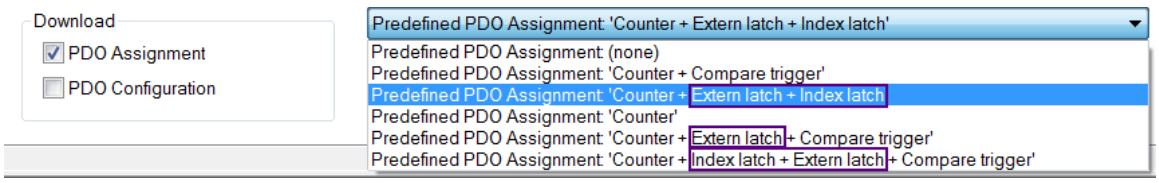
The ECAT-2092T has got two latch inputs for each encoder channel: Index "C" and extern "HR" latch.

- 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 ECAT-2092T 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 "HR" signal has been triggered
- Latch encoder counter: This mode is similar to the index latch. A rising or falling edge (can be configured) input signal at the "HR" channel causes in a hardware latch of the current encoder value.

The extern latch function can be disable. By default it is disabled.
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 18: 0x16n0 - Process data sent to the ECAT-2092T

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.
Reset extern latch value	0x70n1:02	If this variable turns from FALSE to TRUE then the extern latch 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 19: 0x16n1 - Process data sent to the ECAT-2092T

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. The parameter is FALSE if ▪ the "Reset index latch value" (0x70n0:02) is set to FALSE ▪ the firmware is busy resetting the index latch value 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	0x60n0:06	Indicates whether the extern "HR" 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	0x60n0:07	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 20: 0x1An0 - Process data received from the ECAT-2092T

0x1An1 (n= 0;1)		
Parameter	Object	Description
Extern latched counter value	0x60n1:01	▪ Encoder value latched by the extern signal "HR". The encoder value will be latched at either a rising or falling edge of the HR input signal. The trigger level can be set for both encoder channel together ("Extern latch signal polarity", 0x80n0:04) ▪ The value is valid only if • the extern latch function has been enabled ("Enable extern latch done", 0x60n0:06) • the extern latch has been set to "Latch encoder counter" mode. This has to be set via "Extern latch mode" (0x80n0:05)

Table 21: 0x1An1 - Process data received from the ECAT-2092T

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 22: 0x1An3 - Process data received from the ECAT-2092T

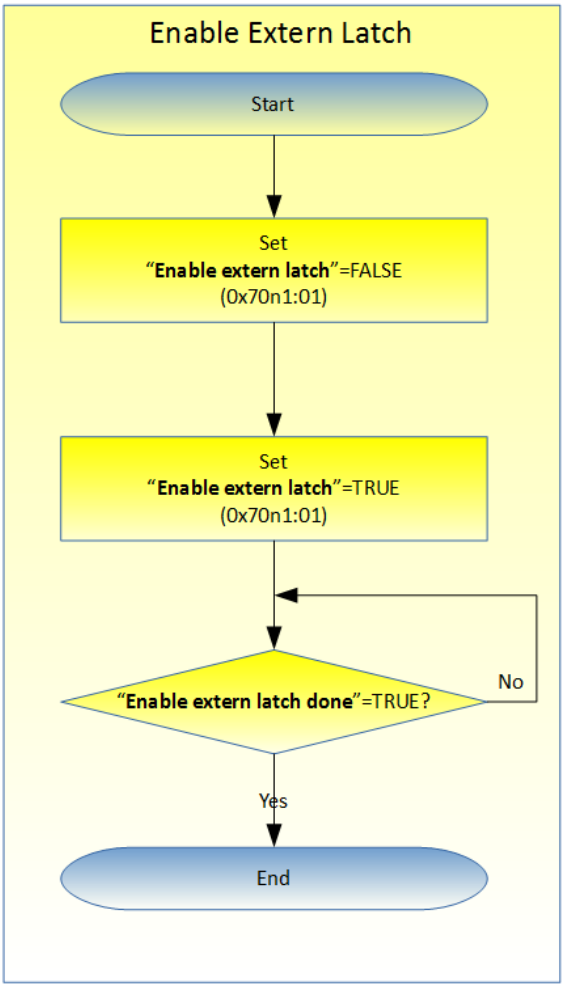


Figure 33: Activating external HR latch

The following table (Table 23) shows the procedure for resetting the index and extern latch value to zero.

