Controlling Synapticon Devices Using TwinCAT3 - a Quick Start Guide

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3. Disclaimer

This document provides an example on how to use SOMANET drives with TwinCAT. Because it is an example, content may not match with the latest version of TwinCAT or the SOMANET Firmware.

The included code is an example; it cannot be used as a reference. In case of doubt, refer to the official TwinCAT and SOMANETdocumentation.

Synapticon GmbH refuses any responsibility for any problem or damage incurred from the use of the example configuration and code!

4. Overview

This document provides the necessary steps for a user to turn a BLDC motor by utilizing TwinCAT 3 on a Windows platform and Synapticon products, e.g., SOMANET Node, SOMANET Circulo and SOMANET Integro.

4.1. Hardware

A block diagram of the wiring used in this example is provided in Figure 4.1 below. The provided code, which is described in the Synapticon Control Package section, assumes that the laptop on which the setup is used has only one Ethernet port and that only one device is connected at the time. In the example provided, integrated encoders for SOMANET Integro and SOMANET Circulo are used, along with an external one for SOMANET Node. However, external ones can be connected - as labeled with cyan color - and used once configured with OBLAC tools. Detailed instructions and wiring diagrams for all devices are available via the Synaption online documentation.

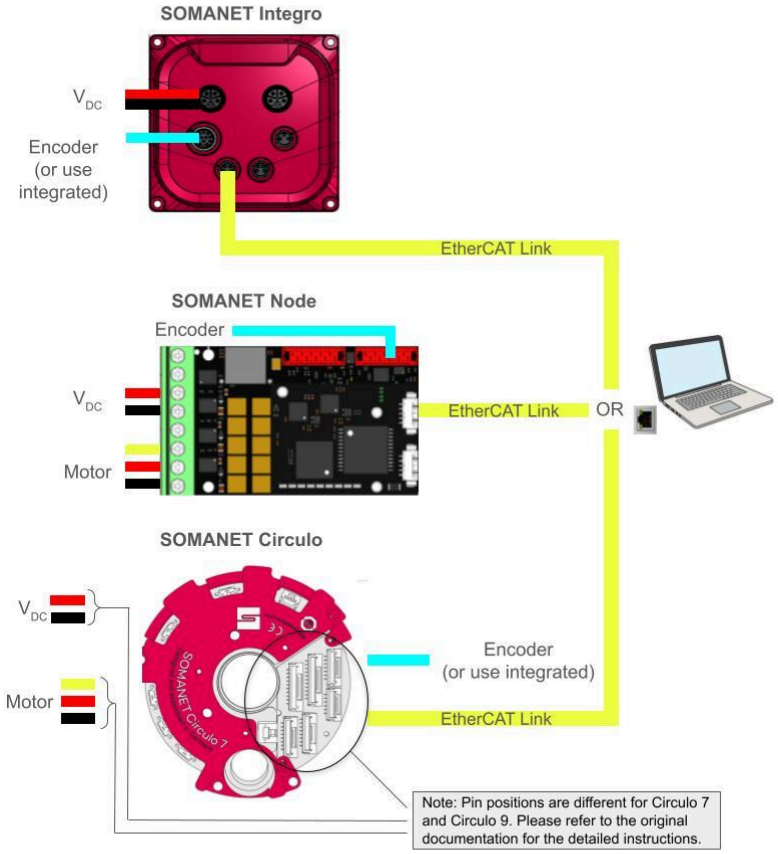


Figure 4.1 - Block diagram of the hardware setup

4.2. Software

For controlling the devices, TwinCAT3 eXtended Automation Engineering (XAE) software was used. Detailed instructions and relevant information are available here.

To download the software, login to the official site and use this link. In this section, a brief description of the installation procedure is provided along with steps to prevent future errors.

4.2.1. Installation

Follow the steps below to install the software:

1. Run the downloaded TwinCAT3 installation file.
2. Confirm the license agreement.
3. Enter the company data.
4. Complete the installation.

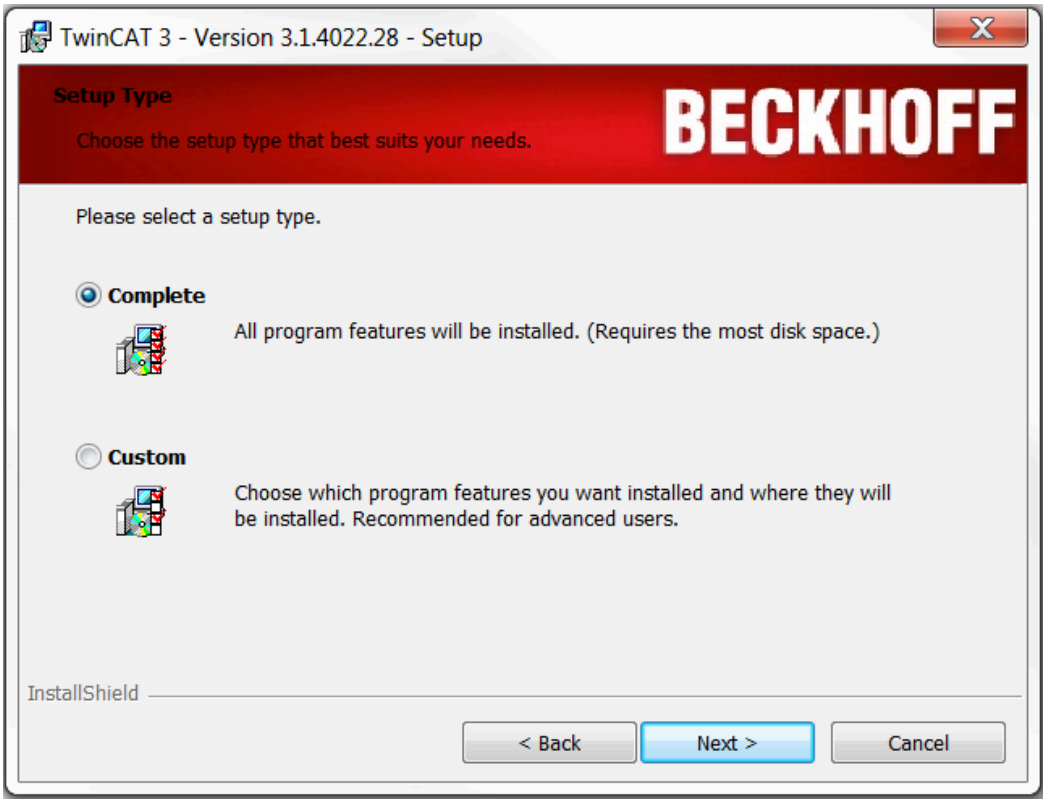


Figure 4.2 - Confirming the complete installation

If Visual Studio® 2013/2015/2017/2019 (or a Visual Studio® Shell 2013-2019) has been installed, activate the “Integrate TwinCAT” check-boxes for the versions in which you want to integrate TwinCAT3.

If a Visual Studio® version is *not* installed, make sure that “Install TwinCAT XAE Shell” is checked in order to install the Visual Studio® Shell as the environment. Refer to Figure 4.3 below.

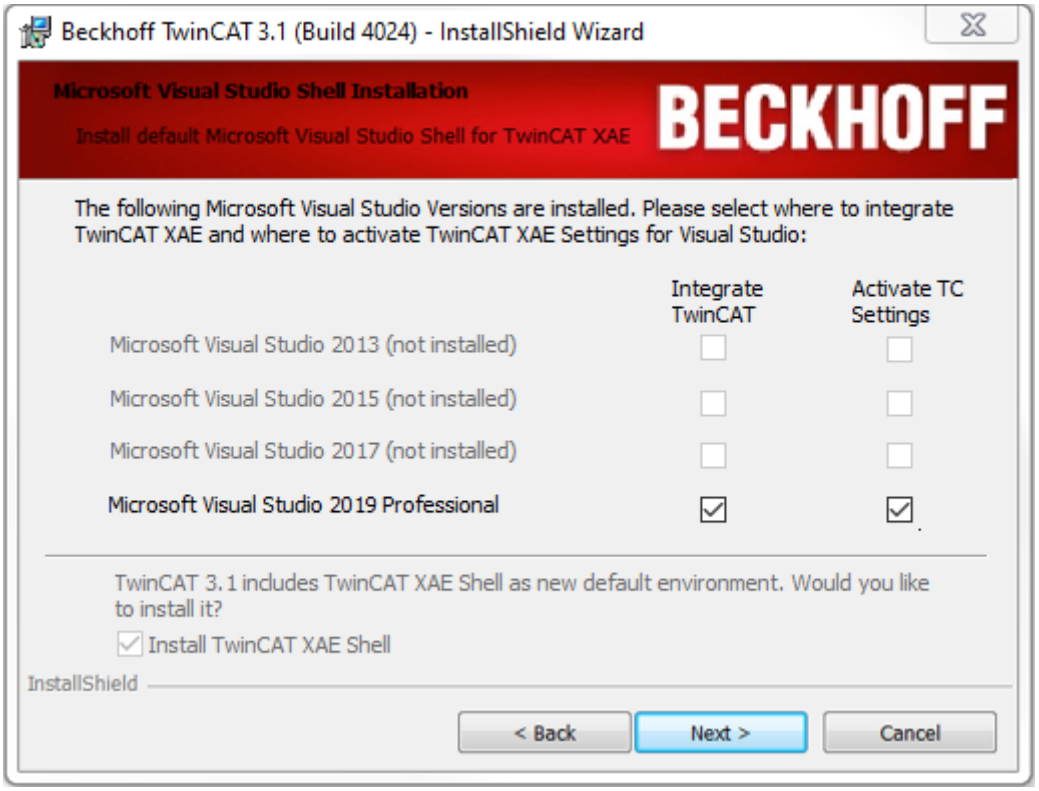


Figure 4.3 - Integrating TwinCAT with Visual Studio/Installing TwinCAT XAE Shell

Once the installation is complete, restart your computer:

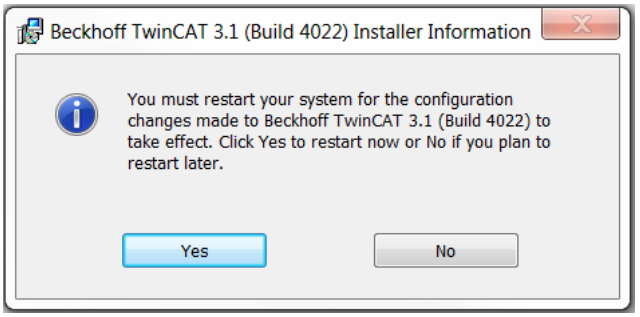


Figure 4.4 - Choose restart at the end of installation

If everything is installed correctly, after the restart, the runtime system (XAR) status should be available in the Windows menu bar. A blue symbol indicates the configuration mode, while a green symbol indicates the run mode; the mode is not relevant currently.

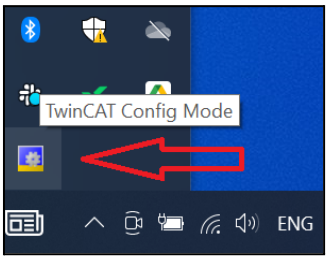


Figure 4.5 - If the installation was successful, this symbol should be present.

4.2.2. Preventing Future Errors

There are two (optionally three) steps that must be followed at this point to prevent some errors occurring when the system tries to switch to Runtime Mode:

1. A windows feature; Hyper-V must be disabled.
   Go to start, type “windows features” and uncheck **Hyper-V**.

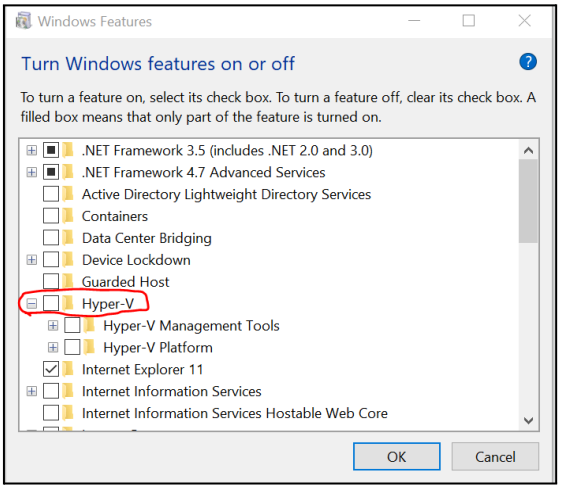


Figure 4.6 - Disabled Hyper-V

2. A batch file must be executed as Administrator.
   Go to the directory *C:\TwinCAT\3.1\System* and “Run as Administrator”, the file “win8settick.bat”. Reboot after this.

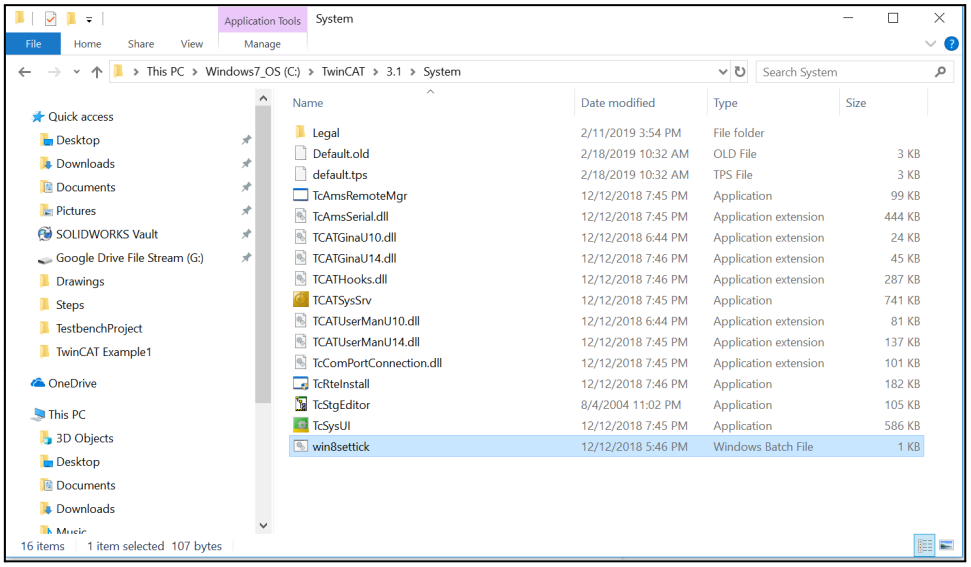


Figure 4.7 - Running the batch file located under the TwinCAT folder

3. (Optional) If the **‘TCRTIME' (200): start of real-time avoided by "HyperV"** message is displayed when running TwinCAT3, it is possible that HyperV is still used in virtualization-based security on your system. To disable it, type “core isolation” in your Windows search bar and disable Memory integrity. Refer to Figure 4.8 below.

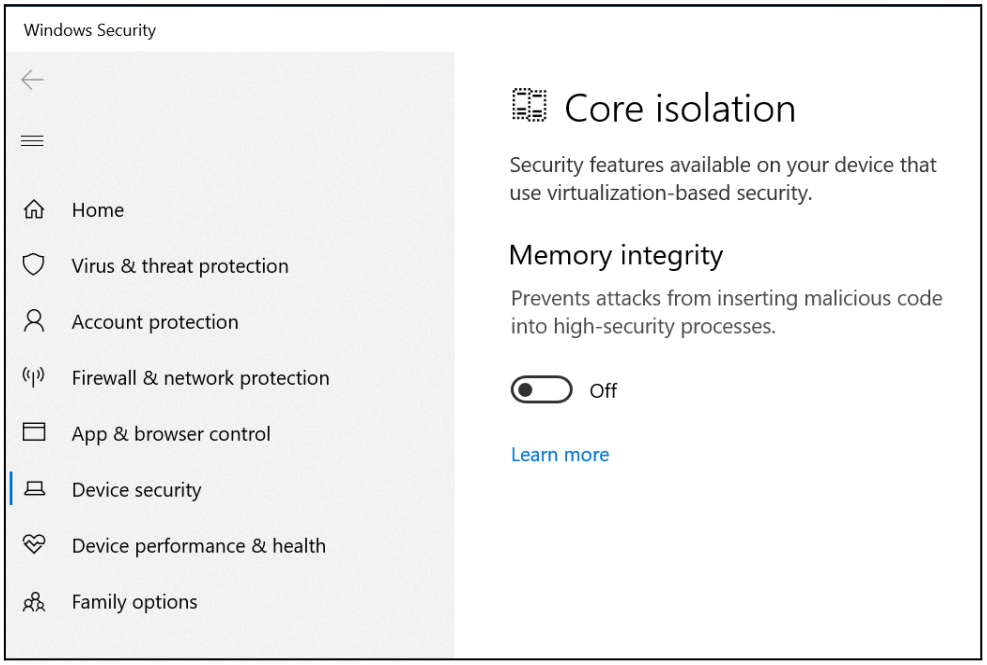


Figure 4.8 - Disabled core isolation

5. Synapticon Control Package

The Synapticon package allows for torque, velocity, and position control by using cyclic synchronization as well as using the profiled motion. Additionally, one mode for homing method is implemented. See Modes of Operation for details on these modes.

