Application Note

Commissioning of CPX-AP-I-EC-M12 in Codesys SP12 with CPX-AP-I-4IOL-M12

This application note gives a step by step description of how to integrate a CPX-AP-I-EC-M12 into the Codesys SP12 programming environment and how to use the CPX-AP-I-4IOL-M12 master

CPX-AP-I-EC-M12
CPX-AP-I-4IOL-M12

100297

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Table of contents

Table of contents

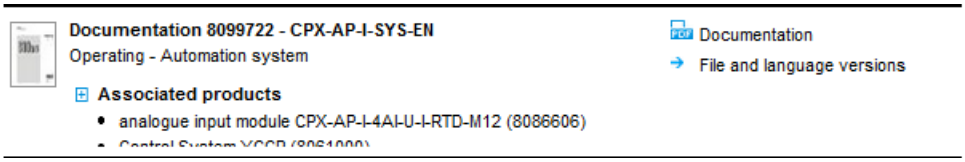
1 Components/Software/ IP address used

Type/Name	Version Software/Firmware	IP address	Subnet mask
CPX-AP-I-EC-M12	1.3.5	--	--
CPX-AP-I-4IOL-M12	V1.3.1	--	--
CPX-E-CEC-M1-EP	1.1.22-73131e464M.2019090	192.168.0.200	255.255.255.0
CPX-E-CEC Package	3.5.12.75	--	--
Laptop with Codesys SP12	--	192.168.0.201	255.255.255.0

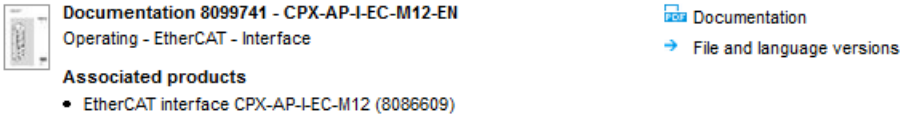
Table 1.1: 1 Components/Software used

1.1 Recommended manuals

A) CPX-AP-I-SYS (System manual)

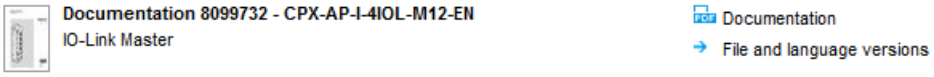


B) CPX-AP-I-EC-M12 (Operating manual)



Source:
https://www.festo.com/net/en-gb_gb/SupportPortal/default.aspx?q=8086609&tab=3

C) CPX-AP-I-4IOL-M12 (Documentation)



Source:
https://www.festo.com/net/en-gb_gb/SupportPortal/default.aspx?q=CPX-AP-I-4IOL-M12&tab=3

1.2 Recommended ESI / FW File

A) Firmware v1.3.5

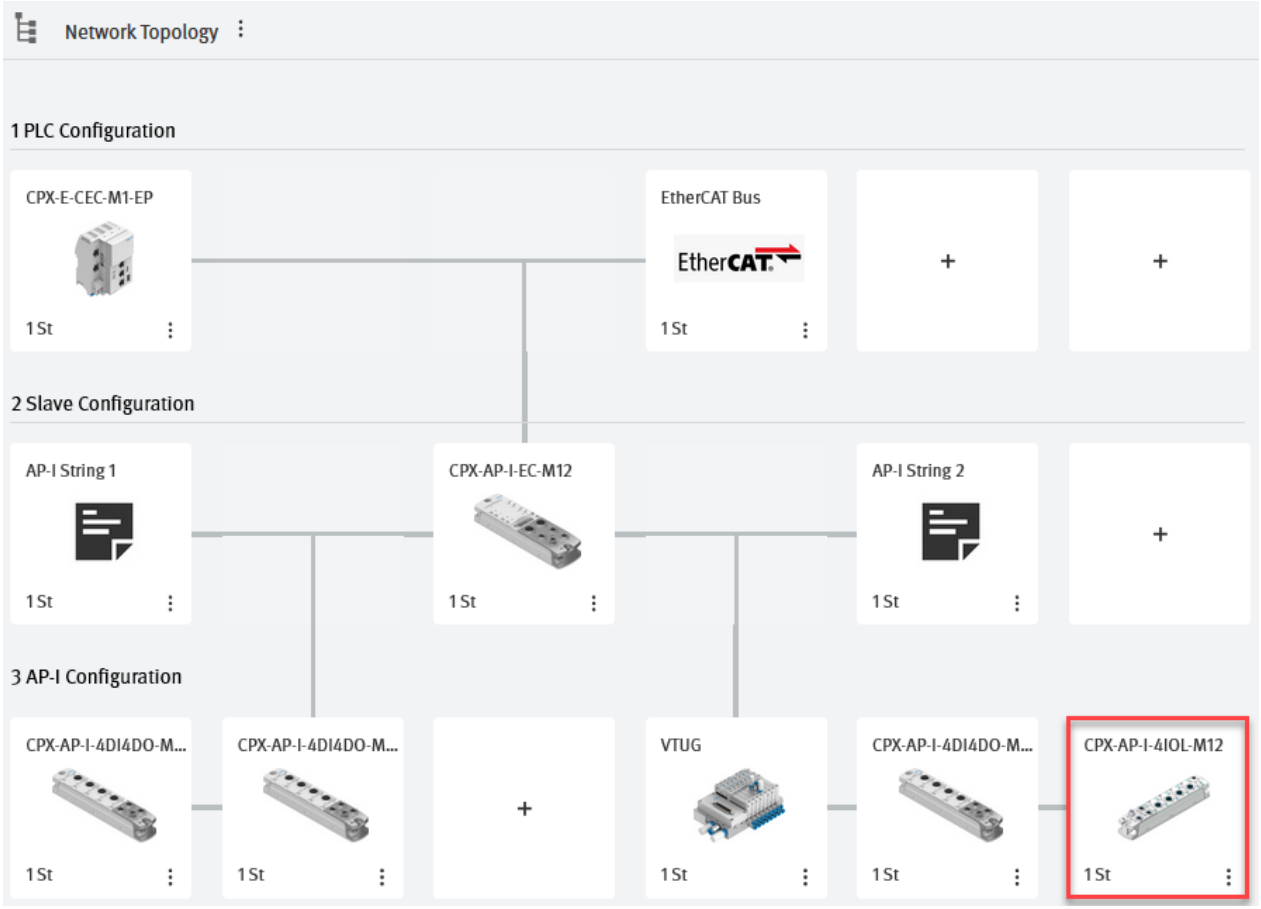
Firmware **Supported systems:** • EtherCAT interface CPX-AP-I-EC-M12 (8086609) Revision 01	v1.3.5	→ Firmware → File and language versions

B) ESI of 31/03/2020

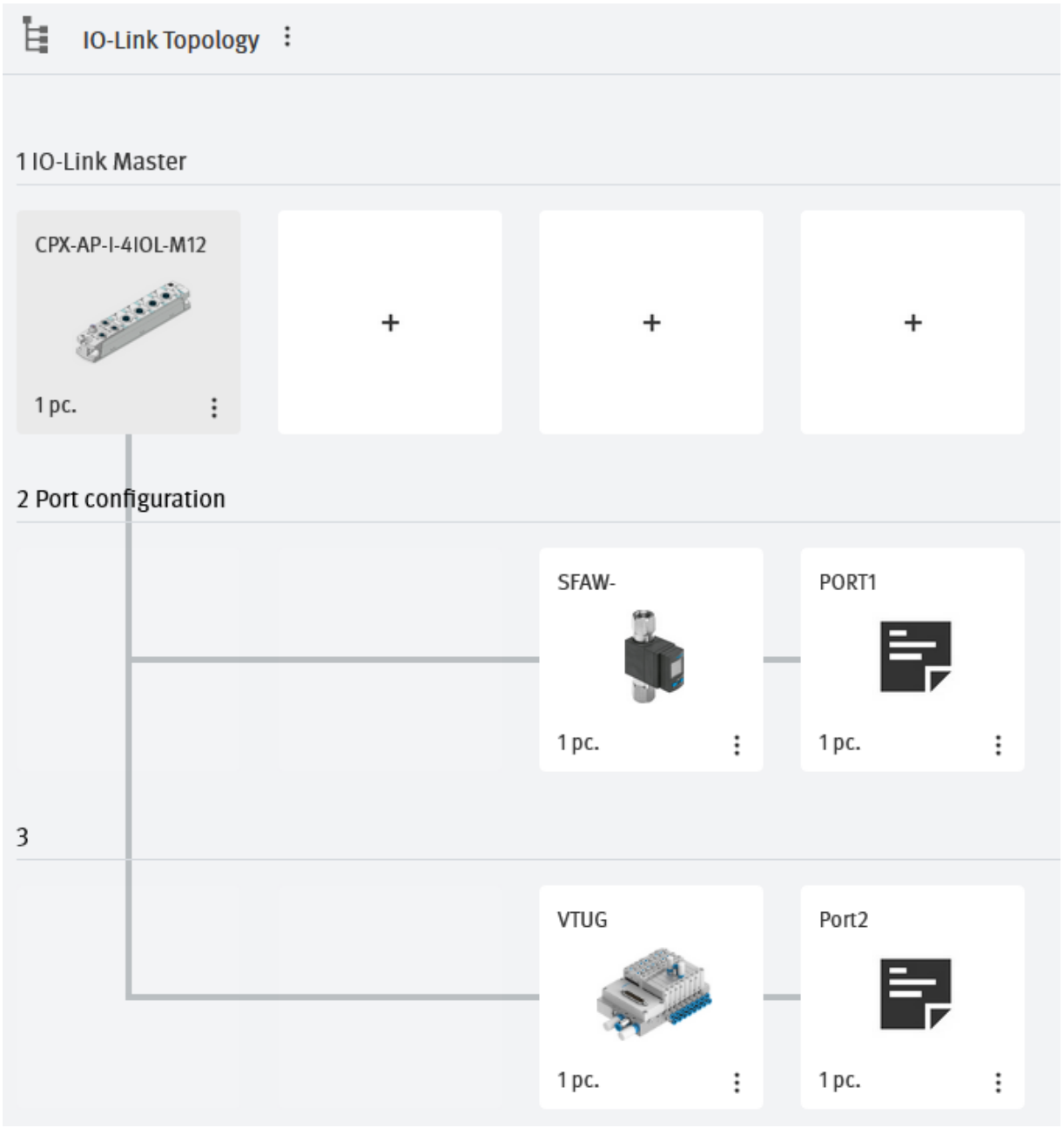
EtherCAT XML EtherCAT Slave Information (ESI) EtherCAT Slave Information (ESI) file for the CPX-AP-I-EC-M12 EtherCAT Interface.	31/03/2020	→ Device Description Files → File and language versions

Source:
https://www.festo.com/net/en-gb_gb/SupportPortal/default.aspx?q=CPX-AP-I-EC-M12&tab=4&s=t#result