Index Latch Resetting	Extern Latch Resetting

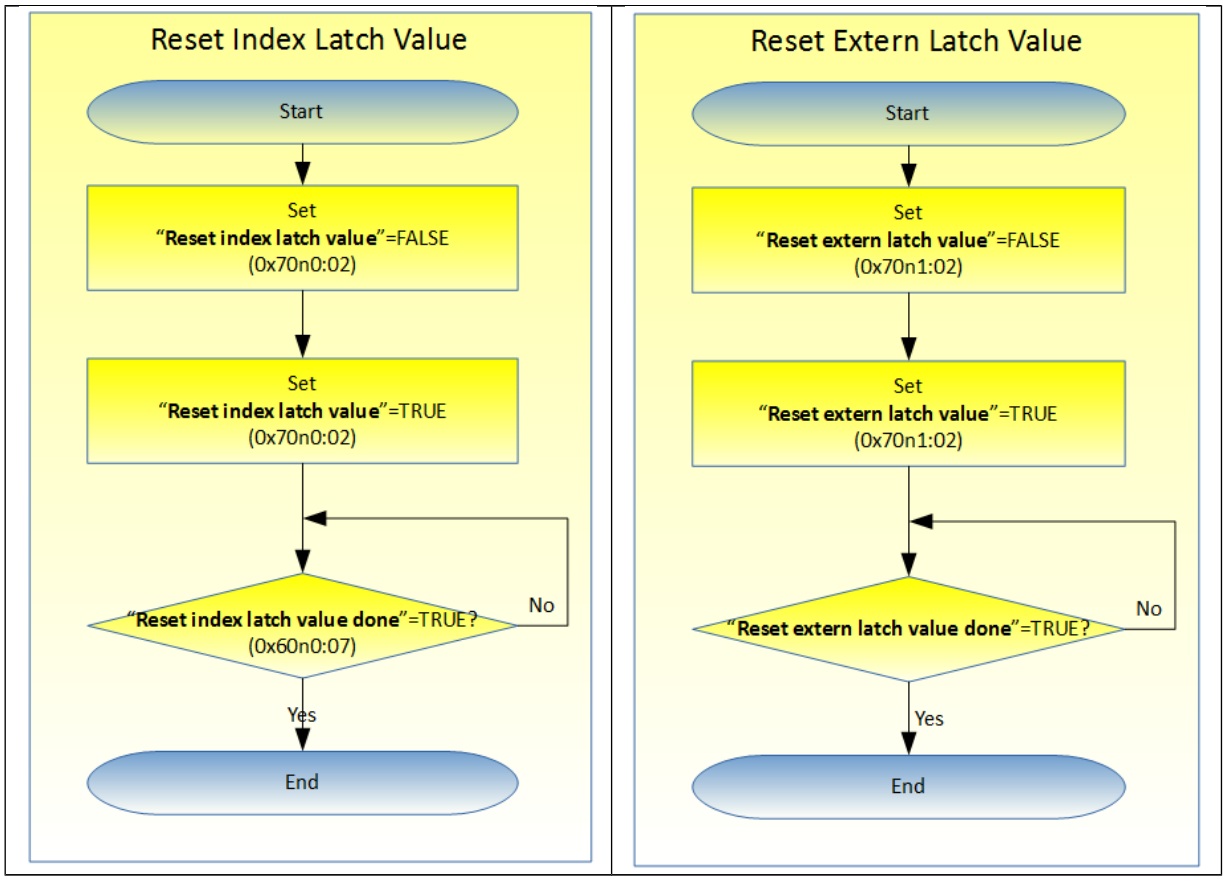


Table 23: Resetting latch register procedure

CoE Interface

7.3 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 ECAT-2092T 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
- 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 34 shows part of the CoE objects available for the ECAT-2092T device, ranging from 0x1000 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 8.