The provided package assumes that each drive is already configured using OBLAC Tools.

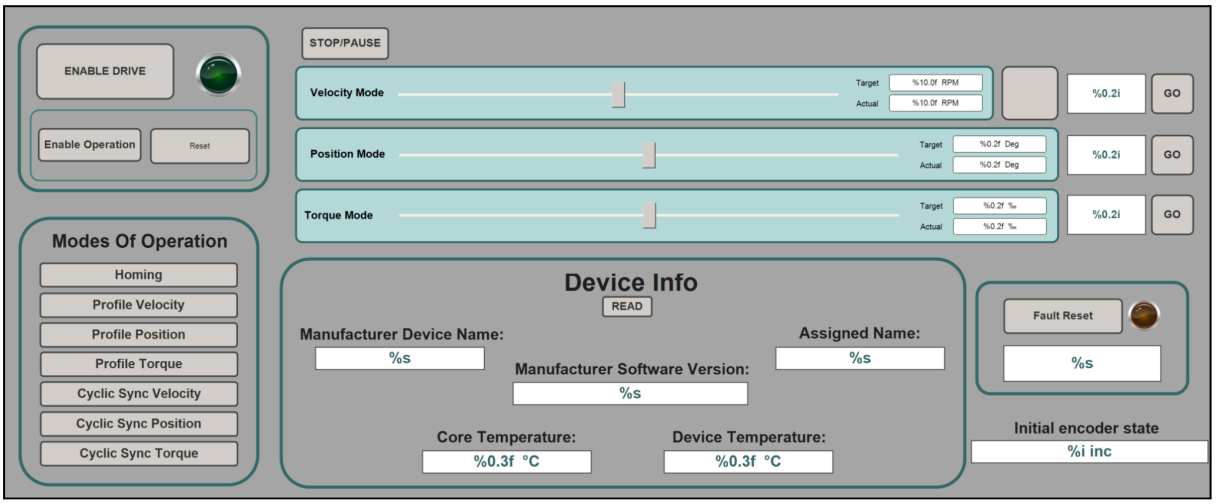


Figure 5.1 - Visual appearance of Synapticon's motor control implementation in TwinCAT3

5.1. Installation

Installation of the provided code is a two-step process as follows:

1. TwinCAT3 is configured to run with EtherCAT.
2. The code is imported.

5.1.1. Installing the Ethernet Driver

To install the Ethernet driver:

1. Open TwinCAT by right clicking on the system tray icon.
2. Select **TwinCAT XAE**.

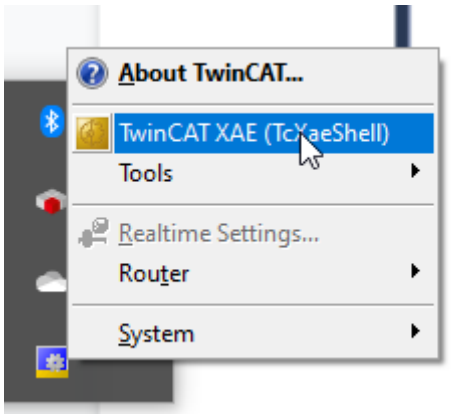


Figure 5.2 - Opening TwinCAT XAE

Once TwinCAT opens, proceed with the Ethernet driver installation.

3. Go to TwinCat menu and click “Show Realtime Ethernet Compatible Devices”:

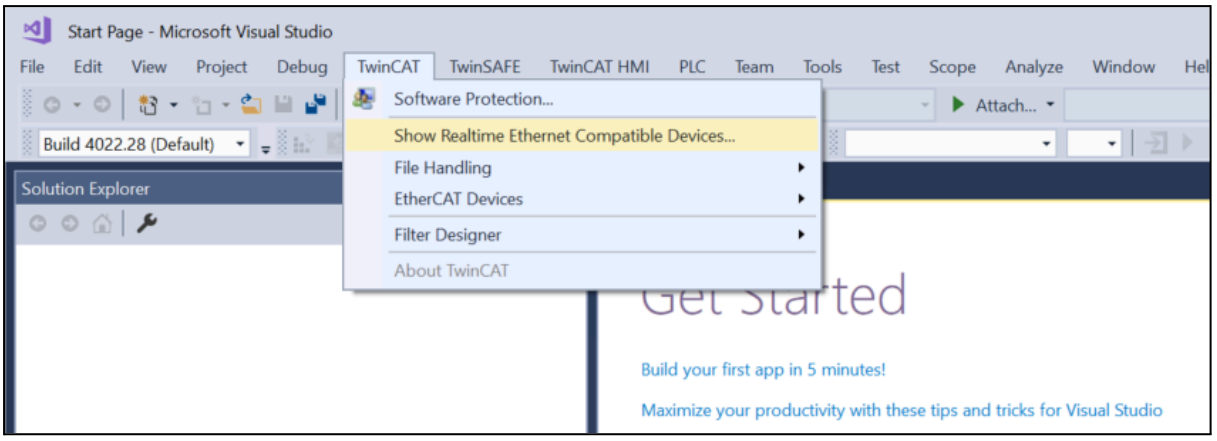


Figure 5.3 - Scanning compatible Ethernet devices for driver installation

4. Select the adapter under the “Compatible devices” section and click “Install”:

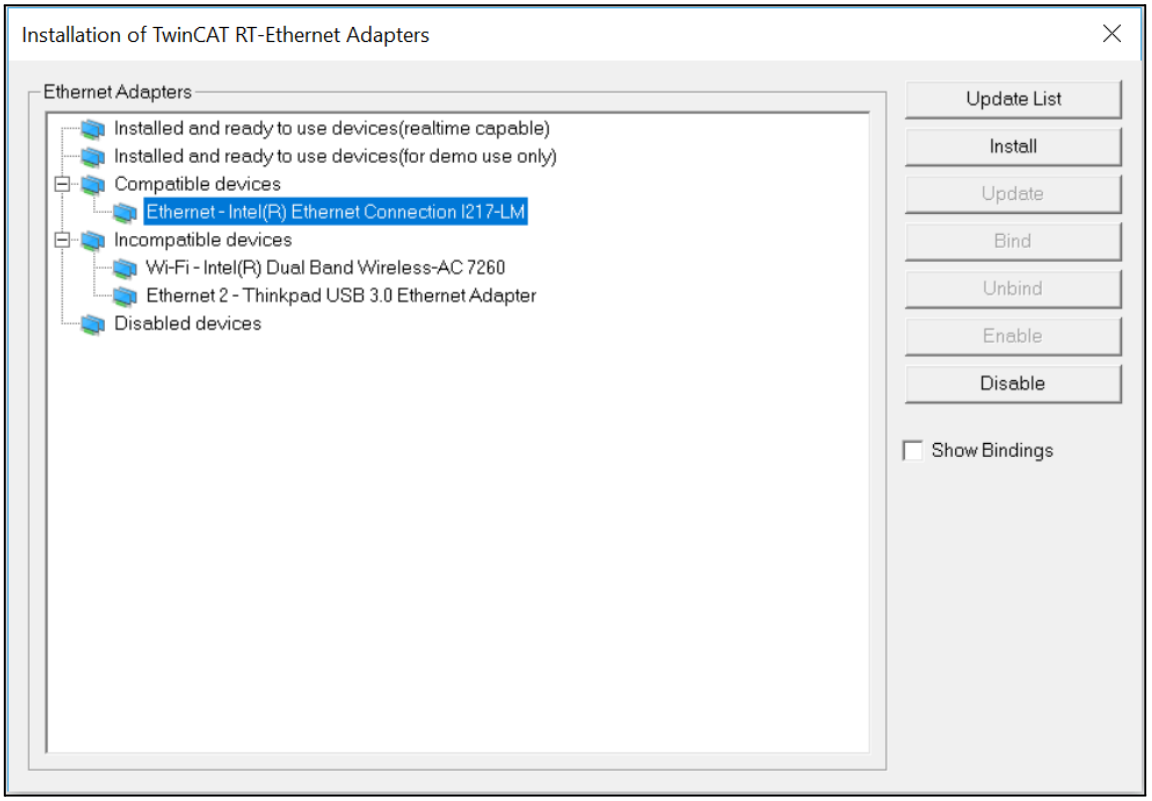


Figure 5.4 - Selecting the adapter

After a successful installation, the TwinCat RT-Ethernet Adapters window should look like that displayed in Figure 5.5 below.

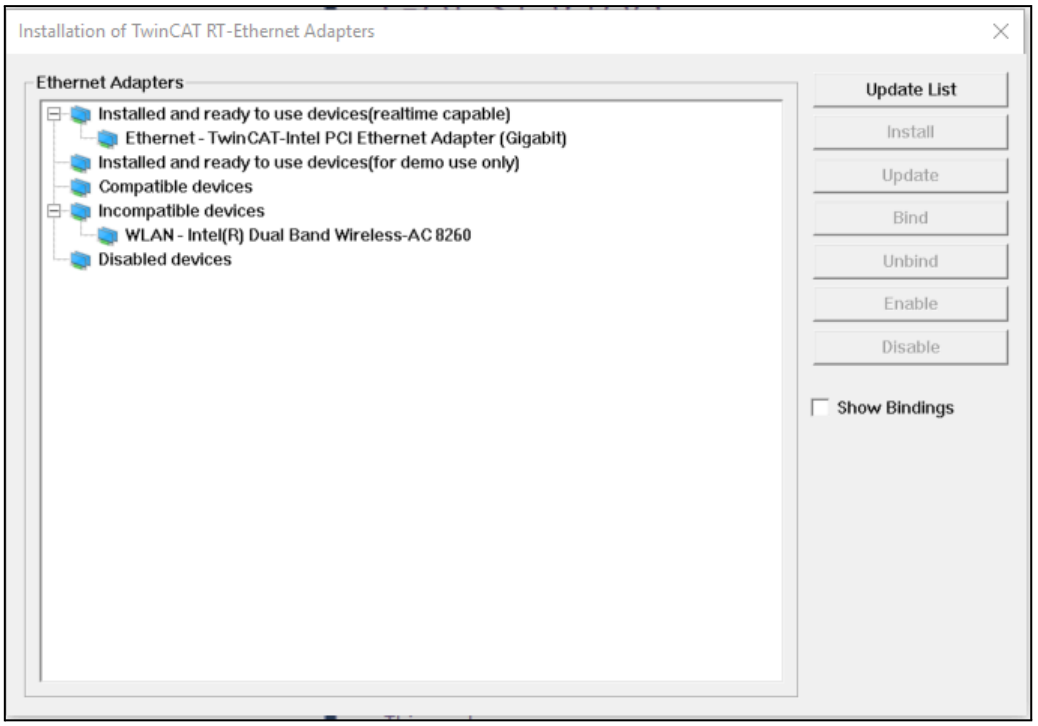


Figure 5.5 - Successfully installed driver

5.1.2. Importing the Synapticon Package

To import the Synapticon package:

1. Import the ESI files of your drives.To do this:
    a. Connect the drives to OBLAC Drive.
    b. Download ESI files from the interface as shown in Figure 5.6 below.

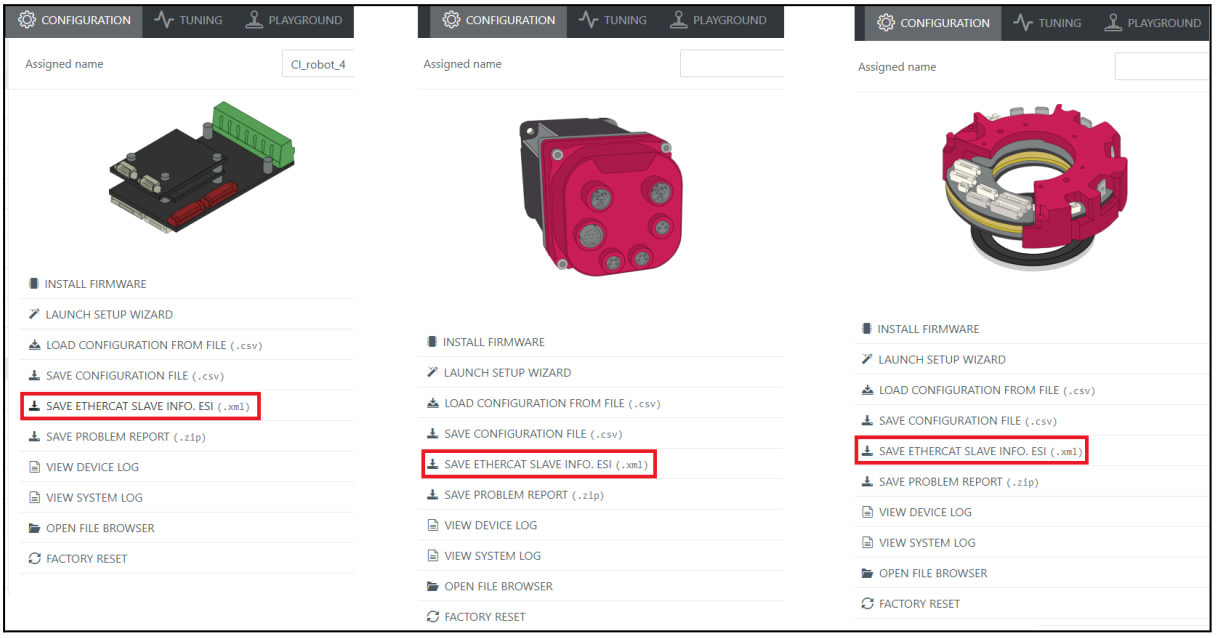


Figure 5.6 - Downloading ESI files for different devices from the OBLAC Drive

The ESI file for all drives that we want to use should be stored to this location: *C:\TwinCAT\3.1\Config\Io\EtherCAT*

This occurs so that TwinCat can associate our drives with their corresponding data.

2. Download the code packed in the TwinCAT archive from this link.

3. To import code from the archive (refer to Figures 5.6 and 5.7), create a new folder and select it. In the example in Figure 5.8, it is named **TwinCAT-Synapticon**.

