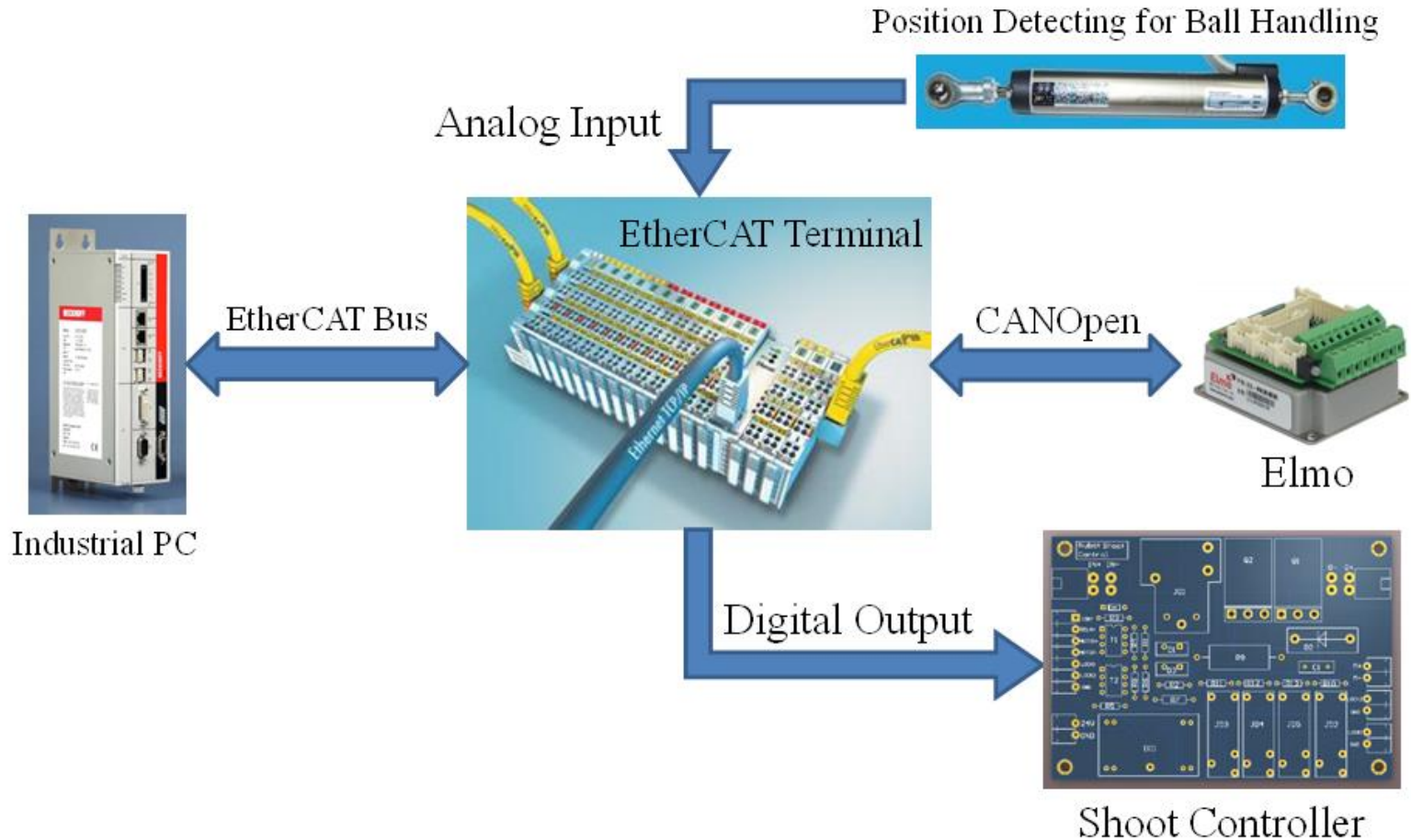


# EL6751 Configuration Using SOEM under Ubuntu Linux

NuBot team, NUDT, China  
For RoboCup MSL Workshop  
2014.11.10, Eindhoven  
[nubot.nudt@gmail.com](mailto:nubot.nudt@gmail.com)

# NuBot Electrical System



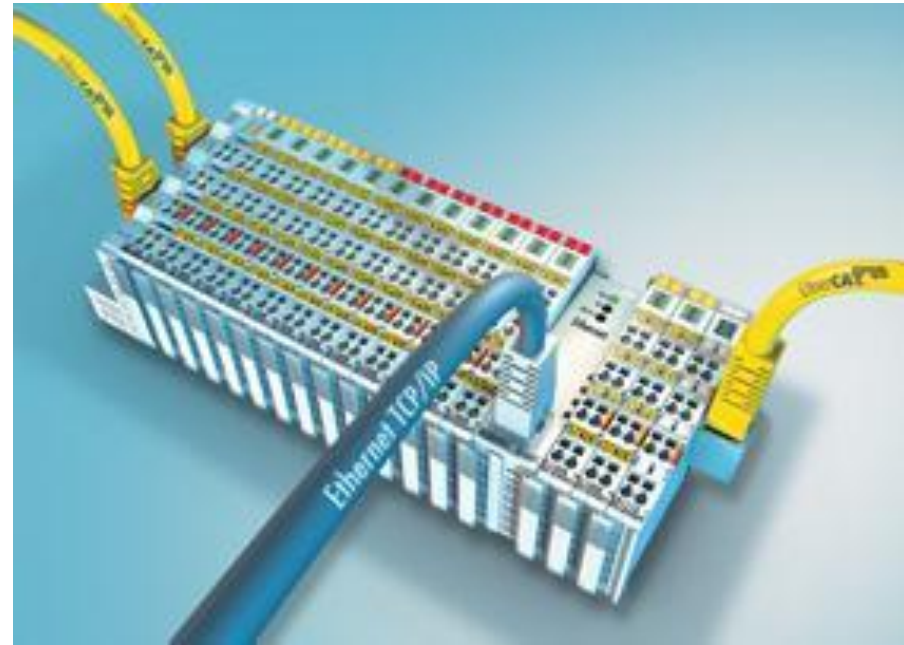
# ◆ Industrial PC

SIZE : (W x H x D) 65 x 231 x 116 mm (2.6" x 9.1" x 4.6") ;  
CPU : Intel® Core™ i7 , 4 Cores ;  
RAM : 8G , DDR3 ;  
HDD : 60G SSD ;  
POWER : DC 24V.

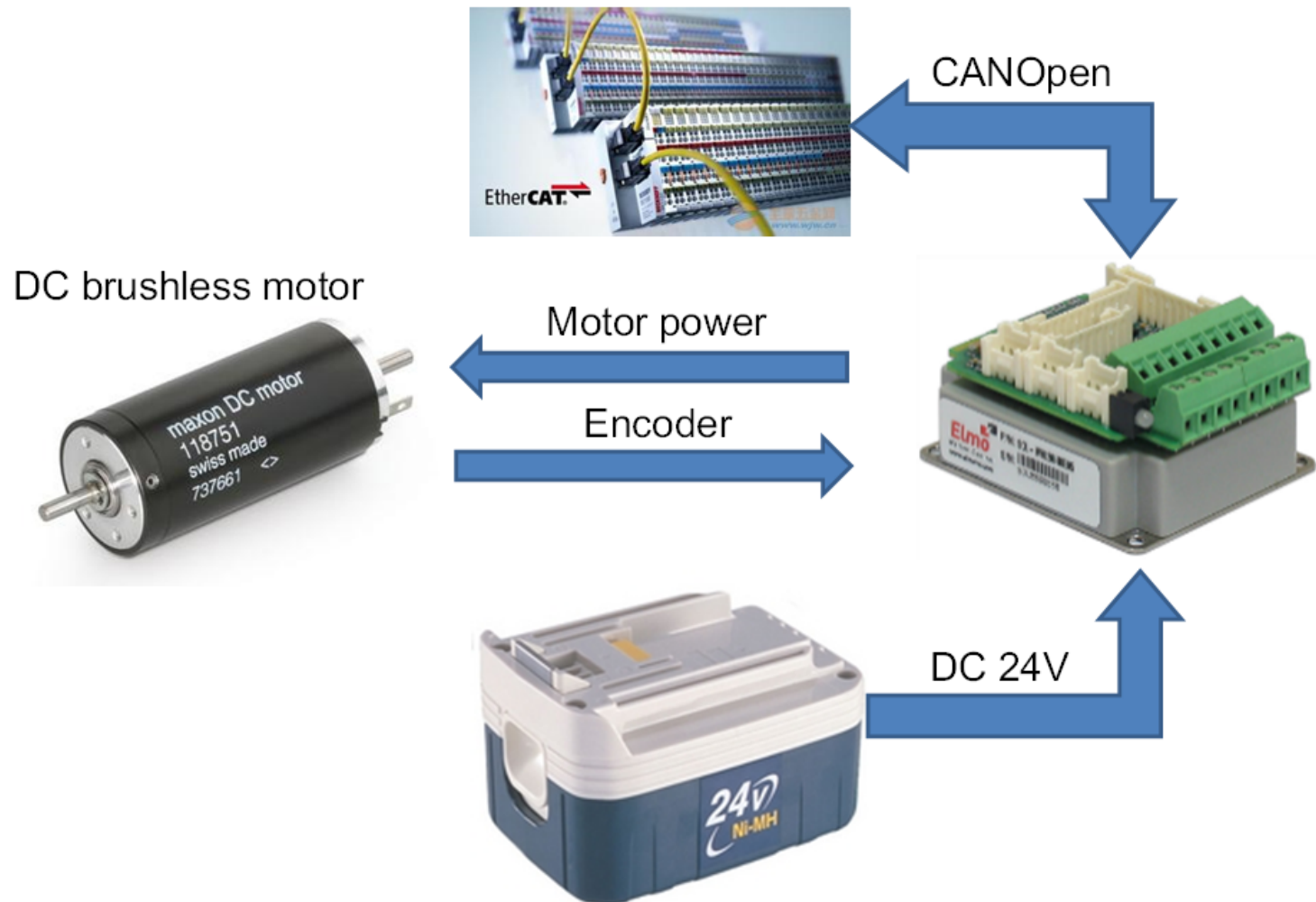


# ◆ EtherCAT Terminals

- **EK1100**  
The EtherCAT Coupler terminal which is essential.
- **EL2008**  
Digital Output terminal for shooting control.
- **EL6751**  
Gateway terminal to bridge EtherCAT with CANOpen.
- **EL3064-0010**  
Analog Input terminal for ball handling position detecting.