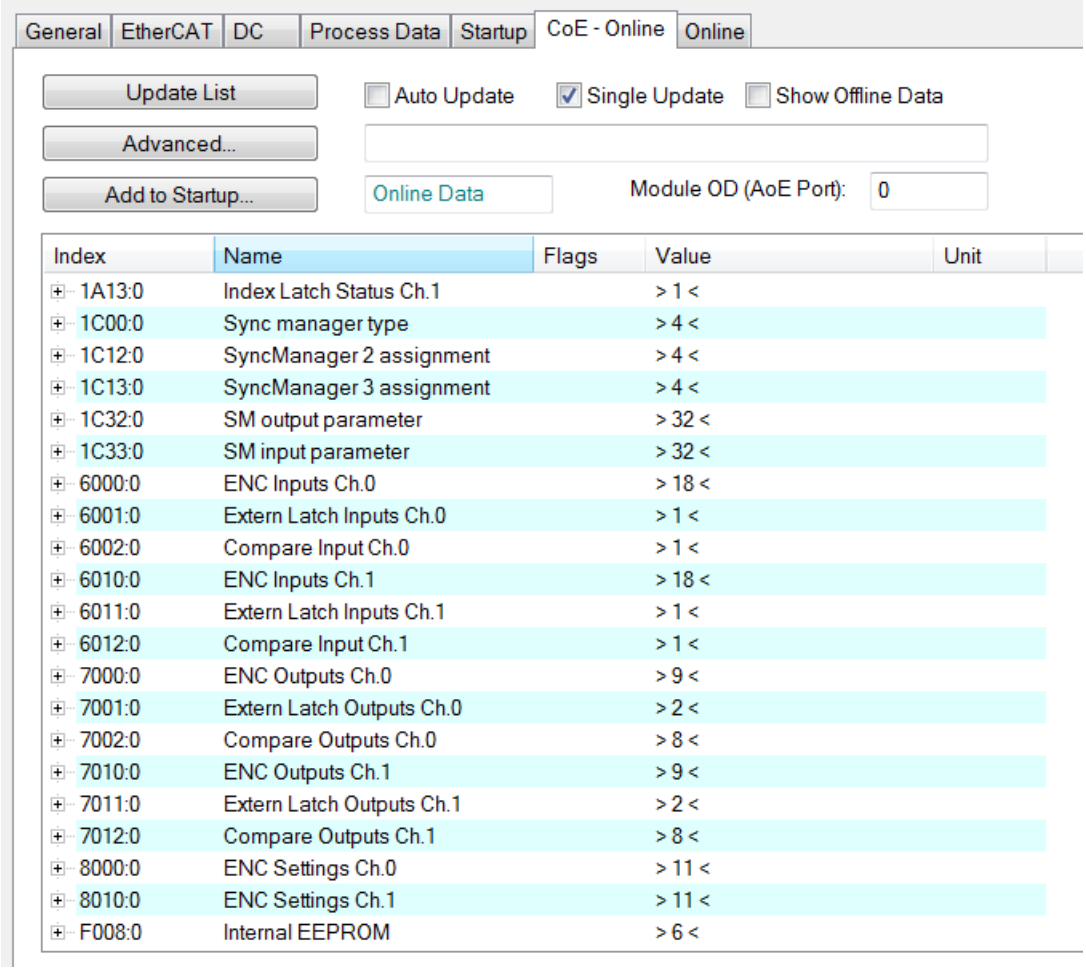


Figure 34: "CoE - Online " tab

7.4 Save Configuration Data to Memory

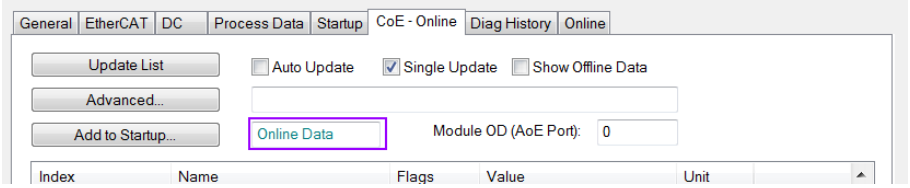
In this section the procedure of saving encoder configuration parameters to the non-volatile memory of the ECAT-2092T is being discussed.

The CoE objects 0x8000 to 0x8010 contains all the parameters needed to configure the ECAT-2092T. TwinCAT allows the user to set the configuration parameters via the System Manager (Figure 34) or from a TwinCAT PLC via ADS (TcEtherCAT.lib library).