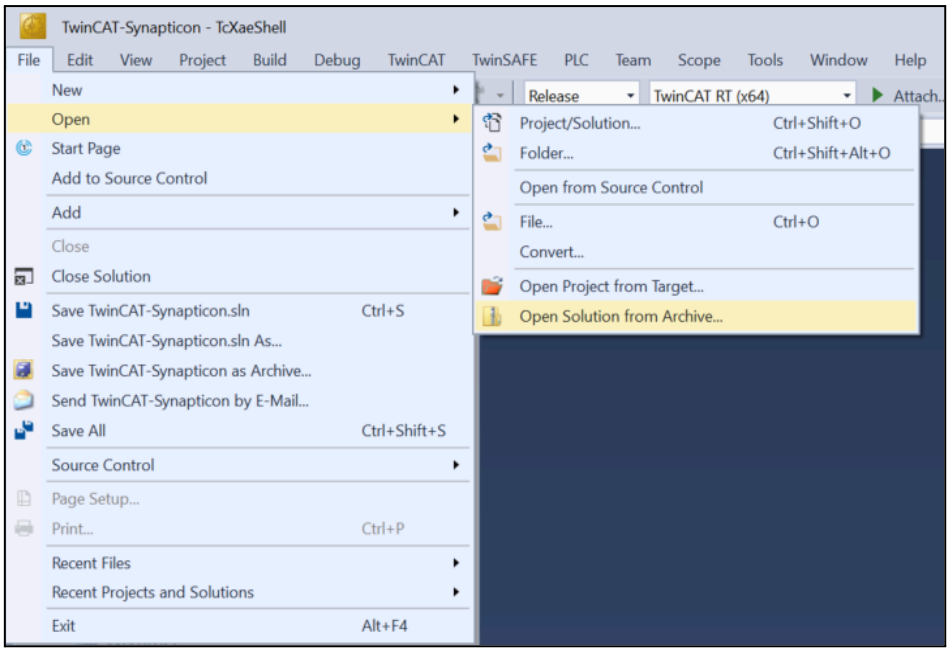


Figure 5.7 - Selecting the option to open Solution from Archive

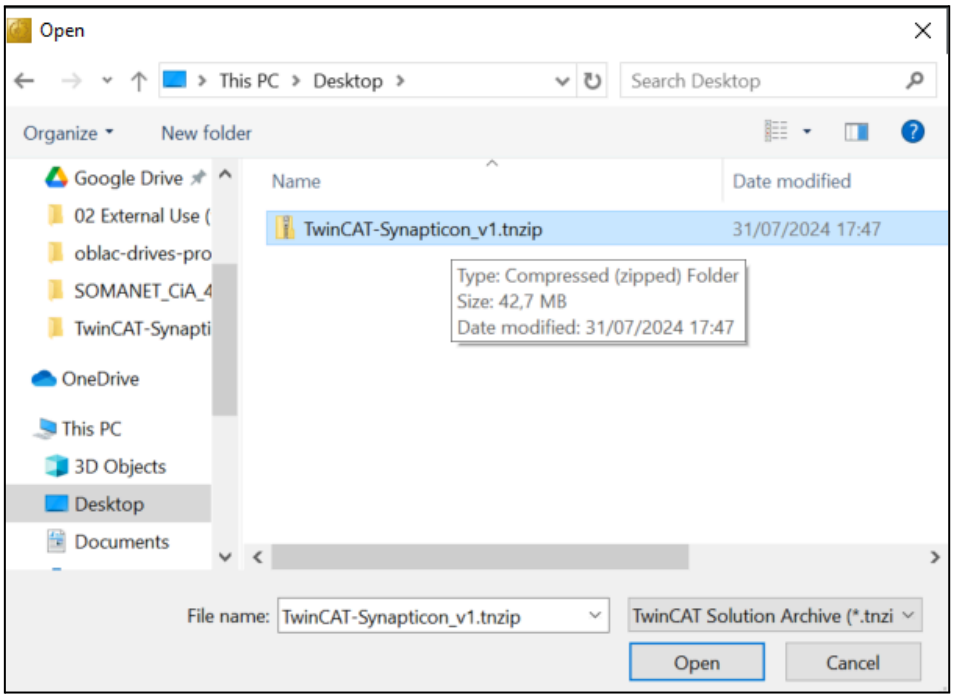


Figure 5.8 - Selecting the provided archive

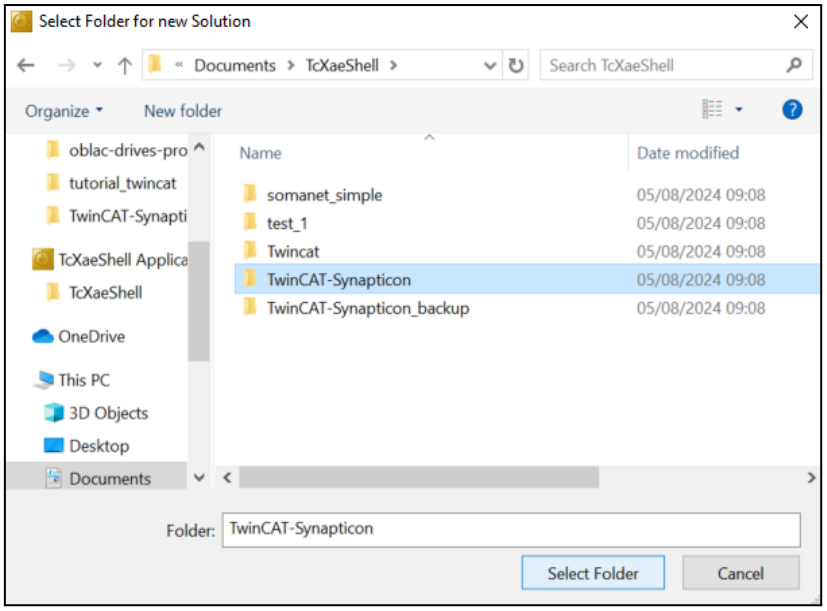


Figure 5.9 - Selecting an empty folder in which the solution will be stored

Once the package is imported, in the solution explorer on the left, three different PLC projects associated with the three drive types are displayed (Figure 5.10). The code for all drives is the same; however, they are separated intentionally so that it is easier to switch between the different products without losing any settings.

NOTE
The following procedure uses SOMANET Node; however the procedure would be the same for all other drives.

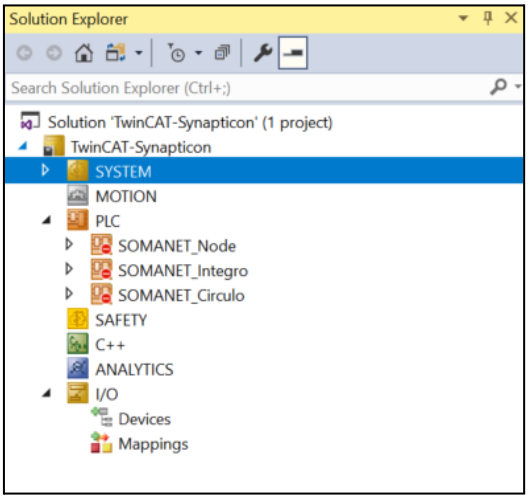


Figure 5.10 - Initial state when the archive is imported

1. Since a virtual PLC is used in this example, the number of Isolated Cores on your system must be adapted. Before doing this, save the project as this step requires a reboot of your PC.

   To do this:

   a. Select *Real Time* in Solution Explorer.
   b. Next, press **Read From Target**; this will check the available cores on your PC. Set it so that at least one isolated core exists, then press **Set on Target.**

> **NOTE**
> If you notice that the program is running slow while going through the next steps, set more cores.

Make sure to select the Isolated core to be used as the default. It is also recommended setting Base Time to 1ms; refer to Figure 5.11 below.

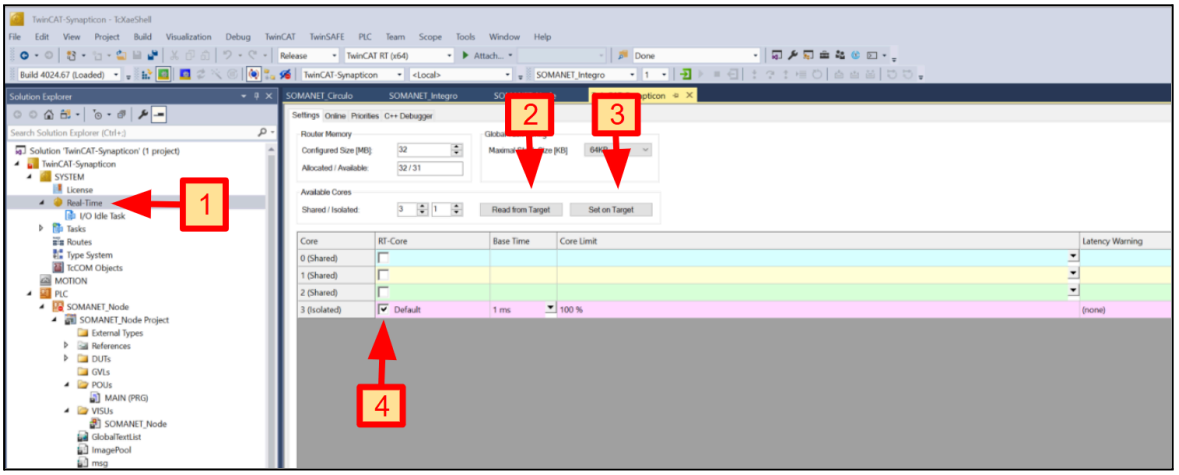


Figure 5.11 - Real time settings for the virtual PLC

2. Make sure that TwinCAT is in the configuration mode as shown below:

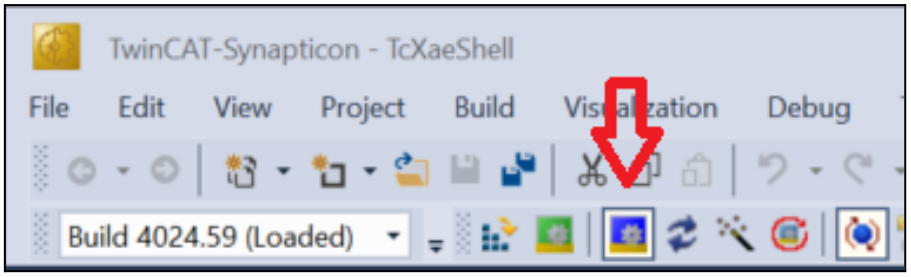


Figure 5.12 - Configuration mode active

3. Enable the project by selecting the PLC project in the solution explorer. To do this:
   a. Go to *TwinCAT-Synapticon > PLC*.
   b. Right click on the device name.
   c. Select **Disable** as displayed in Figure 5.13 in order to re-enable the project. Note that in the initial shared project, all are disabled by default.

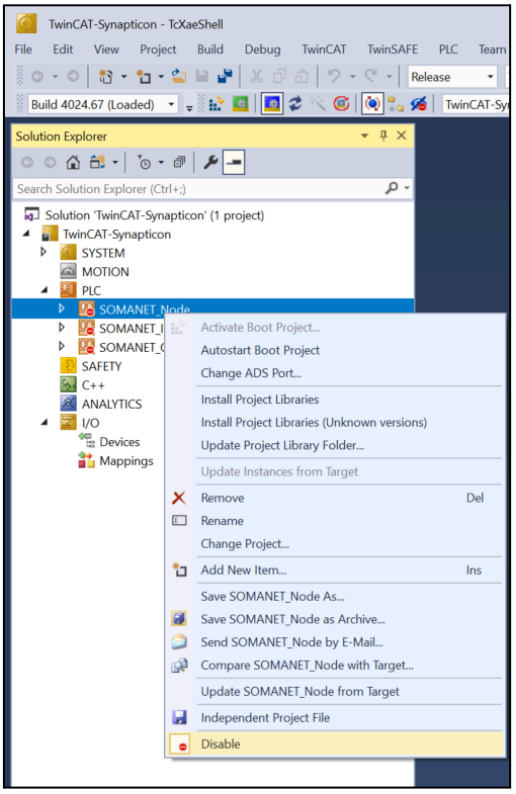


Figure 5.13 - Enabling the project

4. Next, search for the devices. Navigate to the I/O section in the Solution Explorer. Right-click on *Devices* and select **Scan**.

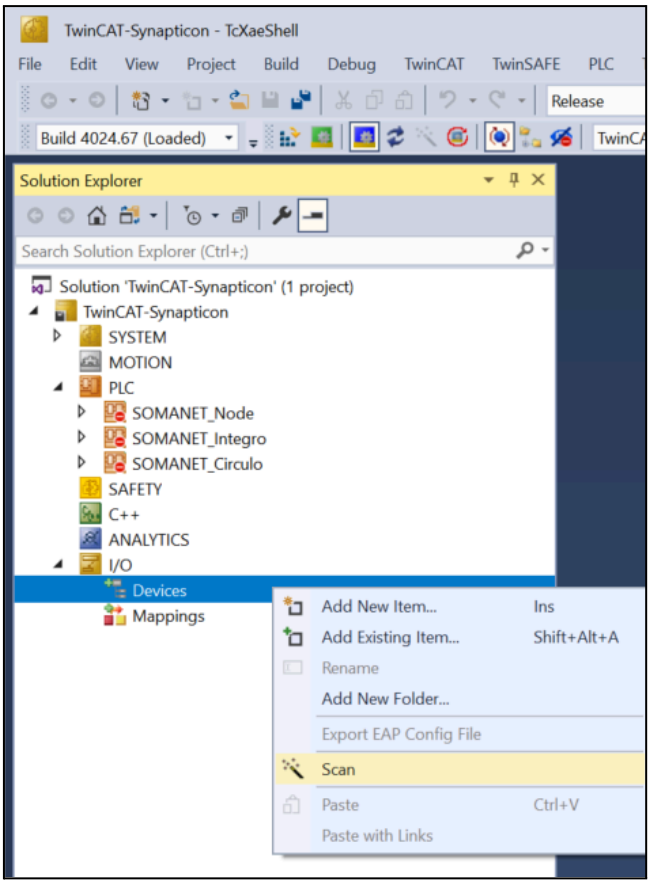


Figure 5.14 - Searching for the devices

5. TwinCAT scans the EtherCAT network. If an I/O device is found, it will be displayed. Confirm by pressing **OK**.

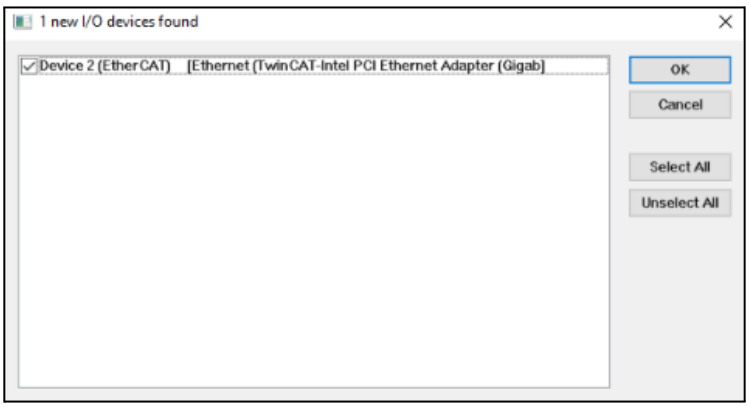
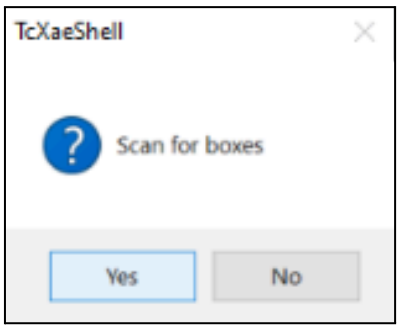
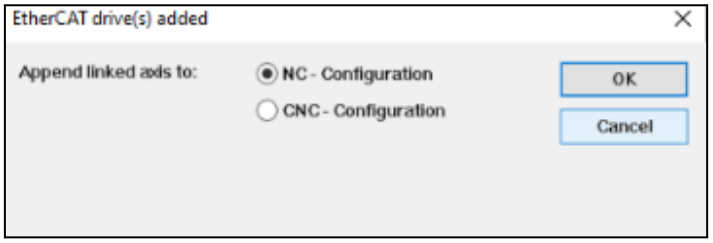


Figure 5.15 - Scanning the EtherCAT network

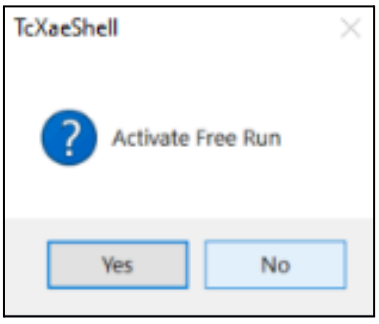
6. Confirm the prompts to scan for boxes (slaves). *Note:*This will work if the correct ESI file from the drive is copied to *C:\TwinCAT\3.1\Config\Io\EtherCAT* and the descriptions are reloaded as described previously.