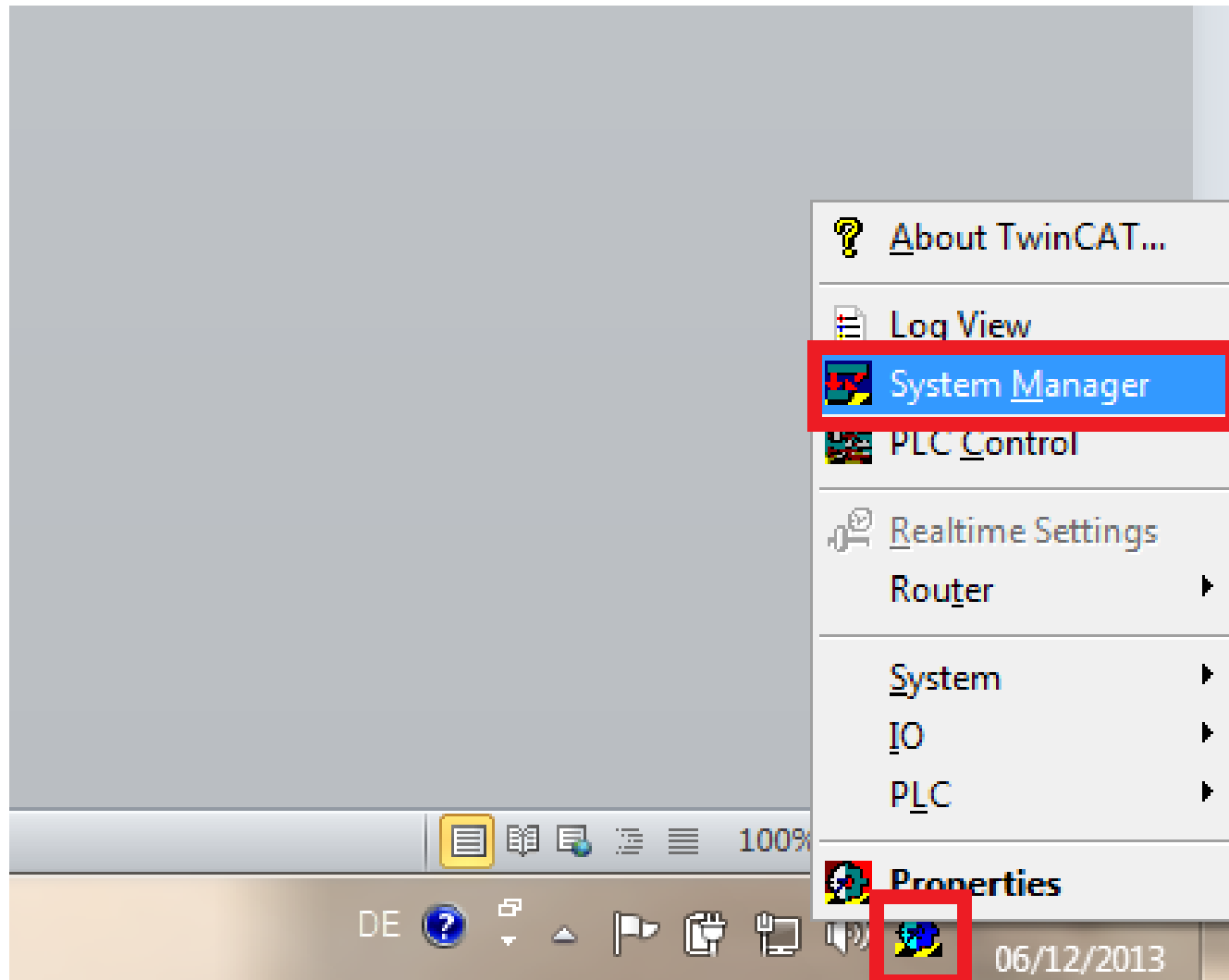
# ◆ Elmo motor controller



## ◆ EL6751 Configuration Using SOEM

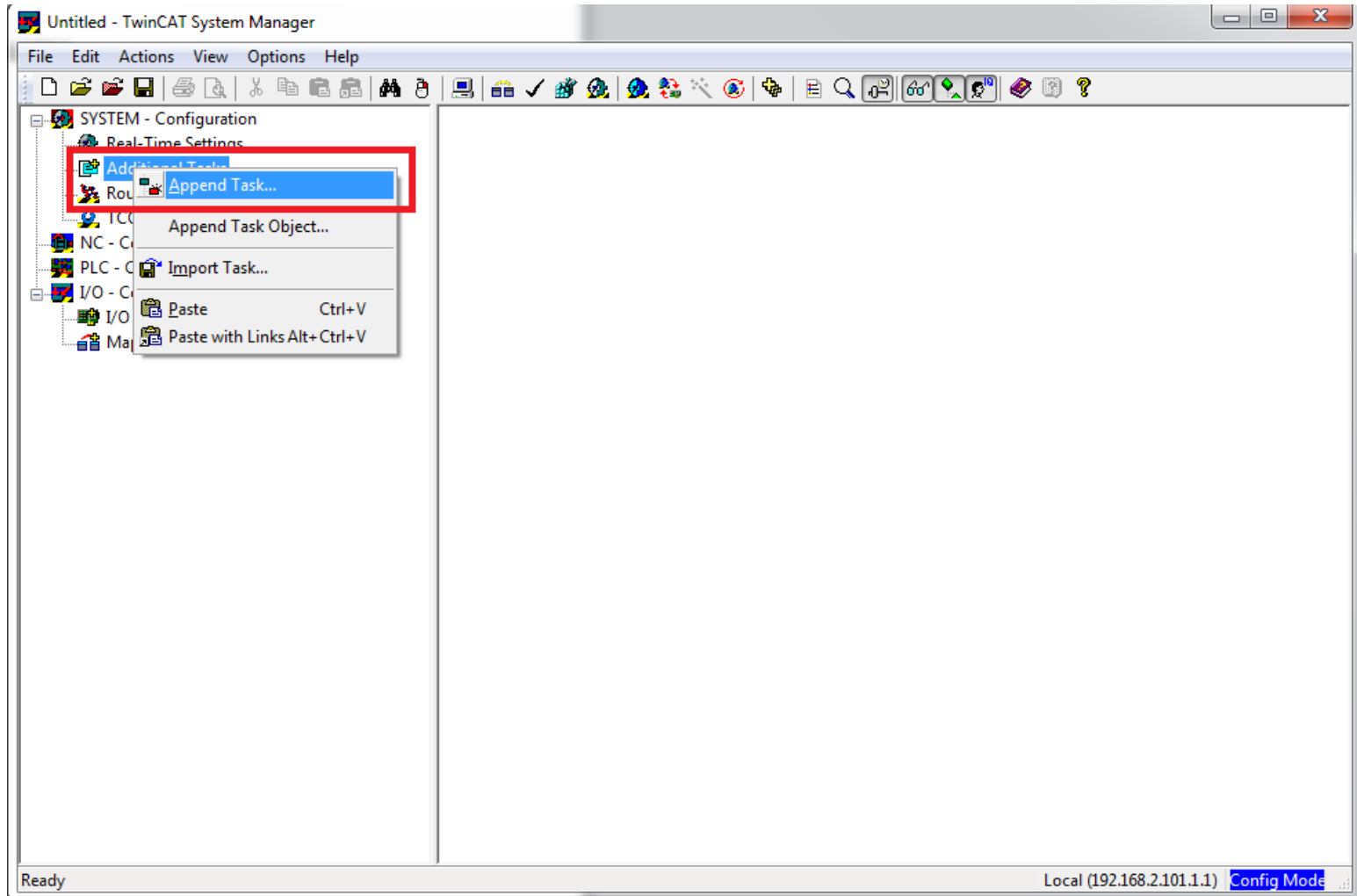
- SOEM is Simple Open-source EtherCAT Master.
  - The configuration of EL6751 using SOEM is quite complex!
    - Few people have configured EL6751 successfully using SOEM.
  - Solution:
    - Generate Startup codes and configuration codes with the help of TwinCAT, which is supported by Beckhoff.
    - Configure EL6751 with the codes generated above using simple functions of SOEM.
- 
- ## ◆ The following is the configuration codes generation using TwinCAT

a. Open TwinCAT System Manager application



b. Create cyclic Task (necessary to give the CANopen config a cycle time)

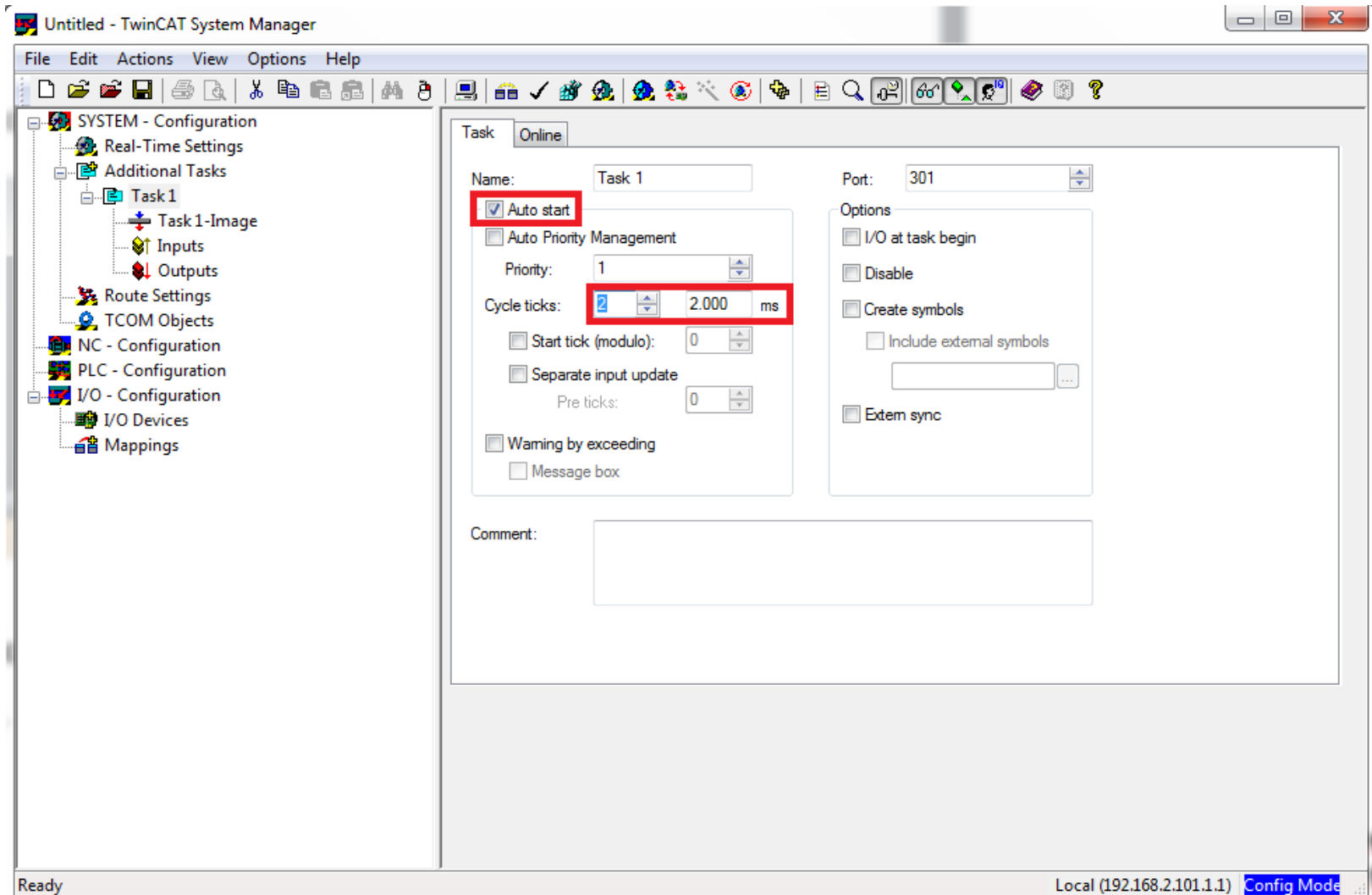
- Create Task (name is in influent)