1.3 Network Topology



1.4 IO-Link Topology

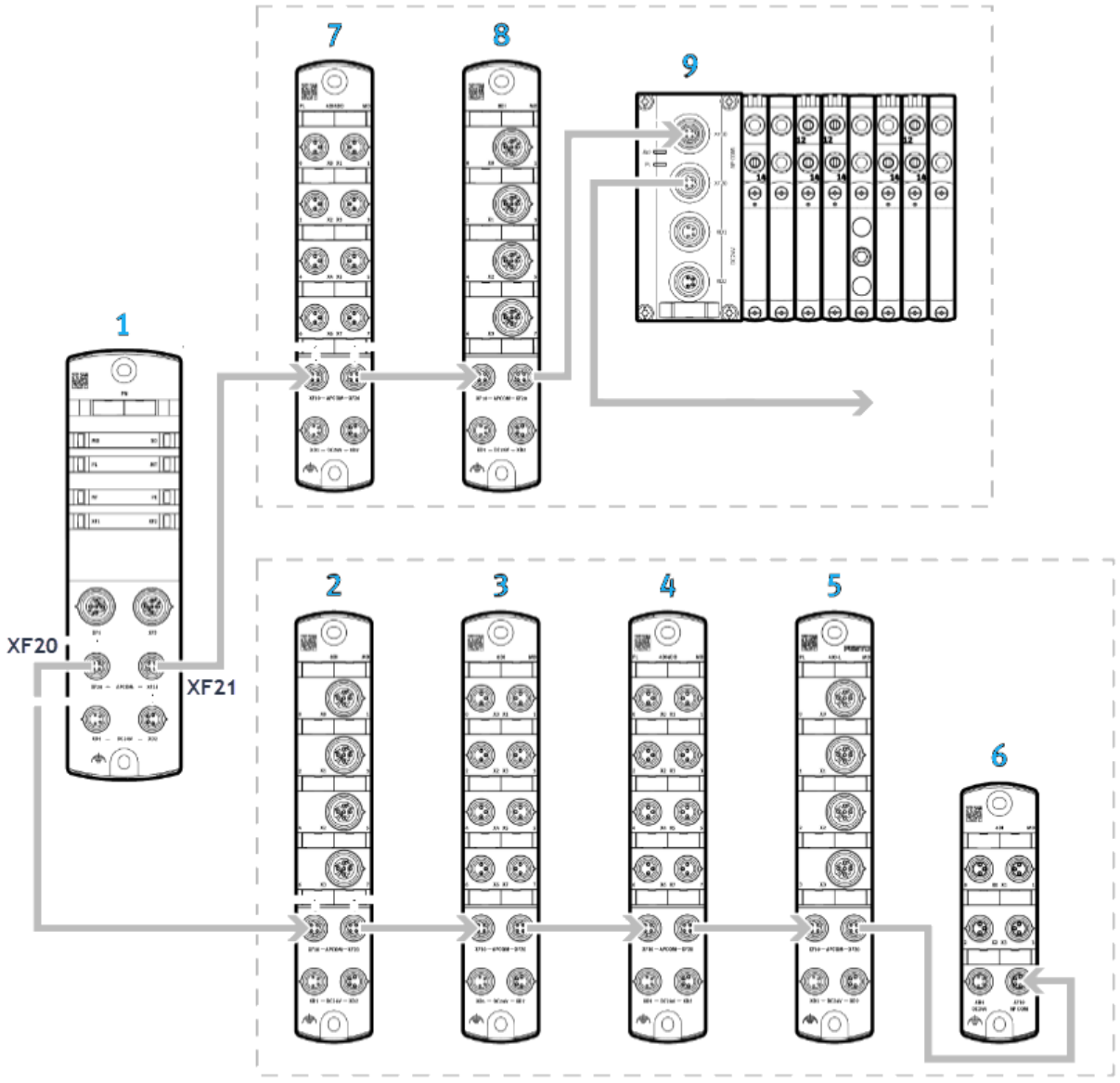


2 System communication and address assignment

For internal system communication between the modules, two strings can be implemented via the connections [XF20] and [XF21] of the CPX-AP-I-EC-M12 module.

The connection of the connecting cables to the individual modules is made via connection [XF10]. The connection [XF20] is available for forwarding to another module.

The addresses of the modules are assigned automatically each time the automation system CPX-AP-I system is starting up. The address 1 is always assigned to the AP-I interface. The modules are addressed at terminals [XF20] and [XF21] in ascending order for each string, starting with the string at terminal [XF20]



(Example screenshot)

➔ **The AP-I master is assigning ID's to modules as long as the upper PLC is not starting to establish the Profinet, Profibus, EtherCAT, Ethernet/IP or Modubs/TCP communication! As soon as this happens the master is closing "the door" for new AP-I modules. This can create challenges if you are using different power supplies, a module is lost or added during operation.**

Please note following information from the system manual:

A)

Loss of function if logic supply PS is switched on late.
If the modules are supplied by different fixed power supplies, the interface must be switched on last, as otherwise they will not be detected by the interface when the automation system CPX-AP starts up.

B)

Behaviour in the event of incorrect configuration after restart
When establishing a connection with the higher-level controller, the configuration is checked for the following criteria, depending on the network protocol of the interface:
- Total number of input and output bytes
- Module codes and sequence of modules
- Length and format of the start-up parameterisation

If there are deviations, the connection to the higher-level controller is refused and a network-specific error message is generated.

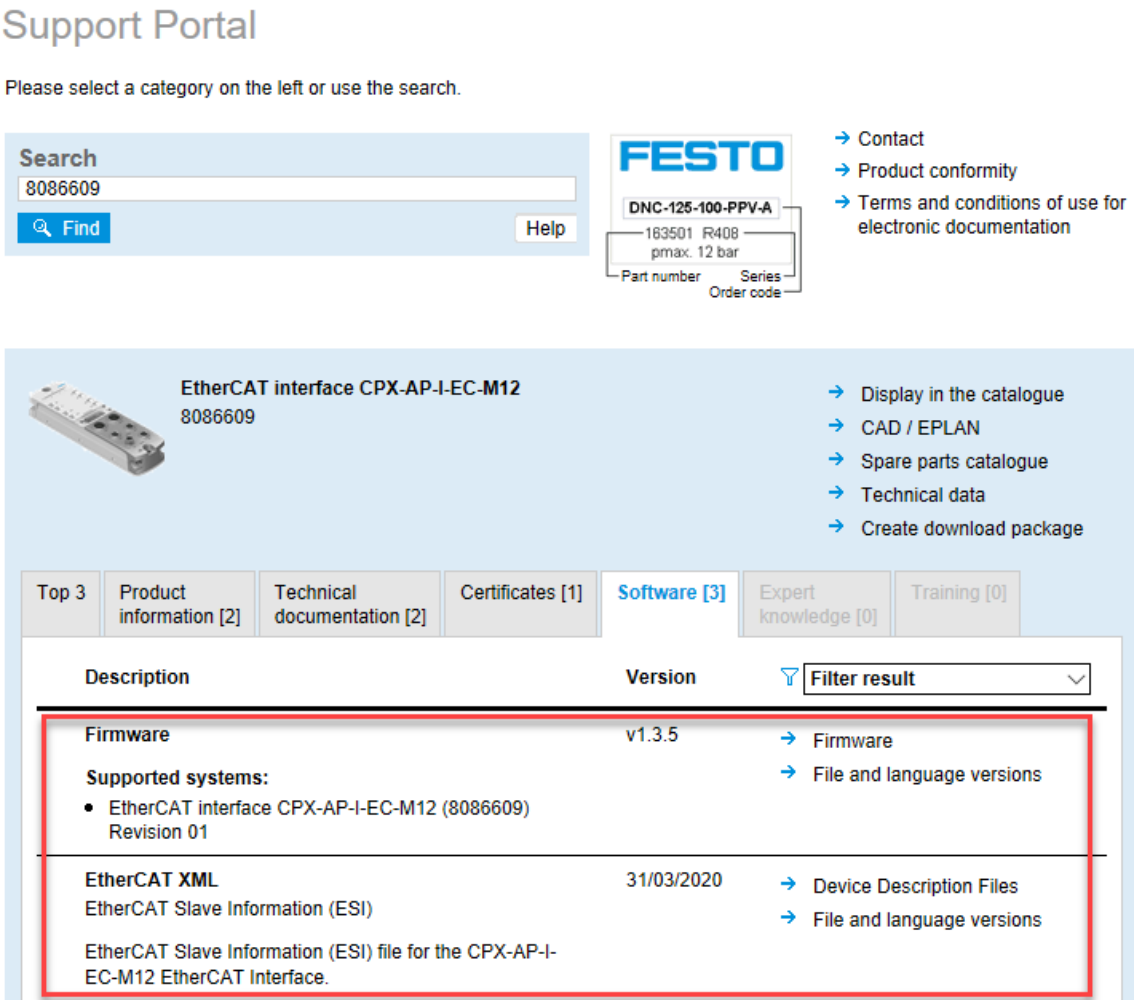
Behaviour when changing the configuration during operation
- If a module is removed during operation, no process data is transferred to the higher-level controller for this module and all subsequent modules. The failure of the module is signalled via a diagnostic message and, if necessary, network-specific status bytes in the process data.
- If an additional module is added after the connection is established with the higher-level controller or an existing module is exchanged, this module is not included in the active configuration and no data exchange with this module is possible.

In order for changes to the configuration to become active, the system must be restarted (switched off/on).

3 ESI File and Firmware

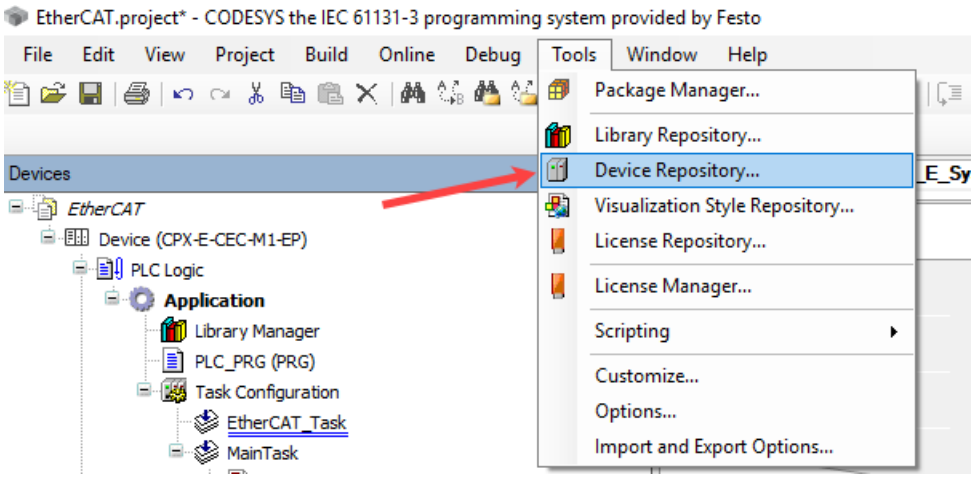
3.1 ESI File

Download the ESI file and Firmware from the Festo Support Portal. ESI files are found under the Software + Driver Tab.

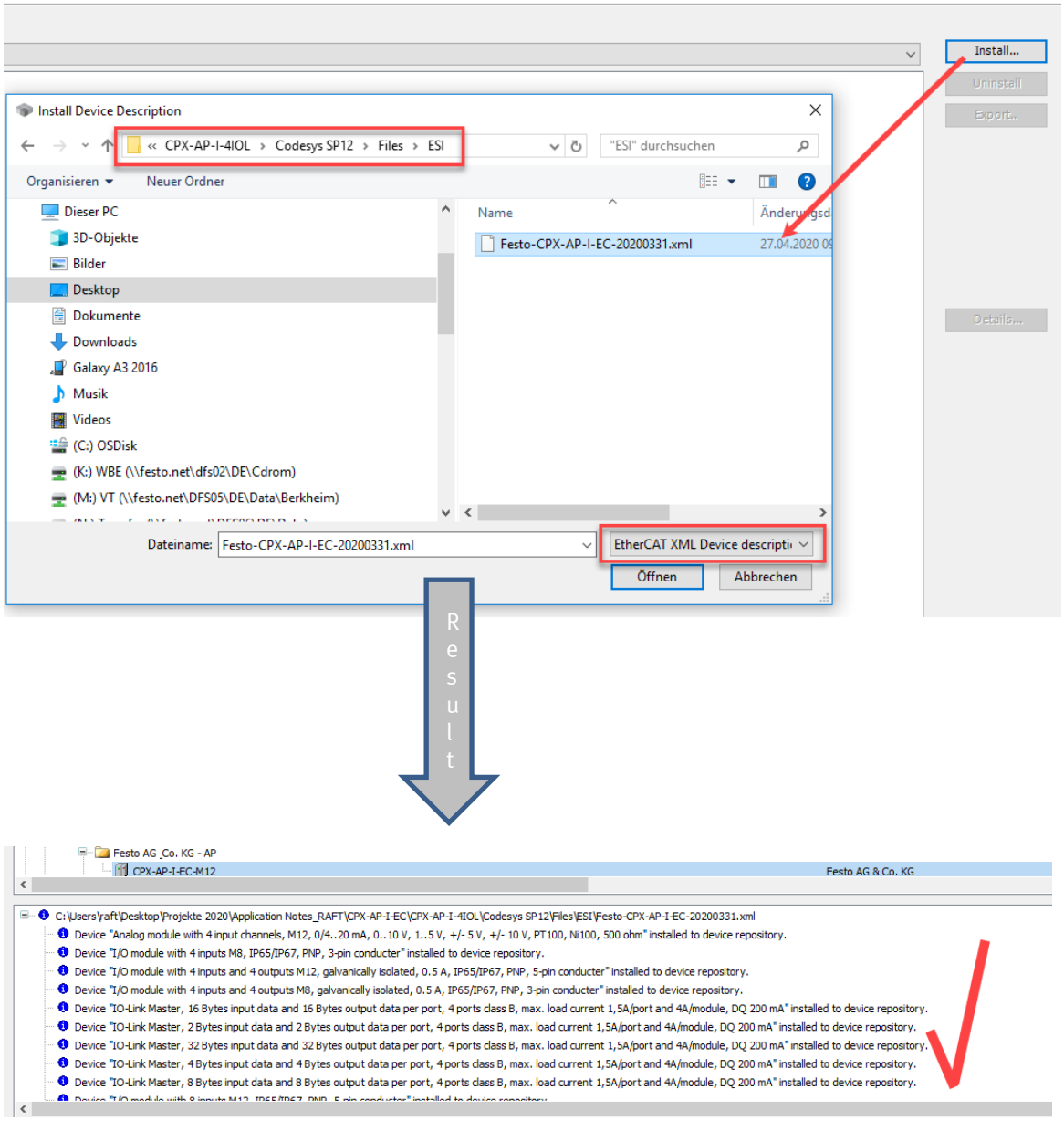


To “install” the ESI File in a new Codeys SP12 project please do following:

A) Open the Device repository in Codesys

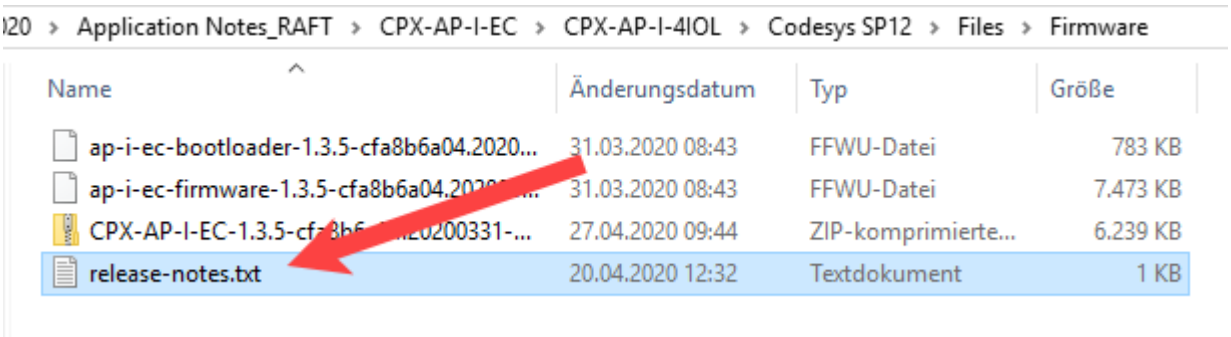


B) Install the actual ESI file from the corresponding path



3.2 Firmware

The latest FW for CPX-AP-I-EC-M12 is **1.3.5**. Only with this FW or higher the module and IO-Link functionality of the CPX-AP-I-4IOL-M12 is supported. As reference please have always a look on the release-notes:

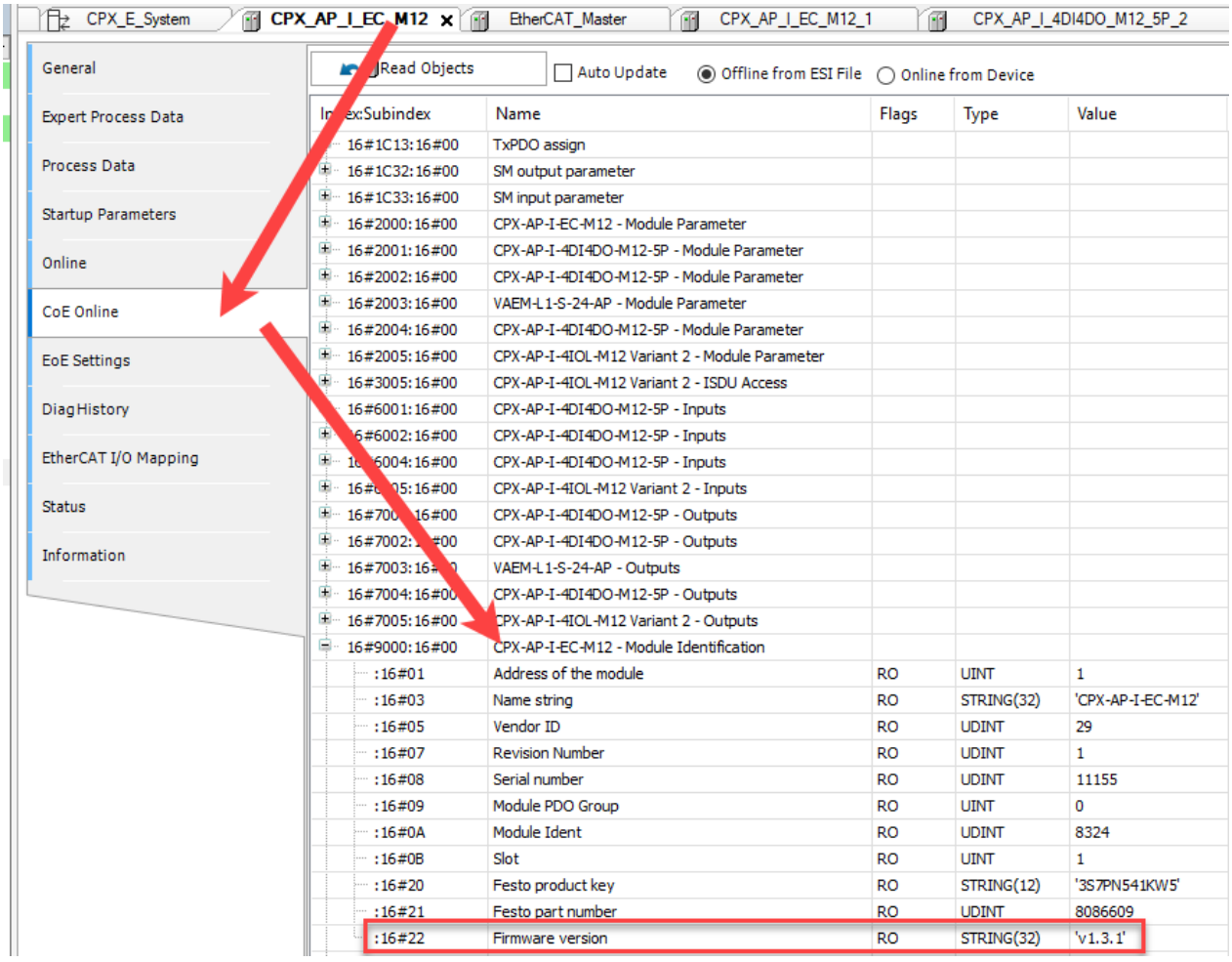


```
**********************************************************************
**********
* LANG=en
**********************************************************************
**********

* 1.3.5
**********************************************************************
**********
* correct diag code in diagnosis history object #3121487
* Static PDO support added
* Added IOL-Module support
* General improvements

* 1.0.1
**********************************************************************
**********
* Productlaunch
```

To check which FW, you actual CPX-AP-I-EC-M12 master has please have a closer look on the object 9000 via CoE Online EtherCAT feature:

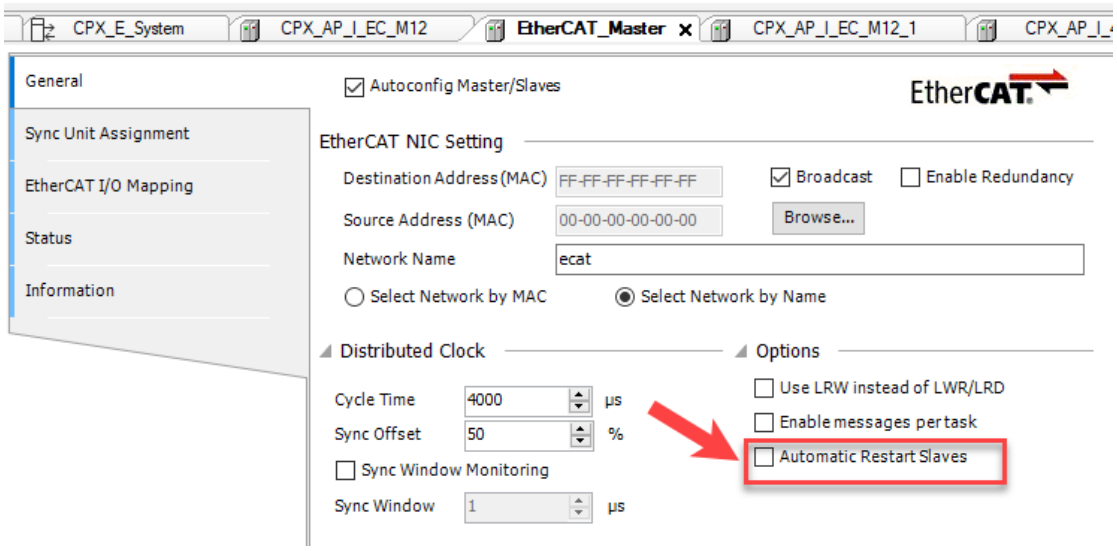


3.2.1 How to do a FW update

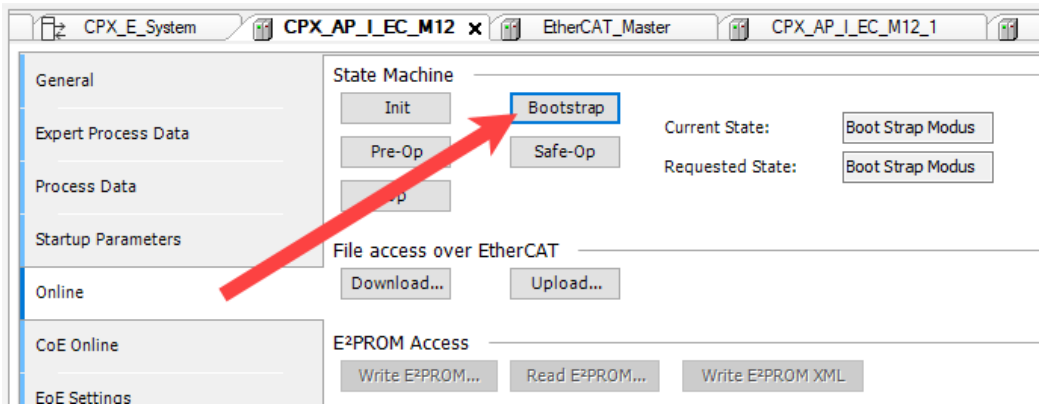
You can do a FW update via EtherCAT feature FoE. Therefore, you must switch the node in the Bootstramp mode.

To do a FW update via Codesys following steps are mandatory:

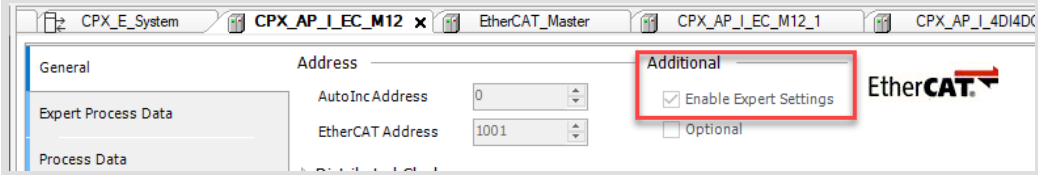
1. Deactivate the Automatic Restart slave EtherCAT Master setting:



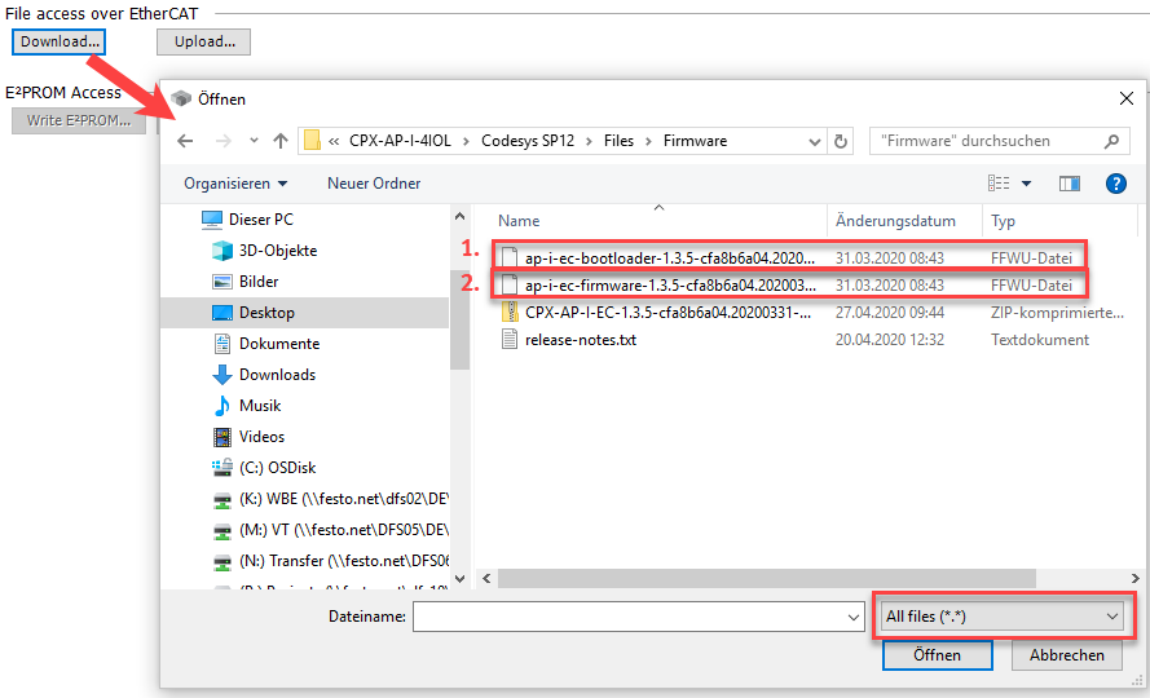
2. Download everything to the PLC and open following tap in the Online mode