7. When prompted to append the linked axis, press **Cancel.**



8. Do not activate Free Run - press **No**.



9. In the Solution Explorer, navigate to your drive under *I/O > Devices > Device [N] (EtherCAT)*.

10. Expand the mappings for TxPDO Mapping 1 and RxPDO Mapping 1.

11. If everything is performed correctly, the I/O in the Solution Explorer should appear as follows:

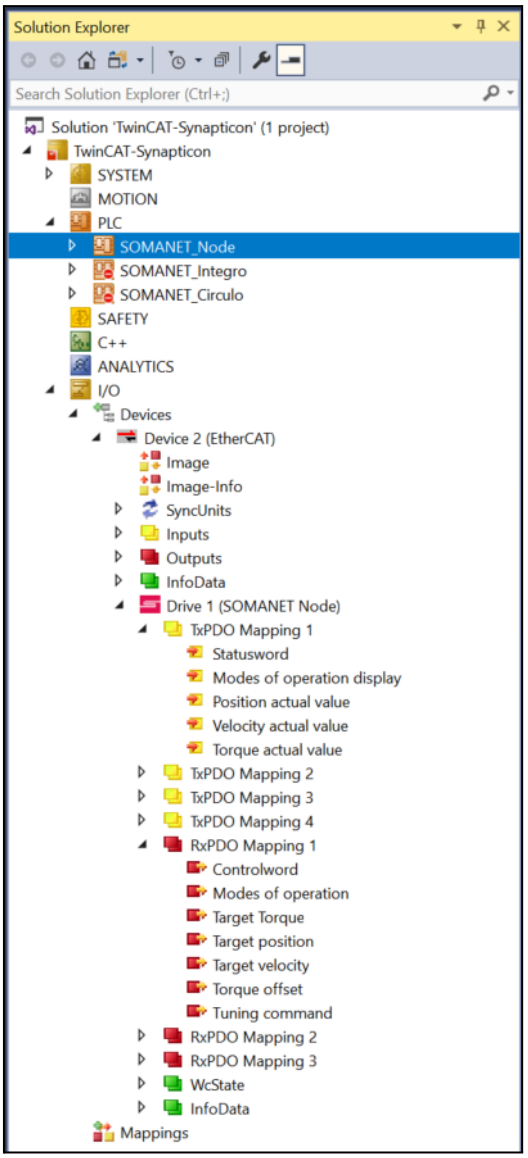


Figure 5.16 - I/O in the Solution Explorer

12. Select **Statusword**, click **Linked to...**, then browse to and select **MAIN.status_word** and confirm.

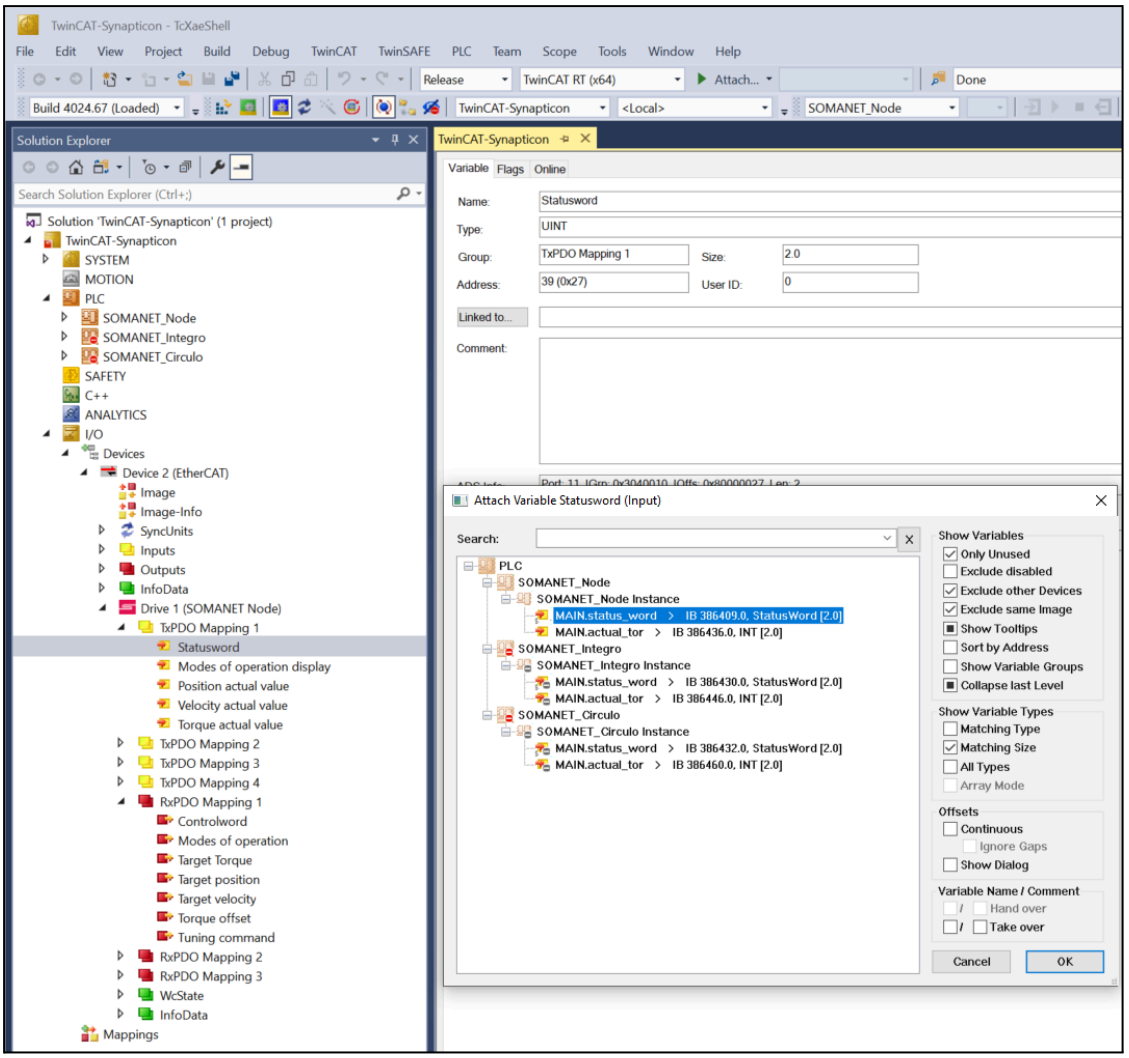


Figure 5.17 - Making selections

13. Select **Position actual value**, click **Linked to...**, select **MAIN.actual_pos** and confirm.

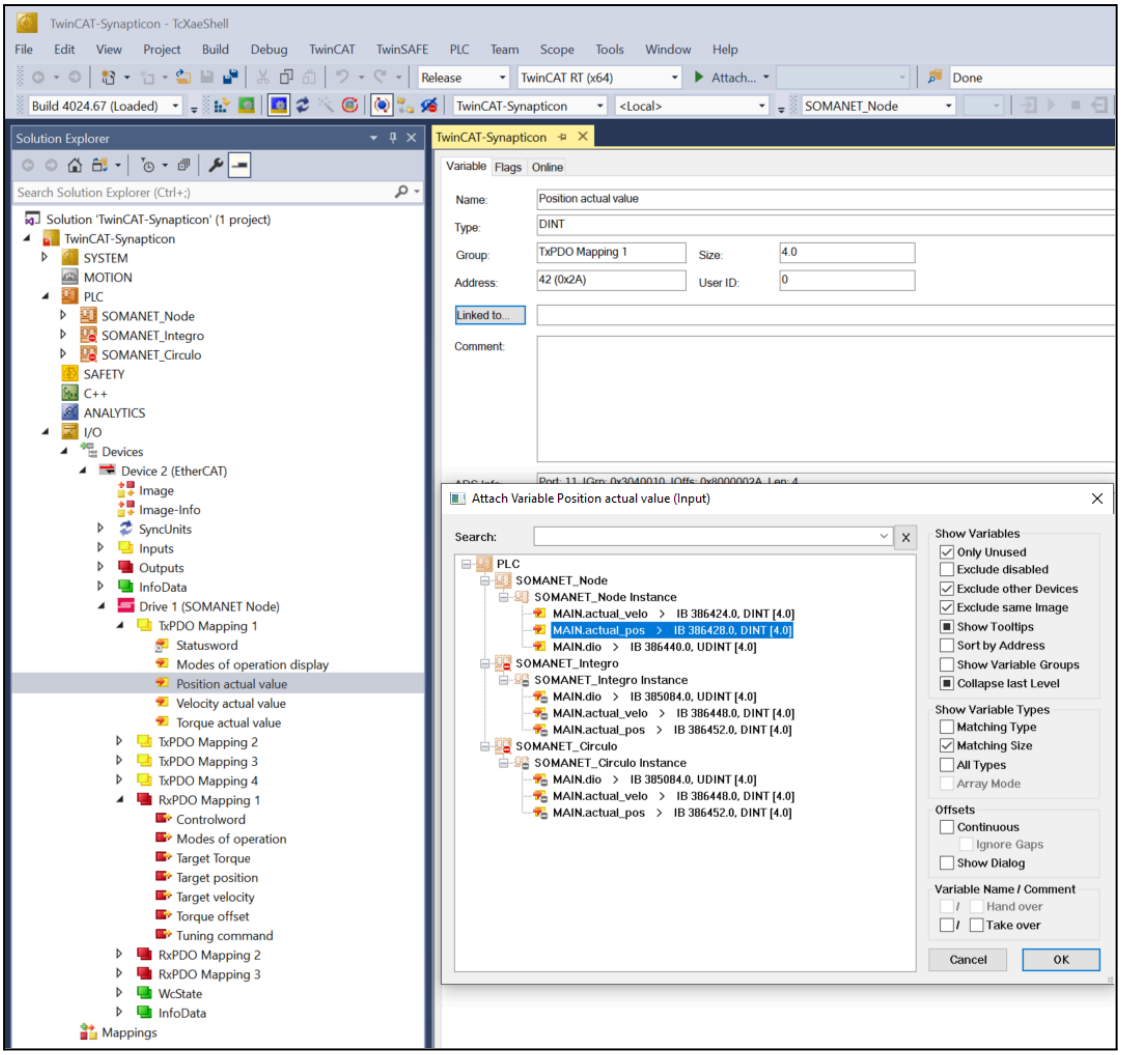


Figure 5.18 - Making selections

14. Select **Velocity actual value**, click **Linked to...**, select **MAIN.actual_velo** and confirm.

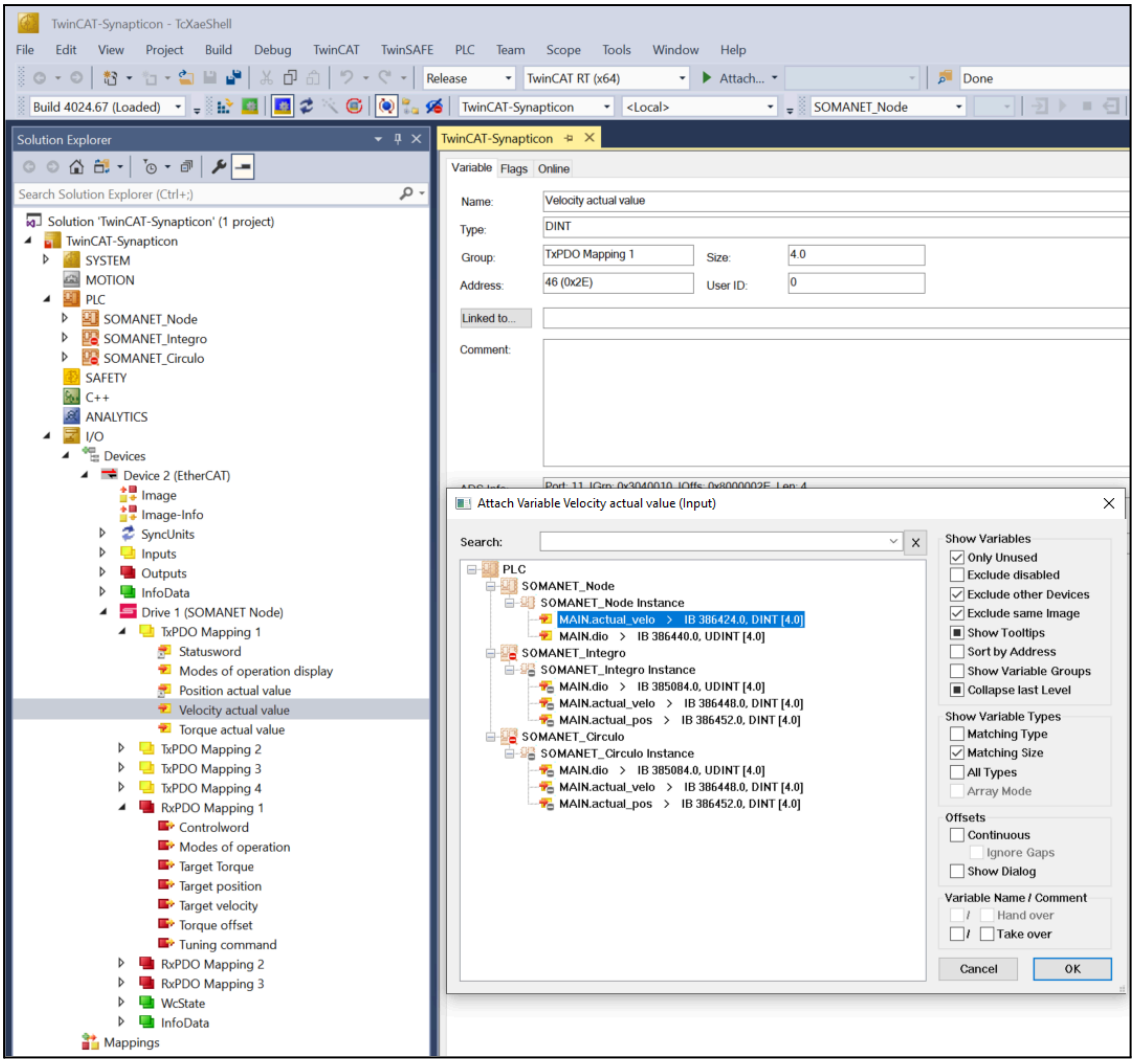


Figure 5.19 - Making selections

15. Select **Torque actual value**, click **Linked to...**, select **MAIN.actual_tor** and confirm.

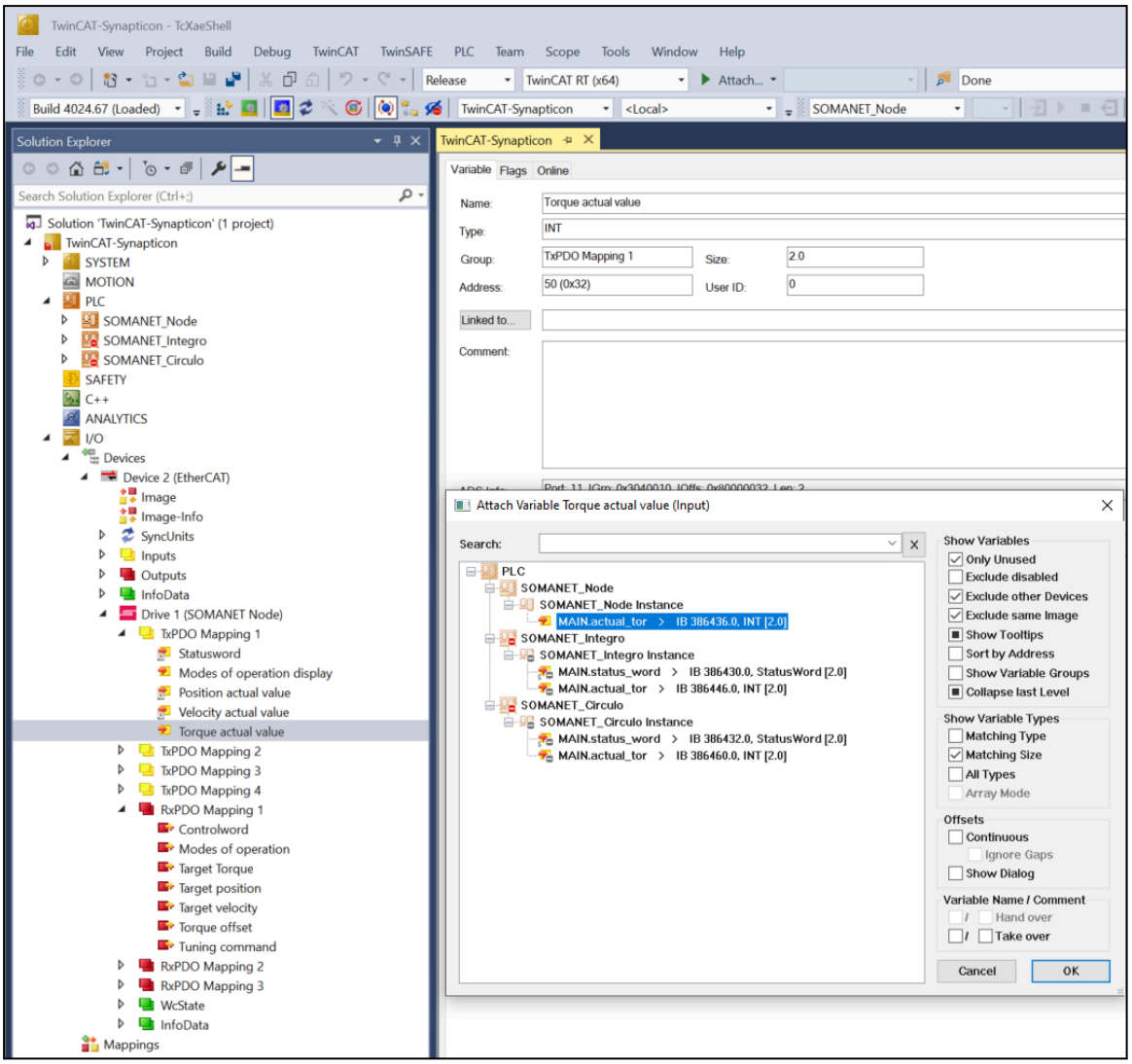


Figure 5.20 - Making selections

16. Select **Controlword**, click **Linked to...**, then browse to and select **MAIN.control_word** and confirm.

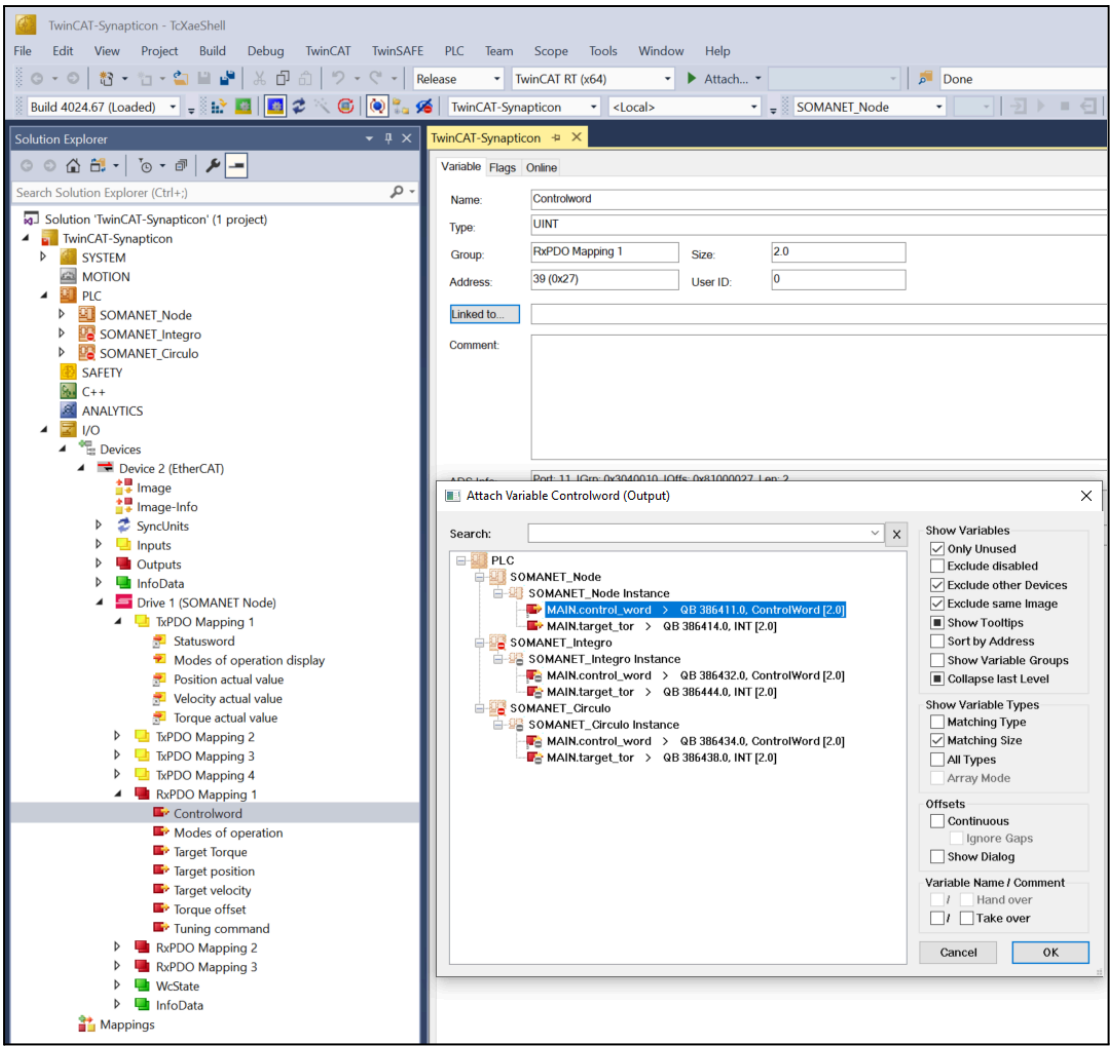


Figure 5.21 - Making selections

17. Select **Modes of operation**, click **Linked to...**, select **MAIN.op_mode** and confirm.