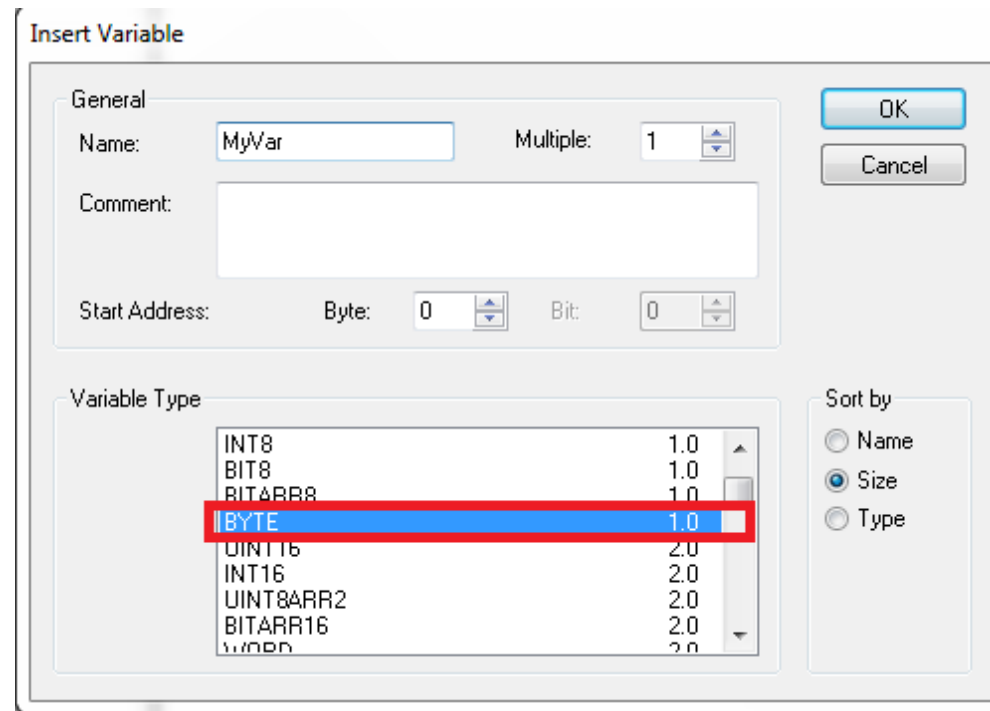
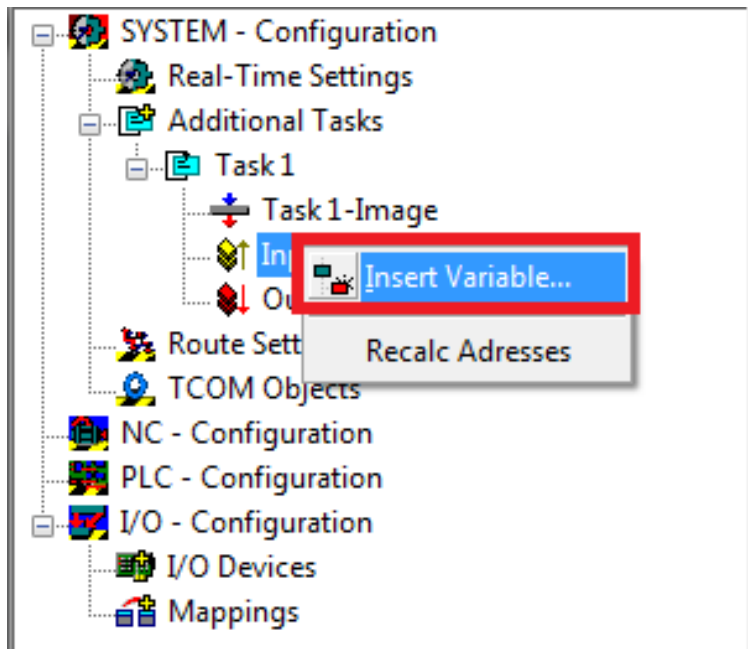
b. Create cyclic Task (necessary to give the CANopen config a cycle time)

- Enable task and set the desired cycle time as multiple of 1ms



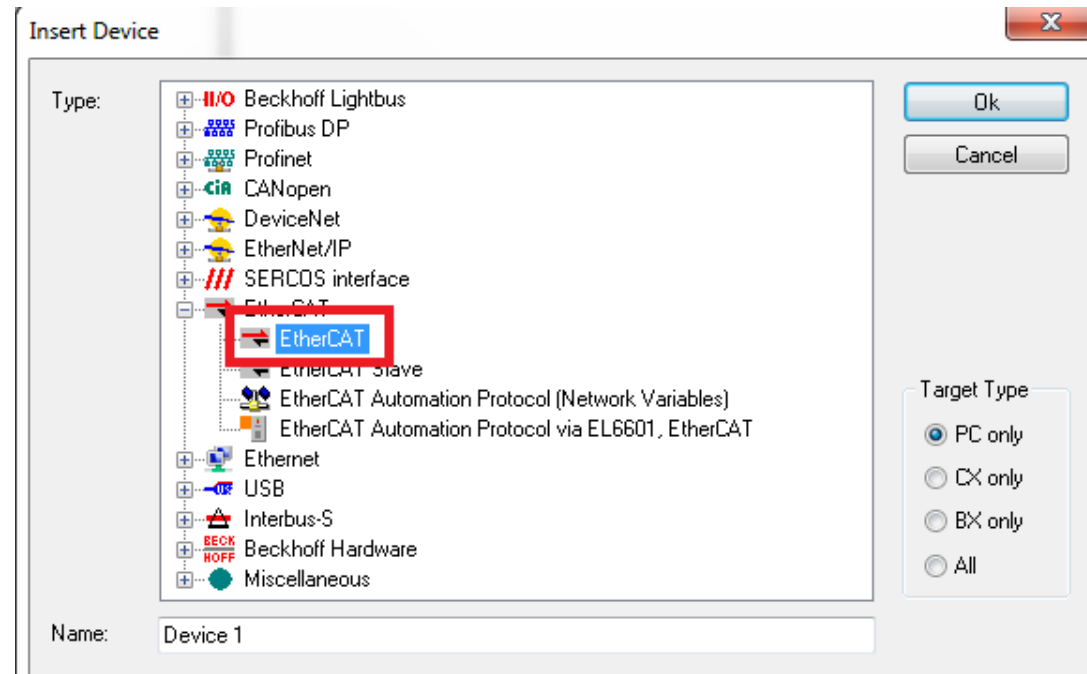
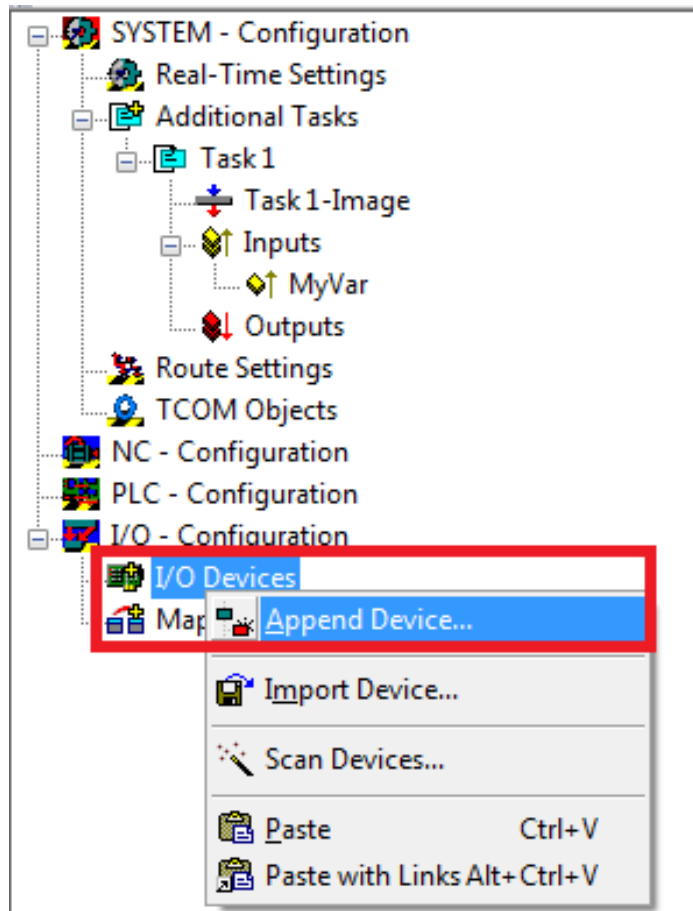
b. Create cyclic Task (necessary to give the CANopen config a cycle time)

- Create an Input variable of BYTE type (name is in influent)



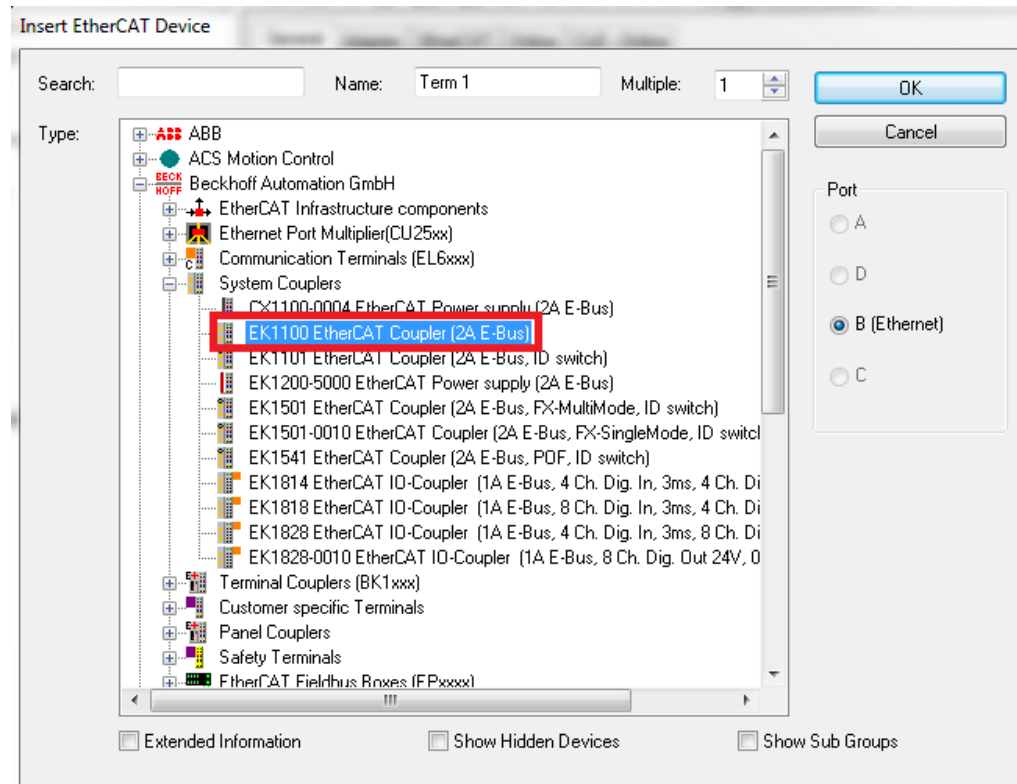
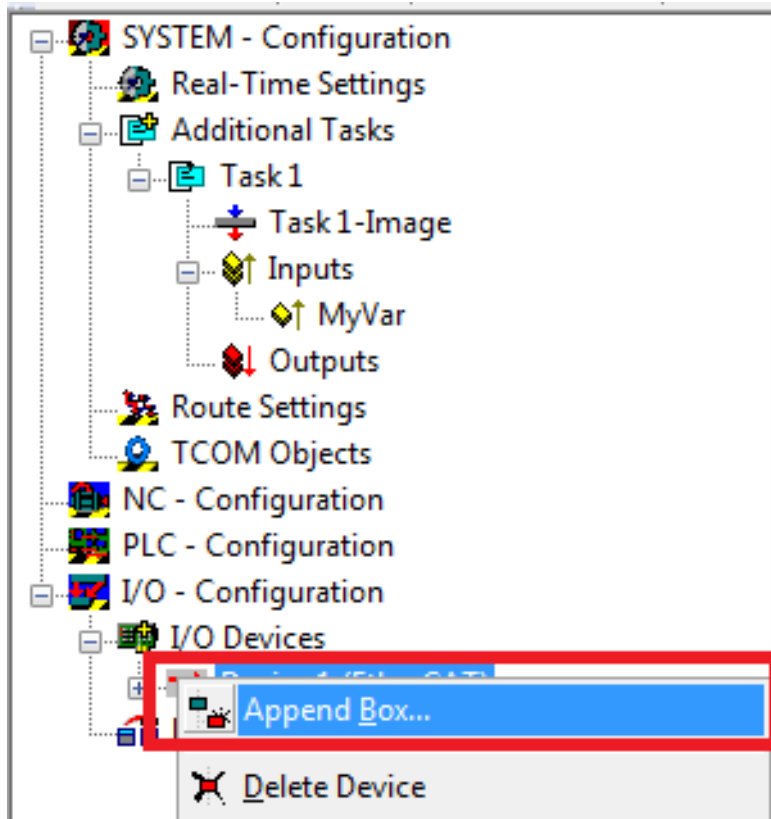
## c. Configure EtherCAT network