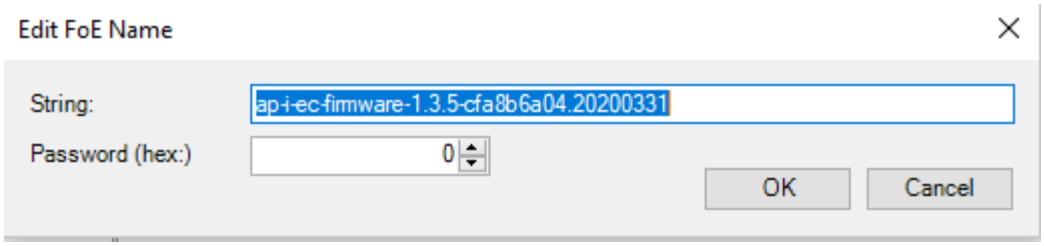
➔ **To have all EtherCAT features of a slave available in Codesys Sp12 following have to be activated:**



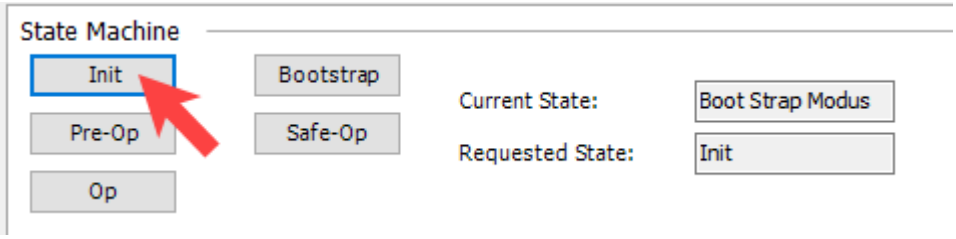
3. Press the Download Button at FoE (File access of EtherCAT) and download
   A) The Bootloader file
   B) The FW file



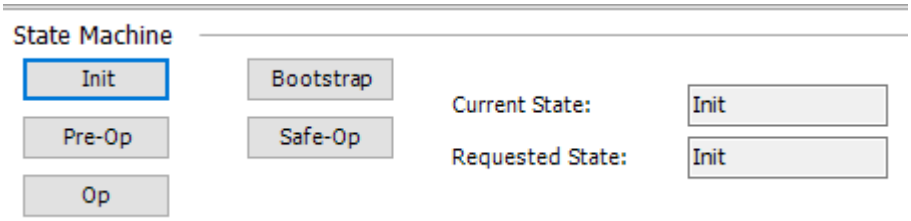
Hint: The password is always 0



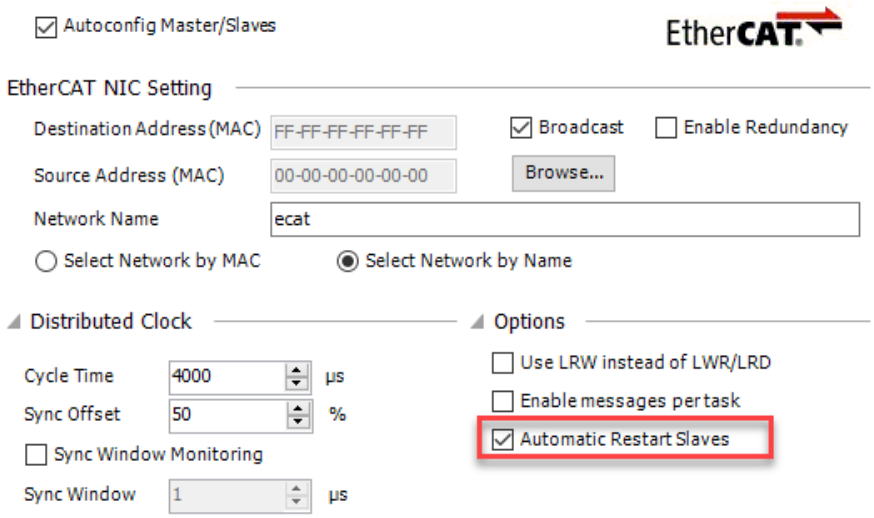
4. After the FW process is finished (it takes several minutes) change the state from BOOT to INIT



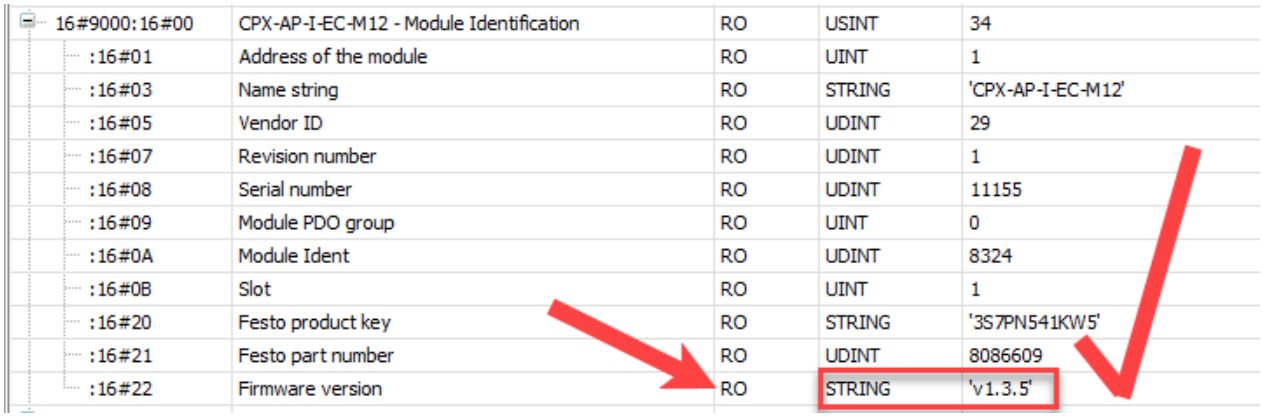
Now the LED's on the node are changing a little bit and the internal Update of the FW is starting
It is finished as soon as you see following in Codesys:



5. Activate the Automatic Restart function in your master and download the project again



6. Check in the object 9000 the actual FW



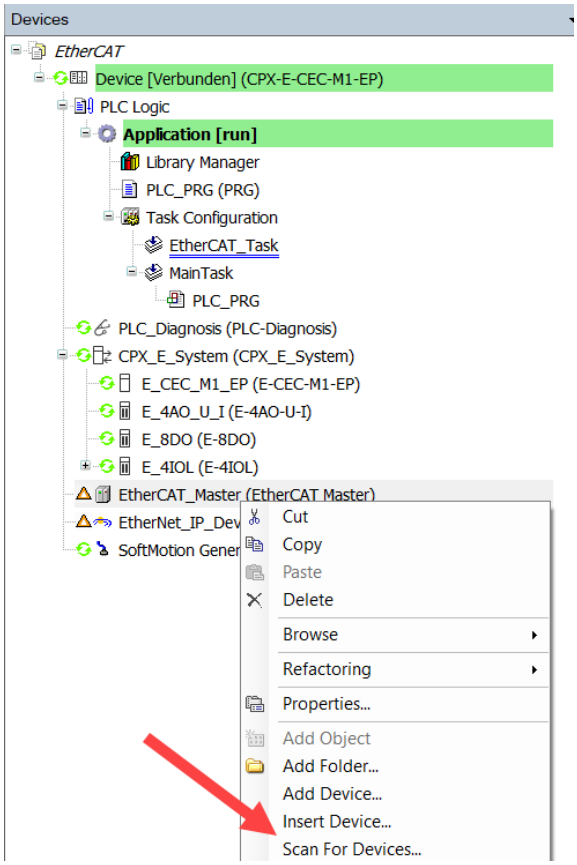
16#9000:16#00	CPX-AP-I-EC-M12 - Module Identification	RO	USINT	34
:16#01	Address of the module	RO	UINT	1
:16#03	Name string	RO	STRING	'CPX-AP-I-EC-M12'
:16#05	Vendor ID	RO	UDINT	29
:16#07	Revision number	RO	UDINT	1
:16#08	Serial number	RO	UDINT	11155
:16#09	Module PDO group	RO	UINT	0
:16#0A	Module Ident	RO	UDINT	8324
:16#0B	Slot	RO	UINT	1
:16#20	Festo product key	RO	STRING	'3S7PN541KW5'
:16#21	Festo part number	RO	UDINT	8086609
:16#22	Firmware version	RO	STRING	'v1.3.5'

4 Codesys 4IOL EtherCAT commissioning

4.1 Establishing the EtherCAT communication

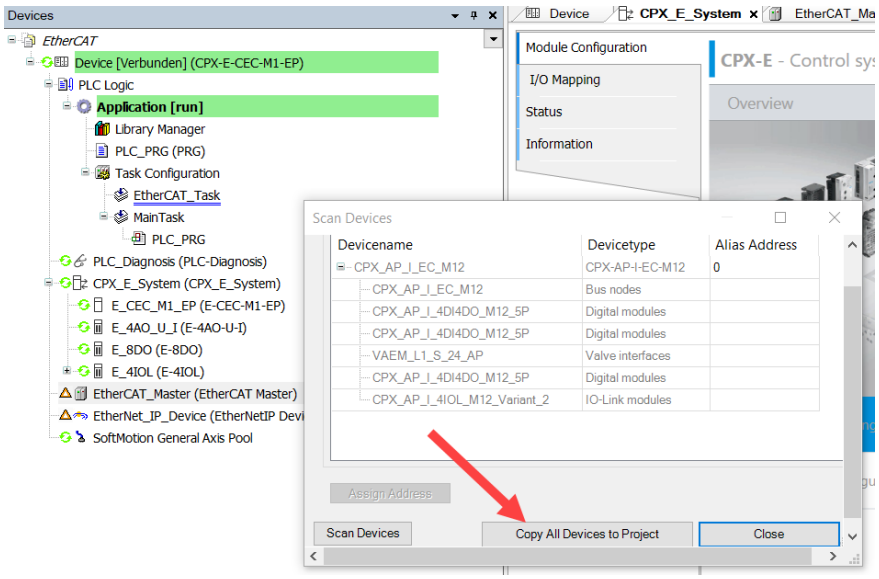
To add existing EtherCAT slave device to you Codesys project the first Online steps are:

1. Use the Scan functionality to check all EtherCAT participants

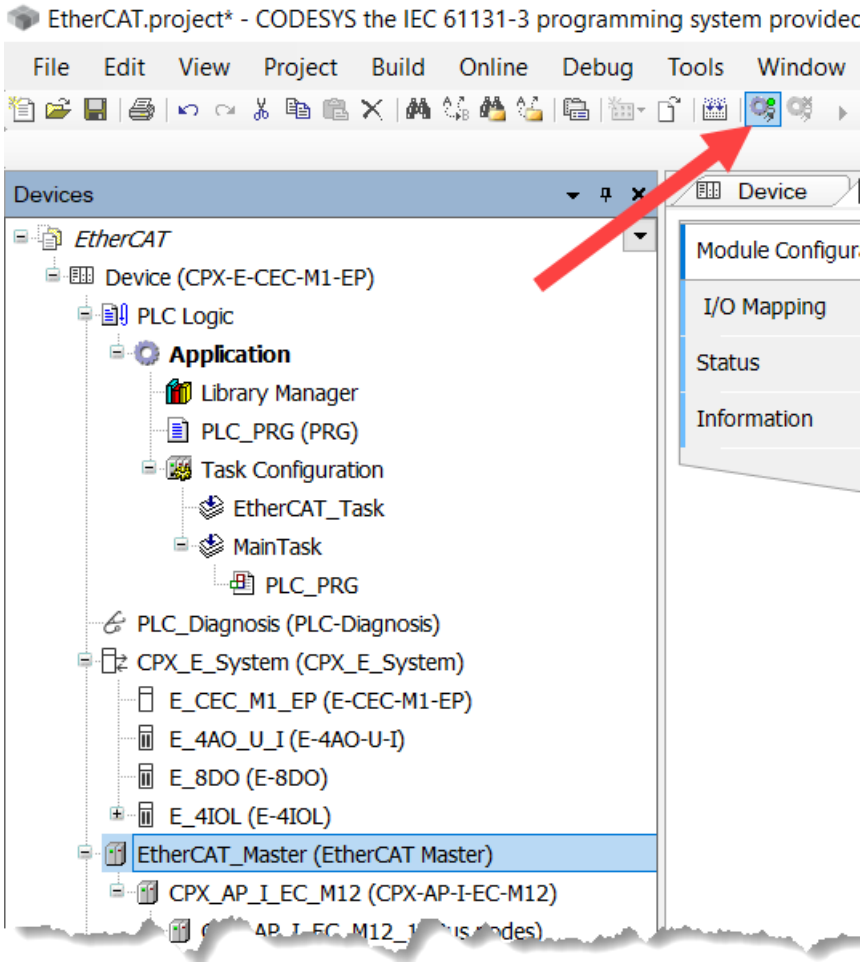


2. Add the EtherCAT slaves to your project.

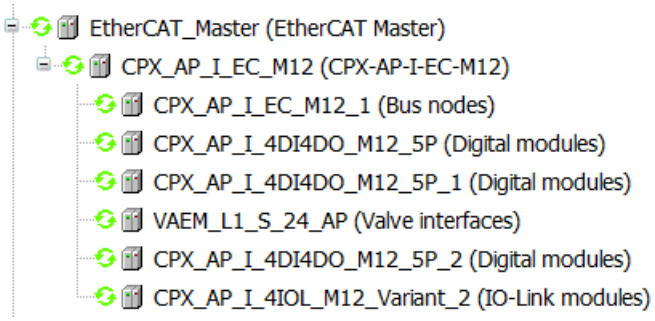
➔ **Please install always the correct ESI otherwise EtherCAT devices will pop up just with the generic information .**



3. Download the project again and go to online Mode

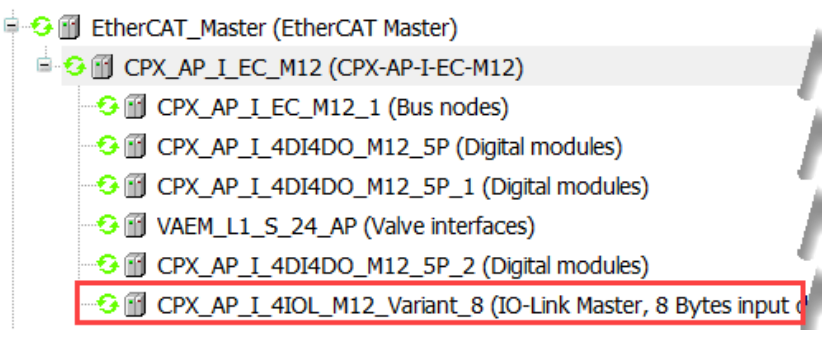


If you have e.g. no AP-I module error, installed the correct ESI and FW then the result is:



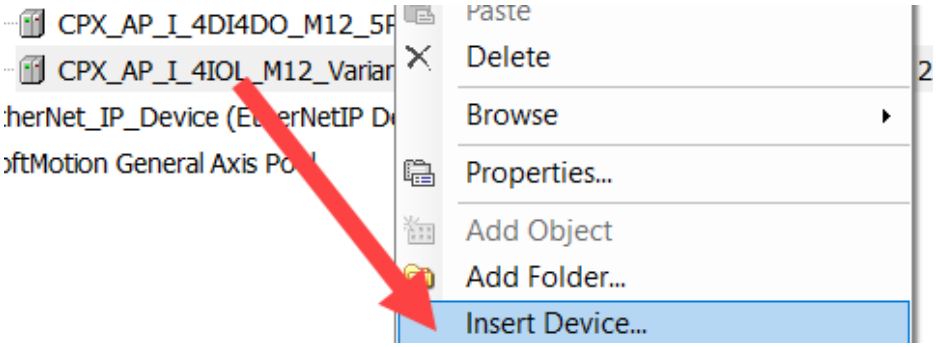
4.2 Changing the CPX-AP-I-4IOL-M12 I/O size

Per factory setting the CPX-AP-I-4IOL will pop up with 8 Byte I/O data per port:

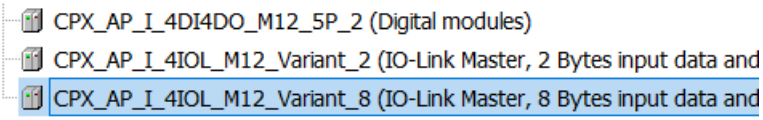


To change the data assignment of the AP-I IO-Link master following steps are to do:

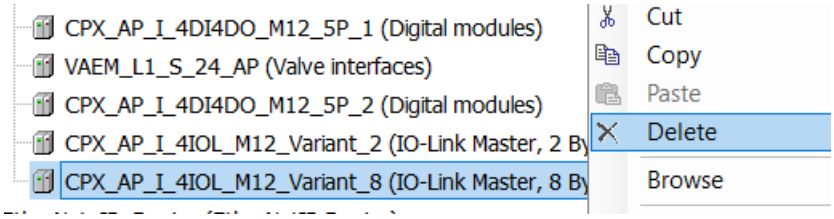
Step1: In Offline mode please insert your new device entry



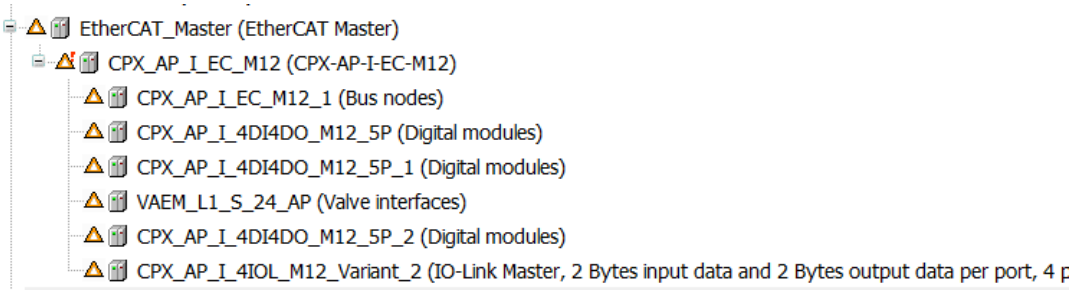
Result:



Step2: Delete the wrong device

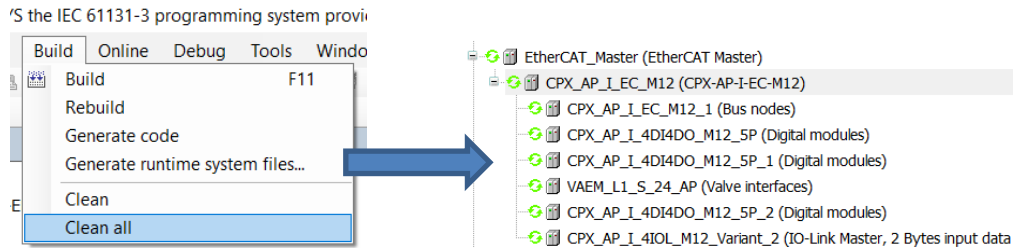


Step3: Compile & download everything to the PLC again and switch to run mode:
The AP-I master will pop up with an error *(SD and MD LED are on and ERR is flashing)*



Step4: Power off / on the AP-I master to activate the new 4IOL configuration *(ERR is still flashing)*

Step5: Clean all and download the project again. After you set the run mode everything is fine and the CPX-AP-I 4IOL-M12 will work with your new settings permanently



4.3 Setting up the Port mode in Codesys

Per factory setting the 4IOL ports are deactivated:

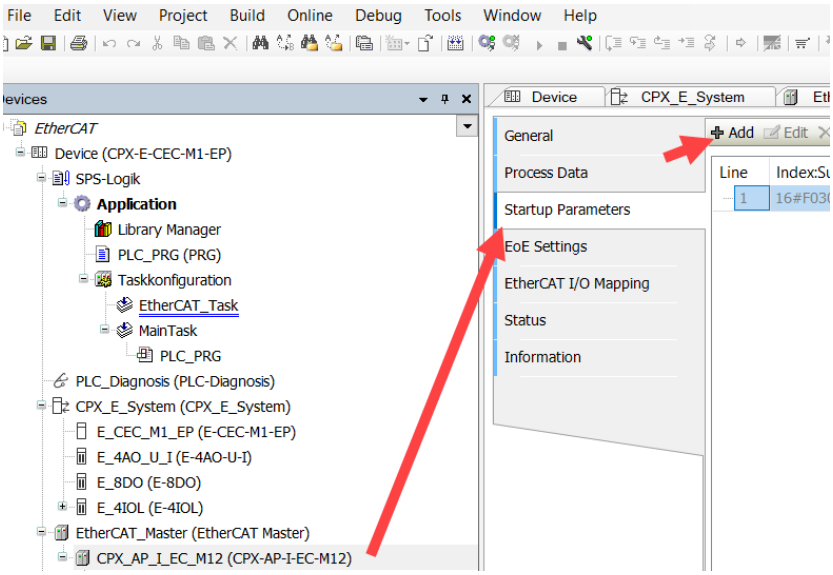
Parameterisation

Fieldbus startup parameters

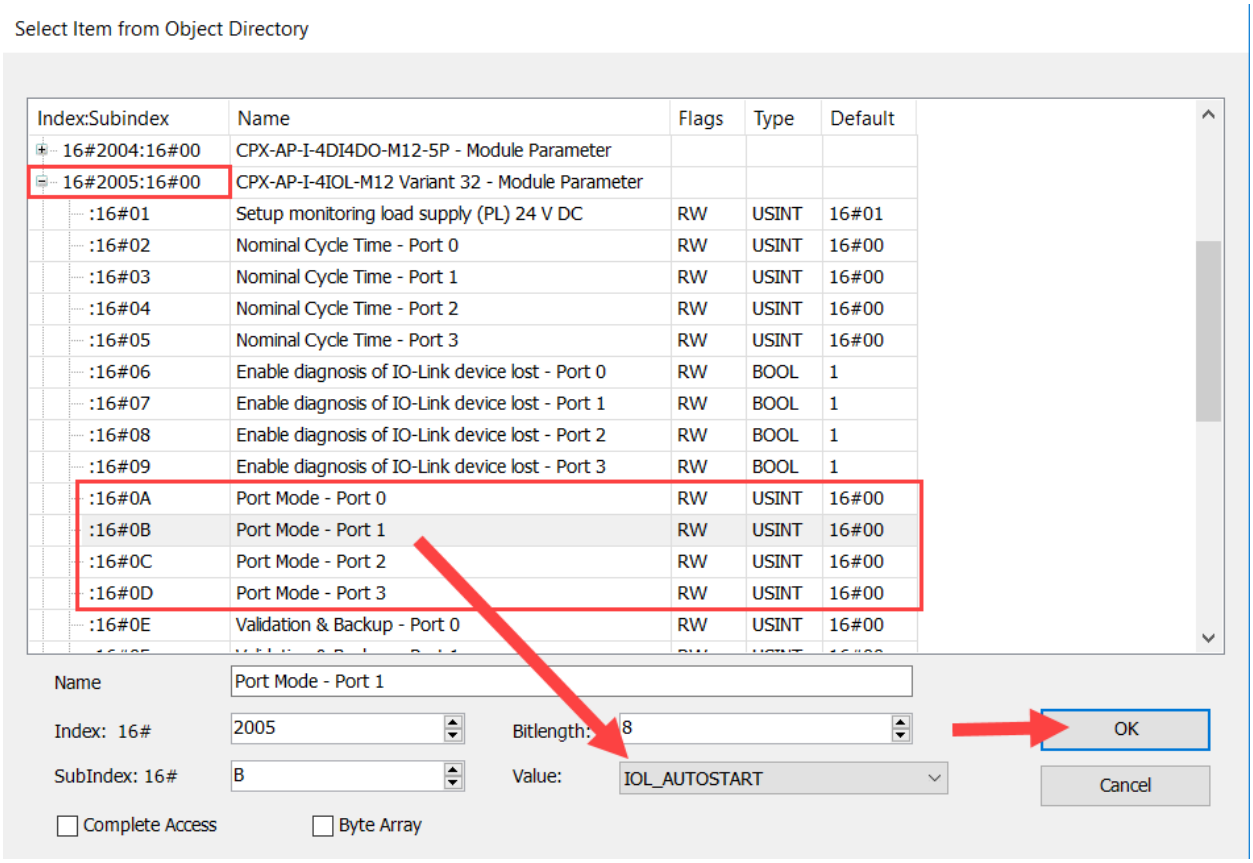
ID	Parameter	Instance-s	Data type	Access[1]	Arraysize
20022	Configuration of voltage monitoring load supply PL – 0: load voltage monitoring inactive – 1: load voltage monitoring active, with suppression of diagnostics at switch-off (factory setting) – 2: load voltage monitoring active	1	UINT8	rw	-
20049	Setpoint cycle time [ms][3] – 0: as fast as possible (factory setting) – 16: 1.6 ms – 32: 3.2 ms – 48: 4.8 ms – 68: 8.0 ms – 73: 10.0 ms – 78: 12.0 ms – 88: 16.0 ms – 98: 20.0 ms – 133: 40.0 ms – 158: 80.0 ms – 183: 120.0 ms	4	UINT8	rw	-
20050	Activation of diagnostics for IO-Link device lost (factory setting TRUE)	4	BOOL	rw	-
20071	Port mode – 0: DEACTIVATED (factory setting) – 1: IOL_MANUAL – 2: IOL_AUTOSTART – 3: DI_CQ – 97: PREOPERATE[3]	4	UINT8	rw	-
20072	Review and backup[2] – 0: no test (factory setting) – 1: device compatible V1.0 – 2: device compatible V1.1 – 3: device compatible V1.1 Data storage Backup+ Restore – 4: device compatible V1.1 Data storage Restore	4	UINT8	rw	-
20073	Target vendor ID[2]	4	UINT16	rw	-