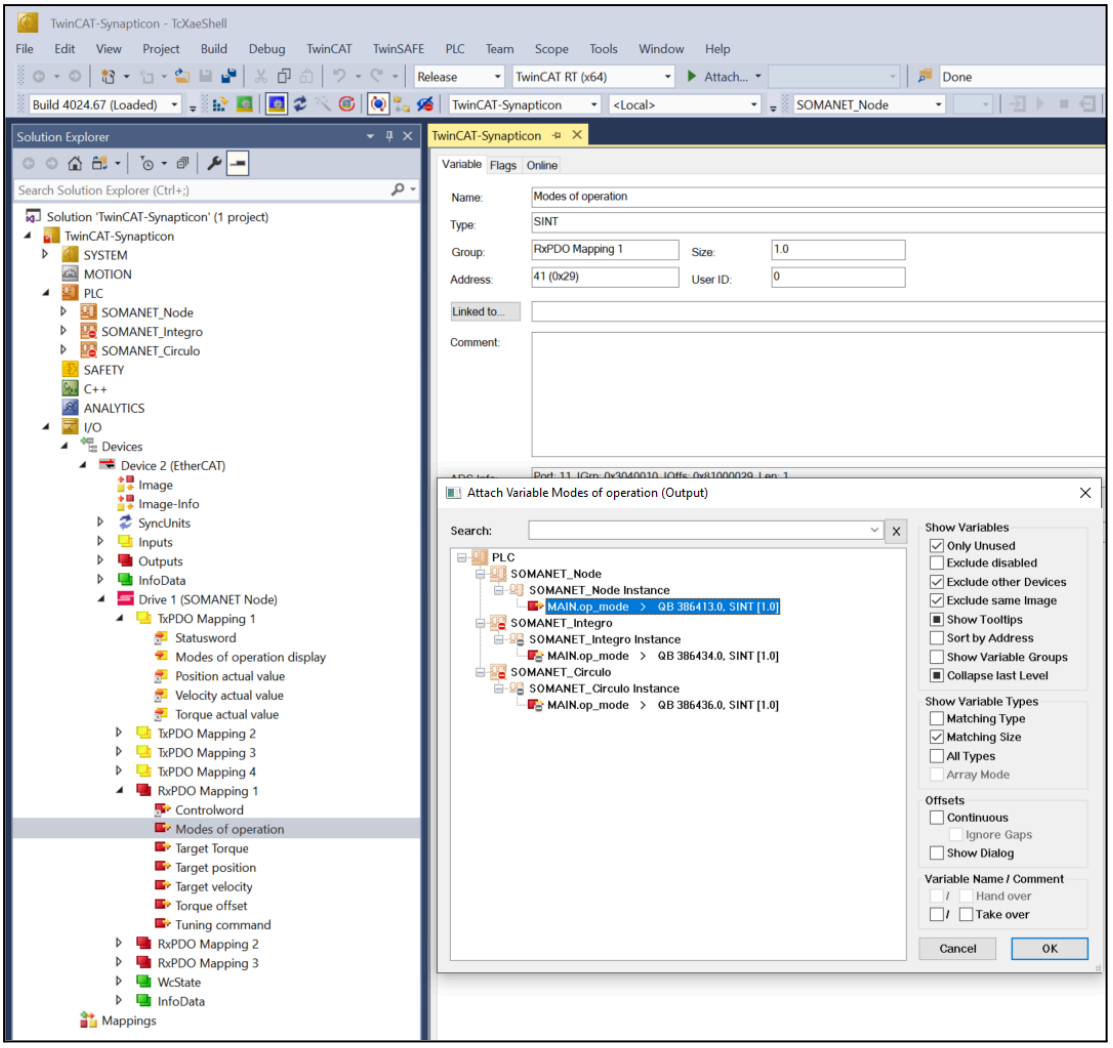


Figure 5.22 - Making selections

18. Select **Target torque**, click **Linked to...**, select **MAIN.target_tor** and confirm.

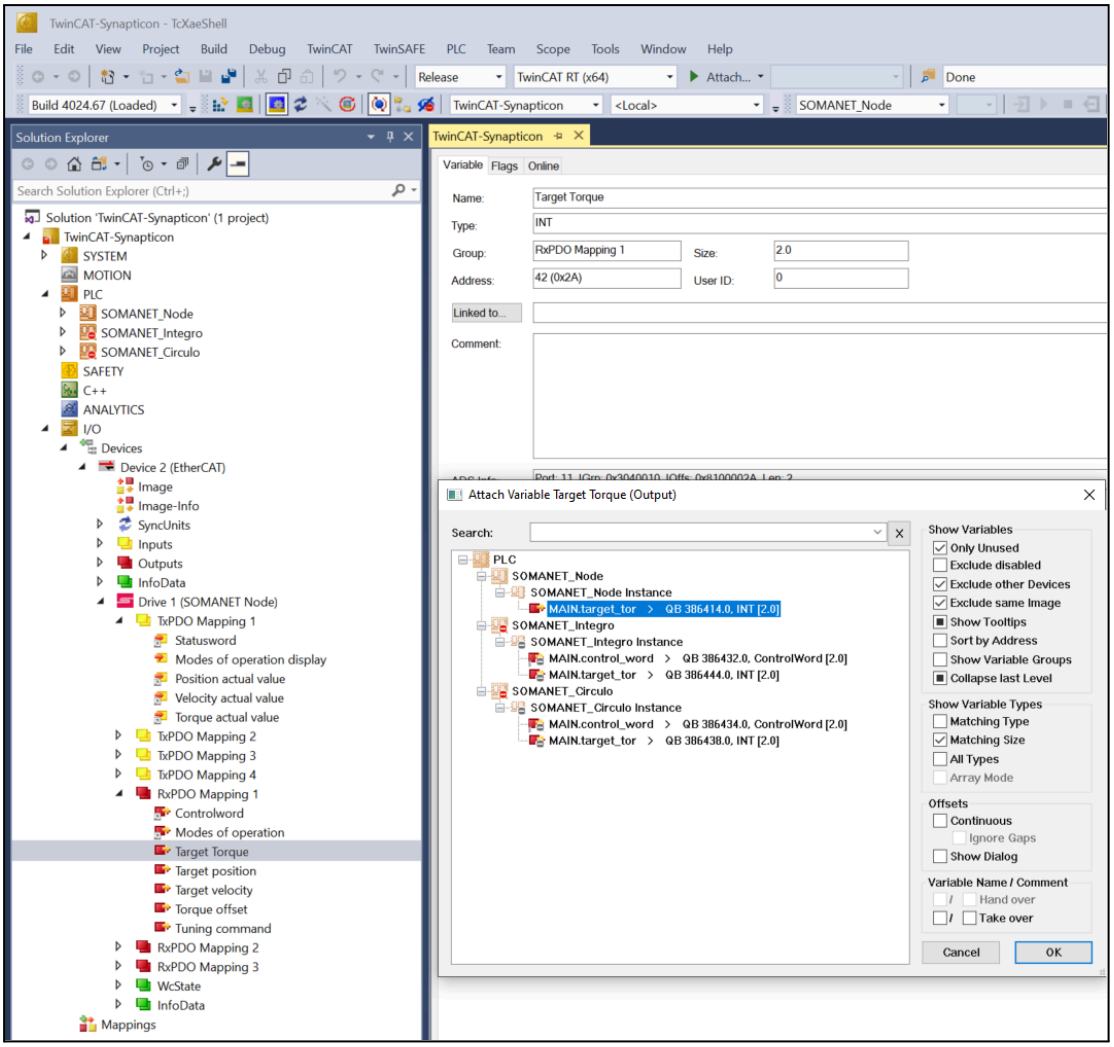


Figure 5.23 - Making selections

19. Select **Target position**, click **Linked to...**, select **MAIN.target_pos** and confirm.

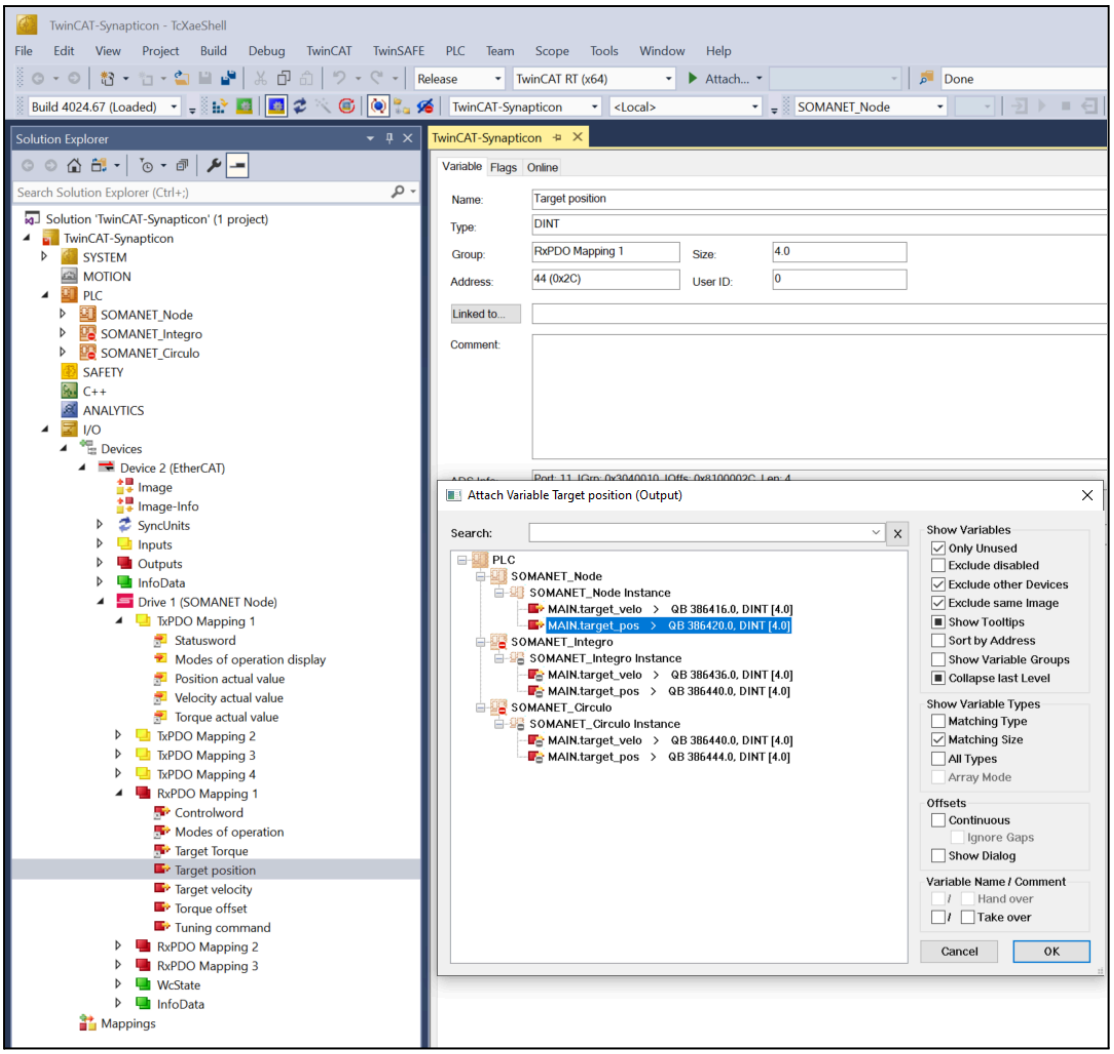


Figure 5.24 - Making selections

20. Select **Target velocity**, click **Linked to...**, select **MAIN.target_velo** and confirm.

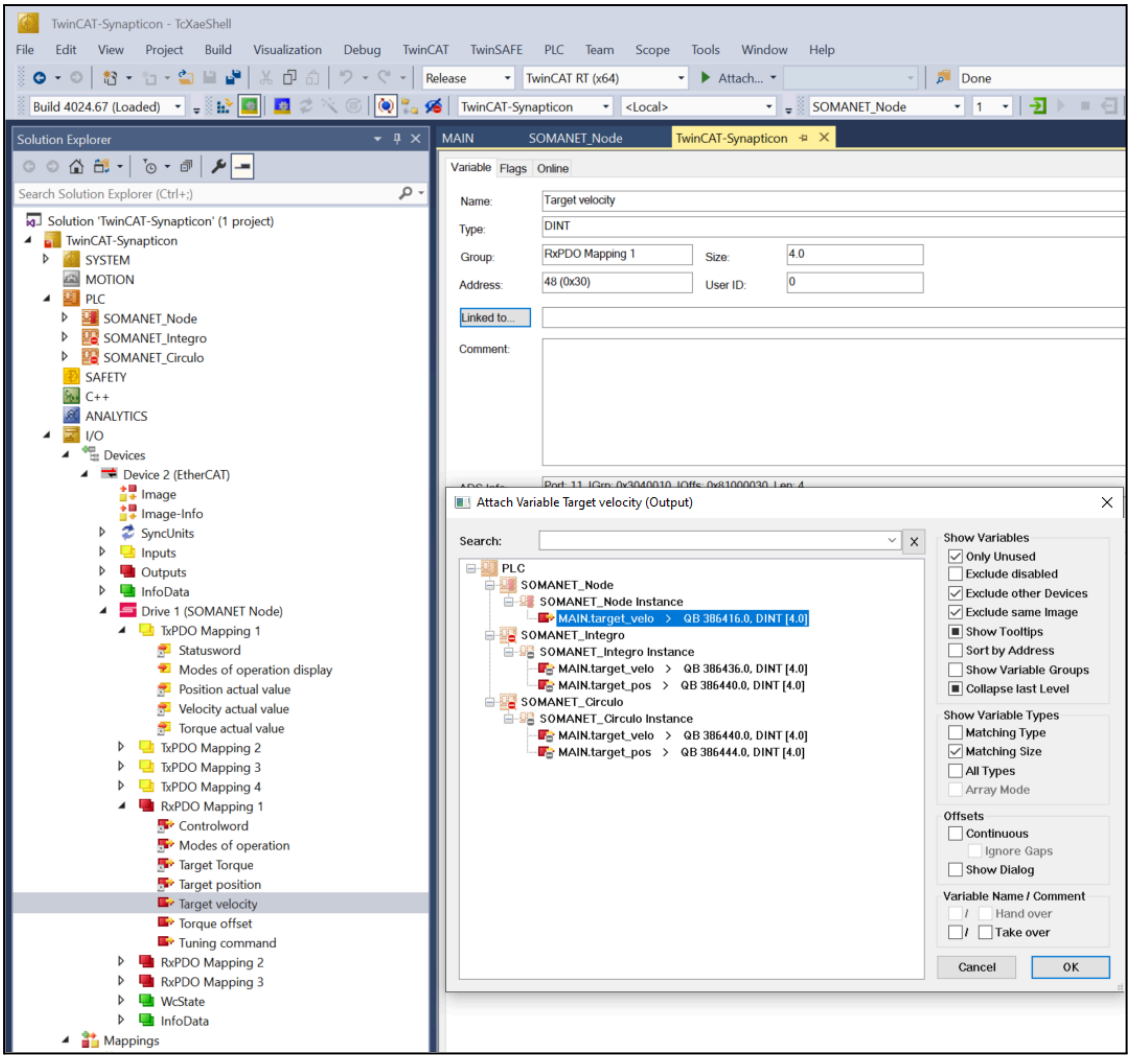


Figure 5.25 - Making selections

21. The only parameter that must be set is the encoder resolution. This should be the same as was established using OBLAC Tools. Additionally, it must be entered in two places:
    a. The first place is in the main code. It is located in *TwinCAT - Synapticon > PLC > SOMANET_Node > MAIN (PRG)* as indicated in Figure 5.26. Change this number to your encoder resolution and save everything by pressing **CTRL+SHIFT+S**.

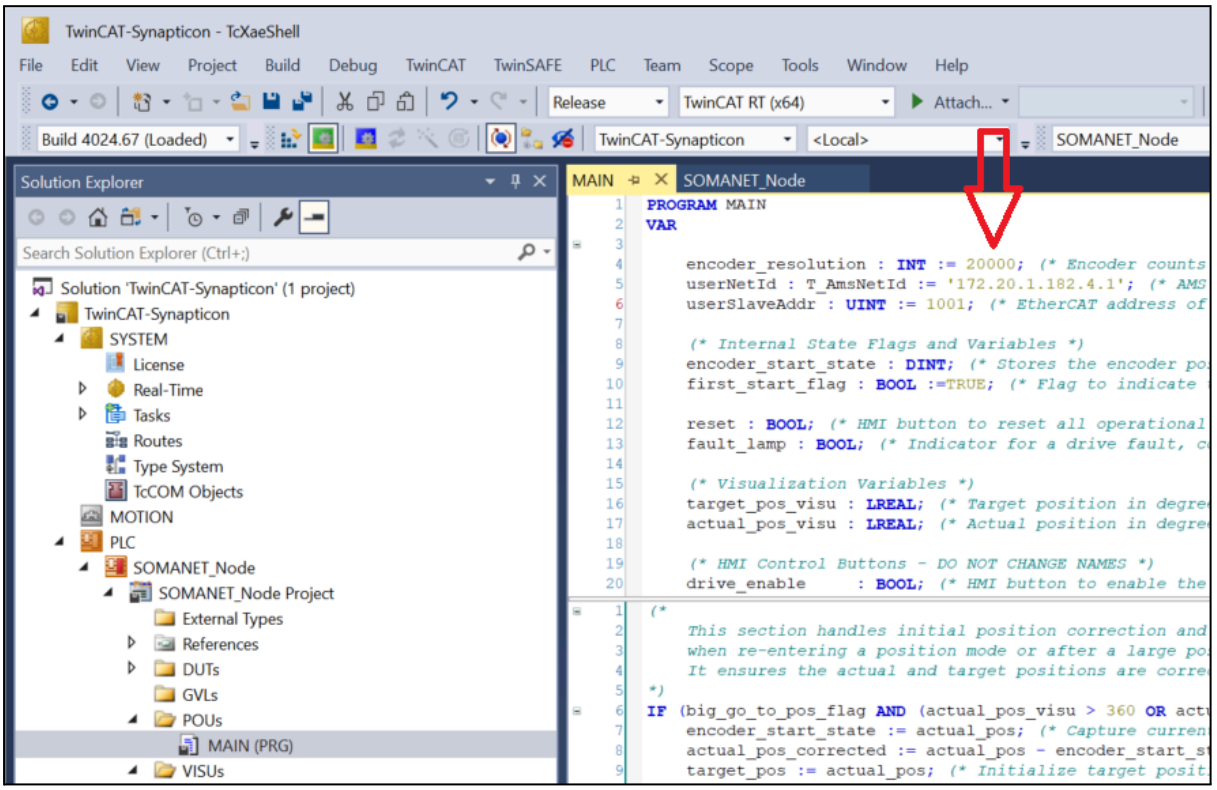


Figure 5.26 - Setting up encoder resolution in the main program

    b. The second place is the GUI and it is located in *TwinCAT - Synapticon > PLC > SOMANET_Node > VISUs > SOMANET_Node*.

22. After the GUI opens, click on the horizontal axis for position. In the Properties box that appears in the right bottom corner, set the *Scale start* and *Scale end* to the encoder resolution. Refer to Figure 5.27.

23. If the desired movements are from -360° to 360°, set it to:
    - "Scale start: *-encoder resolution*" and "Scale end: *encoder resolution*".

    If the movement is from 0° to 360°, as in the case when using an absolute encoder:
    - Set "Scale start: 0" and "Scale end: *encoder resolution*".

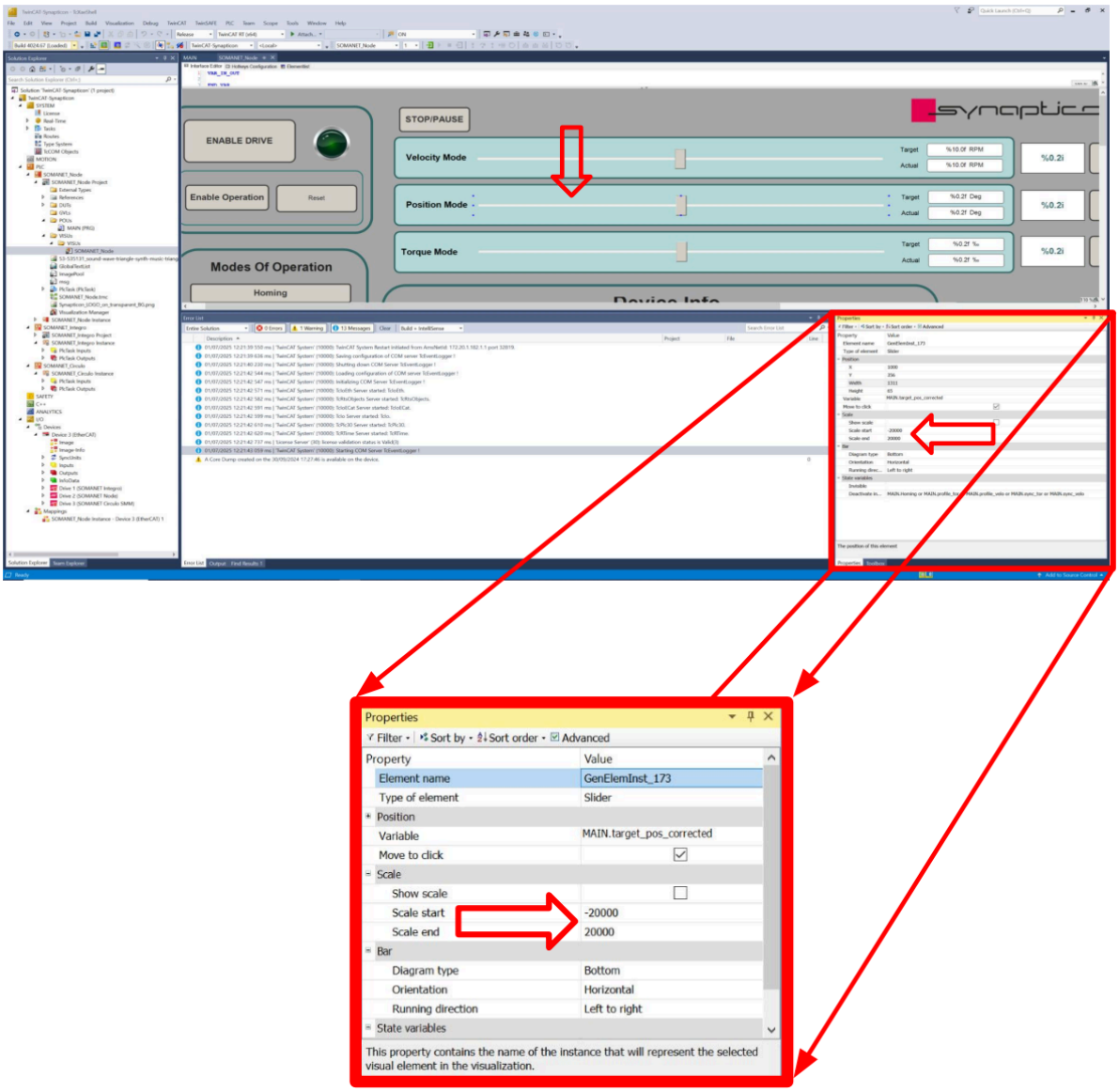


Figure 5.27 - Setting up encoder resolution in the GUI

Once the encoder resolution is set, run the program as shown in Figure. 5.28:

1. Select the main program (1).
2. Activate configuration (2).
3. Confirm the activation (3).
4. Confirm the transition to run mode (4).

After the system is in run mode:

1. Login (5).
2. Confirm creating the new port (6).
3. After pressing play (7), switch to the GUI and start using the program as described in the Usage section.

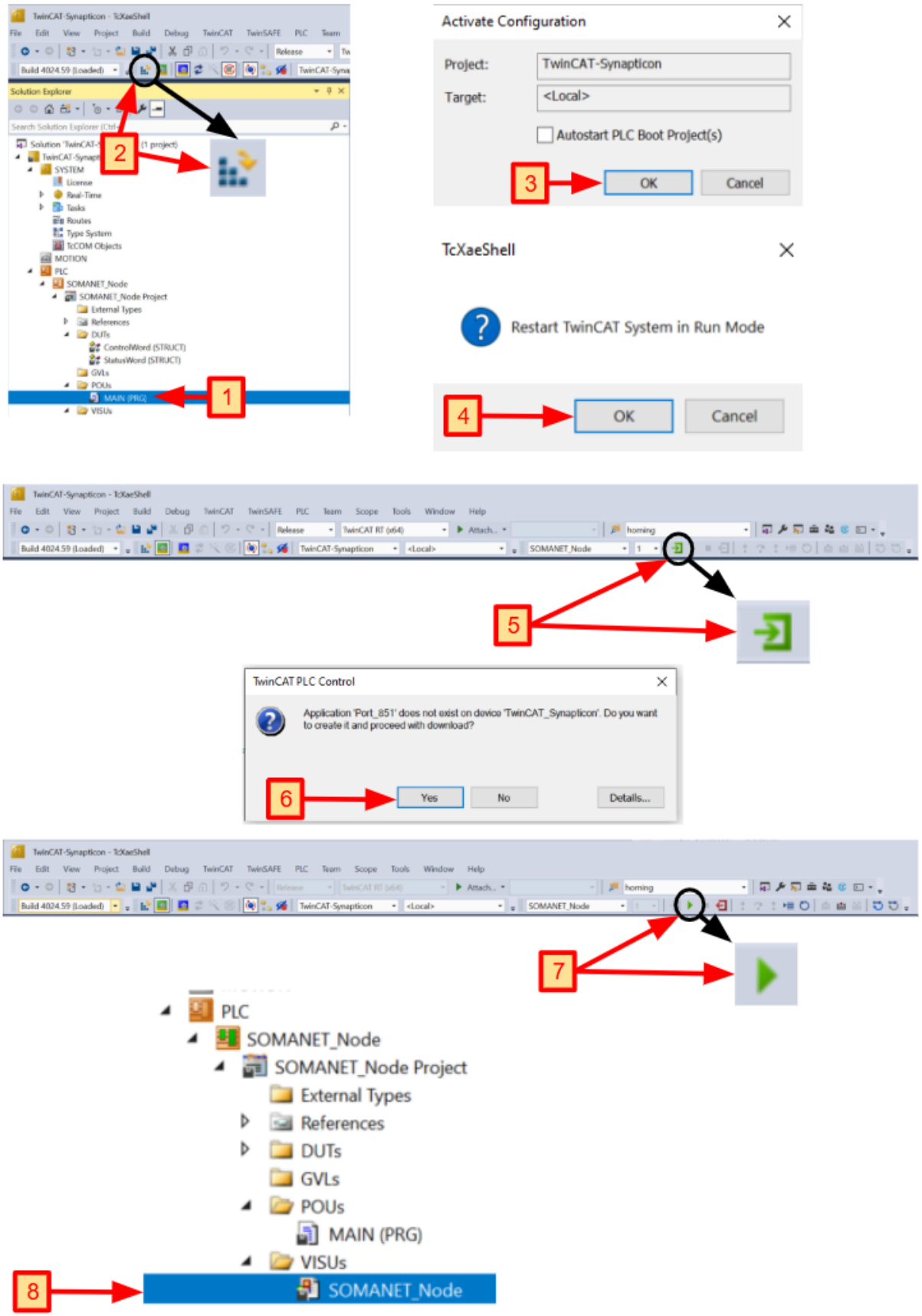


Figure 5.28 - Running the program

5.2. Usage

The TwinCAT implementation allows the device to be controlled in cyclic sync and profile modes for the torque, velocity, and position as well as performing homing. For the details on the modes, refer to Modes of Operation. The GUI for switching between the modes and operating the drive is displayed below in Figure 5.29.

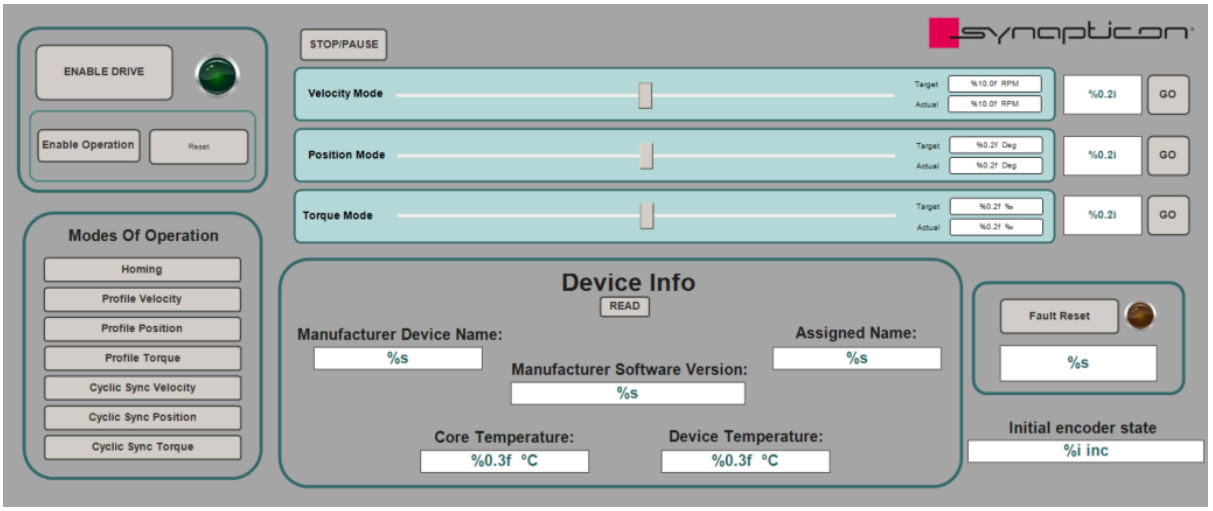


Figure 5.29 - GUI for controlling the drives

5.2.1. Cyclic Synchronous Torque

Cyclic Synchronous Torque mode assumes that the torque is generated fully on the master and the target torque is sent to the drive. Refer to Cyclic Synchronous Torque Mode for details about the mode.