- Append EtherCAT Master functionality



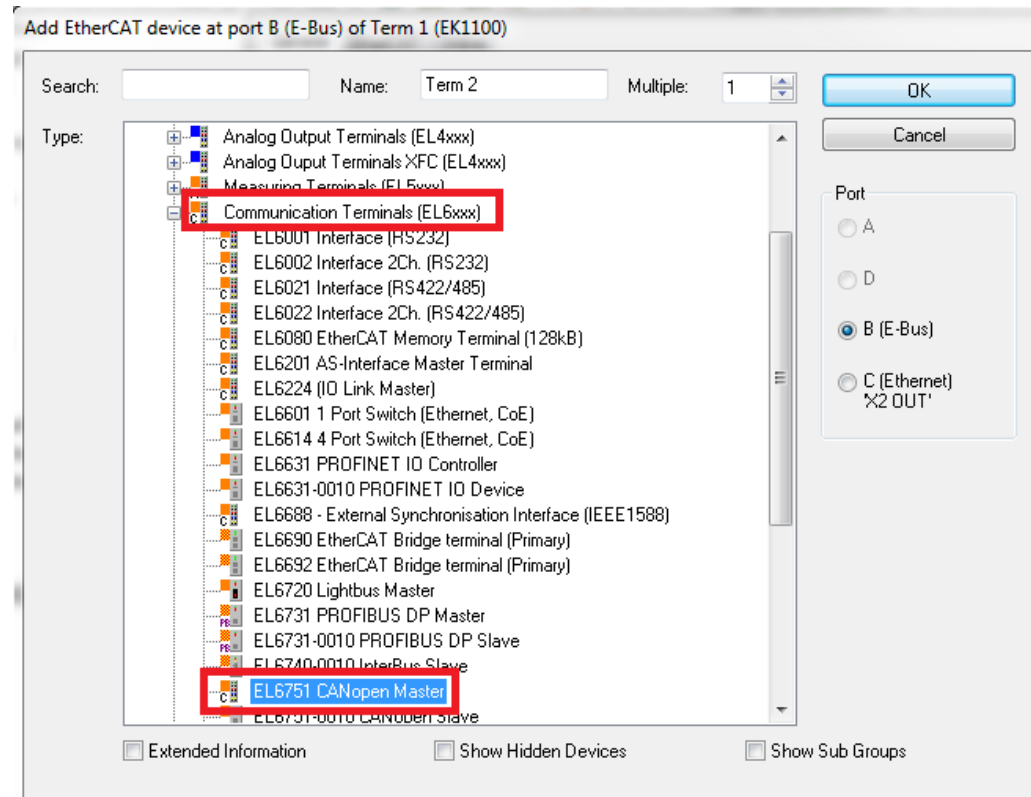
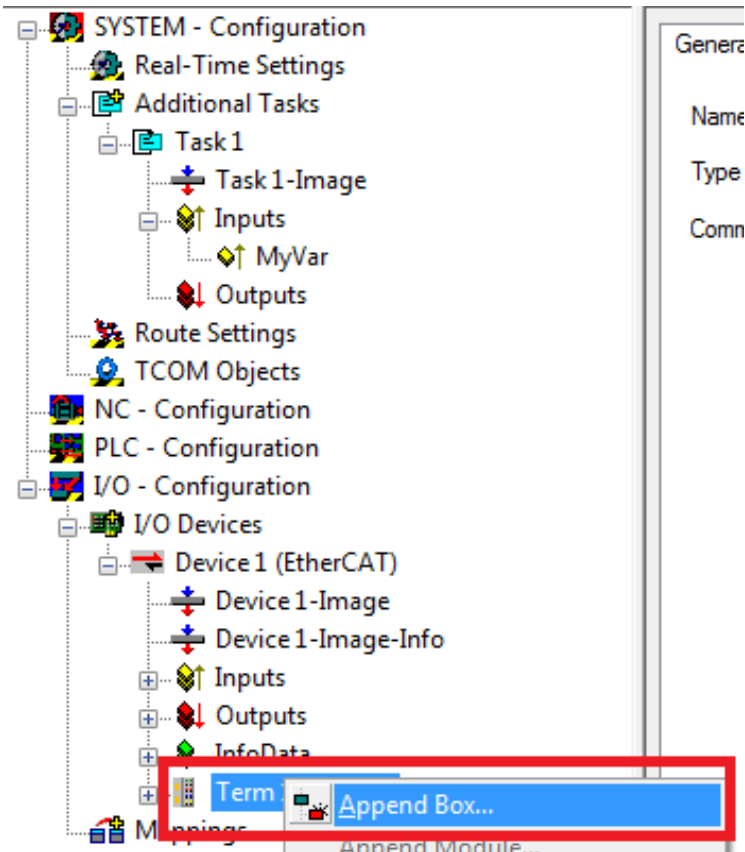
## c. Configure EtherCAT network

- Append EK1100 coupler



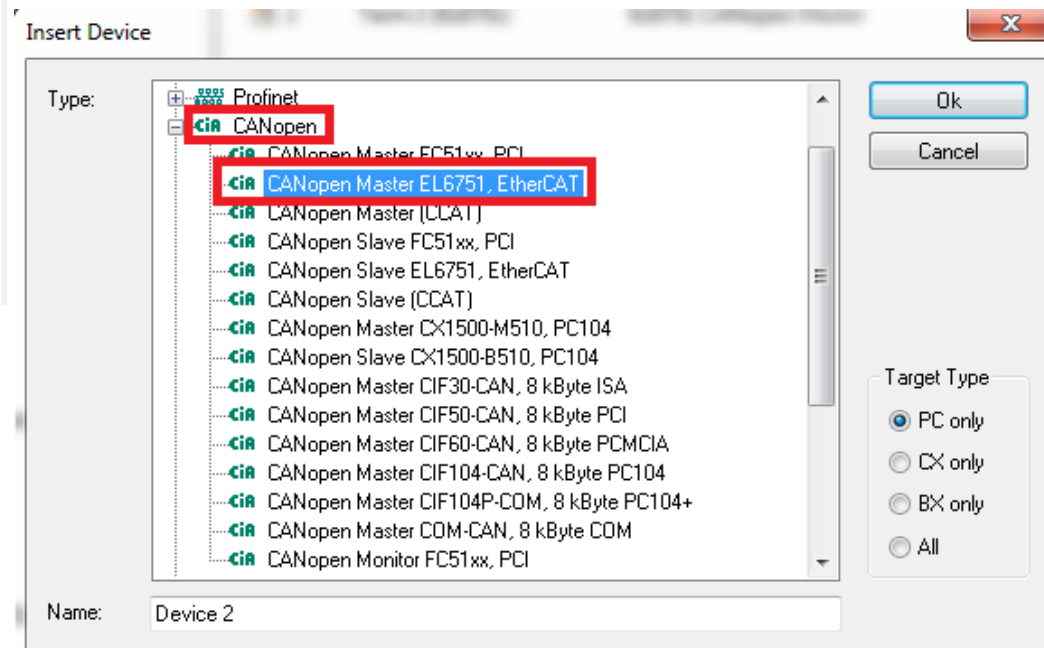
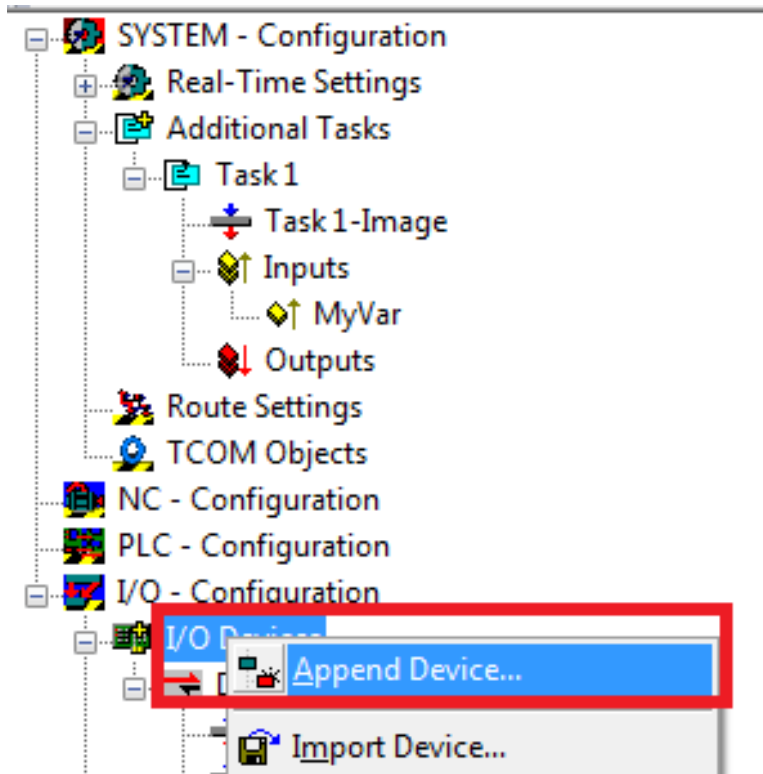
## c. Configure EtherCAT network

- Append EL6751



## d. Append CANopen network configurator

- Append CANopen Master functionality



## d. Append CANopen network configurator

- Check always correct association with EL6751

The screenshot shows the CANopen network configurator interface. The left sidebar displays a tree structure of the system configuration, with 'Device 2 (EL6751)' highlighted. The main panel shows the configuration for this device, with the 'EtherCAT' tab selected. The 'EtherCAT' field is set to 'Term 2 (EL6751)', and a red arrow points from this field to the 'Device 2 (EL6751)' entry in the left sidebar. The 'Master-Node-ID' is set to 127, and the 'Baudrate' is set to 500 k. Other parameters like 'Cycle Time (µs)', 'Sync-Cycle Multiplier', 'Sync-Cycle-Time (in µs)', 'Sync-Tx-PDO Delay (in %)', and 'Input Shift Time (in %)' are also visible. The bottom of the window shows a table with columns: Number, Box Name, Address, Type, In Size, Out Size, and Linked to.

Number	Box Name	Address	Type	In Size	Out Size	Linked to
--------	----------	---------	------	---------	----------	-----------

## d. Append CANopen network configurator

- Enable MDP mapping for EL6751 (necessary to use EL6751 with non-TwinCAT masters)

SYSTEM - Configuration

Real-Time Settings

Additional Tasks

Task 1

Task 1-Image

Inputs

MyVar

Outputs

Route Settings

TCOM Objects

NC - Configuration

PLC - Configuration

I/O - Configuration

I/O Devices

Device 1 (EtherCAT)

Device 1-Image

Device 1-Image-Info

Inputs

Outputs

InfoData

Term 1 (EK1100)

InfoData

Term 2 (EL6751)

Device 2 (EL6751)

Device 2-Image

Inputs

Box 3 (CANopen Node)

Mappings

GeneralEL6751ADSEtherCATGeneral DiagBox StatesDPRAM (Online)

Process Data

Legacy Mapping

MDP Mapping (from V01.00)

Box State

Diag Flag

PDO State

PDO Toggle

Cyclic Times

Control

Message Interface

Size: 0

8-Byte Align of PDOs

Extended Diagnosis

Maximum Diagnosis

Minimum Diagnosis

Backup Parameter (from V01.00)

Add to StartUp Cmds

Start-Up with Backup Storage

Download (from V01.00)

Error Handling (if a slave fails)

Stay in OP

Switch to SAFE-OP (from V01.00)