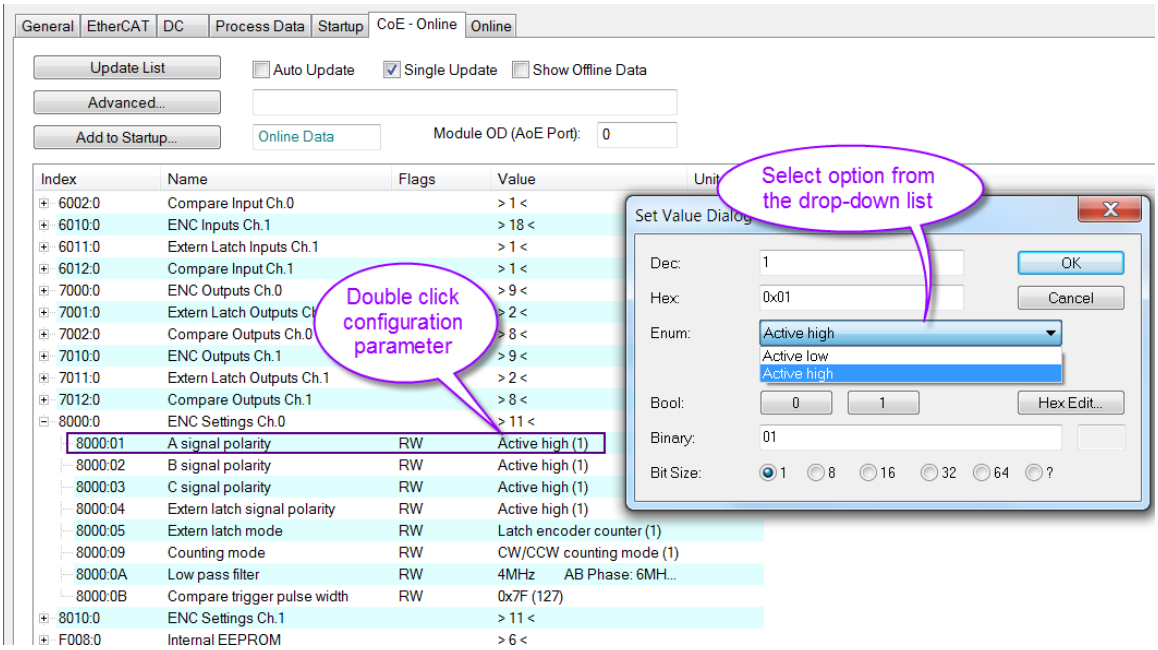
If the CoE parameters of the ECAT-2092T are set online, then the device does not automatically store the data to its non-volatile memory, and therefore the data will be lost once the device is switched off. The 0xF008 object provides functions to store the configuration data permanently to the non-volatile memory of the ECAT-2092T and the setting will be immediately available immediately after a restart.

Procedure for storing configuration data to the local ECAT-2092T memory:

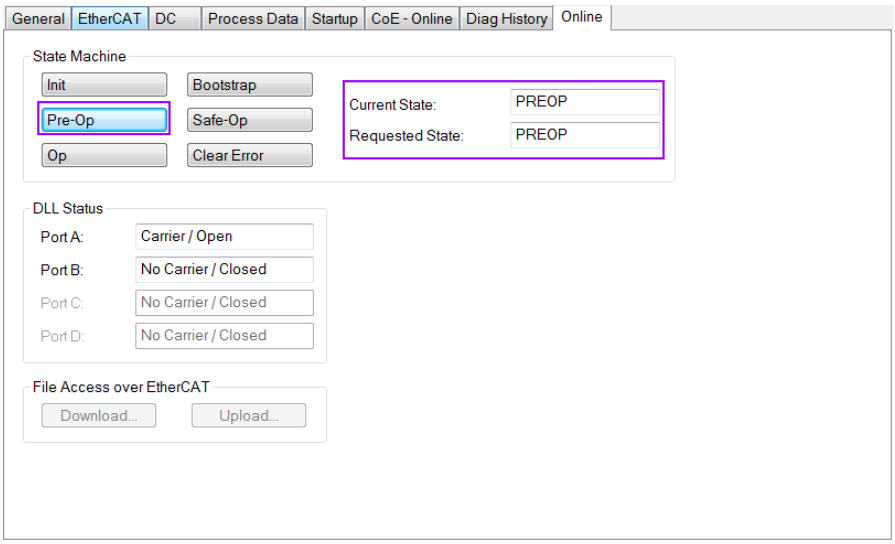
Step 1: Make sure the TwinCAT System Manager is connected to the ECAT-2092T and the "CoE-Online" tab is showing that the slave is online.