To use this mode:

1. Enable the drive.
2. Enable the operation.
3. Select Cyclic Sync Torque as a mode of operation.

Next, select the the desired torque by:

4. Moving the slider, or by entering the desired value.
5. Press the “GO” button. For clarification, refer to Figure 5.30.

To disable the mode:

- Deselect it by again pressing Cyclic Sync Torque. Refer to Step 3 above.

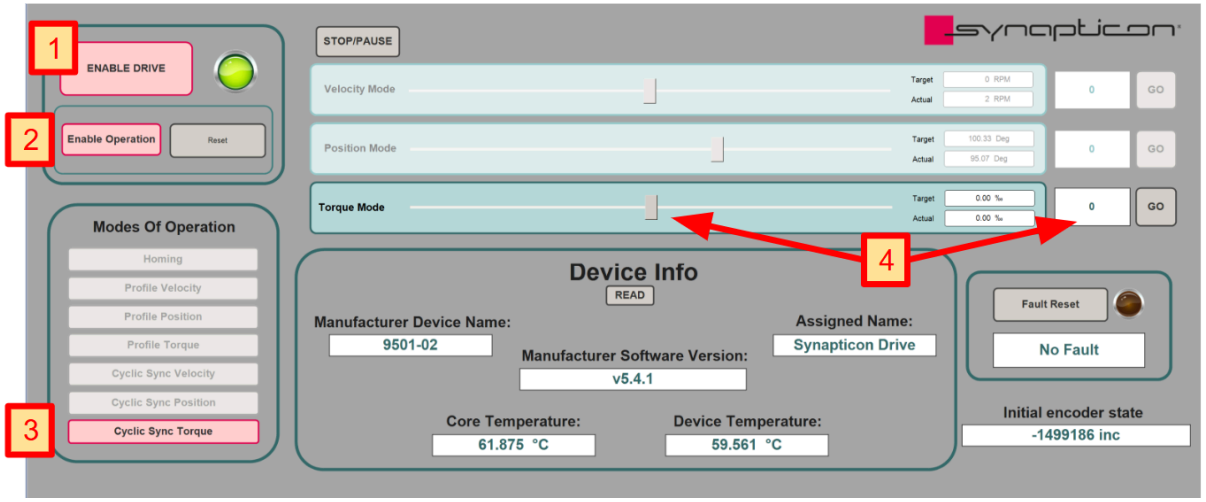


Figure 5.30 - Controlling the drive in cyclic sync torque mode

5.2.2. Cyclic Synchronous Velocity

Cyclic Synchronous Velocity mode assumes that the target velocity is generated fully on the master and sent to the drive, which performs velocity control and torque control. Refer to Cyclic Synchronous Velocity Mode for details about the mode.

To use this mode:

1. Enable the drive.
2. Enable the operation.
3. Select Cyclic Sync Velocity as a mode of operation.

Next, select the the desired velocity by:

4. Moving the slider, or by entering the desired value.
5. Press the “GO” button. For clarification, refer to Figure 5.31.

To disable the mode:

- Deselect it by again pressing Cyclic Sync Velocity. Refer to Step 3 above.

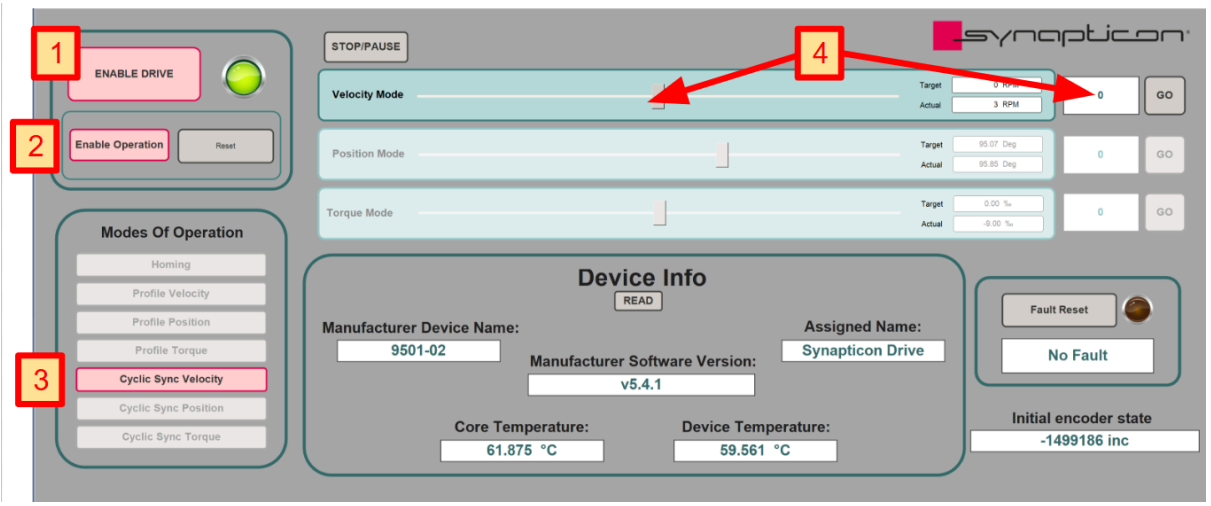


Figure 5.31 - Controlling the drive in cyclic sync velocity mode

5.2.3. Cyclic Synchronous Position

Cyclic Synchronous Position mode assumes that the target position is generated fully on the master and sent to the drive, which performs position, velocity, and torque control. Refer to Cyclic Synchronous Position Mode for details about the mode.

To use this mode:

1. Enable the drive.
2. Enable the operation.
3. Select Cyclic Sync Position as a mode of operation.

Next, select the the desired velocity by:

4. Moving the slider, or by entering the desired value.
5. Press the “GO” button. For clarification, refer to Figure 5.32.

To disable the mode:

- Deselect it by again pressing Cyclic Sync Position. Refer to Step 3 above.

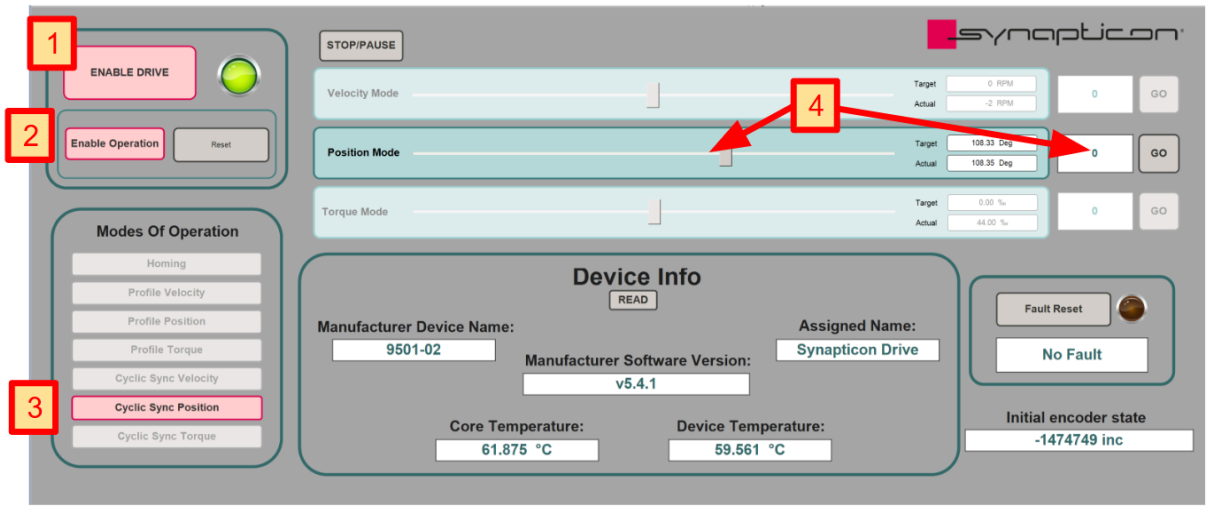


Figure 5.32 - Controlling the drive in cyclic sync position mode

5.2.4. Profile Torque

In the profile torque mode, the target torque is sent to the drive.The drive generates the torque profile so that the target torque is achieved by following the configured slope. Refer to Profile torque mode for details about the mode and the required parameters that must be configured using OBLAC tools.

To use this mode:

1. Enable the drive.
2. Enable the operation.
3. Select Profile Torque as a mode of operation.

Since the drive must ramp the torque, in this case, the correct way to use the slider is to:

4. Click on the desired place on the scale instead of moving it. Note that It can also be moved; however, several targets would be sent one after another.
   - or -
   Write the target torque in the box.
5. Press the “GO” button. For clarification, refer to Figure 5.33.

To disable the mode:

- Deselect it by again pressing Profile Torque. Refer to Step 3 above.

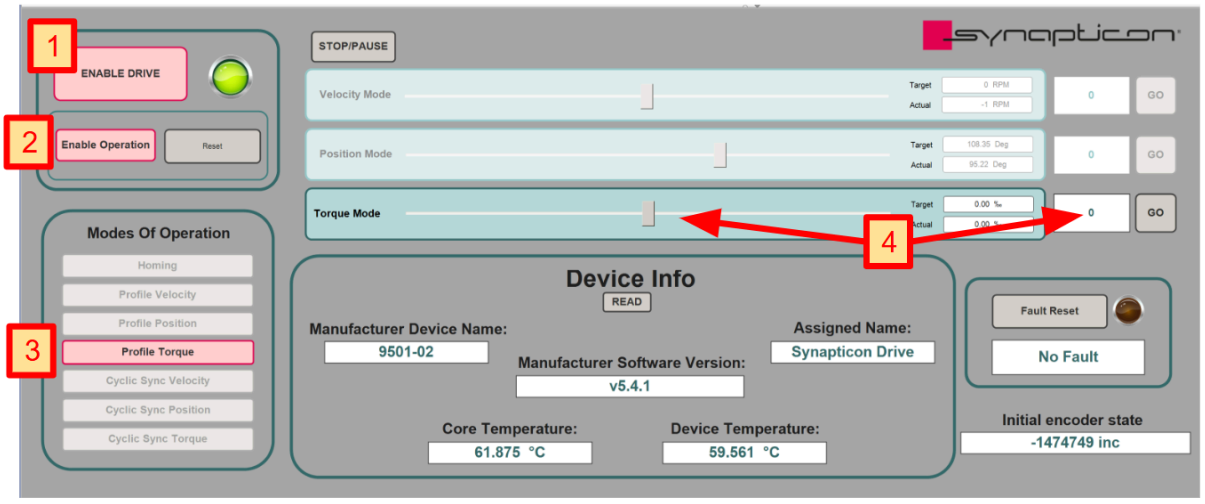


Figure 5.33 - Controlling the drive in profile torque mode

5.2.5. Profile Velocity

In the profile velocity mode, the target velocity is sent to the drive. The drive generates the torque profile so that the target torque is achieved by following the configured slope. Refer to Profile velocity mode for details about the mode and the required parameters that must be configured in OBLAC Drives.

To use this mode:

1. Enable the drive.
2. Enable the operation.
3. Select Profile Velocity as a mode of operation.

Since the drive must ramp the velocity, in this case, the correct way to use the slider is to:

4. Click on the desired place on the scale instead of moving it. Note that It can also be moved; however, several targets would be sent one after another.
   - or -
   Write the target velocity in the box.
5. Press the “GO” button. Additionally, there is an in-built function that can drive a motor by ramping it repeatedly in a positive and negative direction. For clarification, refer to Figure 5.34.

To disable the mode:

- Deselect it by again pressing Profile Velocity. Refer to Step 3 above.

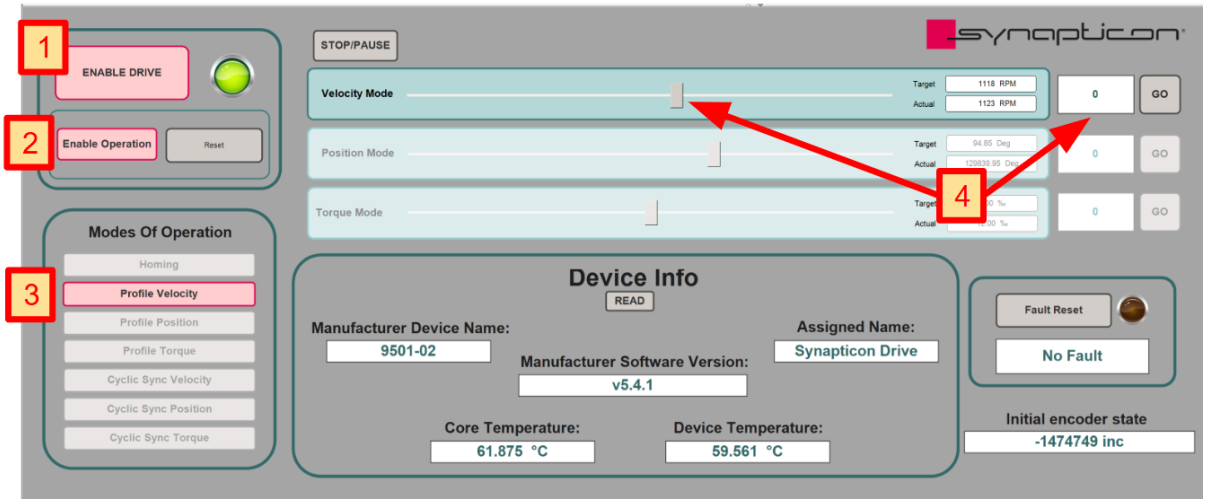


Figure 5.34 - Controlling the drive in profile velocity mode

5.2.6. Profile Position

In the profile trajectory mode, the target position is sent to the drive. The drive generates the target trajectory with respect to the configured speed, position limits, acceleration and deceleration profile. Refer to Profile position mode for details about the mode and the required parameters that must be configured in OBLAC Drives.

To use this mode:

1. Enable the drive.
2. Enable the operation.
3. Select Profile Position as a mode of operation.

Since the drive must generate the target trajectory, in this case, the correct way to use the slider is to:

4. Click on the desired place on the scale instead of moving it. Note that It can also be moved; however, several targets would be sent one after another.
   - or -
   Write the target position in the box.
5. Press the “GO” button. For clarification, refer to Figure 5.35.

To disable the mode:

- Deselect it by again pressing Profile Position. Refer to Step 3 above.

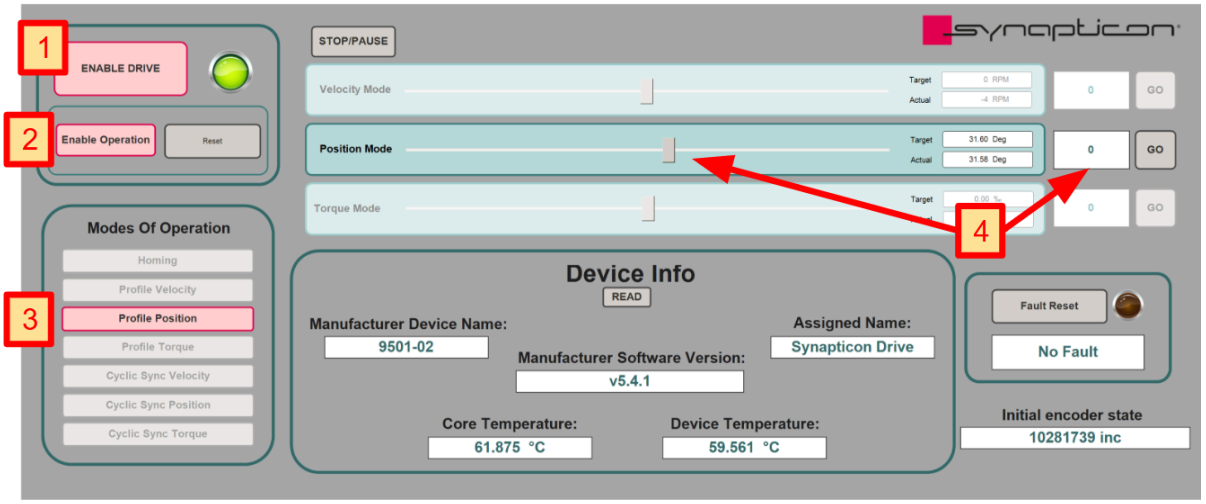


Figure 5.35 - Controlling the drive in profile position mode

5.2.7. Homing

The homing function moves the axes without absolute autoencoder to the predefined location. There are several methods for performing this operation, which are described in Homing modes.

In the code provided, a method was implemented labeled by number 18 and described in Homing method. This method assumes that the device has a physical switch at the predefined (usually) position.

To activate this mode:

1. Enable the drive.
2. Enable the operation.
3. Select the Homing mode.

The motor rotates until the switch is reached and the rising edge of the switch signal is detected; then, it stops. For that purpose, one (in our case the first) of the digital I/Os was configured as the input and used it to receive a signal from the switch.

Note that all of our drives also have a power output on the I/O pins:

- On SOMANET Node and SOMANET Circulo, the 1st pin of the DIO connector
- On SOMANET Integro, the 12th pin of the IO connector

Therefore, this can be used as the power source that is over the switch connected to a digital input. For details about pin locations, refer to the Synaption online documentation.

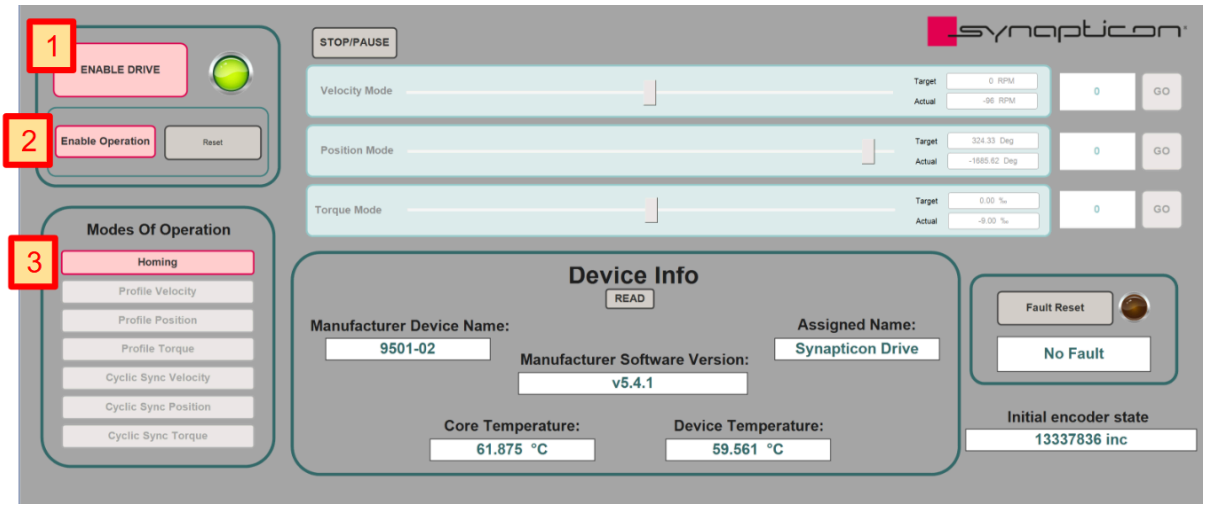


Figure 5.36 - Initiating a homing procedure

5.2.8. Additional Buttons and Signals

In this section, additional buttons are listed. Since they are self-explanatory, a brief explanation on their usage is provided.

5.2.8.1. Reset Fault Button and Signal

If there is an error e.g., overvoltage, lost ticks in encoder, etc., the yellow light (1) will turn on. To delete the fault (if it is possible), Fault Reset button (2) must be pressed. After resetting the fault, it is possible to enable operation again.

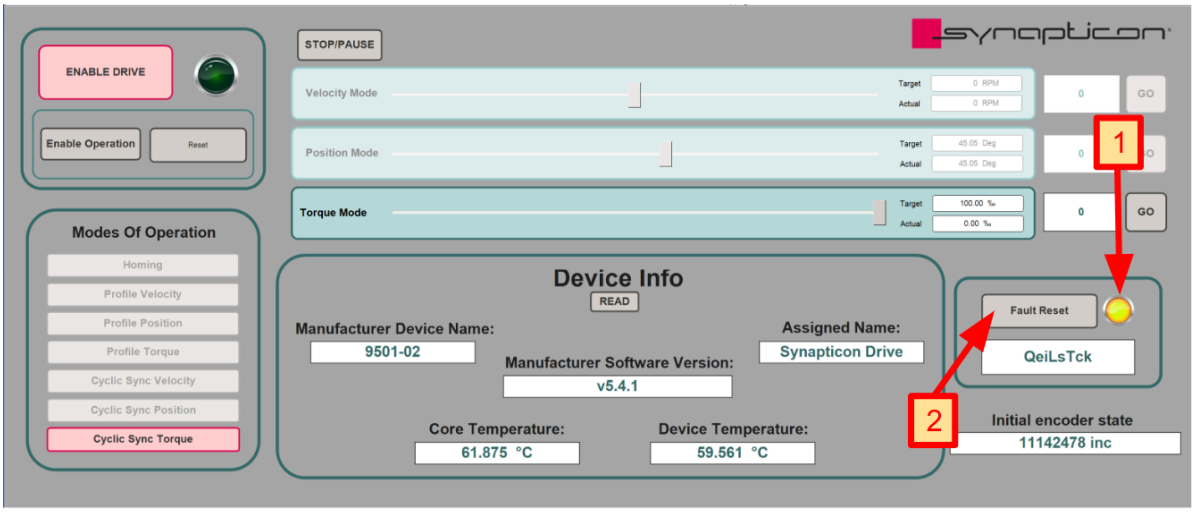


Figure 5.37 - Fault reset button and signal

5.2.8.2. Pause/Stop

The Pause/Stop button switches off the bit that allows sending signals to the drive. It can be disabled and enabled without the operation being disabled or the mode switched off.

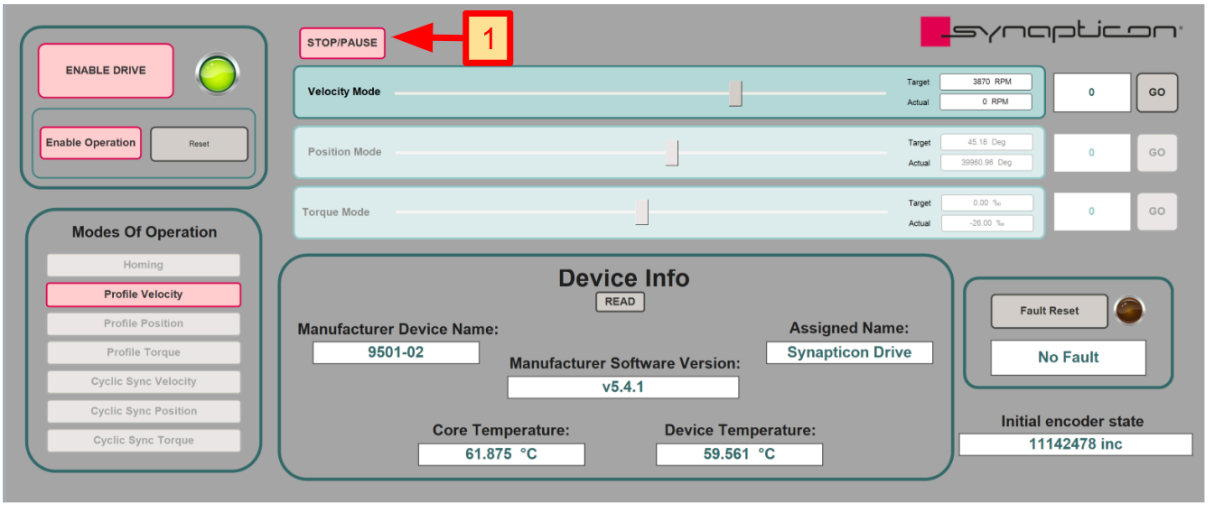


Figure 5.38 - Pause button

5.2.8.3. Reset

The Reset button switches off all the modes and sets target velocity, target torque to 0 and the target position to be equal to the current position.

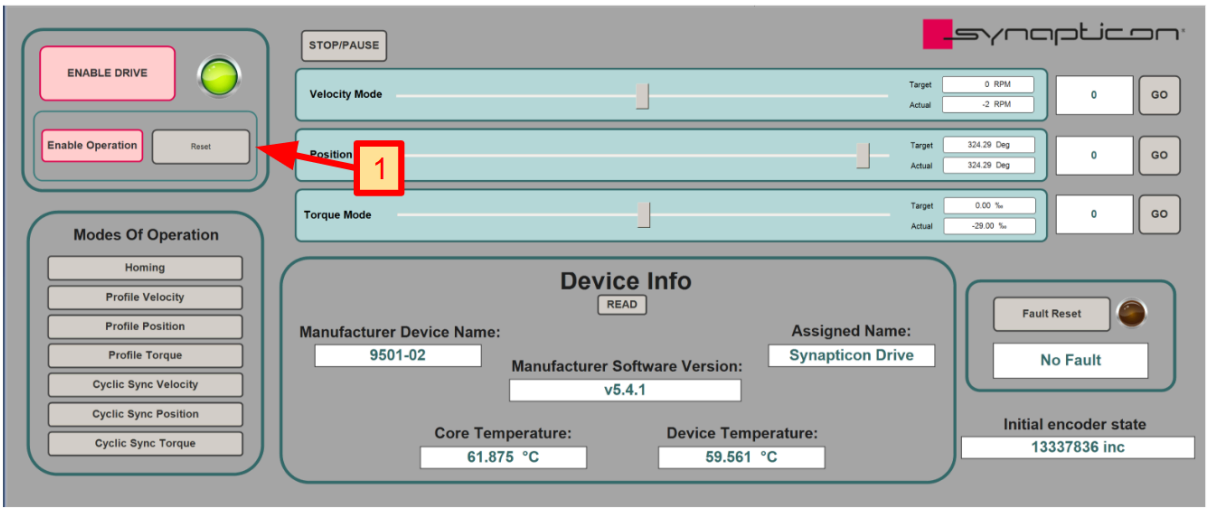


Figure 5.39 - Reset button

5.2.8.4. Read

To use this option (see Figure 5.40), manually enter the IP address of your EtherCAT device to the code.

You can find this address in:
“TwinCAT-Synapticon > I/O > Device 3 (EtherCAT) > (Tab) EtherCAT”

It should be copied in:
“TwinCAT - Synapticon > PLC > SOMANET_Node > MAIN (PRG)”

For details, refer to Figure 5.41.

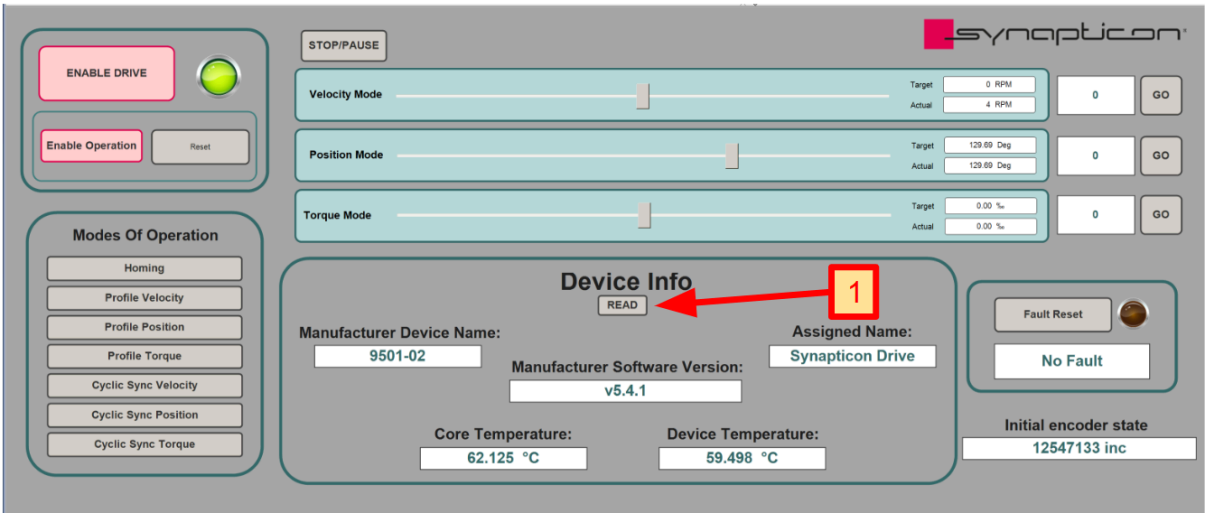


Figure 5.40 - Reading the device information

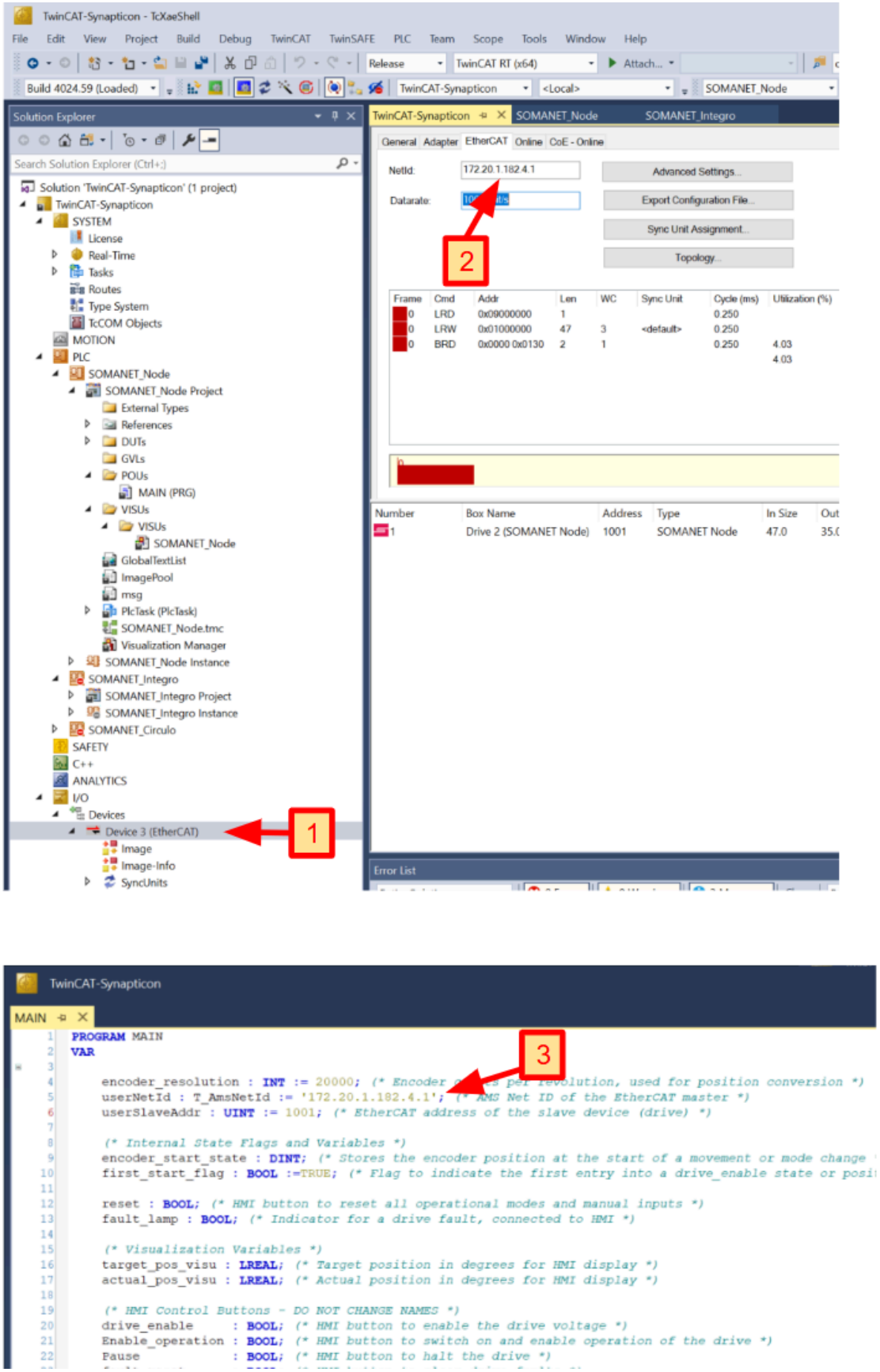


Figure 5.41 - Setting up the IP address for reading information about the device