ADS-Server for acyclic indications

ADS-Server settings in StartUp

NetId: 0.0.0.0.0.0

Port: 0

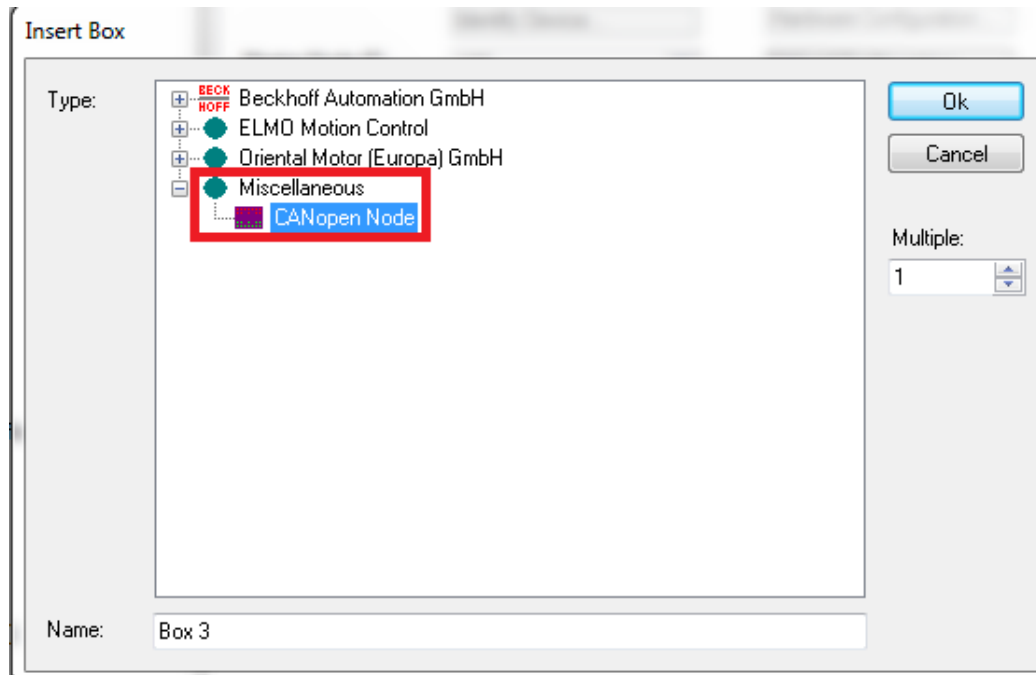
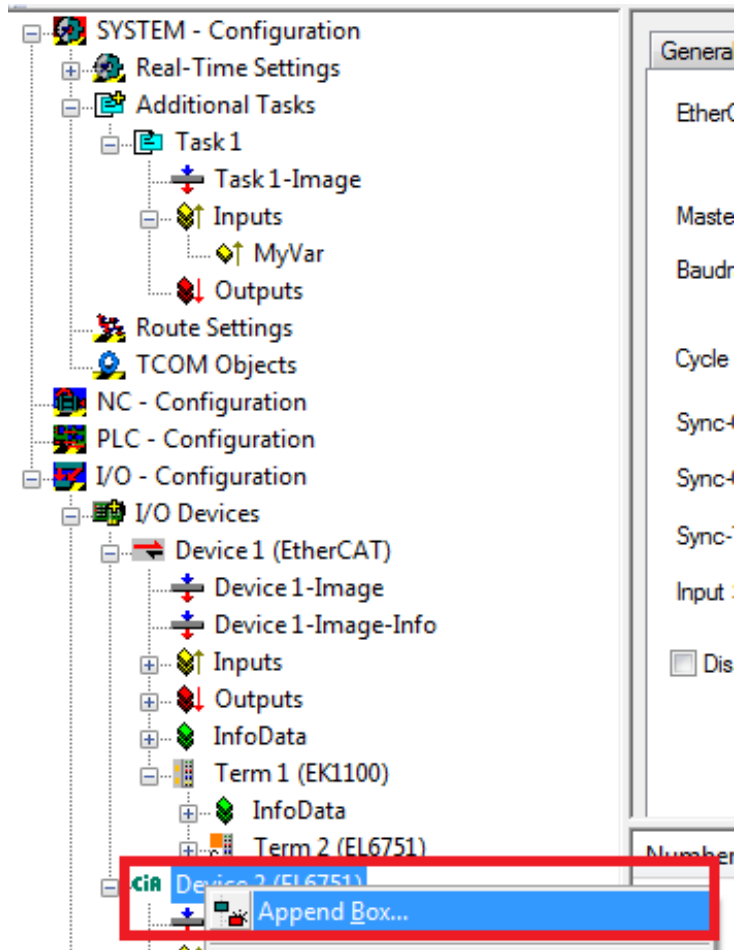
Export Module File...

Number	Box Name	Address	Type	In Size	Out Size	Linked to
1	Box 3 (CANopen Node)	1	CANopen Node			



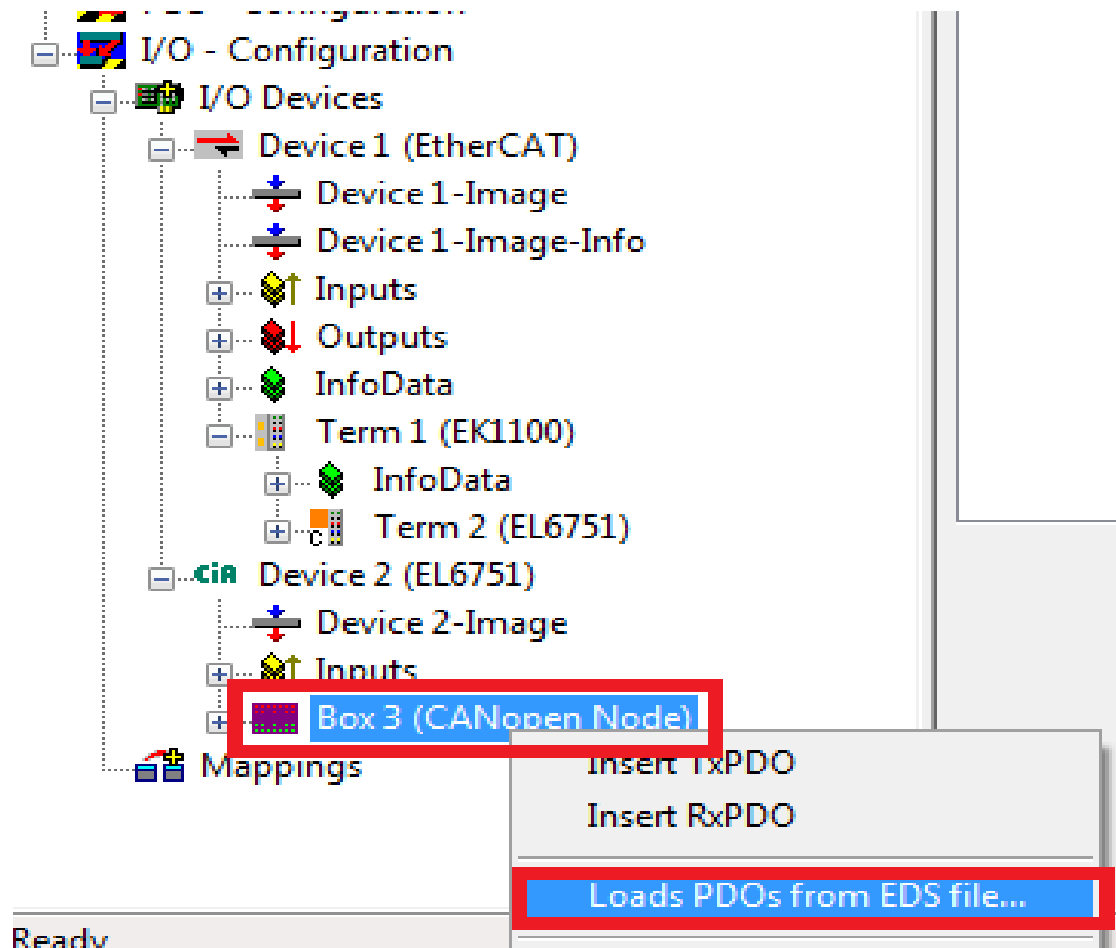
## d. Append CANopen network configurator

- Append the desired CANopen Slaves



## d. Append CANopen network configurator

- For CANopen slaves (Layer 7) : import properties from EDS



## d. Append CANopen network configurator

- For CAN bus slaves (Layer 2) : disable Layer 7

The screenshot displays the CANopen network configurator interface. On the left, a tree view shows the system configuration hierarchy. On the right, the 'CAN Node' configuration tab is active, showing various parameters for a CANopen node.

**Left Panel (Tree View):**

- SYSTEM - Configuration
  - Real-Time Settings
  - Additional Tasks
    - Task 1
      - Task 1-Image
        - Inputs
          - MyVar
        - Outputs
  - Route Settings
  - TCOM Objects
  - NC - Configuration
  - PLC - Configuration
  - I/O - Configuration
    - I/O Devices
      - Device 1 (EtherCAT)
        - Device 1-Image
        - Device 1-Image-Info
        - Inputs
        - Outputs
        - InfoData
        - Term 1 (EK1100)
          - InfoData
          - Term 2 (EL6751)
      - Device 2 (EL6751)
        - Device 2-Image
        - Inputs
        - Box 3 (CANopen Node)**
  - Mappings

**Right Panel (CAN Node Configuration):**

General | **CAN Node** | Diag

Node Id: 1

Profile No.: 0 0x0

Add. Information: 0 0x0

Guard Time (ms): 100

Life Time Factor: 3

Emcy. COB Id: 129 0x81

Guard COB Id: 1793 0x701

☒ Use Heartbeat

Check, if none zero

Vendor ID: 0 0x0

Product-Code: 0 0x0

Serial No.: 0 0x0

Revision No.: 0 0x0

☒ Automatic Adjust PDO COB Ids

☒ Automatic PDO Parameter Download

**Node-Fail Reaction**

☒ Stop Node

☐ No reaction

**Node-Restart**

☒ Automatic Restart

☐ Manual Restart

**Network Reaction**

☒ No Reaction

☐ Stop All Nodes

**Input-Fault-Reaction**

☒ Inputs will be set to 0

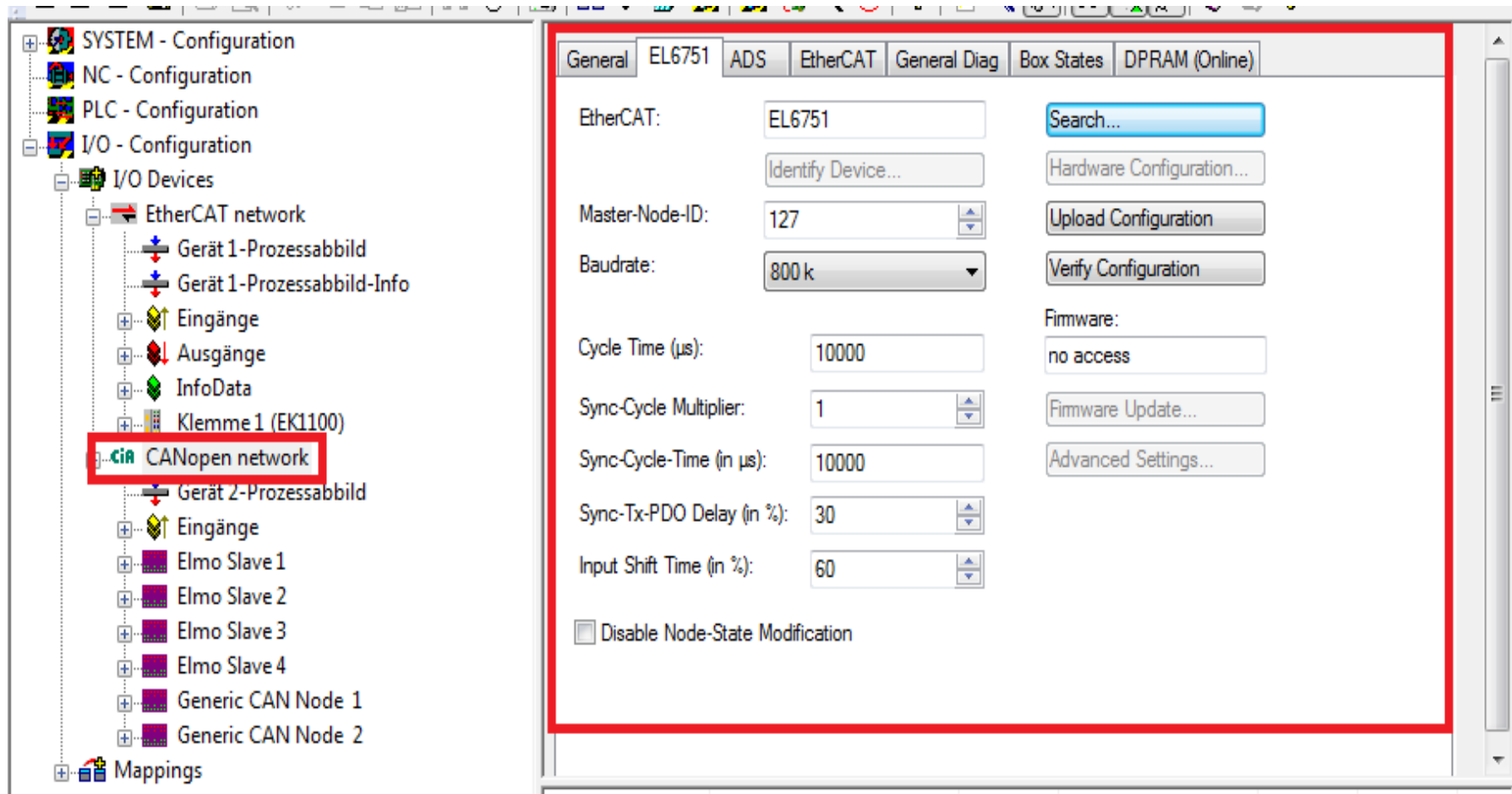
☐ No Reaction

☒ General CAN-Node (direct access to layer 2, no NMT)

Advanced...