To change such start-up parameters, you have do following:

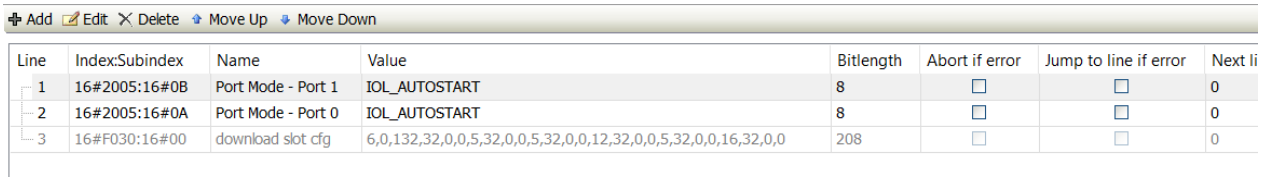
Step 1: Go to the Startup up tab and press the ADD Button



Step 2: Define each Port setting singly in the register 200x (x depends on the location in the AP-I network)



As result you get a new entry with e.g. your start-up parameters for the IO-Link ports

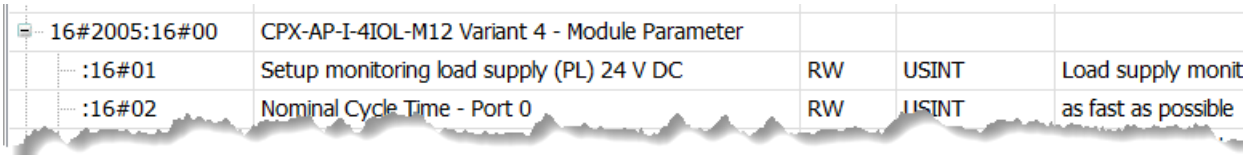


After downloading everything to the PLC the configured modes on the Ports are active:

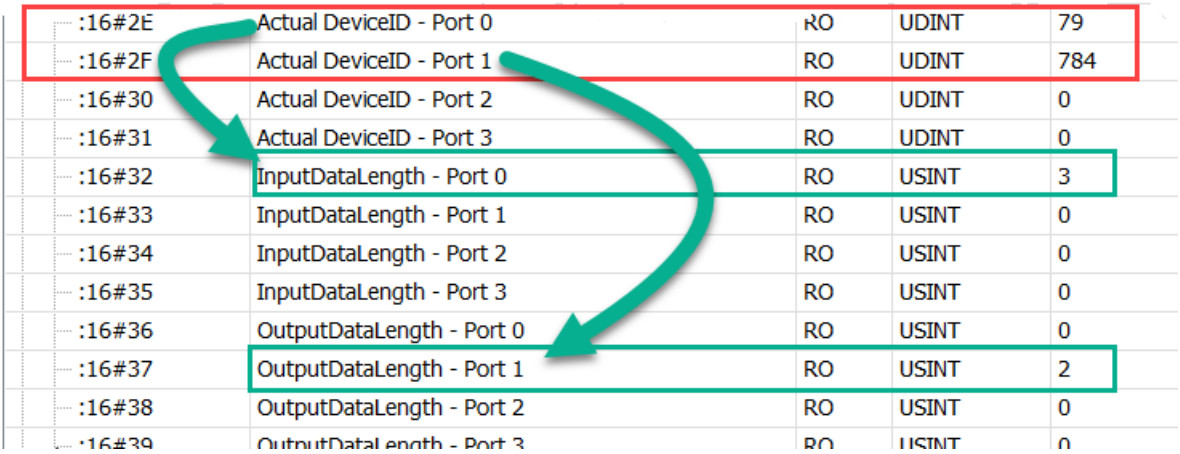
4.3.1 Testing the CPX-AP-I-4IOL-M12 Module IO Mapping

On the IO-Link master we have connected two devices:

Details to the devices you can find out via the EtherCAT CoE function in the module parameter object 0x200x:

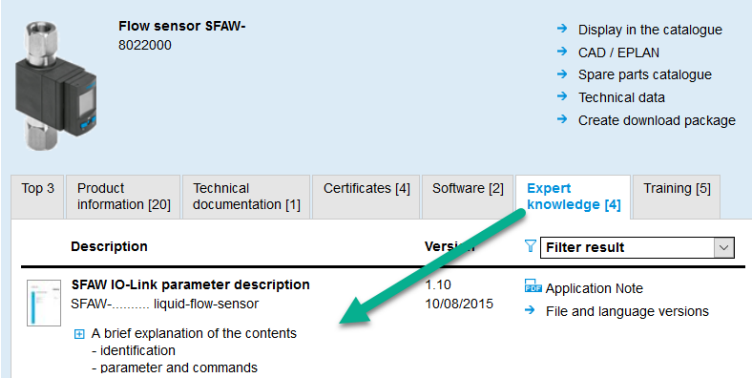


16#2005:16#00	CPX-AP-I-4IOL-M12 Variant 4 - Module Parameter			
:16#01	Setup monitoring load supply (PL) 24 V DC	RW	USINT	Load supply monit
:16#02	Nominal Cycle Time - Port 0	RW	USINT	as fast as possible



:16#2E	Actual DeviceID - Port 0	RO	UDINT	79
:16#2F	Actual DeviceID - Port 1	RO	UDINT	784
:16#30	Actual DeviceID - Port 2	RO	UDINT	0
:16#31	Actual DeviceID - Port 3	RO	UDINT	0
:16#32	InputDataLength - Port 0	RO	USINT	3
:16#33	InputDataLength - Port 1	RO	USINT	0
:16#34	InputDataLength - Port 2	RO	USINT	0
:16#35	InputDataLength - Port 3	RO	USINT	0
:16#36	OutputDataLength - Port 0	RO	USINT	0
:16#37	OutputDataLength - Port 1	RO	USINT	2
:16#38	OutputDataLength - Port 2	RO	USINT	0
:16#39	OutputDataLength - Port 3	RO	USINT	0

Details to the connected Festo IO-Link device you find in the Festo Support Portal. Please check e.g. the device operating instruction or IO-link parameter description. Example:



Device ID [dec]	Device ID [hex]	Order Code
64	00 00 40	SFAW-15T-PNLK-PN-VBA
65	00 00 41	SFAW-32T-PNLK-PN-VBA
66	00 00 42	SFAW-50T-PNLK-PN-VBA
67	00 00 43	SFAW-100T-PNLK-PN-VBA
68	00 00 44	SFAW-15-PNLK-PN-VBA
69	00 00 45	SFAW-32-PNLK-PN-VBA
70	00 00 46	SFAW-50-PNLK-PN-VBA
71	00 00 47	SFAW-100-PNLK-PN-VBA
72	00 00 48	SFAW-15T-PNLK-PNVBA
73	00 00 49	SFAW-32T-PNLK-PNVBA
74	00 00 4A	SFAW-50T-PNLK-PNVBA
75	00 00 4B	SFAW-100T-PNLK-PNVBA
76	00 00 4C	SFAW-15-PNLK-PNVBA
77	00 00 4D	SFAW-32-PNLK-PNVBA
78	00 00 4E	SFAW-50-PNLK-PNVBA
79	00 00 4F	SFAW-100-PNLK-PNVBA

Table 3.2: Device IDs

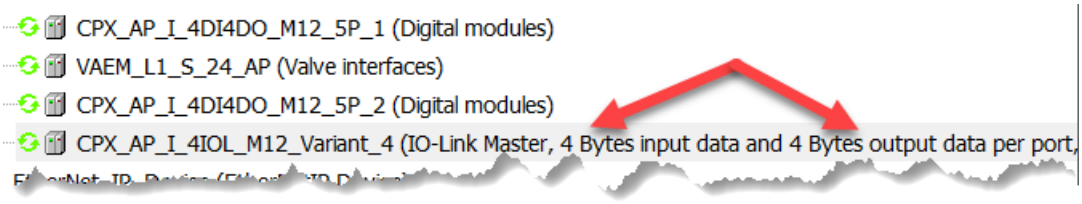
Process Data IN for variants without temperature option

Bit	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8
Significance	not used		MSB													LSB
Process data			PDV Flow													
Data content			14-bit measured value (InA)													
Index			0x0028													
Sub-Index			1													
Data type			UInteger14													

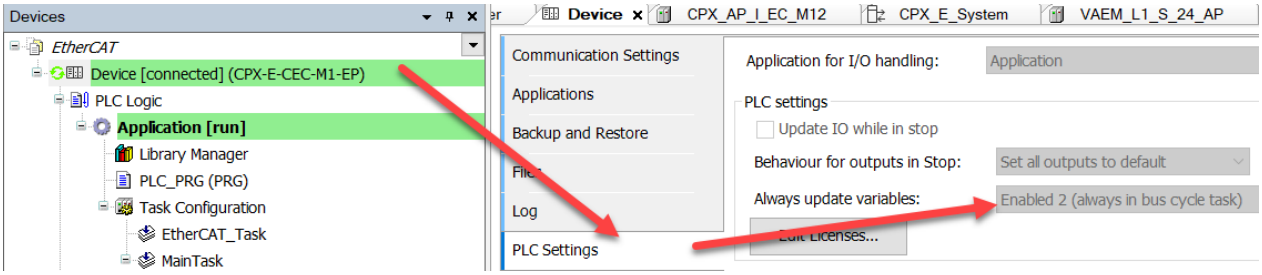
Bit	7	6	5	4	3	2	1	0
Process data	not used					BDC4	BDC3	BDC1
Data content						OutD	OutC	OutA
Index						0x0028		
Sub-Index						2	3	4
Data type						Boolean		

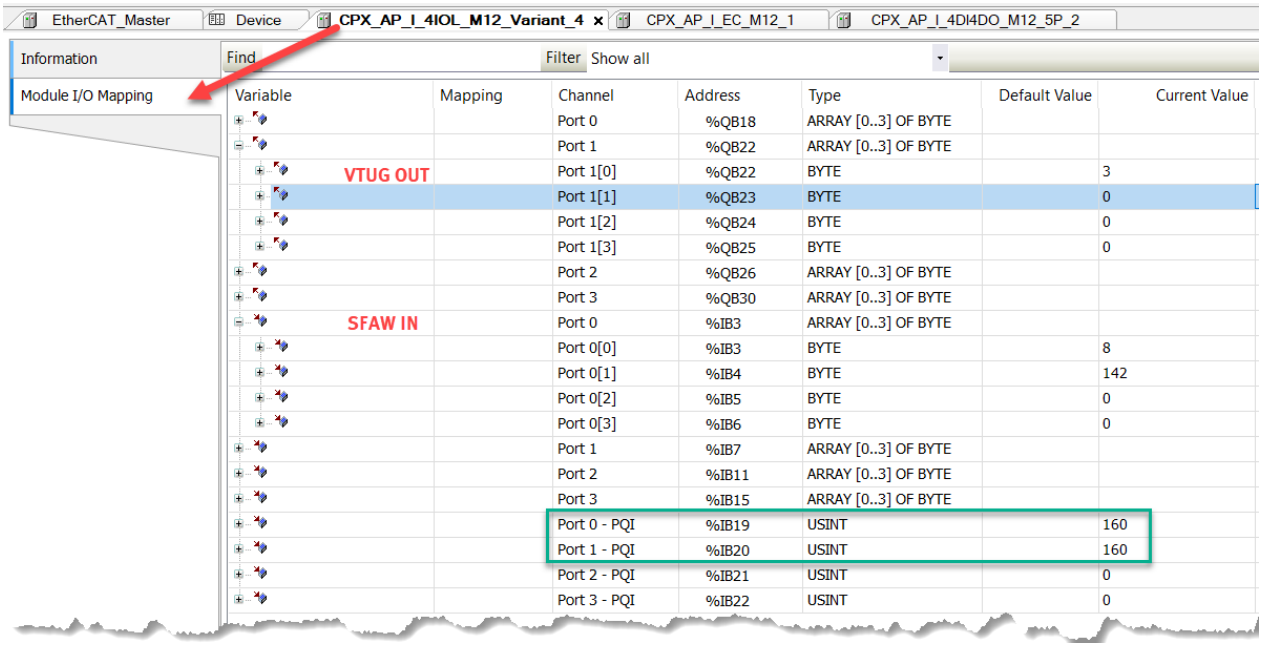
Table 3.15: Process data mapping for SFAW-..-...