Step 2: Do all the necessary configuration by entering the correct parameter values for the configuration objects (0x8000, 0x8010). 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.



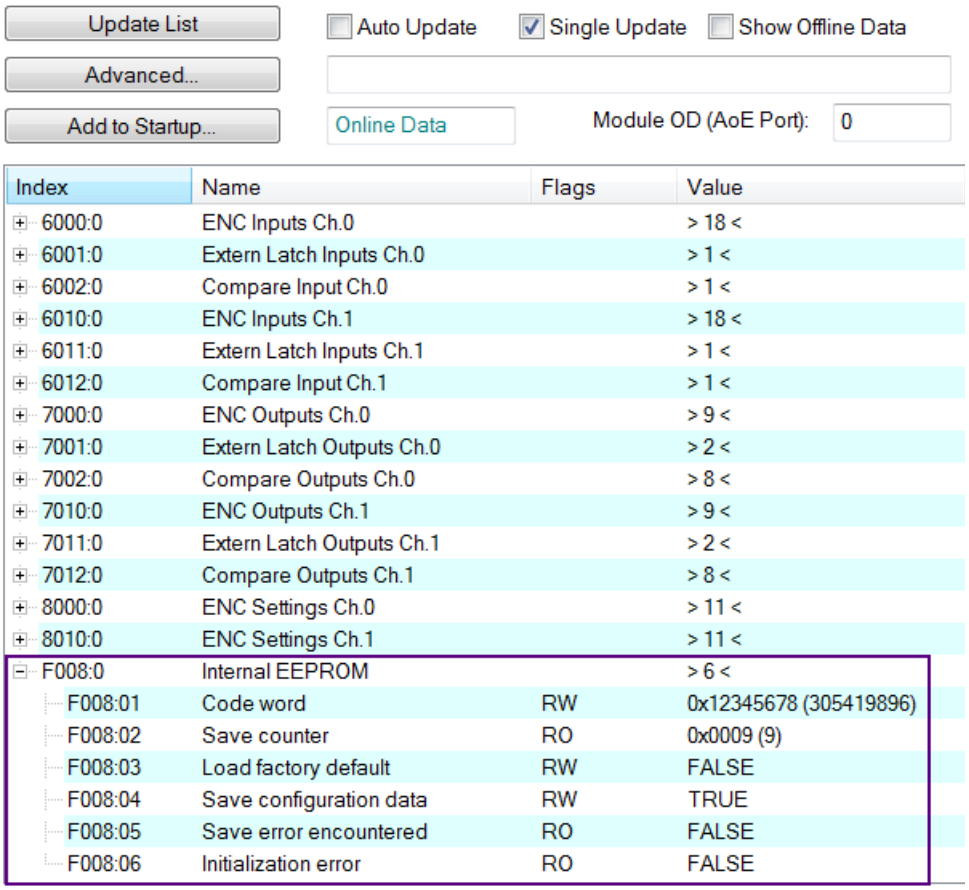
Step 3: After all the configurations have been done set the slave into Pre-Op mode. Data can only be stored to the local device if it is in Pre-Op mode. On the "Online" tab click the "Pre-OP" button to put the slave into Pre-OP mode.



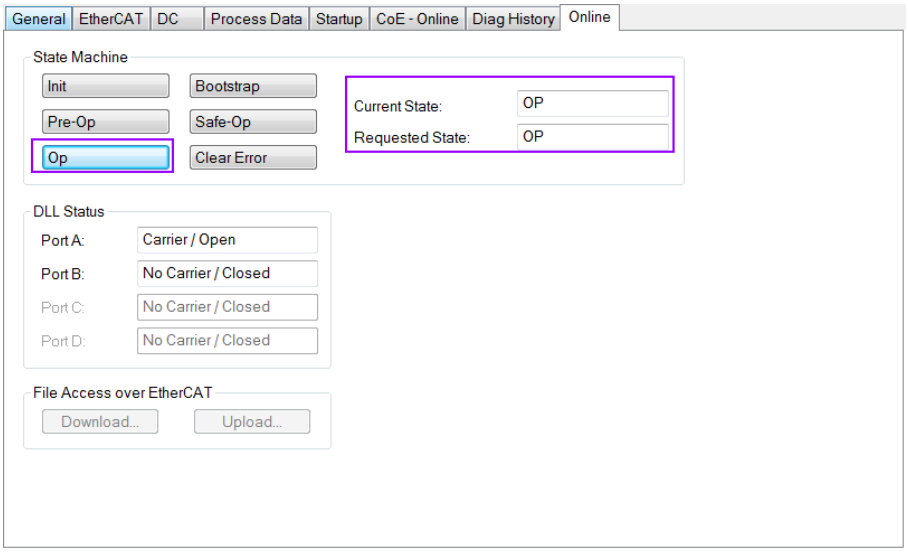
Step 4: The parameters of the 0xF008 object handles the save procedure.