## e. Configure the CANopen properties of the master

- Configure network Baud-Rate and Master CAN address, as well as other properties



## f. Configure the CANopen properties of your nodes

- For CANopen slaves : communication properties (will be EtherCAT objects 0x8yz0)

The screenshot displays the 'SYSTEM - Configuration' interface. On the left, a tree view shows the system hierarchy: 'SYSTEM - Configuration' > 'I/O - Configuration' > 'I/O Devices' > 'Device 1 (EtherCAT)' > 'Inputs' > 'Box 3 (CANopen Node)'. The 'Box 3 (CANopen Node)' is highlighted with a red box. On the right, the 'CAN Node' configuration tab is active, showing various settings for the selected node. The settings are organized into sections: 'General' (Node Id: 1, Profile No.: 0, Add. Information: 0, Guard Time (ms): 100, Life Time Factor: 3, Emcy. COB Id: 129, Guard COB Id: 1793, Use Heartbeat: checked), 'Node-Fail Reaction' (Stop Node selected), 'Node-Restart' (Automatic Restart selected), 'Network Reaction' (No Reaction selected), 'Input-Fault-Reaction' (Inputs will be set to 0 selected), and 'Check, if none zero' (Vendor ID: 0, Product-Code: 0, Serial No.: 0, Revision No.: 0). A red box highlights the 'CAN Node' tab and its settings. An 'Advanced...' button is visible at the bottom right of the configuration panel.

**SYSTEM - Configuration**

- Real-Time Settings
- Additional Tasks
  - Task 1
    - Task 1-Image
      - Inputs
        - MyVar
      - Outputs
    - Route Settings
    - TCOM Objects
- NC - Configuration
- PLC - Configuration
- I/O - Configuration
  - I/O Devices
    - Device 1 (EtherCAT)
      - Device 1-Image
      - Device 1-Image-Info
      - Inputs
      - Outputs
      - InfoData
      - Term 1 (EK1100)
        - InfoData
      - Term 2 (EL6751)
    - Device 2 (EL6751)
      - Device 2-Image
      - Inputs
      - Box 3 (CANopen Node)**

**CAN Node Configuration**

General | CAN Node | SDOs | ADS | Diag

Node Id: 1

Profile No.: 0 0x0

Add. Information: 0 0x0

Guard Time (ms): 100

Life Time Factor: 3

Emcy. COB Id: 129 0x81

Guard COB Id: 1793 0x701

☒ Use Heartbeat

Check, if none zero

Vendor ID: 0 0x0

Product-Code: 0 0x0

Serial No.: 0 0x0

Revision No.: 0 0x0

☐ General CAN-Node (direct access to layer 2, no NMT)

☒ Automatic Adjust PDO COB Ids

☒ Automatic PDO Parameter Download

Node-Fail Reaction

☒ Stop Node

☐ No reaction

Node-Restart

☒ Automatic Restart

☐ Manual Restart

Network Reaction

☒ No Reaction

☐ Stop All Nodes

Input-Fault-Reaction

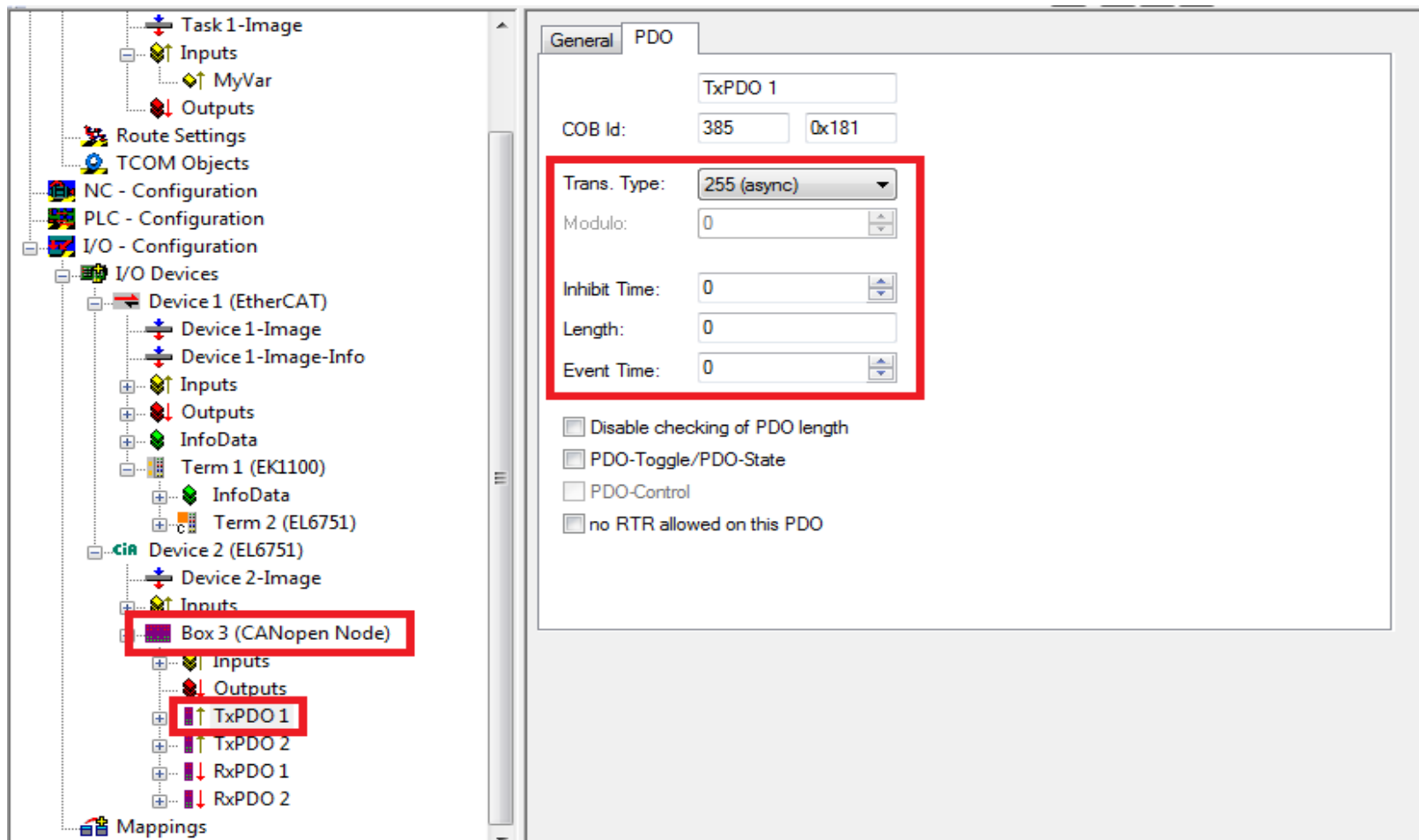
☒ Inputs will be set to 0

☐ No Reaction

Advanced...

## f. Configure the CANopen properties of your nodes

- For CANopen slaves : PDO properties (PDO Cob-Ids are automatically set according to the node address according to the CANopen rule, will be EtherCAT objects 0x8yz6 and 0x8yz8)



## f. Configure the CANopen properties of your nodes

- For CANopen slaves : start-up SDOs (will be EtherCAT objects 0x8yz3)

The screenshot displays a software interface for configuring CANopen nodes. On the left, a project tree shows the hierarchy: Task 1-Image, Inputs, MyVar, Outputs, Route Settings, TCOM Objects, NC - Configuration, PLC - Configuration, I/O - Configuration, I/O Devices, Device 1 (EtherCAT), Device 1-Image, Device 1-Image-Info, Inputs, Outputs, InfoData, Term 1 (EK1100), InfoData, Term 2 (EL6751), Device 2 (EL6751), Device 2-Image, Inputs, **Box 3 (CANopen Node)**, TxPDO 1, TxPDO 2, RxPDO 1, RxPDO 2, and Mappings. The 'Box 3 (CANopen Node)' is highlighted with a red box.

The right pane shows the configuration for the selected node, with the 'SDOs' tab selected. The table below lists the SDOs:

Obj. idx	Sub. idx	Length	Value (dec)	Value (hex)
<0x1800>	1	4	385	0x181
<0x1800>	2	1	255	0xFF
<0x1801>	1	4	641	0x281
<0x1801>	2	1	255	0xFF
<0x1400>	1	4	513	0x201
<0x1400>	2	1	255	0xFF
<0x1401>	1	4	769	0x301
<0x1401>	2	1	255	0xFF

Below the table, there are configuration options:

- ☐ Restart Node when no TxPDOs are received for 10s after Start Node
- max. SDOs in Send Queue: 5
- max. Boot-Up Timeout (s): 0
- max. SDO Timeout (ms): 2000

Buttons at the bottom: Create PDO Par, Append..., Insert..., Delete..., Edit...

## f. Configure the CANopen properties of your nodes

- For CAN bus slaves : set address

The screenshot displays a software interface for configuring CANopen properties. On the left, a project tree shows a hierarchy of components: Task 1-Image, Inputs, MyVar, Outputs, Route Settings, TCOM Objects, NC - Configuration, PLC - Configuration, I/O - Configuration, I/O Devices, Device 1 (EtherCAT), Device 1-Image, Device 1-Image-Info, Inputs, Outputs, InfoData, Term 1 (EK1100), InfoData, Term 2 (EL6751), Device 2 (EL6751), Device 2-Image, Inputs, **Box 3 (CANopen Node)**, Outputs, TxPDO 1, TxPDO 2, RxPDO 1, RxPDO 2, and Mappings. The 'Box 3 (CANopen Node)' is highlighted with a red box.

On the right, the 'CAN Node' configuration tab is active. It contains several sections of parameters:

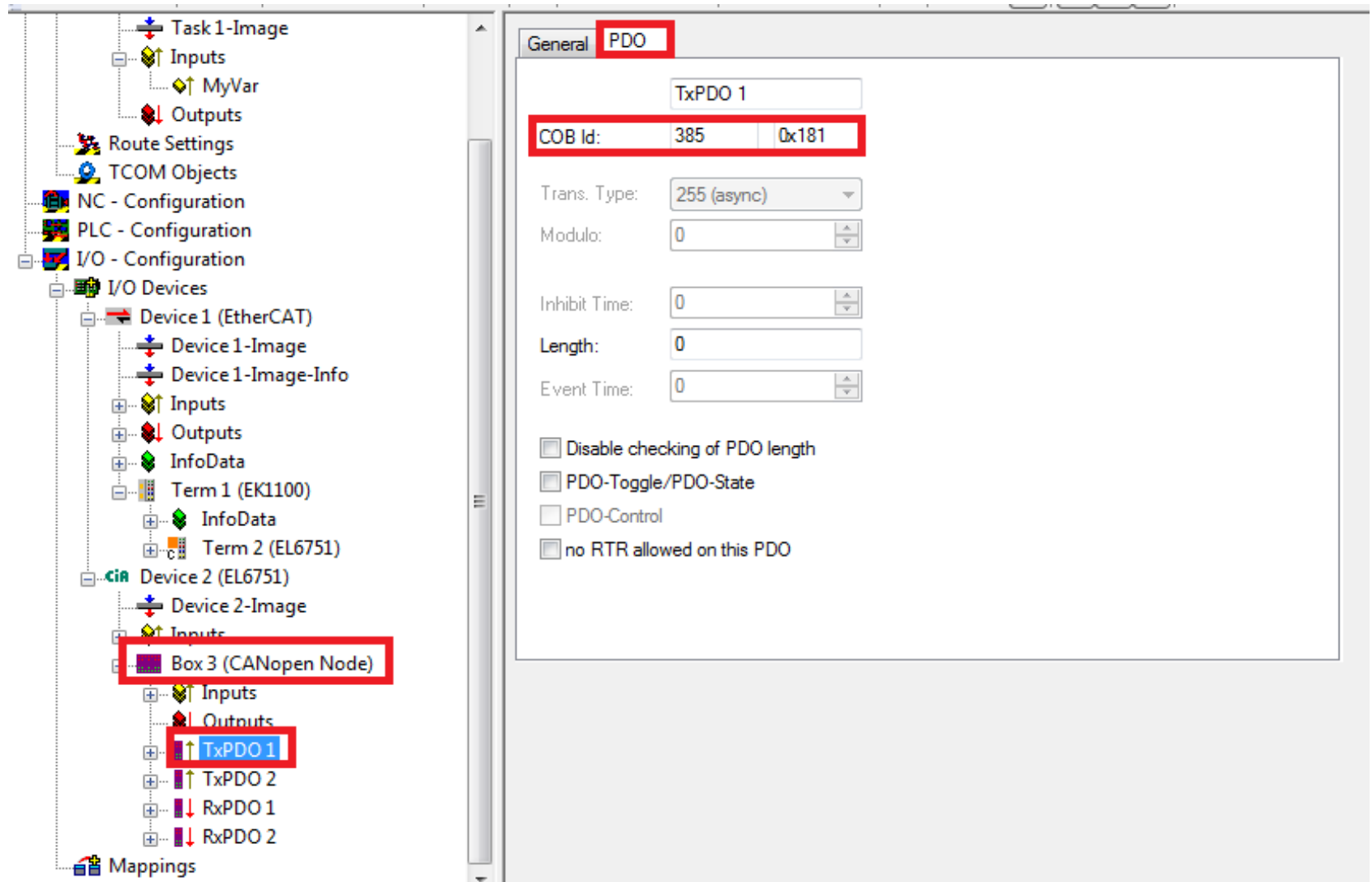
- General CAN Node** (highlighted with a red box):
  - Node Id: 1 (highlighted with a red box)
  - Profile No.: 0 (hex: 0x0)
  - Add. Information: 0 (hex: 0x0)
  - Guard Time (ms): 100
  - Life Time Factor: 3
  - Emcy. COB Id: 129 (hex: 0x81)
  - Guard COB Id: 1793 (hex: 0x701)
  - ☒ Use Heartbeat
  - Check, if none zero**:
    - Vendor ID: 0 (hex: 0x0)
    - Product-Code: 0 (hex: 0x0)
    - Serial No.: 0 (hex: 0x0)
    - Revision No.: 0 (hex: 0x0)
  - ☒ General CAN-Node (direct access to layer 2, no NMT)
- Automatic Adjust PDO COB Ids** (checked)
- Automatic PDO Parameter Download** (checked)
- Node-Fail Reaction**:
  - ☒ Stop Node
  - ☐ No reaction
- Node-Restart**:
  - ☒ Automatic Restart
  - ☐ Manual Restart
- Network Reaction**:
  - ☒ No Reaction
  - ☐ Stop All Nodes
- Input-Fault-Reaction**:
  - ☒ Inputs will be set to 0
  - ☐ No Reaction

An 'Advanced...' button is located at the bottom right of the configuration panel.



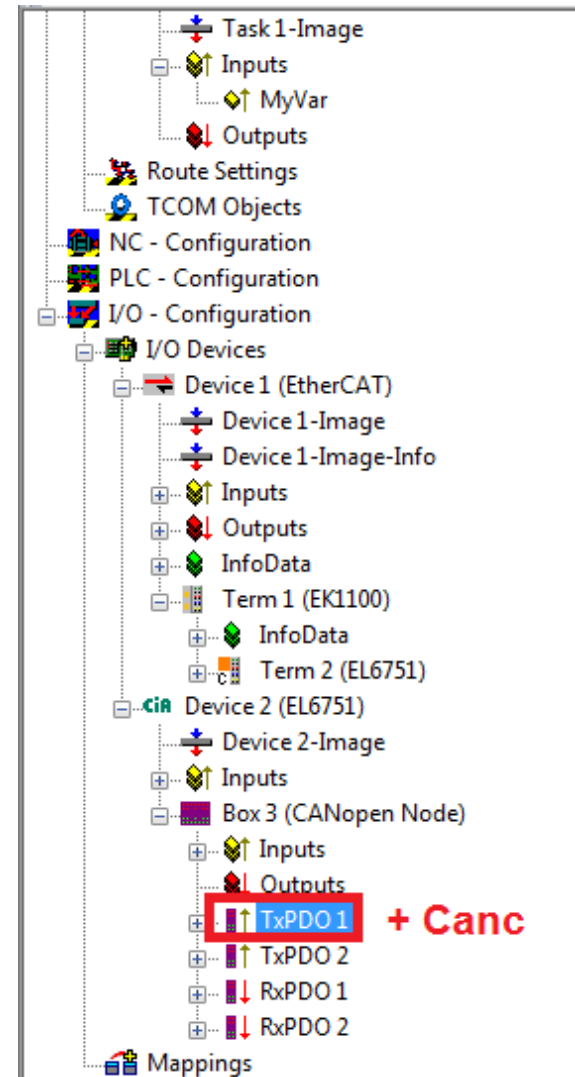
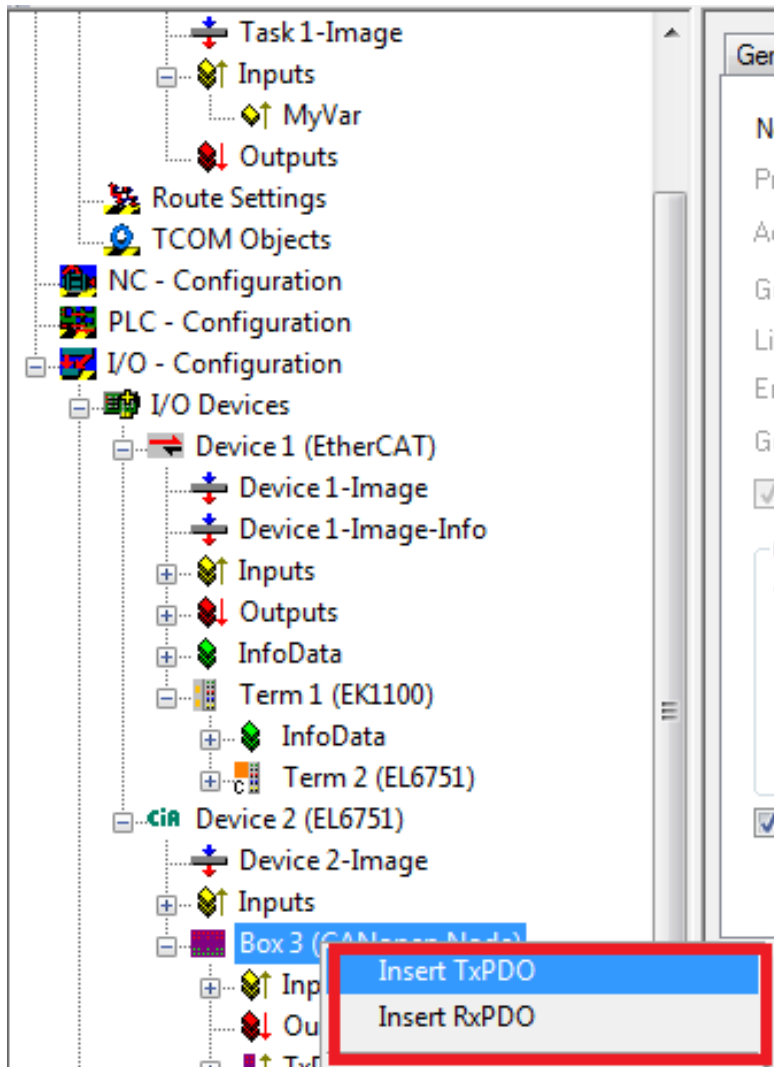
## f. Configure the CANopen properties of your nodes

- For CAN bus slaves : freely choose Cob-Id of telegrams



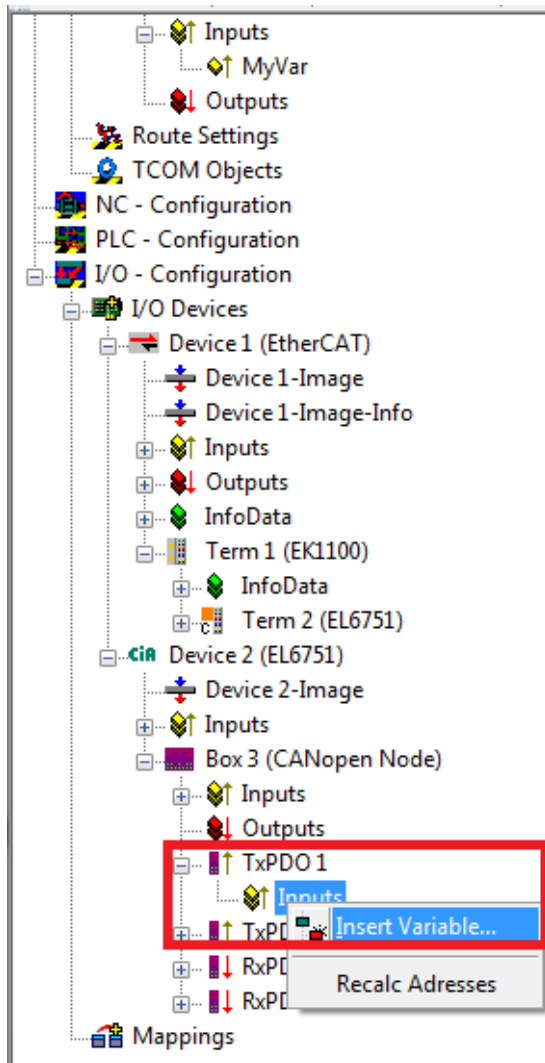
## f. Configure the CANopen properties of your nodes

- For CAN bus slaves : add/remove telegrams



## f. Configure the CANopen properties of your nodes

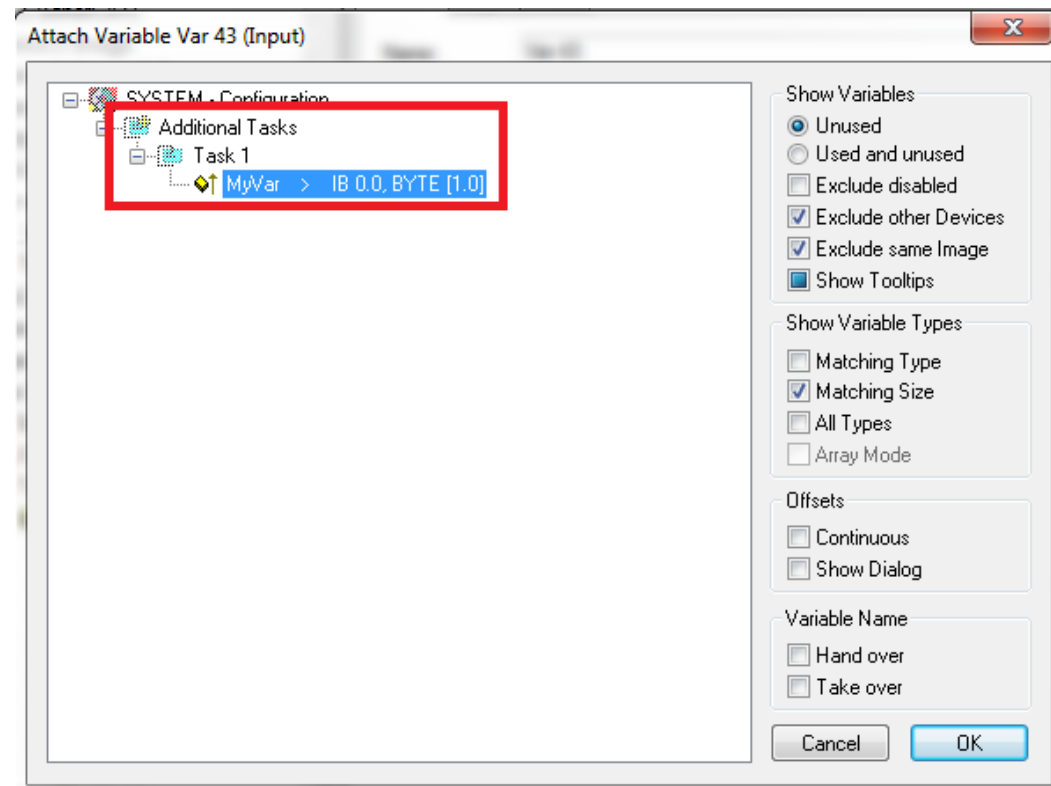
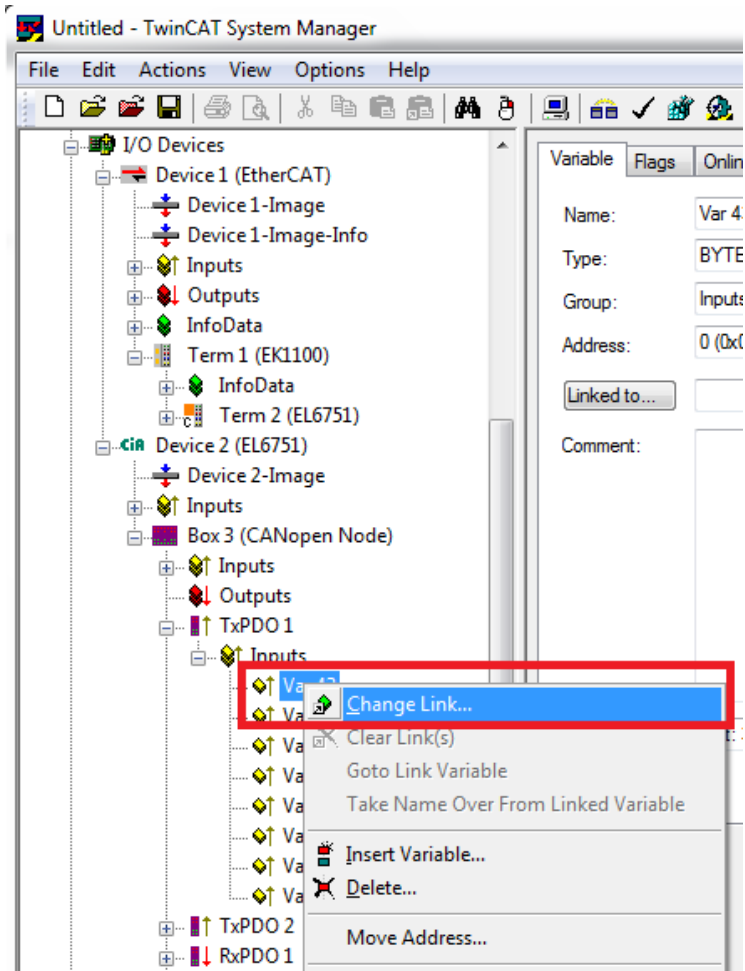
- For CAN bus slaves : freely configure multiple of BYTE for each telegram (max 8 bytes)



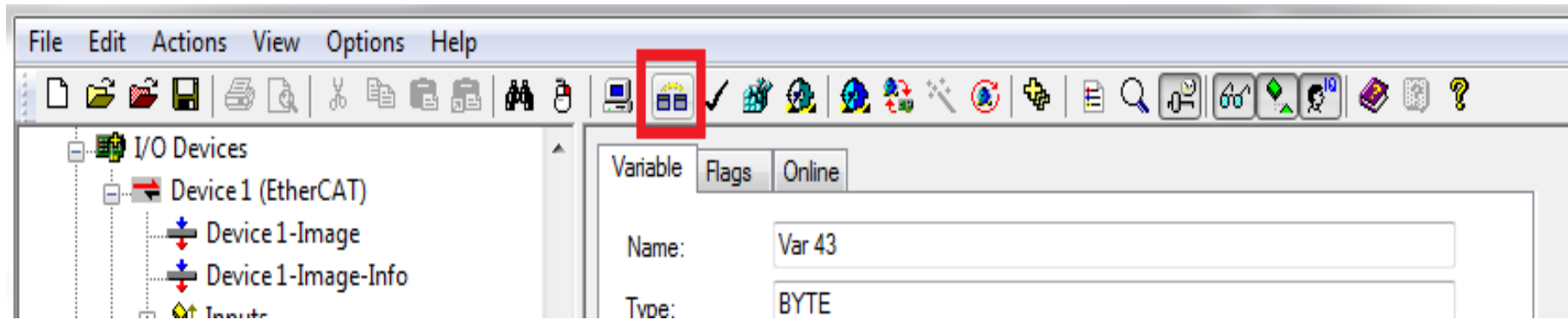
The 'Insert Variable' dialog box is shown with the following fields and options:

- General**
  - Name: Var 43
  - Multiple: 1.0 (highlighted with a red box)
  - Comment: (empty text box)
  - Start Address: (empty text box)
  - Byte: 0 (spin box)
  - Bit: 0 (spin box)
- Variable Type**
  - BYTE (highlighted with a red box)
  - UINT16
  - INT16
  - UINT8ARR2
  - BITARR16
  - WORD
  - ENUM
  - VARTYPE\_DPV2TIMESTAMPSTATUS
  - UINT24
- Sort by**
  - ☐ Name
  - ☒ Size
  - ☐ Type
- Buttons**
  - OK
  - Cancel

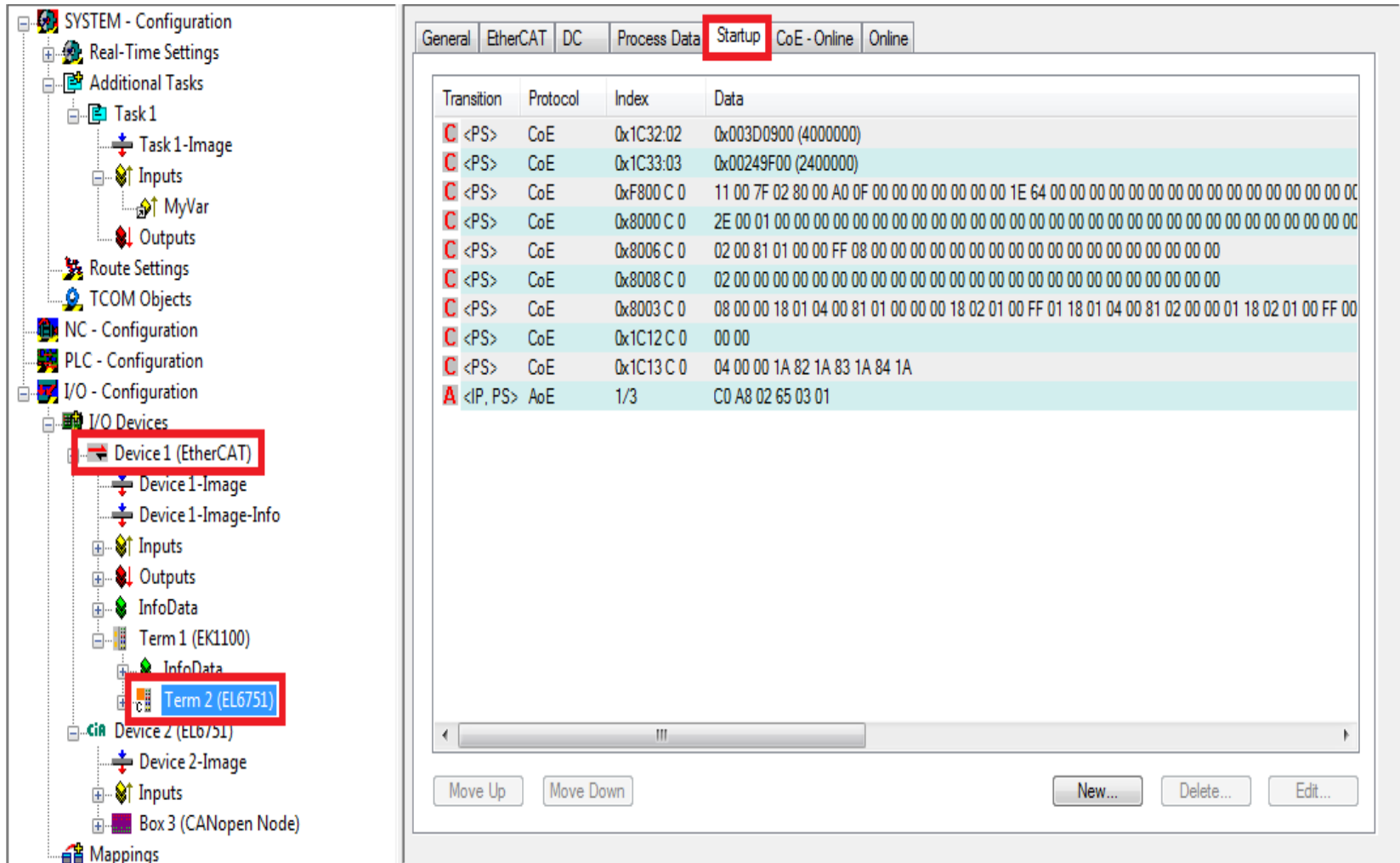
## g. Link CANopen variable to cyclic Task (associate timing to CANopen)



## h. Validate configuration



# i. Read EtherCAT Start-Up list for EL6751 (final result of the configuration)



The screenshot displays the configuration software interface. On the left, a tree view shows the project structure. The 'I/O - Configuration' folder is expanded, and 'Device 1 (EtherCAT)' is selected. Under 'Device 1 (EtherCAT)', 'Term 2 (EL6751)' is highlighted. On the right, the 'Startup' tab is active, showing a table of transition data.

Transition	Protocol	Index	Data
C <PS>	CoE	0x1C32:02	0x003D0900 (4000000)
C <PS>	CoE	0x1C33:03	0x00249F00 (2400000)
C <PS>	CoE	0xF800 C 0	11 00 7F 02 80 00 A0 0F 00 00 00 00 00 00 00 00 1E 64 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C <PS>	CoE	0x8000 C 0	2E 00 01 00
C <PS>	CoE	0x8006 C 0	02 00 81 01 00 00 FF 08 00
C <PS>	CoE	0x8008 C 0	02 00
C <PS>	CoE	0x8003 C 0	08 00 00 18 01 04 00 81 01 00 00 00 18 02 01 00 FF 01 18 01 04 00 81 02 00 00 01 18 02 01 00 FF 00
C <PS>	CoE	0x1C12 C 0	00 00
C <PS>	CoE	0x1C13 C 0	04 00 00 1A 82 1A 83 1A 84 1A
A <IP, PS>	AoE	1/3	C0 A8 02 65 03 01

At the bottom of the window, there are buttons for 'Move Up', 'Move Down', 'New...', 'Delete...', and 'Edit...'.

## j. Read EtherCAT Init Commands for EL6751 (final result of the configuration)

The screenshot shows the configuration software interface. On the left is a tree view of the system configuration. The main window has tabs for 'General', 'EtherCAT', 'Process Data', 'Startup', 'CoE - Online', and 'Online'. The 'EtherCAT' tab is active, showing fields for 'Type' (EL6751 CANopen Master), 'Product/Revision' (EL6751-0000-0019), 'Auto Inc Addr' (FFFF), 'EtherCAT Addr' (1002), and 'Identification Value' (0). A red box highlights the 'Advanced Settings...' button. Below this, the 'Advanced Settings' dialog box is open, showing the 'Init Commands' table. The 'Init Commands' table is also highlighted with a red box.

**Init Commands Table:**

IP	PS	PI	SP	SO	SI	OS	OP	OI	IB	BI	CMD	Comment
		X			X			X		X	APWR	set device state to INIT
		X			X			X			APRD	check device state for INIT
										X	APRD	check device state for INIT
X									X		APWR	set device state to INIT
X									X		APRD	check device state for INIT
X											APWR	assign EEPROM to ECAT
X											APWR	check vendor id
X											APRD	check vendor id
X											APWR	check product code
X											APRD	check product code
X									X		APWR	set physical address
X		X			X			X	X		FPWR	clear sm 0/1 (mailbox out/in)
										X	APWR	clear sm 0/1 (mailbox out/in)
X											FPWR	set sm 0 (mailbox out)