Based on the connected IO-Link devices you could change the process data assignment (see chapter 4.2) to optimize the handling:



And via the module I/O table and following PLC setting you can test everything:





Variable	Mapping	Channel	Address	Type	Default Value	Current Value
		Port 0	%QB18	ARRAY [0..3] OF BYTE		
		Port 1	%QB22	ARRAY [0..3] OF BYTE		
VTUG OUT		Port 1[0]	%QB22	BYTE		3
		Port 1[1]	%QB23	BYTE		0
		Port 1[2]	%QB24	BYTE		0
		Port 1[3]	%QB25	BYTE		0
		Port 2	%QB26	ARRAY [0..3] OF BYTE		
		Port 3	%QB30	ARRAY [0..3] OF BYTE		
SFAW IN		Port 0	%IB3	ARRAY [0..3] OF BYTE		
		Port 0[0]	%IB3	BYTE		8
		Port 0[1]	%IB4	BYTE		142
		Port 0[2]	%IB5	BYTE		0
		Port 0[3]	%IB6	BYTE		0
		Port 1	%IB7	ARRAY [0..3] OF BYTE		
		Port 2	%IB11	ARRAY [0..3] OF BYTE		
		Port 3	%IB15	ARRAY [0..3] OF BYTE		
		Port 0 - PQI	%IB19	USINT		160
		Port 1 - PQI	%IB20	USINT		160
		Port 2 - PQI	%IB21	USINT		0
		Port 3 - PQI	%IB22	USINT		0

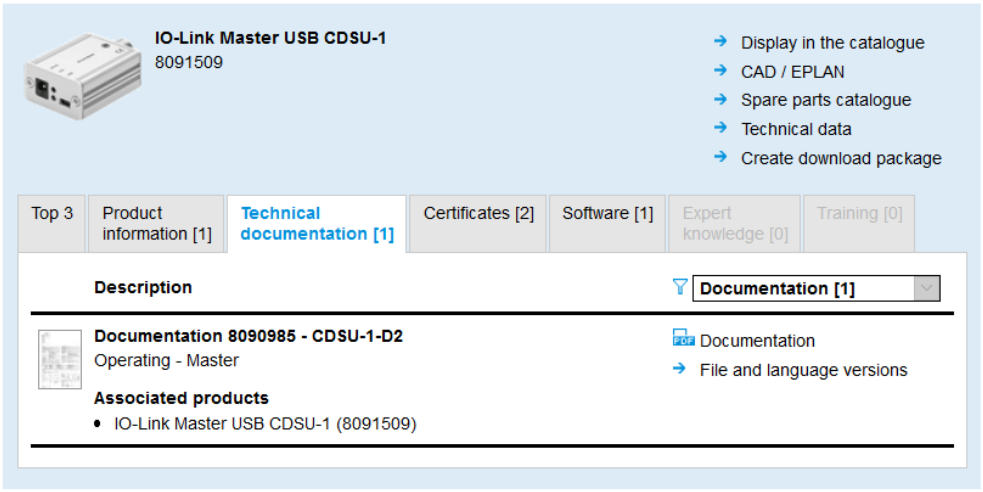
Result example:

At VTUG with value 3 = 2 coils on:

4.4 Changing IO-Link slave start up parameter

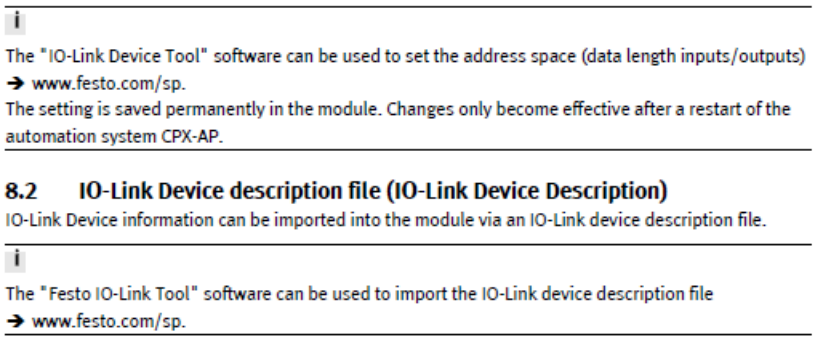
To change IO-Link slave start up parameter 3 options exist

Option 1:
Use the Festo CDSU-1 HW and SW and parameterize each slave individually via the corresponding IODD.



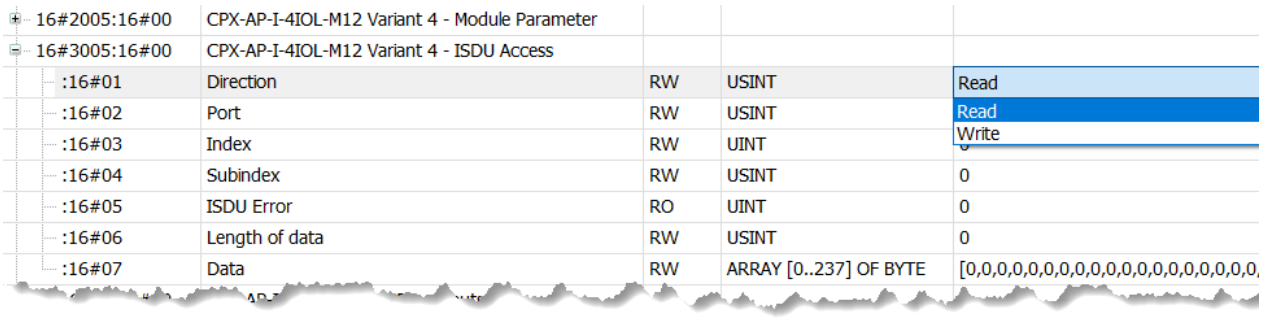
After you have done the parameterization the IO-Link slave will “wake-up” always with your settings and you can connect it to the CPX-AP-I-4IOL.M12 Master.

Option 2:
Use the Festo IO-Link Device Tool software for our CPX-AP-I-xx-M12 field bus slaves to have access to the 4IOL
(From the date of publishing of this AppNote the Festo IO-Link Device Tool was not released. Please check www.festo.com/sp for the Tool)



(Screenshot from CPX-AP-I-4IOL-M12 manual)

Option 3:
Use CoE object 300x (ISDU Access) and define the with Index and Sub Index the start up parameters
(see also Note after the example!)



Example option 3:

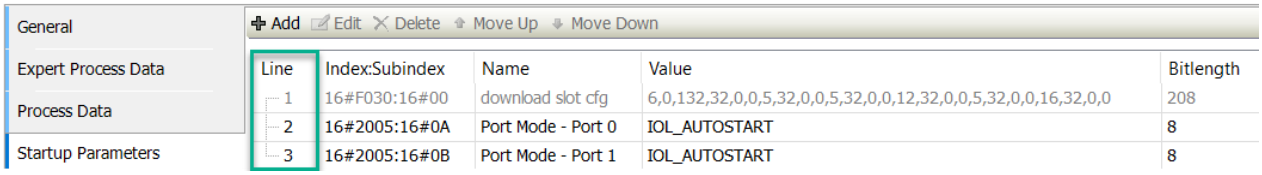
To change the backlight color and unit of the SFAW flow we need the corresponding Index and Subindex from the manual

3.3.5 Device specific parameters

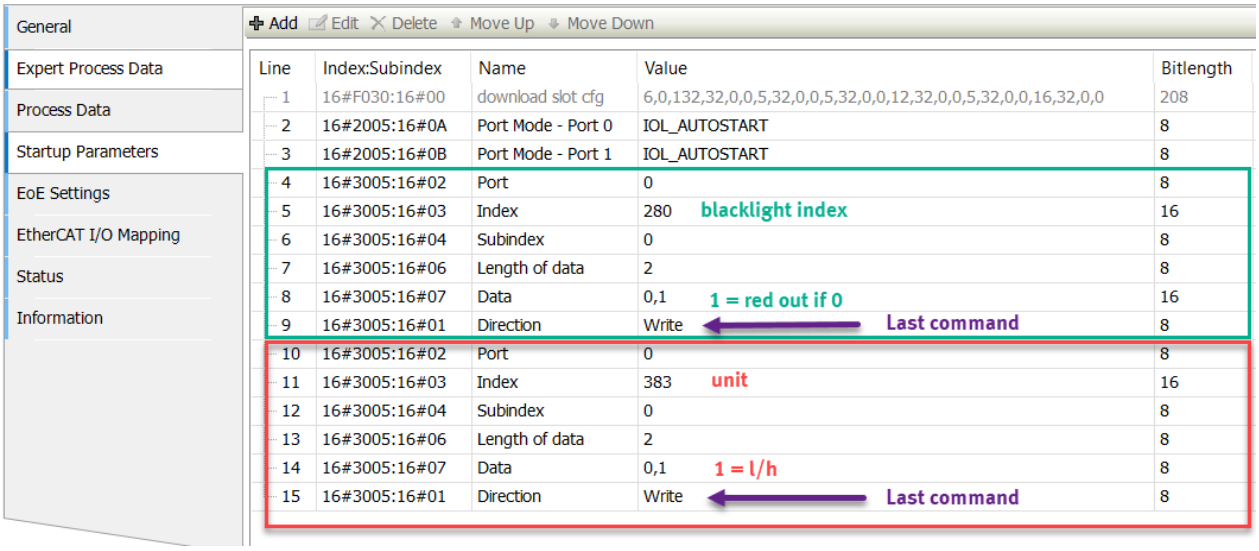
Index	Sub-Index	Name	Value	Access[1]			Length bytes	Format
				U	M	S		
0x0118	0	OutA, backlight color	0: allways blue (default) 1: red if Out = 0 2: red if Out = 1	R	R/W	R/W	2	UInteger16
0x0136	0	OutB, backlight color [2) 3)]	0: allways blue (default) 1: red if Out = 0 2: red if Out = 1	R	R/W	R/W		
0x0149	0	OutC, volume impulse length	10 ... 1000 (ms) default 100 (ms)	R	R/W	R/W		
0x0172	0	OutD, backlight color	0: allways blue (default) 1: red if Out = 0 2: red if Out = 1	R	R/W	R/W		
0x017F	0	InA, unit	0: l/min (default) 1: l/h 2: cfm 3: gal/min	R	R/W	R/W		

Index 0x0118 = 280dec and Subindex = 0 , the length of data is 2 Byte
Index 0x017F = 383dec and Subindex = 0 , the length of data is 2 Byte