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 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 Counter" (F008:02) shows how often configuration data has been stored to the local memory in the lifetime of the device.

   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.



Step 5: Set the ECAT-2092T back into OP mode.



8 Object Description and Parameterization

8.1 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	0x00020000

Index 1008 Device name

Index (hex)	Name	Description	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	ECAT-2092T

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 (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 (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	0x00209254
1018:03	Revision	Revision number of the EtherCAT slave	UINT32	RO	0x00010000
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: 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

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.			

8.2 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

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

8.3 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 (1 Bit)	UINT32	RO	0x60n00201
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__Enable extern latch done	Extern latch has been enabled (1 Bit)	UINT32	RO	0x60n00601
1An0:07	Status__Reset extern latch counter done	Extern latch counter has been set to zero (1 Bit)	UINT32	RO	0x60n00701
1An0:08	Status__Enable compare	Position compare has	UINT32	RO	0x60n00801

Index (hex)	Name	Description	Data type	Flags	Default
	done	been enabled (1 Bit)			
1An0:09	Status__Gap9	Empty (1 Bit)	UINT32	RO	0x00000001
1An0:0A	Status__GapA	Empty (1 Bit)	UINT32	RO	0x00000001
1An0:0B	Status__GapB	Empty (1 Bit)	UINT32	RO	0x00000001
1An0:0C	Status__GapC	Empty (1 Bit)	UINT32	RO	0x00000001
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	0x01
1An1:01	Status__Extern latched counter value	Extern latched encoder position (32 Bit)	UINT32	RO	0x60n10120

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

8.4 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 3: Process Data Write (Outputs)	UINT8	RO	0x03
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	0x1C
1C12:01	SubIndex 001	Default assignment: ENC Control Channel 0	UINT16	RW	0x1600
1C12:02	SubIndex 002	Default assignment: ENC Control Channel 1	UINT16	RW	0x1610
1C12:03	SubIndex 003	Default assignment: ENC Control Channel 2	UINT16	RW	0x1620

Index 0x1C13 TxPDO assign

Index (hex)	Name	Description	Data type	Flags	Default
1C13:0	TxPDO assign	SyncManager 3 assignment: PDO Assign Inputs	UINT8	RO	0x20
1C13:01	SubIndex 001	Default assignment: ENC Status Channel 0	UINT16	RW	0x1A00
1C13:02	SubIndex 002	Default assignment: ENC Status Channel 1	UINT16	RW	0x1A10
1C13:03	SubIndex 003	Default assignment: ENC Status Channel 2	UINT16	RW	0x1A20

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: • 0: Free Run • 1: Synchronous without SM 2 event	UINT8	RO	0x0001

Index (hex)	Name	Description	Data type	Flags	Default
		• 2: DC-Mode - Synchronous with SYNC0 Event • 3: DC-Mode - Synchronous with SYNC1 event			
1C32:02	Cycle Time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchronous with SM 2 event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time	UINT8	RO	0x00000000
1C32:04	Synchronization Types supported	Supported synchronization modes: • Bit 0 = 1: free run is supported • Bit 1 = 1: Synchron with SM 2 event is supported • Bit 2-3 = 01: DC mode is supported • 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 • 1: Measurement of the local cycle time is started 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
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: • 0: Free Run • 1: Synchron with SM 3 Event (no outputs available) • 2: DC - Synchron with SYNC0 Event • 3: DC - Synchron with SYNC1 Event • 34: Synchron with SM 2 Event (outputs available)	UINT8	RO	0x0022
1C33:02	Cycle Time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchronous with SM 2 event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time	UINT8	RO	0x00000000
1C33:04	Synchronization Types supported	Supported synchronization modes: • Bit 0 = 1: free run is supported • Bit 1 = 1: Synchron with SM 2 event is supported • Bit 2-3 = 01: DC mode is supported • 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 • 1: Measurement of the local cycle time is started Set parameter to 1 in order to update the Cycle Time (1C32:02, 1C33:02) parameter with the maximum measured value		RW	0x0000
1C33:09	Delay Time	Time between SYNC1 event and reading of the inputs (in ns, only DC mode)		RO	0x00000000

Index (hex)	Name	Description	Data type	Flags	Default
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

8.5 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	Enable extern latch done	Indicates whether the external latch has been enabled	BOOLEAN	RO	
60n0:07	Reset extern latch value done	Indicates whether the external latch counter has been reset	BOOLEAN	RO	
60n0:08	Enable compare done	Indicates whether the position compare function has been enabled	BOOLEAN	RO	
60n0:0F	Sync error	The Sync error bit is only required for DC	BOOLEAN	RO	

Index (hex)	Name	Description	Data type	Flags	Default
		mode. It indicates whether a synchronization error has occurred during the previous cycle			
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	0x01
60n1:01	Extern latched value	Latched encoder position triggered by the HRn 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	

8.6 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. • By setting this Boolean from FALSE to TRUE the counter register will be assigned the value of parameter 70n0:09 ("Set counter value")	BOOLEAN	RO	FALSE
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 HR signal latch • By setting this Boolean from FALSE to TRUE the hardware HR signal latch function is enabled. The encoder value (60n0:11) will be latch when the HR input level is being triggered • By setting this variable to FALSE the extern latch function will be disabled and the latched counter value register (60n1:01) reset to	BOOLEAN	RO	FALSE

Index (hex)	Name	Description	Data type	Flags	Default
		zero			
70n1:02	Reset extern latch value	Set the extern latch value to zero • By setting this Boolean from FALSE to TRUE the extern latch value (60n1:01) will be set 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 compare output trigger function • By setting this Boolean from FALSE to TRUE the compare function will be enabled • By setting this variable to FALSE the extern latch function will be disabled • It is suggested to first set all the compare parameters (70n2:02, 70n2:07, 70n2:08) before enabling the compare trigger function • 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
70n2:02	Set auto increment compare direction	Set the auto-incremental direction for the compare value • 0 - positive direction • 1- negative direction	BOOLEAN	RO	FALSE
70n2:07	Set first compare position	The first compare	INT32	RO	0

Index (hex)	Name	Description	Data type	Flags	Default
		position			
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) • Disable the auto-increment compare function by setting this parameter to zero	INT32	RO	0

8.7 Configuration Data

Index 0x80n0 ENC Settings Ch.n

Index (hex)	Name	Description	Data type	Flags	Default
80n0:0	ENC Settings Ch.n	Encoder settings	UINT8	RO	0x0B
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	Extern latch signal polarity	Polarity of extern latch HR input signal 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.	DT0803EN01	RW	0x01 ("Active high")
80n0:05	Extern latch mode	Extern latch setting: • Latch encoder counter or • Reset encoder counter	DT0804EN01	RW	0x01 ("Latch encoder counter ")
80n0:09	Counting mode	Counter mode selection: • CW/CCW, • Pulse/Direction,	DT0801EN08	RW	0x03 ("Quadrant counting

Index (hex)	Name	Description	Data type	Flags	Default
		• Quadrant			mode")
80n0:0A	Low pass filter	Low pass filter setting	DT0802EN08	RW	0x00 ("4MHz AB Phase: 6MHz (filter disabled)")
80n0:0B	Compare trigger pulse width	Pulse width of the compare trigger output	UINT8	RW	0x7F

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

8.8 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 Counter	Total number of save sequence	UINT16	RO	0x0000
F008:03	Load factory default	Load factory default configuration immediately after power on. • 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. • Set to TRUE in order to save the configuration data (0x8000 to 0x8020) to the memory of	BOOLEAN	RW	FALSE

Index (hex)	Name	Description	Data type	Flags	Default
		the ECAT-2092T			
F008:05	Save error encountered	Indicates whether data has been successfully written to memory	BOOLEAN	RO	FALSE