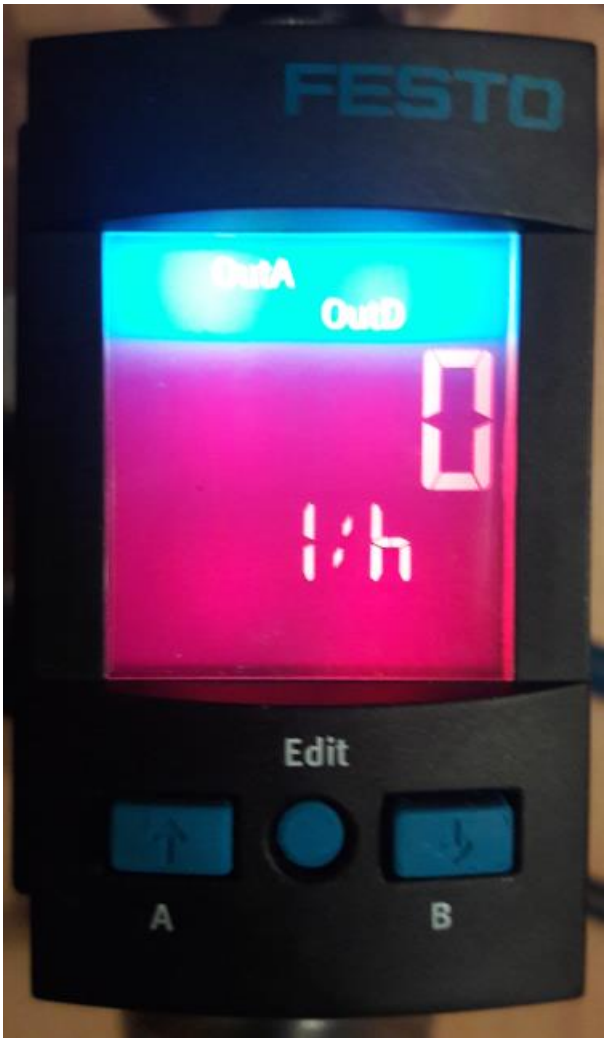
The EtherCAT startup parameters settings are using for each line a single SDO command via CoE



To write IO-Link parameter data it is a must to fill up first the necessary information and afterwards to use SDO write command for the transfer. In our example the data flow would look like these:



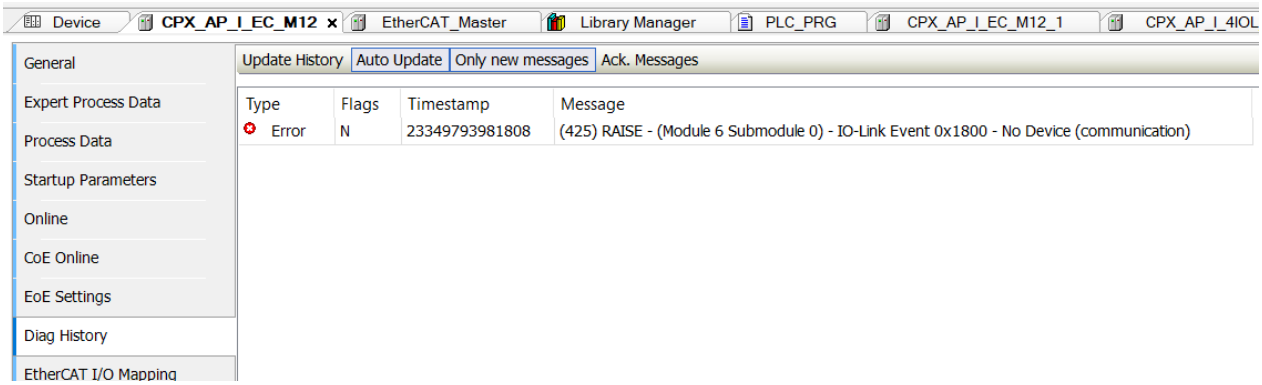
The result on the display is:



Note
From firmware 1.4.3. and higher, of CPX-AP-I-4IOL-M12 the CoE object address start from 220x (ISDU Access)

4.5 Diagnostic of IO-Link events

At EtherCAT in Codesys you have e.g. the Diagnostic history where you can check easily the actual error
If e.g. an IO-Link slave is lost due cable damage or … then you get following message:

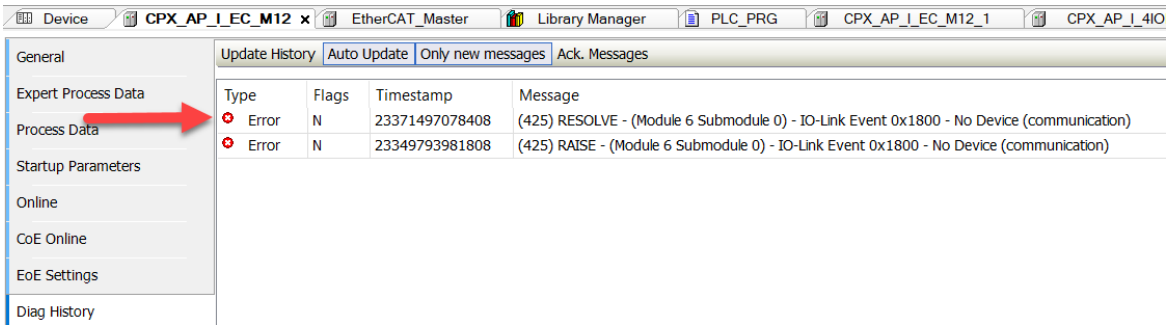


As reference please check the CPX-AP-I-4IOL-M12 manual too.

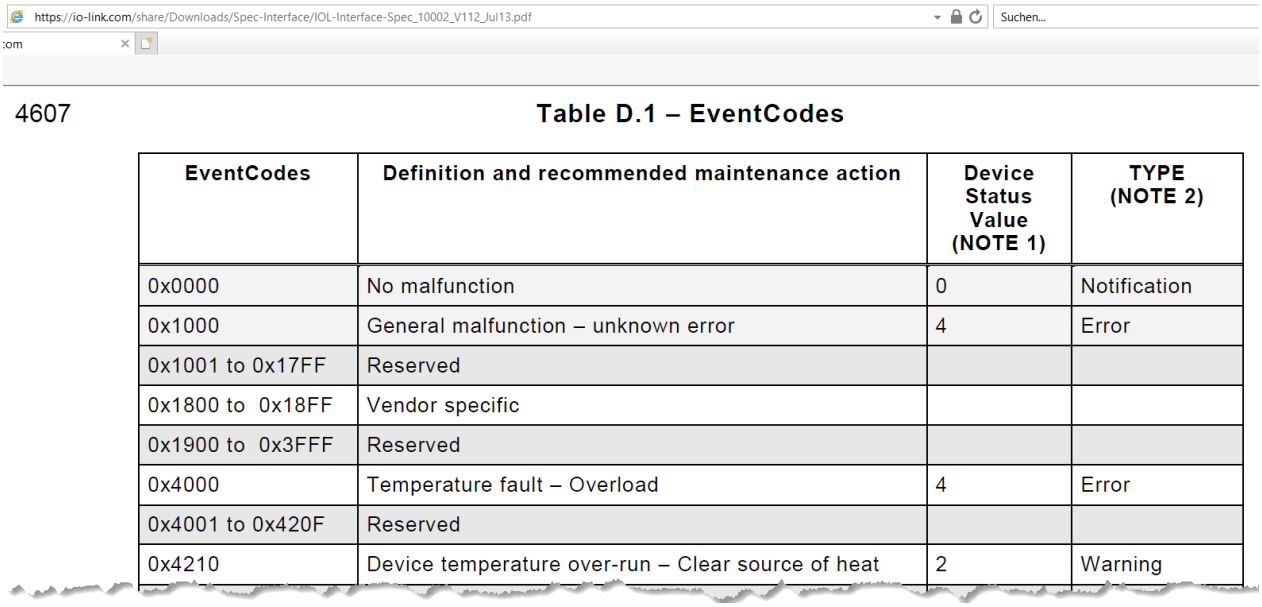
IO-Link master event codes

IO-Link event code hex	Diagnostics ID hex	Message	Description	
1800h	08 I 0A I 01A9	No device connected	No IO-Link device connected	
			Remedy	– Check whether an IO-Link device is connected.
			Diagnost-ic status	Error
1802h	08 I 0A I 016B	Incorrect VendorID; deviation of the Inspection Level	The recognized IO-Link device does not match the configured VendorID.	
			Remedy	– Check whether the correct IO-Link device is connected.
			Diagnost-ic status	Error
1803h	08 I 0A I 01A8	Incorrect Device ID; deviation of the Inspection Level	The recognized IO-Link device does not match the configured Device ID.	
			Remedy	– Check whether the correct IO-Link device is connected.
			Diagnost-ic status	Error

As soon as the problem is solved you see following the Diag History tab:



If the error code is not listed in the manual then the probability is high that it is a general IO-Link event code. In such case please check the IO Link specification too. It is free available in the Internet.



https://io-link.com/share/Downloads/Spec-Interface/IOL-Interface-Spec_10002_V112_Jul13.pdf

Suchen...

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Table D.1 – EventCodes

EventCodes	Definition and recommended maintenance action	Device Status Value (NOTE 1)	TYPE (NOTE 2)
0x0000	No malfunction	0	Notification
0x1000	General malfunction – unknown error	4	Error
0x1001 to 0x17FF	Reserved		
0x1800 to 0x18FF	Vendor specific		
0x1900 to 0x3FFF	Reserved		
0x4000	Temperature fault – Overload	4	Error
0x4001 to 0x420F	Reserved		
0x4210	Device temperature over-run – Clear source of heat	2	Warning

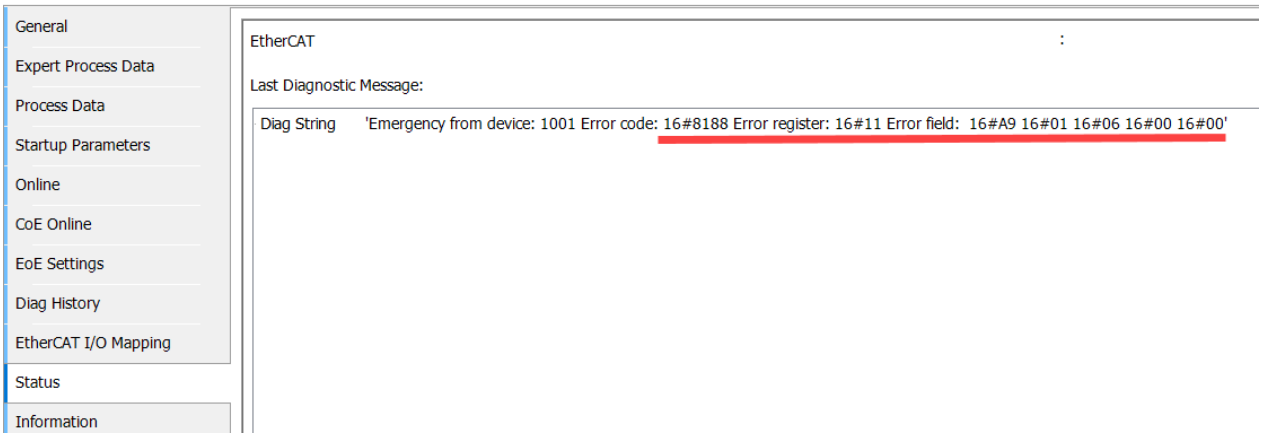
(Screenshot from the IO-Link specification PDF)

The actual Emergency code will pop up automatically. It is in EtherCAT an 8 Byte message

Byte							
0	1	2	3	4	5	6	7
Emergency error code ➔ Tab. 29 Emergency error code		Error register ➔ 0x1001	Error number of the diagnostics ID ➔ Tab. 19 Diagnostic Messages		Module number		Channel number

Tab. 28 Structure of the Emergency message

(Screenshot from CPX-AP-I-EC-M12 manual)



The meaning is

- Error code 16#8188

0x8188	8	Communication

(Screenshot from CPX-AP-I-EC-M12 manual)

- Register value: = 11 means

0x1001	0	Error register	U32	ro	Bit 0: generic error Bit 1: current error Bit 2: voltage error Bit 3: temperature error Bit 4: communication error Bit 5: device-profile-specific error Bit 6: reserved Bit 7: manufacturer-specific error

(Screenshot from CPX-AP-I-EC-M12 manual)

- Error number = A9 01 is

IO-Link master event codes

IO-Link event code hex	Diagnostics ID hex	Message	Description	
1800h	08 I 0A I 01A9	No device connected	No IO-Link device connected	
			Remedy	– Check whether an IO-Link device is connected.
			Diagnost-ic status	Error

(Screenshot from CPX-AP-I-4IOL-M12 manual)

- Module number: = 6

- Channel number: = 0 = Port 0

In a Codesys program you can read the EMCY message easily via e.g. following code too: