AC20 Series

EtherCAT– Communication Option
Technical Manual

ENGINEERING YOUR SUCCESS.

1 Safety

IMPORTANT: Please read this information BEFORE installing the equipment.

1.1 Intended Users

This manual is to be made available to all persons who are required to install, configure or service equipment described herein, or any other associated operation.
The information given is intended to highlight safety issues, and to enable the user to obtain maximum benefit from the equipment.

Complete the following table for future reference detailing how the unit is to be installed and used.

INSTALLATION DETAILS	
Model Number *(see product label)*	
Where installed *(for your own information)*	

1.2 Application Area

The equipment described is intended for industrial motor speed control utilizing AC induction motors or AC permanent magnet synchronous machines.

1.3 Personnel

Installation, operation, and maintenance of the equipment should be carried out by competent personnel. A competent person is someone that is technically qualified and familiar with all safety information and established safety practices; with the installation process, operation, and maintenance of this equipment, and with all the hazards involved.

1.4 Product Warnings

Special attention must be paid to the information presented in warning, caution, and information notices when they appear in this manual. Definitions of caution, warning and information notices are shown below:

DANGER Risk of electric shock	WARNING Hot surfaces	Caution Refer to documentation	Earth/Ground Protective Conductor Terminal

Application Risk

The specifications, processes and circuitry described herein are for guidance only and may need to be adapted to the user's specific application. We cannot guarantee the suitability of the equipment described in this Manual for individual applications.

Risk Assessment

Under fault conditions, power loss or unintended operating conditions, the drive may not operate as intended. In particular:

- Stored energy might not discharge to safe levels as quickly as suggested and can still be present even though the drive appears to be switched off.
- The motor's direction of rotation might not be controlled
- The motor speed might not be controlled
- The motor might be energised

A drive is a component within a drive system that may influence its operation or effects under a fault condition. Consideration must be given to:

- Stored energy
- Supply disconnects
- Sequencing logic
- Unintended operation

1.5 Safety Information

Risk of Electric Shock

DANGER!
Ignoring the following may result in injury:
- This equipment can endanger life by exposure to rotating machinery and high voltages.
- The equipment must be permanently earthed due to the high earth leakage current, and the inverter motor must be connected to an appropriate safety earth.
- Ensure all incoming supplies are isolated before working on the equipment. Be aware that there may be more than one supply connection to the inverter.
- There may still be dangerous voltages present at power terminals (motor output, supply input phases, DC bus and the brake, where fitted) when the motor is at standstill or is stopped.
- For measurements use only a meter to IEC 61010 (CAT III or higher). Always begin using the highest range. CAT I and CAT II meters must not be used on this product.
- Allow at least 5 minutes for the inverter's capacitors to discharge to safe voltage levels (<50V). Use the specified meter capable of measuring up to 1000V dc & ac rms to confirm that less than 50V is present between all power terminals and between power terminals and earth.
- Unless otherwise stated, this product must NOT be dismantled. In the event of a fault the inverter must be returned. Refer to "Routine Maintenance and Repair".

Safety & EMC Requirements

Where there is a conflict between safety and EMC requirements, personnel safety shall always take precedence.

WARNING!
Ignoring the following may result in injury or damage to equipment:

- Never perform high voltage resistance checks on the wiring without first disconnecting the inverter from the circuit being tested.
- Whilst ensuring ventilation is sufficient, provide guarding and /or additional safety systems to prevent injury or damage to equipment.
- When replacing an inverter in an application and before returning to use, it is essential that all user defined parameters for the product's operation are correctly installed.
- When replacing an inverter in an application and before returning to use, it is essential that all user defined parameters for the product's operation are correctly installed.
- All control and signal terminals are SELV, i.e. protected by double insulation. Ensure all external wiring is rated for the highest system voltage.
- Thermal sensors contained within the motor must have at least basic insulation.
- All exposed metalwork in the Inverter is protected by basic insulation and bonded to a safety earth.
- RCDs are not recommended for use with this product but, where their use is mandatory, only Type B RCDs should be used.

WARNING!
Ignoring the following may result in injury or damage to equipment:

- In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.
- This equipment contains electrostatic discharge (ESD) sensitive parts. Observe static control precautions when handling, installing and servicing this product.
- This is a product of the restricted sales distribution class according to IEC 61800-3. It is designated as "professional equipment" as defined in EN61000-3-2 for. Permission of the supply authority shall be obtained before connection to the public low voltage supply.

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2   Manufacturing Location

Germany

Parker Hannifin Manufacturing Germany GmbH & Co. KG

Electric Motion & Pneumatic Division (EMPD)

Robert-Bosch-Strasse 22

77656 Offenburg (Germany)

Tel.: + 49 (0781) 509-0

Website: **www.parker.com/eme**

Certified according to ISO 9001:2015

Parker Hannifin Manufacturing Germany GmbH & Co. KG - Sitz: Bielefeld - Amtsgericht: Bielefeld HRA 15699
persönlich haftende Gesellschafterin: Parker Hannifin GmbH - Sitz: Bielefeld - Amtsgericht Bielefeld HRB 35489
Geschäftsführung der Parker Hannifin GmbH: Ulrich Jochem, Achim Kohler, Andreas Paulsen, Kirsten Stenvers
Vorsitzender des Aufsichtsrates: Dr.-Ing. Gerd Scheffel

3 Waste Electrical and Electronic Equipment (WEEE)

Waste Electrical and Electronic Equipment - must not be disposed of with domestic waste. It must be separately collected according to local legislation and applicable laws.

Parker Hannifin Company, together with local distributors and in accordance with EU directive 2002/96/EC, undertakes to withdraw and dispose of its products, fully respecting environmental considerations.
For more information about how to recycle your Parker supplied waste equipment, please contact your local Parker Service Centre.

Packaging

During transport our products are protected by suitable packaging. This should be taken for central disposal as secondary raw material.

4   Table of Contents

5 Introduction

5.1 Product Features

- CANopen over EtherCAT (CoE)

- DS301 compliant

- Ethernet RJ45 connectors

- Network cycle time down to 100μs

- Fast data transfer: Up to 1486 bytes of process data in each direction

- Synchronous operation using distributed clock.

- IIoT (Industrial Internet of Things) ready: Includes Email Client, Web server with customizable content, SSI (Service Side Include) functionality and FTP server

- Ethernet Over EtherCAT (EoE).

- File Access Over EtherCAT (FoE)

- EtherCAT Slave Interface (ESI) files provided

- Run and Error LEDs

Note:

The CANopen Communication Profile (DS 301) defines the basic communication mechanisms for exchanging data via a CANopen-based networks. This includes the structure of the object dictionary, the network management and boot-up as well as communication objects like PDO, SDO, SYNC and time stamp.

6 Installation

<table>
<tr><td></td><td>DANGER!
RISK OF ELECTRIC SHOCK
Terminal covers, main covers, and cover fixings must remain in place while the drive is energized.
These should only be removed once the supply to the unit and/or system has been disconnected, and the residual energy in the DC link capacitors has been discharged.</td><td></td></tr>
</table>

<table>
<tr><td></td><td>CAUTION!
ESD SENSITIVE EQUIPMENT
Take ESD precautions when handling the Communication Interface Option Cards to avoid any risk of damaging the equipment.</td><td></td></tr>
</table>

- All activities covered in this chapter should be carried out when there is no power to the inverter.
- If the drive has been powered up, ensure enough time has elapsed that the inverter has discharged its residual energy.
- Always check that the voltages on the user terminals are at a safe level (<50V) before carrying out any of these activities.

6.1 Order Codes

| Order Code	Description
2003-CB-00	CANopen communication interface option card
2003-EC-00	EtherCAT communication interface option card
2003-IP-00	Ethernet IP communication interface option card
2003-PB-00	Profibus DP-V1 communication interface option card
2003-PN-00	PROFINET IO communication interface option card
2003-RS-00	RS485 Modbus RTU communication interface option card

6.2 Fitting the Option

Frames 2 – 5

The Communication Interface Option Cards are intended to be customer installed.
The control module housing cover will need to be removed prior to option card installation.
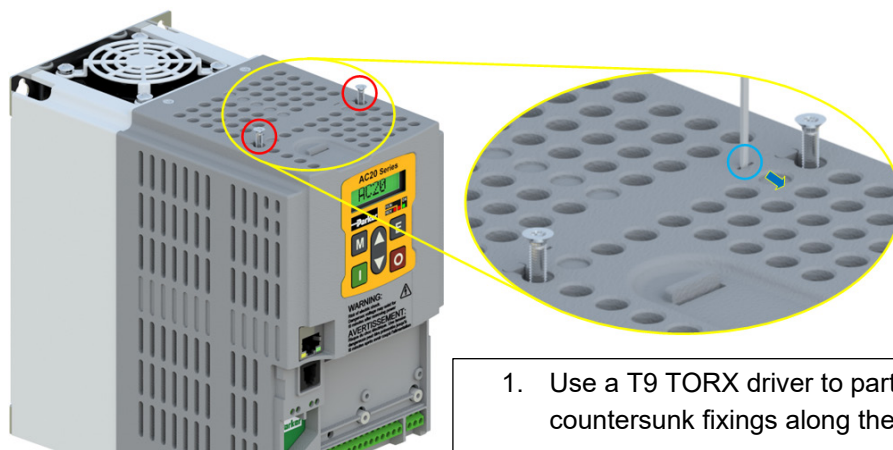
1. Use a T9 TORX driver to partially unscrew the two 3x12 countersunk fixings along the top of the product.

2. Insert a flat head screwdriver into the moulding features and lever the control module housing away from the power
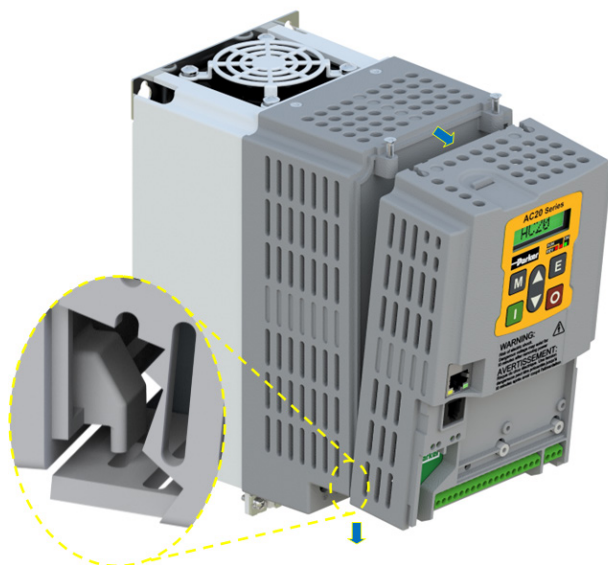
3. Unhook the bottom of the control module housing from the power stack.

4. Gently turn the control module upside down so it rests to the right of the power stack, with the interface cables still connected.
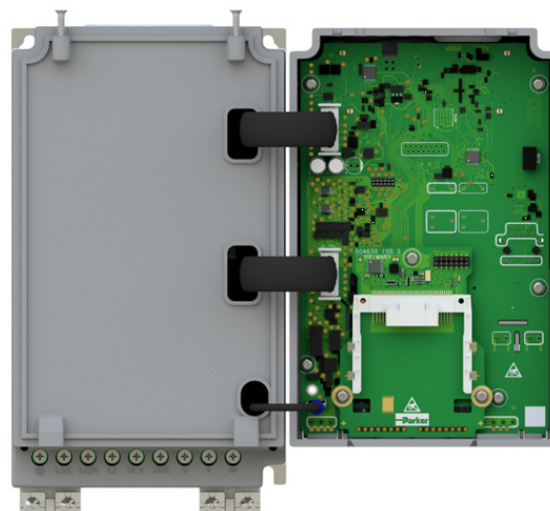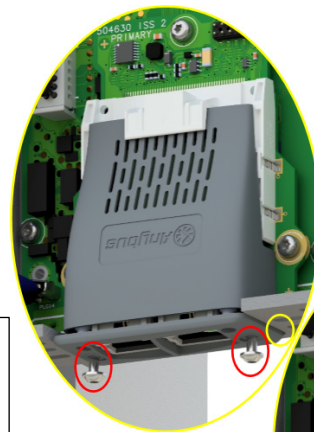
5. Remove and discard the Comms Option break-out feature in the control module housing by cutting the 7x bridges using suitable small side cutters.
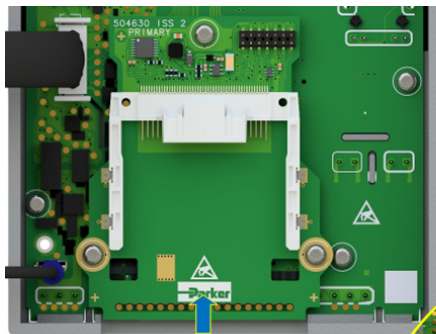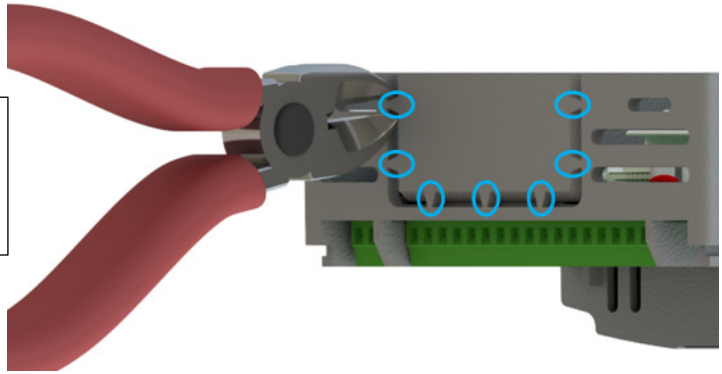
6. Remove the Comms Interface Option card from its packaging.

7. Slide the Comms Card along the PCB using the connector features for alignment.

   Note: The front facia of the Option should be loose at this point.

9. Now fully tighten the two T8 screws on the front facia of the Communication Interface Option Card.

10. Check that the Option Card is secure and that it cannot slide out.

11. Reassemble the product by performing the reverse process of steps 1 – 4.

In the event that the Communication Interface Option Card needs to be removed, follow the installation process, but perform steps 7 and 8 in reverse.

Frame 6 – 10

On Frames 6 – 10, the lower terminal cover will need to be removed prior to option card installation.

1. Remove the Comms Interface Option card from its packaging.
2. Slide the Comms Card along the PCB using the connector features for alignment.

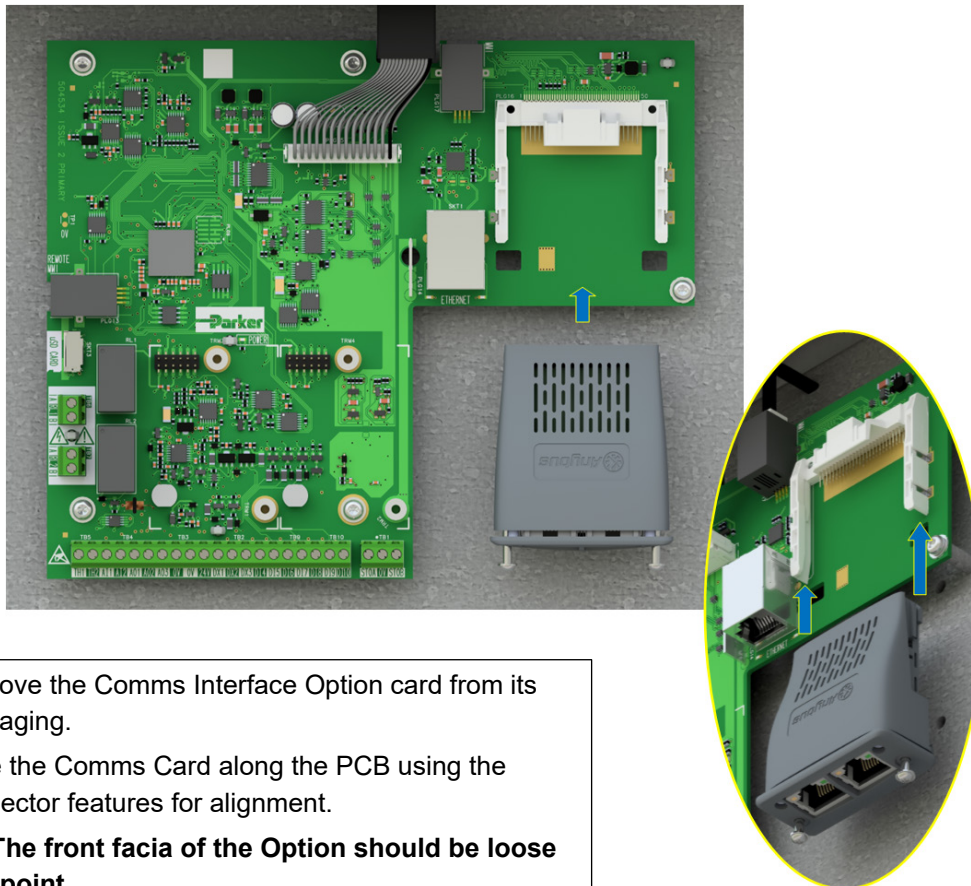   **Note: The front facia of the Option should be loose at this point.**

3. When the Comms Interface Option Card is fully engaged in the connector and its housing has hocked onto the edge of the PCB, fully tighten the two T8 screws on the front facia.
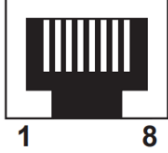4. Check that the Option Card is secure and that it cannot slide out.

In the event that the Communication Interface Option Card needs to be removed, perform steps 2 & 3 in reverse.

7   Network

7.1   Network Connector and Cable Specification

Two RJ45 Ethernet sockets are provided. The IN socket is connected to the master or the preceding slave coming from the direction of the master. The OUT socket is connected to the IN socket of the next slave, if there is one. The last OUT socket is Not connected

Ethernet Connector (RJ45)

Pin	Signal	Description	
1	TX+	-	
2	TX-	-	
3	RX+	-	
4	-	Normally left unused; to ensure signal integrity, these pins are tied together and terminated to PE via a filter circuit in module.	
5	-		
6	RX-	-	
7	-	Normally left unused; to ensure signal integrity, these pins are tied together and terminated to PE via a filter circuit in module.	
8	-		

Cable

For connecting EtherCAT devices only Ethernet cables that meet at least the requirements of category 5 (CAT5) according to EN 50173 or ISO/IEC 11801 should be used. EtherCAT uses 4 wires for signal transfer.
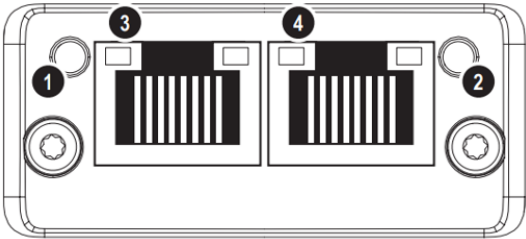Only use cables terminated with RJ45 plugs. The cable length between two EtherCAT devices must not exceed 100m.
.

Wiring Example
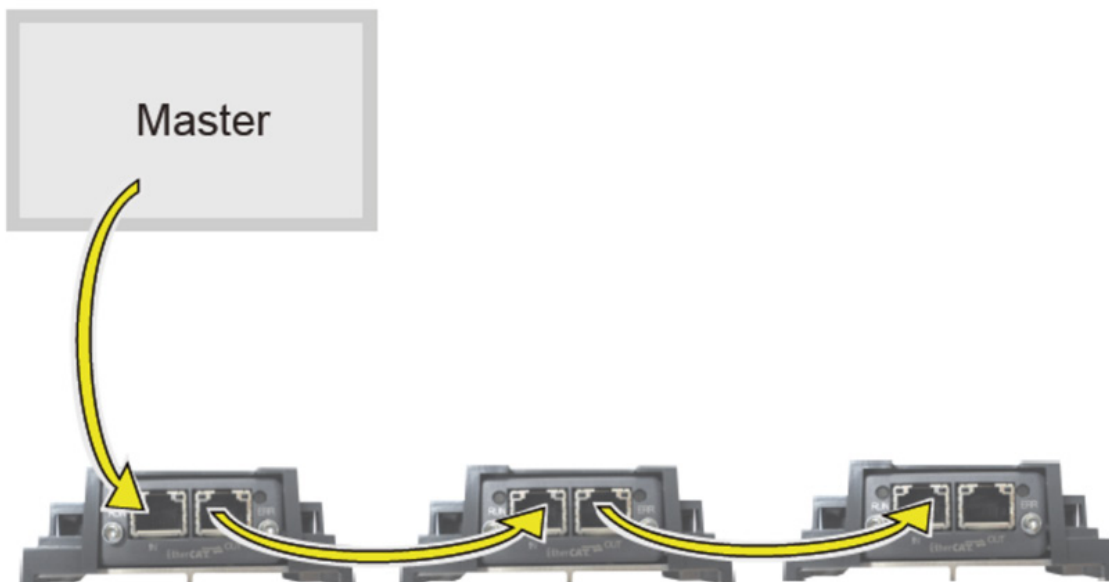
7.2 LED Indications

LED	Description
1	RUN LED
2	ERROR LED
3	Link/Activity (IN Port)
4	Link/Activity (OUT Port)

RUN LED

This LED reflects the status of the EtherCAT device.

LED State	Description	Comments
Off	-	No Power. EtherCAT device in 'INIT'-state
Green	OPERATIONAL	-
Green, Blinking	PRE-OPERATIONAL	-
Green, 1 Flash	STOPPED	-
Flickering	BOOT	-
Red	EXCEPTION	Fatal Event

If RUN and ERR turn red, this indicates a fatal event, forcing the bus interface to a physically passive state.

ERR LED

This LED indicates EtherCAT communication errors.

LED State	Description	Comments
Off	No Error	No power or No Error
Red, Blinking	Invalid Configuration	Invalid register or object settings
Red, 1 flash	Unsolicited state change	EtherCAT state change autonomously
Red, 2 flash	Sync Manager watchdog timeout	-
Red	Application controller failure	Module in EXCEPTION
Flickering	Booting error detected	Failure. Contact Parker technical support

Link/Activity LED

These LEDs indicate the EtherCAT link status and activity.

LED Status	Description	Comments
Off	No Link	Link not sensed or No power.
Green	Link sensed	No activity, no traffic detected
Flickering	Link sensed	Activity, traffic detected

8 Configuration

The option comms configuration is accessible through the keypad under the menu **Option Comms**, through DSE Lite function block **Option Comms Config** or through the webserver following the path **Home > Engineer > Communications > Option Comms**.

The AC20 EtherCAT option requires configuration of both communication parameters and process data mapping.

8.1 Communication parameters

Keypad Menu Path	DSE-Lite Function Block	Webserver

The network parameters of the slave must be set to establish communication with master.

- The parameter **0691 COMMS REQUIRED** must be set to **EtherCAT.**
- The parameter **2566 MASTERMAPPING** must be set to choose how process data mapping is defined. (See *8.2 Process Data for detail)*

Configuration with DSE Lite

When performing an online configuration, the fitted option card will automatically be selected.

In offline mode, display your configuration page in DSE Lite and click the plus sign [+] at the left of function block **Option Comms Config** to see set communication parameters.
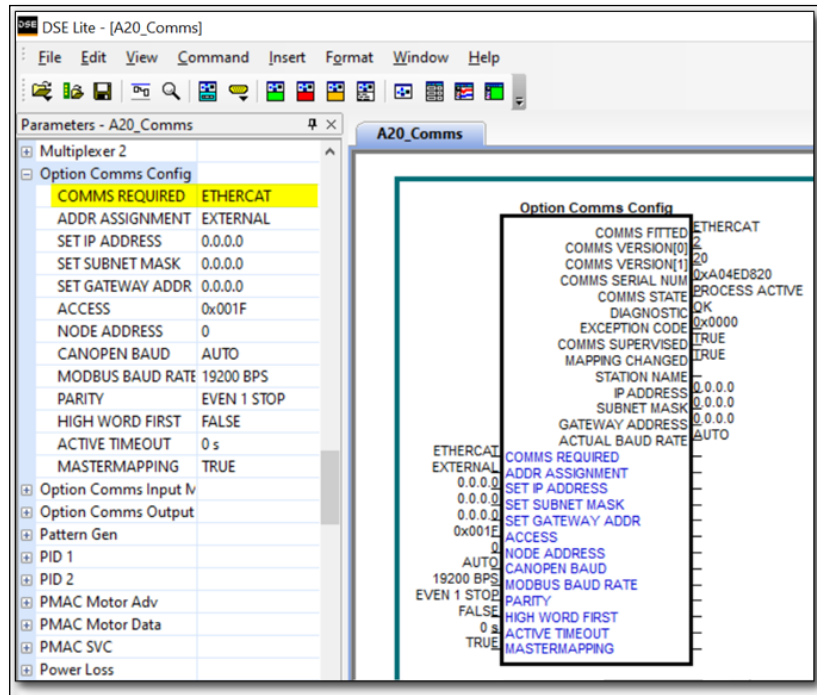
Alternatively. perform the steps described above by double clicking on the function block **Option comms config** to open parameters tab in the configuration interface.
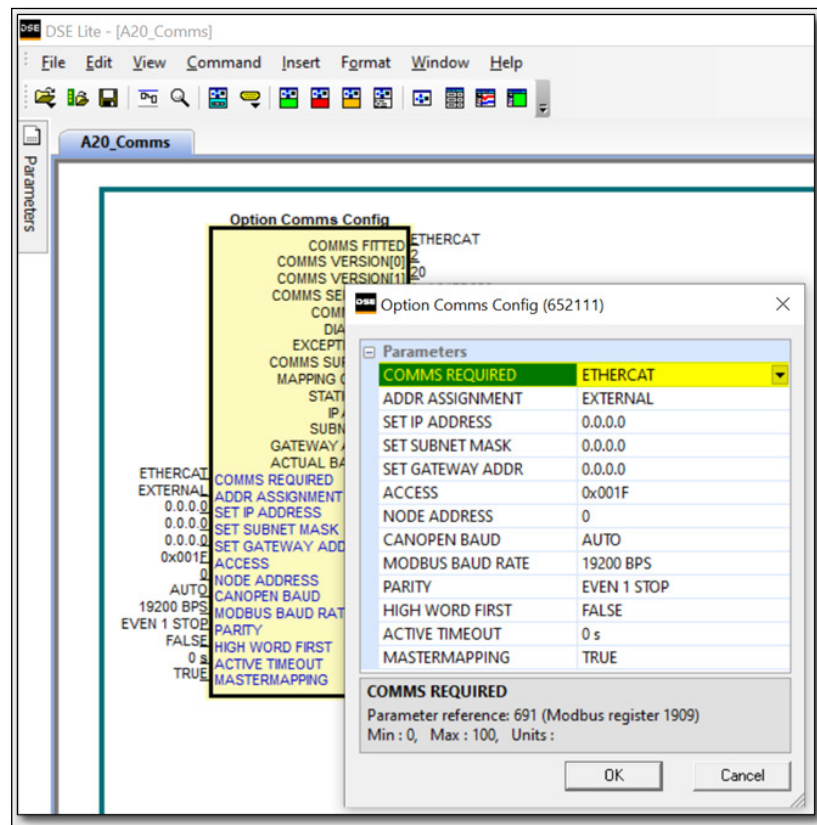
Configuration with the webserver

Access the AC20 webserver by typing the IP-Address of the drive into the web browser.
The drive must be in configuration state. Set the EtherCAT Option comms parameters as shown below.

AC20 Webserver view when Master mapping is TRUE

AC20 Webserver view when Master mapping is FALSE

8.2 Process Data

AC20 parameters implementation

The AC20 device implements CANopen over EtherCAT. The CANopen over EtherCAT (CoE) protocol enables the complete CANopen profile family to be utilized via EtherCAT.

CANopen is object-based, meaning AC20 node has an **object dictionary**, which contains communication objects. These communication objects cover acyclic configuration data, which is handled by **Service Data Objects (SDOs)**; cyclic real-time data, which is handled by **Process Data Objects (PDOs).**

AC20 parameters can be accessed from the network via dedicated object entries in the **Manufacturer Specific range and the Profile range** (2001h - FFFFh). The SDO information protocol allows nodes to retrieve the name and data type of the AC20 parameters.

Each object entry in the **manufacturer specific objects** corresponds to an AC20 parameter number, with parameter number 1 corresponding to object index 2001h, parameter number 2 to object index 2002h, etc.

For standard parameters (of a single element), sub-index 00h of the object represents the value of the parameter. Its data type and access depend on the AC20 parameter.
For multiple element parameters (parameter arrays), sub-index 00h represents the number of parameter elements and sub-indexes 01h-FEh represents the value of each of the parameter elements.

In the example below parameter number 1 is a single element parameter and parameter number 2 is a 4-element parameter array:

AC20 Parameter number	Index	Subindex	Description	Type / Access
1	2001h	00h	Parameter Value	Parameter dependent
2	2002h	00h	Number of Elements	Unsigned8 / Read only
		01h	value of element 0	
		02h	value of element 1	Parameter dependent
		03h	value of element 2	
		04h	value of element 3	

Config Mapping

The AC20 EtherCAT option requires configuration of process data mapping. Parameters mapped as Process Data can be exchanged cyclically as Process Data Objects (PDOs) on the bus.

The AC20 EtherCAT device supports up to 6 TPDOs and up to 6 RPDOs, each supporting up to 254 SDO (service Data Object) mappings. Each SDO equals one Process Data mapped drive parameter element. *(See Appendix – CANopen Object Dictionary).*

There are two methods to define process data mapping: The process data can be mapped using the AC20 input and output mapping tables or from the PLC.

The parameter **2566 MASTERMAPPING** defines the method: If FALSE the AC20 input and output mapping tables will be used to configure process data mapping. If TRUE, the bus master set/configures the Process data mapping and AC20 input and output mapping tables will be cleared.
*Note: For parameter **2566 MASTERMAPPING = 'FALSE'**: If the AC20 mapping tables are both set to zeros or AC20 mapping tables differs from PLC mapping then the option will be mapped from the PLC.*

Set process data using AC20 input and output mapping tables

These tables are two parameter arrays in which AC20 parameter numbers may be added. The parameter **2566 MASTERMAPPING** must be set to **FALSE.**

Read Mapping:

The read process data represents cyclic data sent from the PLC to the AC20, this is mapped into the table **Option Comms Input Mapping**. Only writable AC20 parameters that are not configuration parameters may be added to the read process data.

Keypad Menu Path	DSE Lite Function Block	Webserver

Write Mapping:

The write process data represents cyclic data sent from the AC20 to the PLC, this is mapped into the table **Option Comms Output Mapping.**

Keypad Menu Path	DSE Lite Function Block	Webserver

Note: String-type parameters cannot be mapped.

Set process data from EtherCAT master

The ESI file defines the list of manufacturer specific objects. Each object corresponds to an AC20 parameter.

When configuring the PLC, the objects may be mapped to the **process data objects** (PDO) as required. These objects map to the process data in the order in which they are added.

The parameter **2566 MASTERMAPPING** must be set to **TRUE** and this will auto reset any AC20 input and output mapping inside the drive.

Cyclic Data Exchange

Cyclic data exchange will occur when the option is in the OPERATIONAL (PROCESS ACTIVE) or STOP (IDLE) state.

However, the read process data will only update the mapped parameters when in the PROCESS ACTIVE state.

On transition into the PROCESS ACTIVE state all read process mapped parameters will be updated.

When in the PROCESS ACTIVE state, the read process mapped parameters will all update only when a change in the read process data occurs.

Mapping status

The process data mapping status can be accessed from AC20 via the following parameters:

- Parameter **2586 InMappingStatus**: shows the status of the currently active cyclic data input mapping table (32 entries), value is the Tag ID of the parameter to be cyclic read In.
- Parameters **2619 OutMappingStatus**: Shows the status of the currently active cyclic data output mapping table (32 entries), value is the Tag ID of the parameter to be cyclic sent out.

The parameters **2586 InMappingStatus** and **2619 OutMappingStatus** are visible from webserver if Parameter **2566 MasterMapping = TRUE** and are valid if **Parameter 0774 Comms State** = PROCESS ACTIVE.
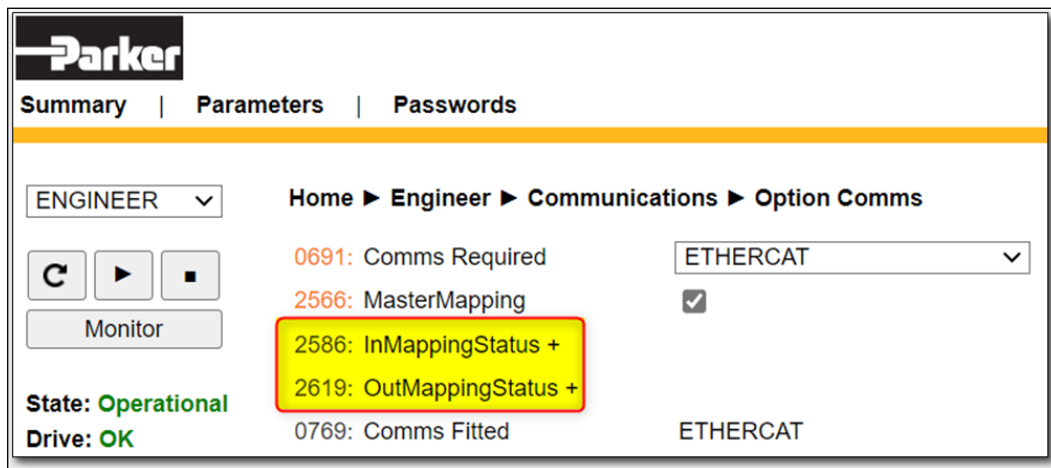
8.3 Acyclic Data Exchange

AC20 parameters may be accessed using the SDO (Service Data Object) protocol. The parameter numbers are mapped to the manufacturer specific range as described in the Manufacturer Specific Objects section.

Accessing Parameters

The value of a single-element AC20 parameter is accessed by via its corresponding object:

> *index = 2000h + parameter number*
> *sub-index = 00h*

The values of a multi-element AC20 parameter are accessed via its corresponding object:

> *index = 2000h + parameter number*
> *sub-index = element number + 1*

Alternatively, each element has its own parameter number and may be accessed via its corresponding object index.

A string parameter array must be accessed via each element of the array. Each element has its own parameter number.

Status Codes

The following CANopen report codes may be reported

CANopen Abort Code	Description
0602 0000h	Object does not exist in the object dictionary (Parameter does not exist)
0609 0011h	Sub-index does not exist
0601 0002h	Attempt to write to read-only object
0601 0001h	Attempt to read a write-only object
0607 0012h	Data type does not match. Too much data.
0607 0013h	Data type does not match. Not enough data.
0609 0030h	Out of range.

8.4 EtherCAT ESI File

AC20 EtherCAT option is associated with an Electronic Slave Interface (ESI file) in XML format, which holds a description of the device and its functions.
ESI files for the AC20 EtherCAT option may be downloaded from www.parker.com
Some masters do not require an ESI file and can automatically extract the configuration description from the slave.

9 Example Configuration and Programming

9.1 AC20 Motor Control Application

Use DSE Lite to create, parameterize and configure user defined applications or parameterize and connect fixed motor control blocks in the application. Download the application into the drive then connect to the PLC to read/write the value of the parameters.

In the example below the PLC is used to set motor speed and control, then to read the speed feedback, status of the control and speed reference.
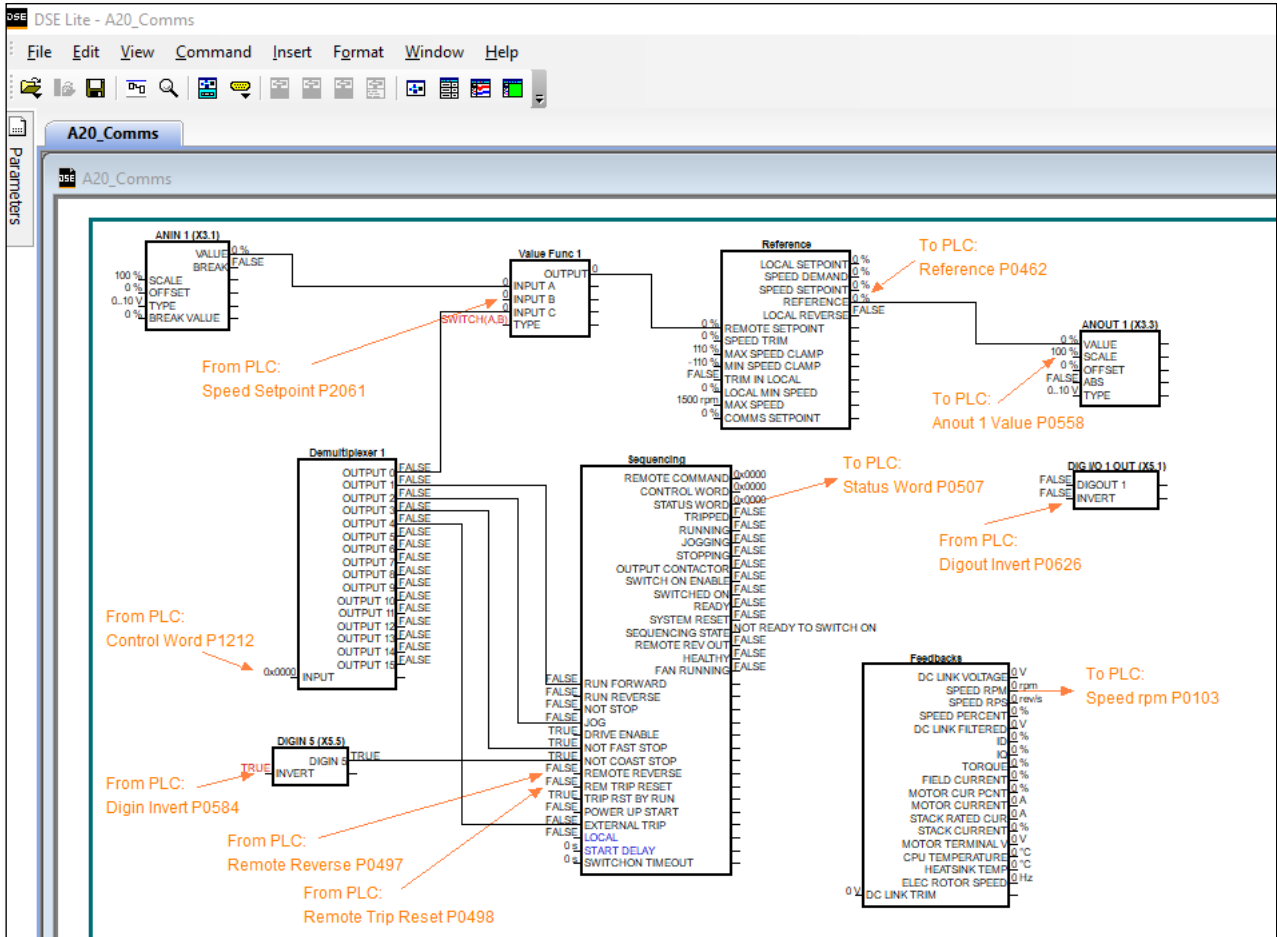
The data highlighted will be mapped into the AC20 process data mapping table in the example below.

9.2 List of process data

Read / Write Process Data mapping list for master/PLC

AC20 Input Mapping	Data Type	Comments	PLC Module
1212 Input Demultiplexer 1	WORD	Control Word	
2061 Input B Value Func 1	REAL	Speed Setpoint	
0584 Digin Invert	WORD	Invert digital input	
0626 Digout Invert	WORD	Invert digital Output	Output
0497 Remote reverse	BOOL	Invert motor Rotation	
0498 Rem Trip Reset	BOOL	Trip Reset	

AC20 Output Mapping	Data Type	Comments	PLC Module
0507 Status Word	WORD	Status Word	
0462 Reference	REAL	Speed Reference	
0103 Speed rpm	REAL	Speed Feedback	
0534 Anin1 Value	REAL	Analog In1 Value	
0540 Anin2 Value	REAL	Analog In2 Value	Input
0558 Anout1 Value	REAL	Analog Out1 Value	
0563 Anout2 Value	REAL	Analog Out2 Value	
0610 Digin Word	WORD	Digital Input state	
0625 Digout Word	WORD	Digital Output state	

9.3 Programming using Codesys platform

The example uses Codesys V3.5 running on a PC as a soft PLC. A trial version is available to download on the Codesys website. Prior knowledge of Codesys software is assumed.

EtherCAT ESI File Installation

- Download the AC20 EtherCAT option comms ESI file from the Parker website.
- Start Codesys and from menu select **Tools > Device Repository**
- From Device Repository tab, click on **Install**, Select AC20 XML device description file then click **Add** to install device into the Codesys catalog.
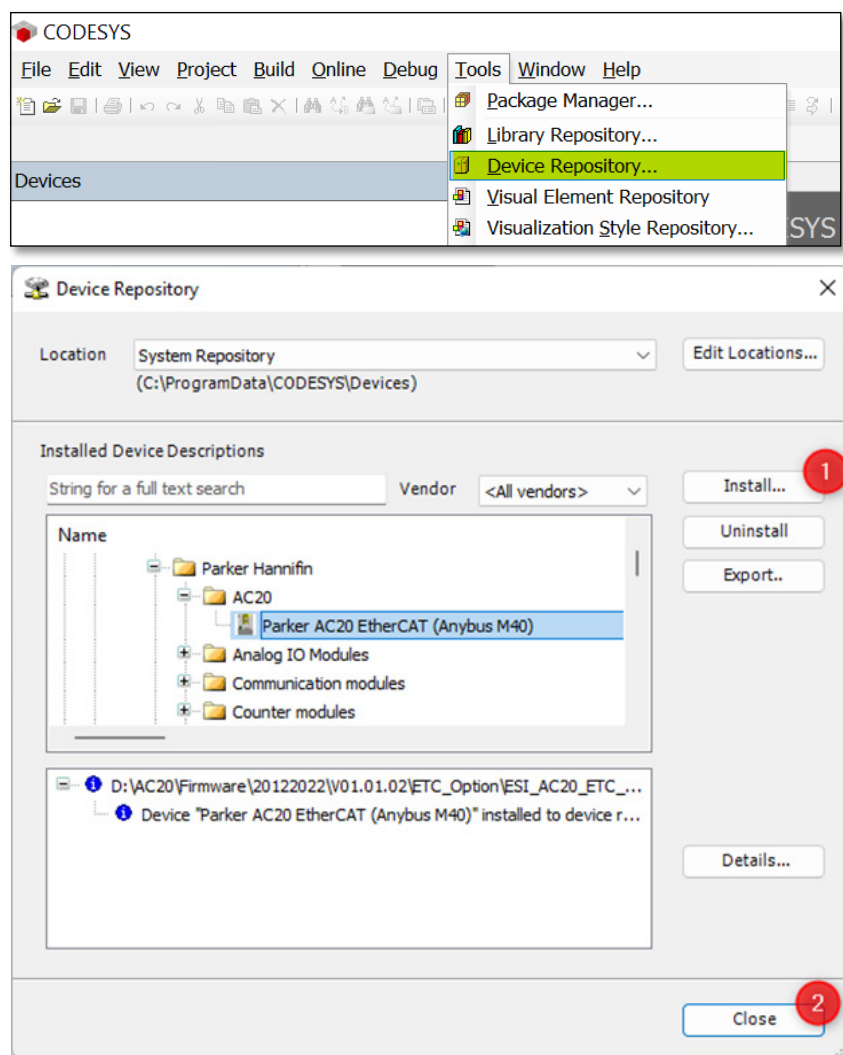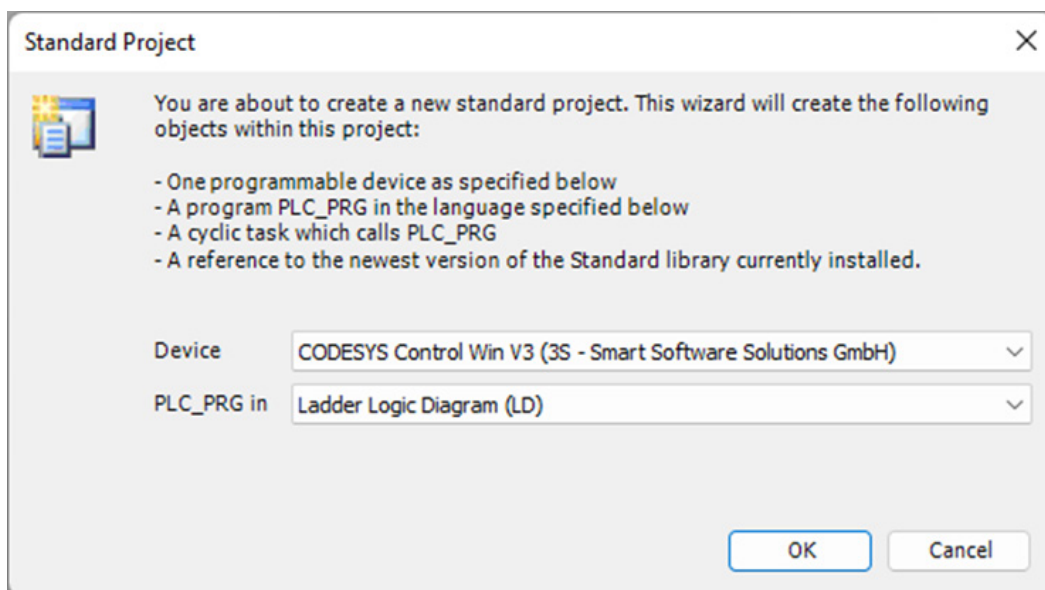
Create a project

- Launch Codesys and select **New Project** from the start page. In the **New Project** Tab select project type and define properties, then click on **OK**.
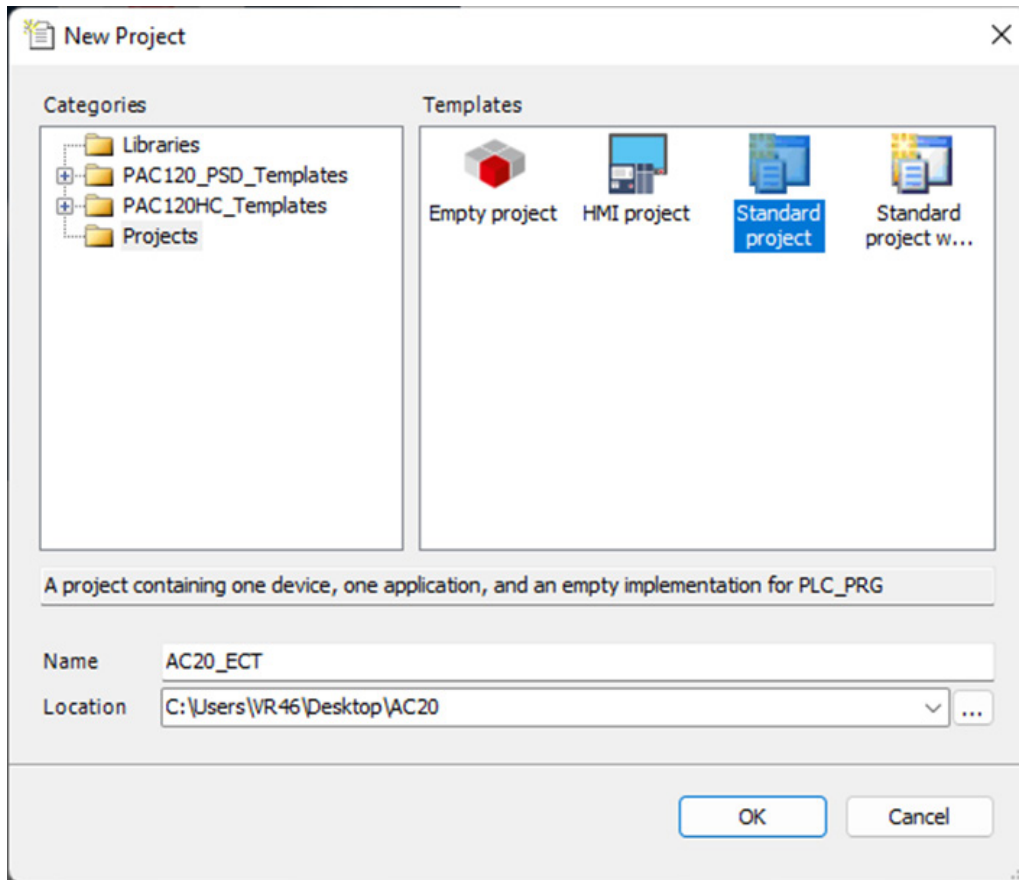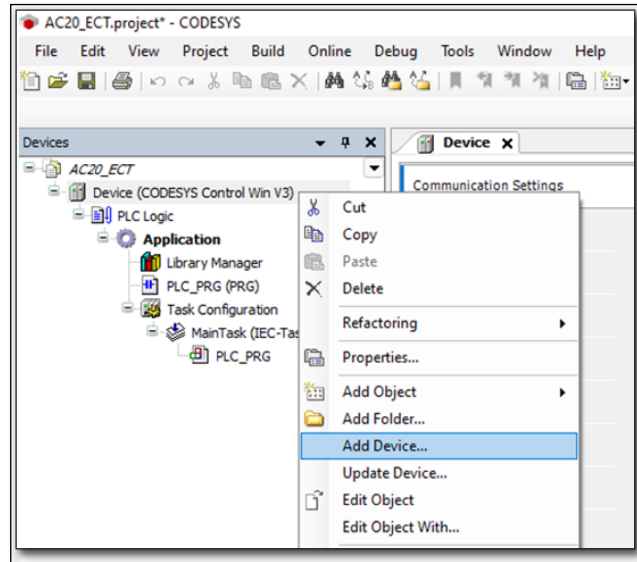

Select Codesys Control Win V3 as controller and select programming language, then press **OK**.
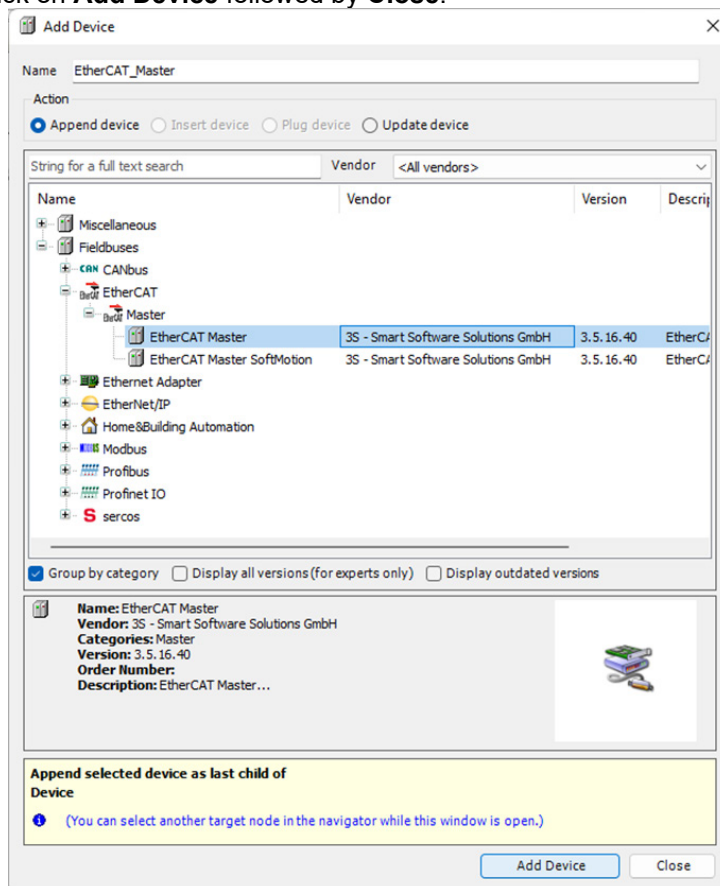
Set the Gateway

Double-click the Device **(Codesys Control Win V3)**. In device tab select **Communication settings** and click on **Scan network** to find the required node. From the **Scan network** pane click the required node to make it the active path.

Note: If the node is not found, make sure the soft PLC is in "Start PLC" mode.

Add EtherCAT master

- Right click on Device **(CoDeSys Control Win V3)** open **Add device** Tab, select the **EtherCAT Master** and click on **Add Device** followed by **Close**.

- The EtherCAT Master device and an EtherCAT task will be added. Click on **Browse…** to find the target network adapter. The gateway must be active (*see previous section*).
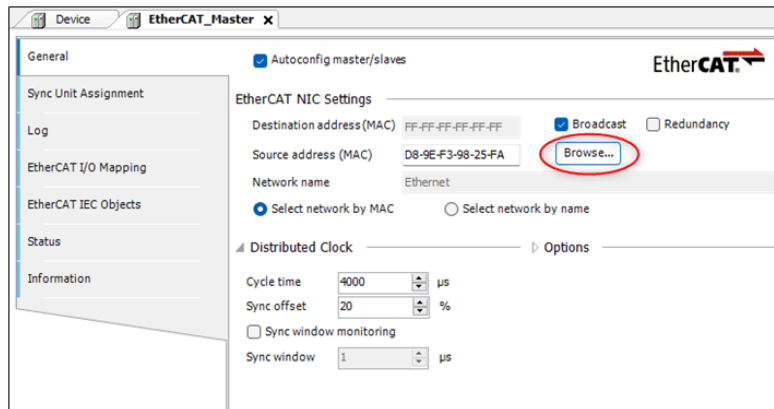
- Build and download into the Controller

Add AC20 EtherCAT Slave
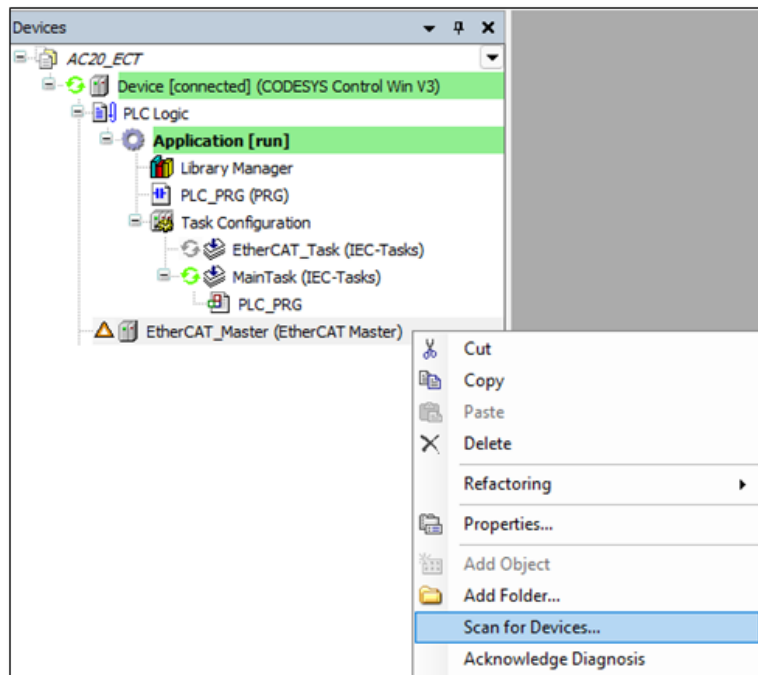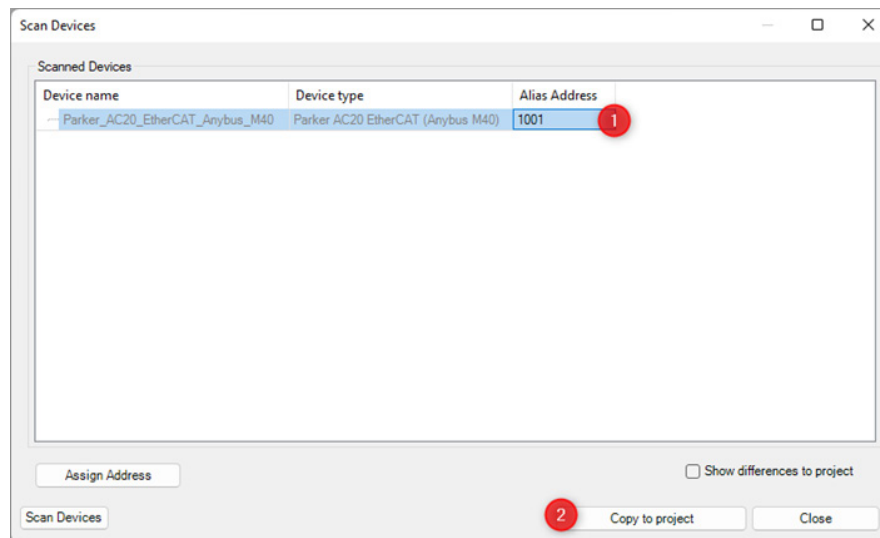
Scan for Device

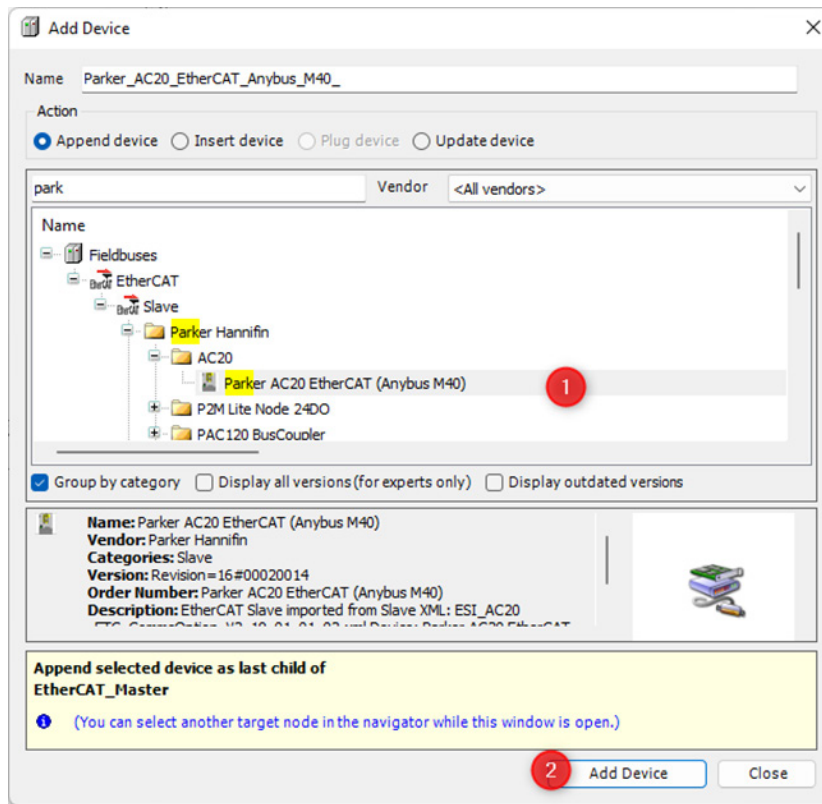- Right-click EtherCAT Master and select Scan for Devices

- Select device found and click on **Copy All Devices to Project**.

Add Device Manually

- Right-click on **EtherCAT_Master** and select **Add Device…** Select the device **Anybus_CompactCom_40_EtherCAT** and click on **Add Device** and then **Close.**

Configure Process Data Mapping

Option 1: Using AC20 Input and output mapping tables

- The parameter **2566 MASTERMAPPING** must be set to **FALSE** to prevent the PLC from overwriting the mapping.
- Through the mapping tables from the keypad, DSE Lite or Webserver, add parameter numbers into the appropriate table.

Note: If the first row of a table (input mapping or Output mapping) is empty or equal to 0, the table will not be accessible and configurable from PLC.

- From the Codesys project tree double-Click **Parker_AC20_EtherCAT_Anybus_M40** to open device tab, select **PDOs**, and add process data objects.

- Select **"General",** then check "**Expert settings**" to make visible "**Expert Process Data**".
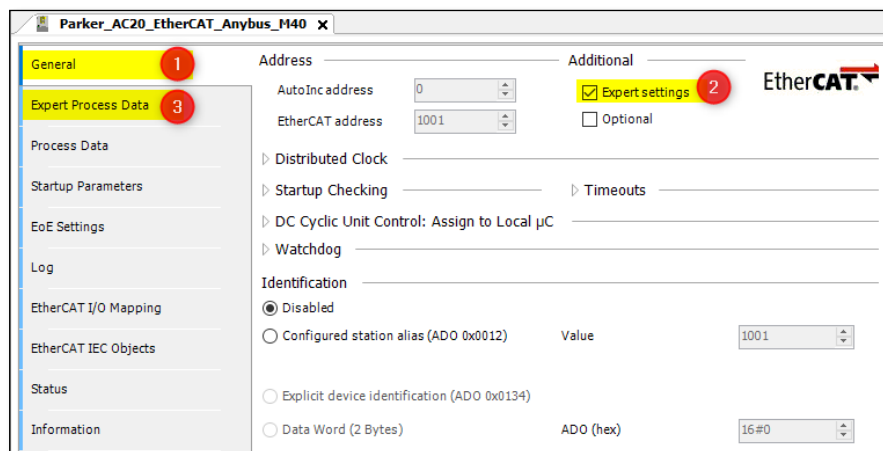
- Click on "Expert Process Data" to open the Tab, uncheck "PDO configuration".
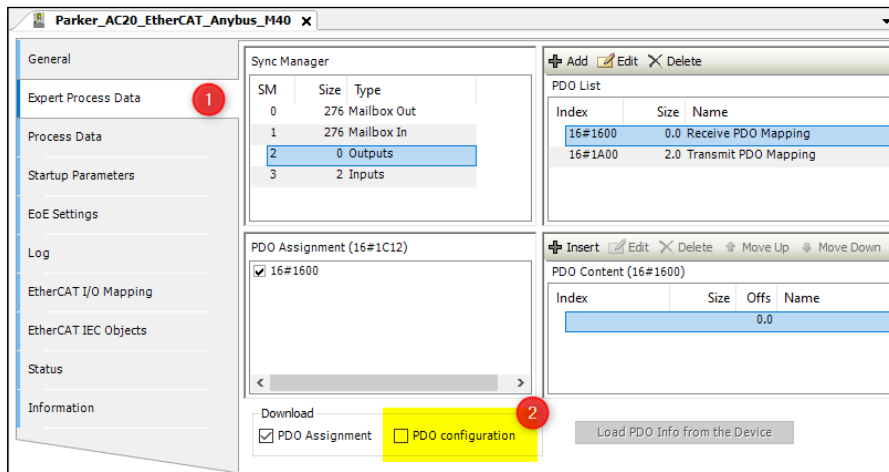
- Build and download the project into the PLC then go online, from slave "Expert Process Data" Tab, click on **"Load PDO Info from The Device"** to load the configured I/O mapping table into the project.
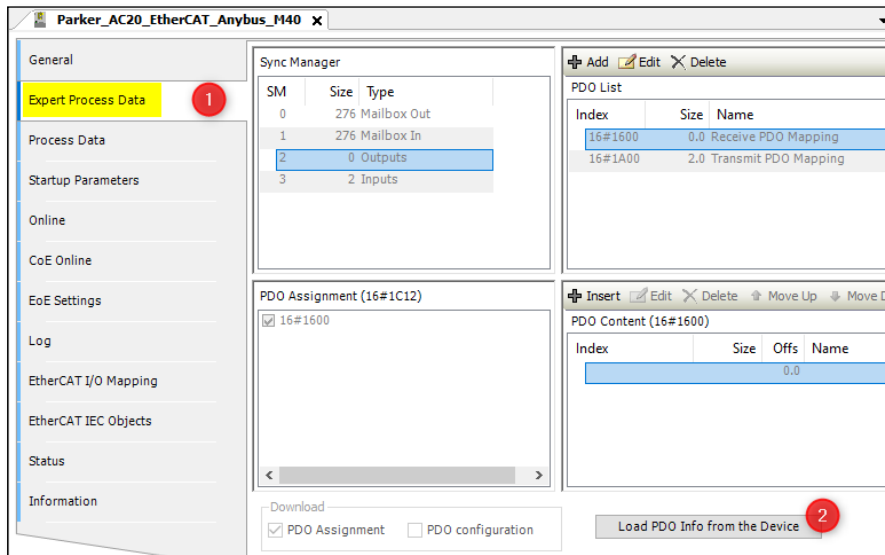
- The "**Transmit PDO Mapping**" now contains the objects from output mapping table of the device
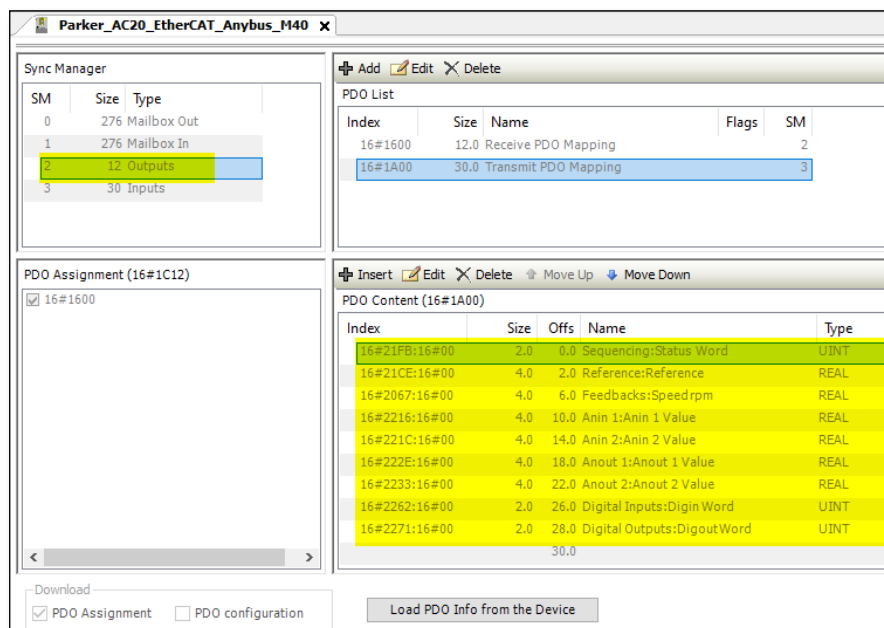
- The "**Receive PDO Mapping**" now contains the objects from output mapping table of the device
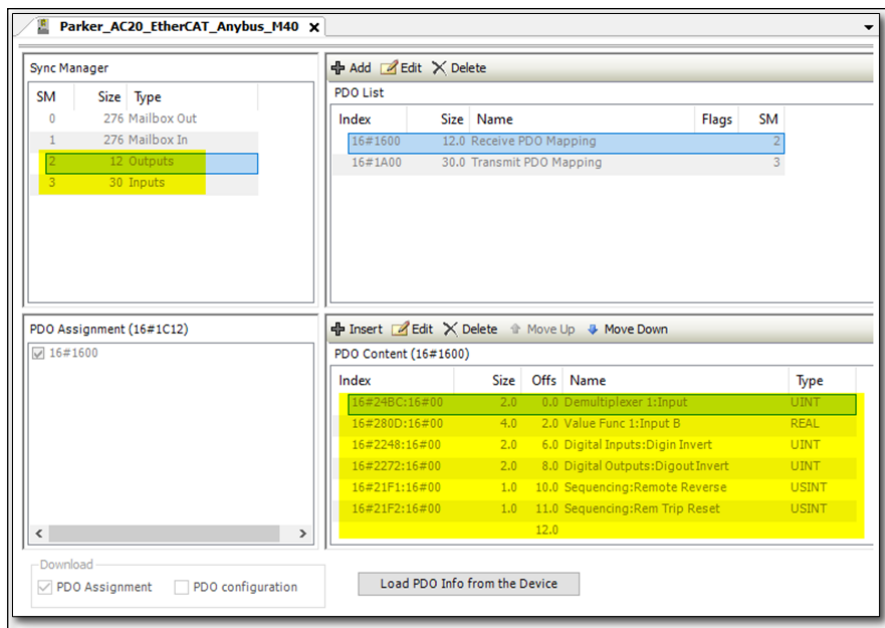
Option 2 : From PLC

- The parameter **2566 MASTERMAPPING** must be set to TRUE to allow the PLC to transfer the mapping to the AC20.
- In Codesys, after adding AC20 slave manually or by scanning into the project tree, double click the device "**Parker_AC20_EtherCAT_Anybus_M40**" to open the Tab.
- Select **"General",** then check "**Expert settings**" to make "**Expert Process Data**" visible.
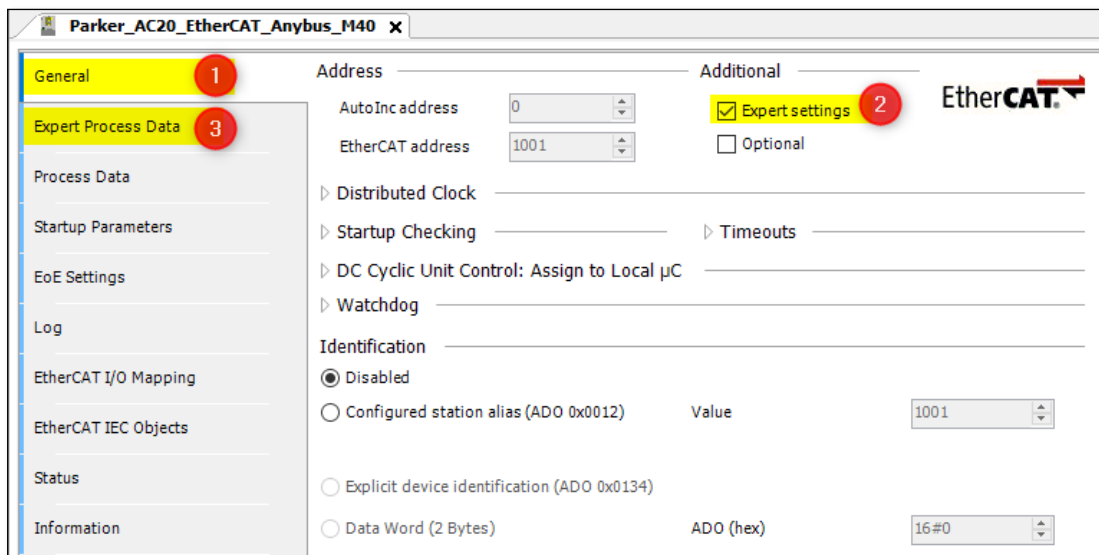
- Click on "Expert Process Data" to open the pane, make sure "PDO configuration" is checked.
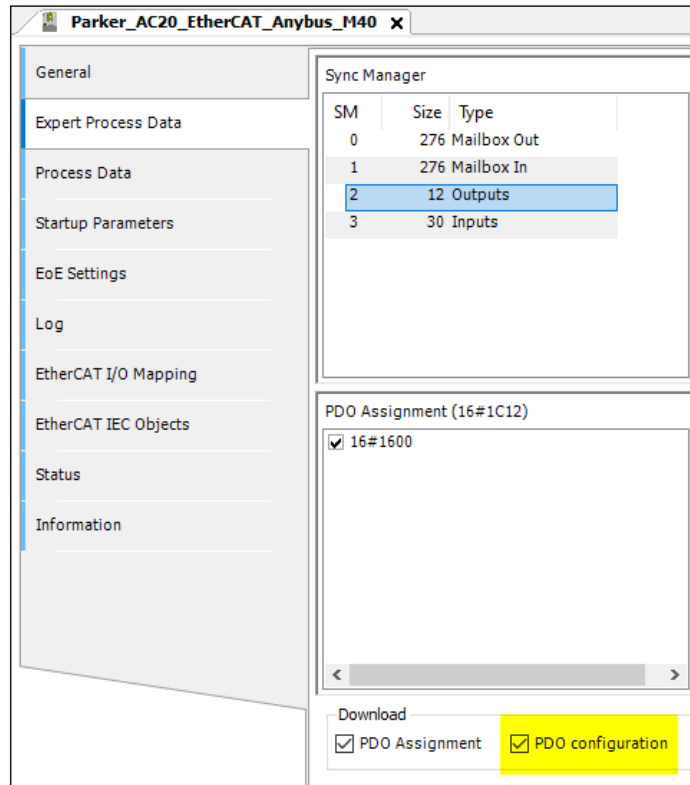
- Select the **"Expert Process Data"** pane, in "**PDO list**" Pane select "**Transmit PDO Parameter**" or "**Receive PDO Parameter**", then in "**PDO Content**" click "**Insert**" and select items from the object directory in the opened tab and click **OK**. Repeat this task to add all parameters required.
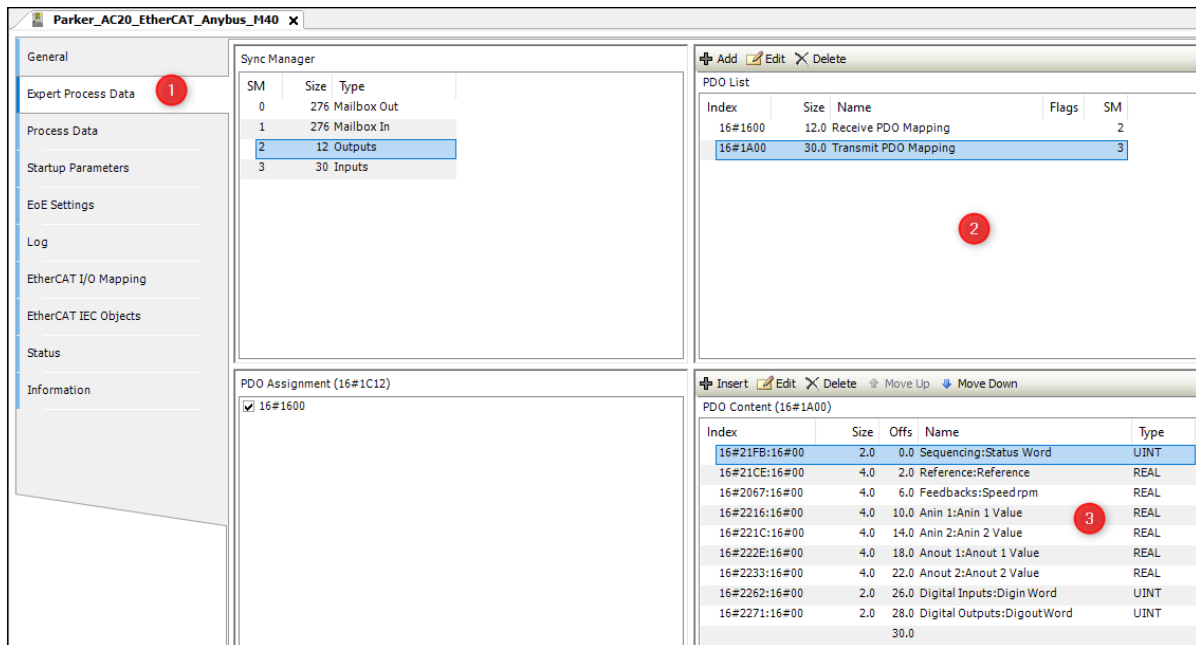
Note: The AC20 Input/Output mapping table will be set to zero and will not have effect in this configuration.

- After process data mapping configuration, compile the project then select **EtherCAT I/O Mapping** and assign a name to the variables.
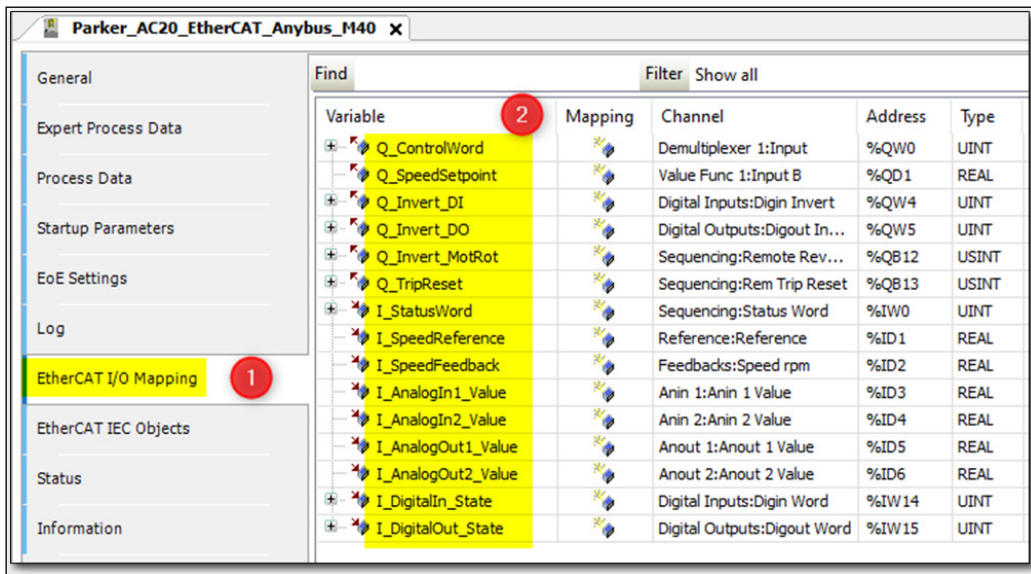
Create a program to transfer data

In the example ladder code below, in Network 1 the data is read from drive to PLC and in Network 2 the PLC writes data to the drive.
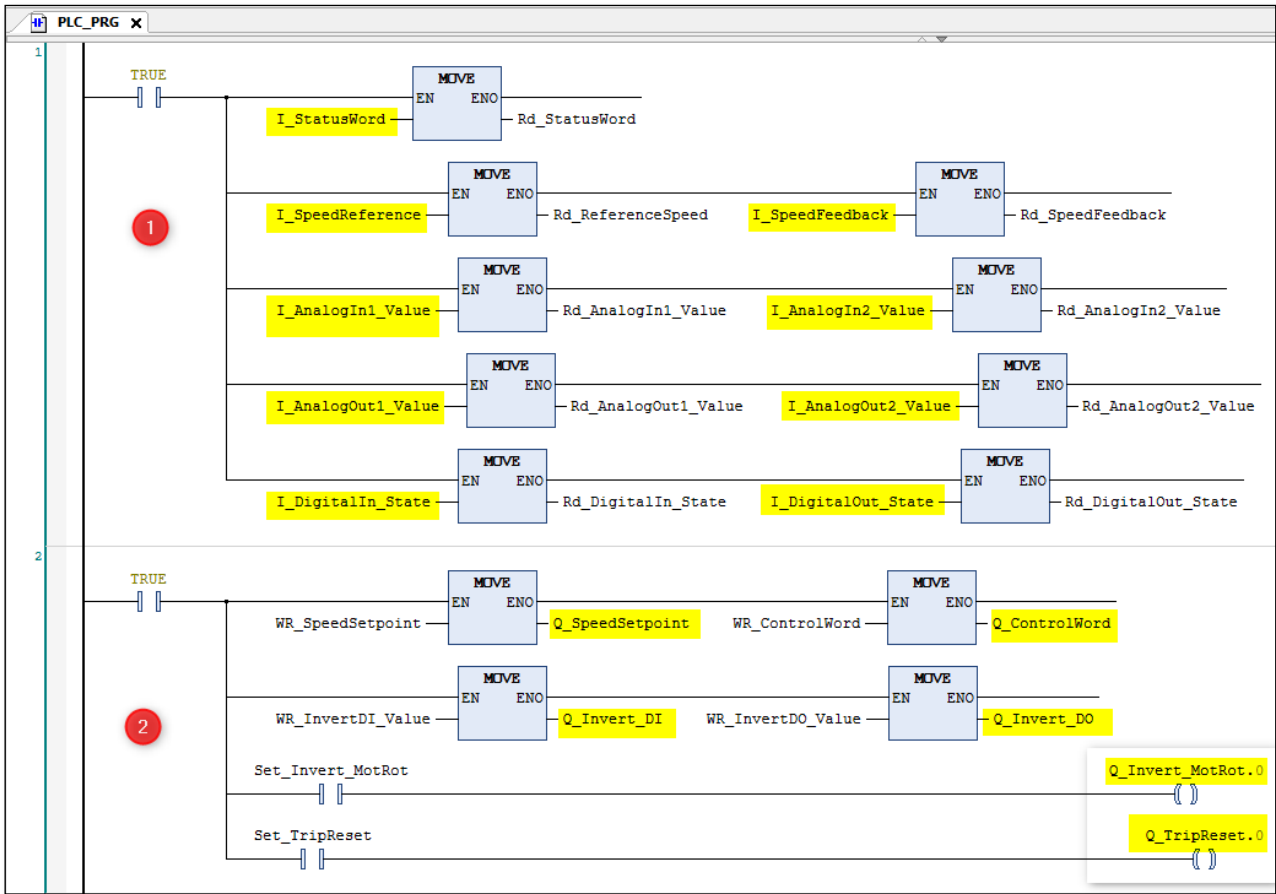
Read / Write parameters Acyclically

The acyclic read / Write services can be achieved using the functions "**ETC_CO_SdoRead"** and
"ETC_CO_SdoWrite".
- Add function block Library: From project tree, double-click on **"Library Manager"**, then Click on
  "add Library" select "**EtherCATStack**" Library and press **OK** to Add.
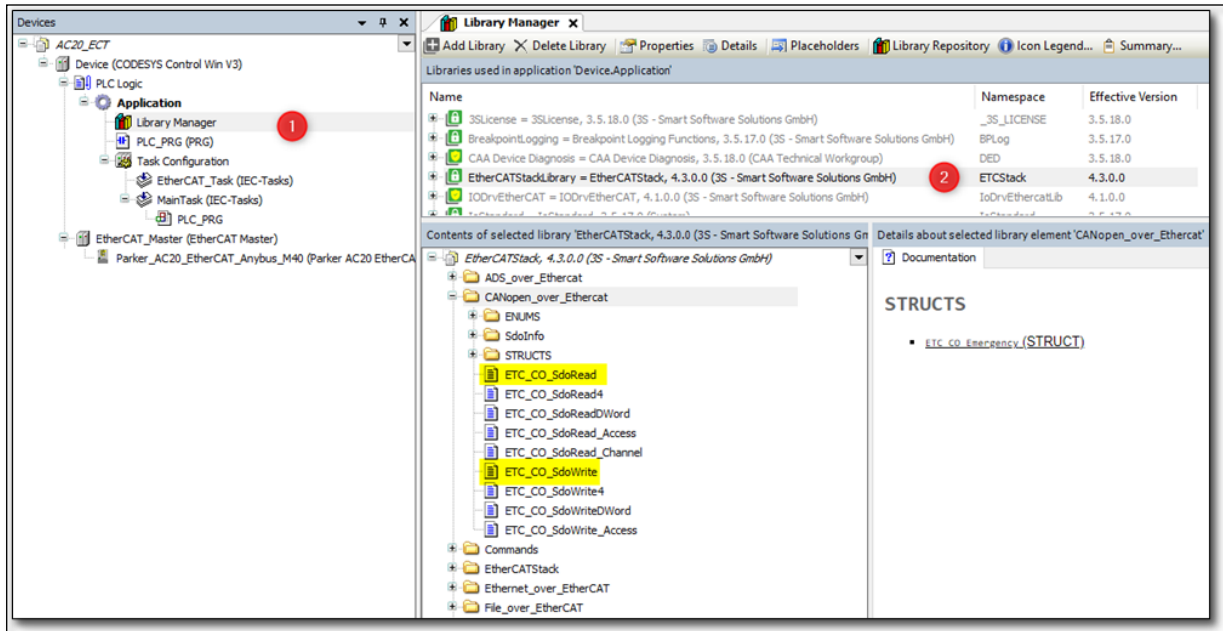
- Example: Read parameter **0056 Current Limit Out** (2038h).
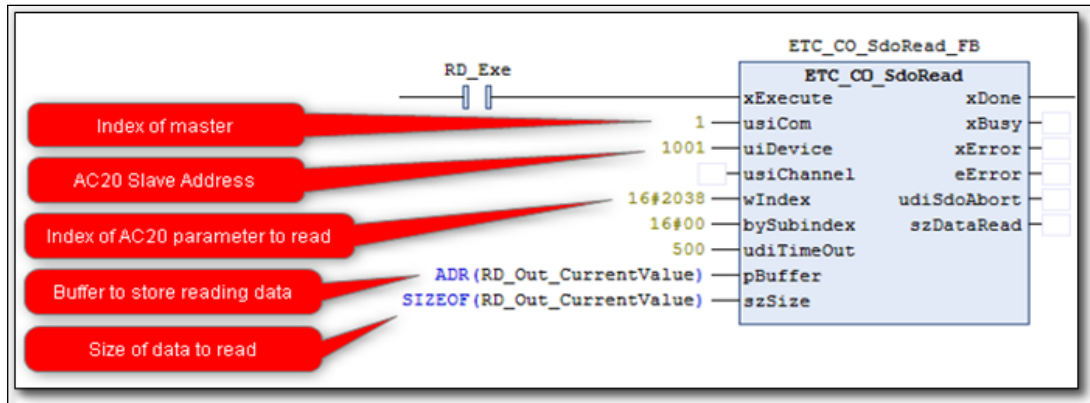
- Example: Write parameter 0457 Motor Max Speed (21C9h).
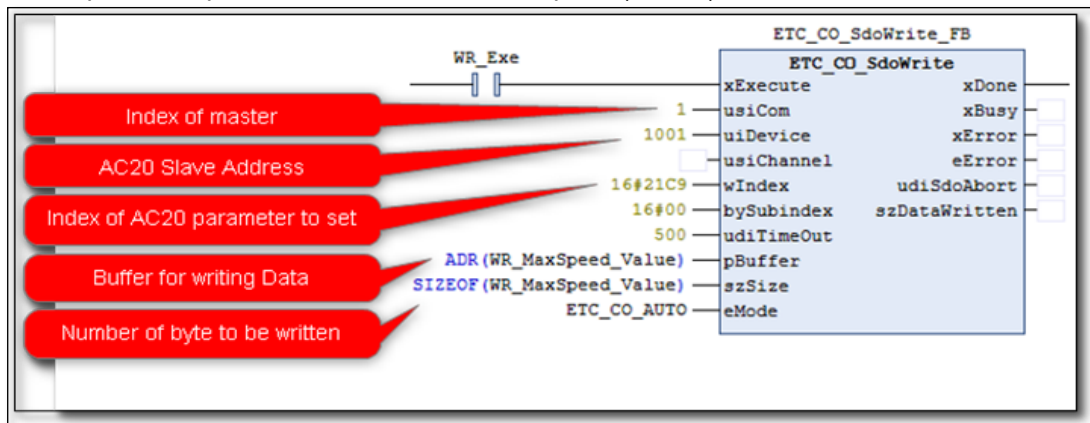
9.4 Programming using TwinCAT platform

The example uses TwinCAT 3 running on a PC as a soft PLC. Prior knowledge of TwinCAT software is assumed.

EtherCAT ESI File Installation

- Download the AC20 EtherCAT option comms ESI file from the Parker website.
- Copy the file ESI into the folder **C:\TwinCAT\3.1\Config\IO\EtherCAT**.

Create a project

- Launch TwinCAT XAE from windows taskbar > Notification, then click on open a New TwinCAT project to create a new project.
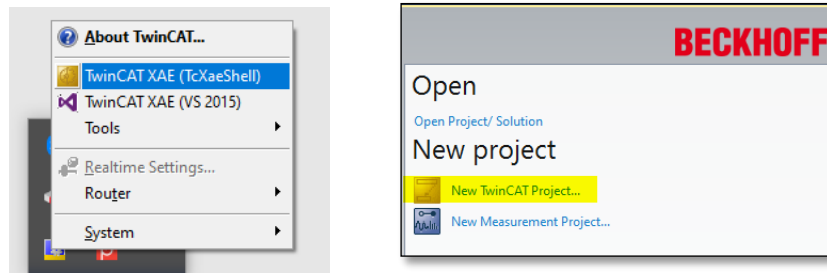
- Define project properties, then press **OK**.
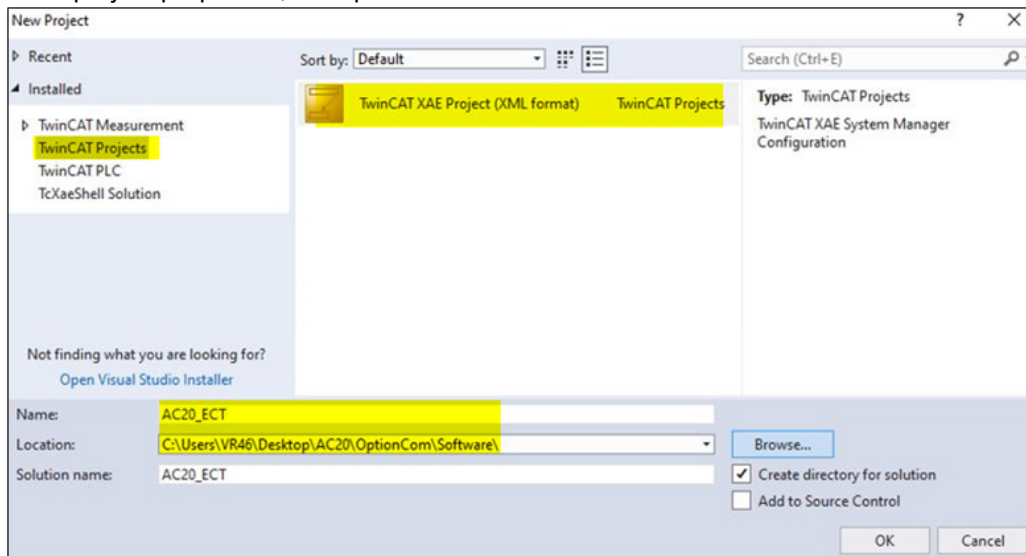
Add EtherCAT Slave

- Check the target system and the state
- Target system should be in **Config mode** for system setting.

Config Process Data Mapping

Option 1: Using AC20 Input and output mapping tables

- The parameter **2566 MASTERMAPPING** must be set to **FALSE** to prevent the PLC from overwriting the mapping.
- Through the mapping tables from the keypad, DSE Lite or Webserver, add parameter numbers into the appropriate table.

Note: If the first row of a table (input mapping or Output mapping) is empty or equal to 0, the table will not be accessible and configurable from PLC.

- In TwinCAT, right click **I/O > Devices** and scan the network
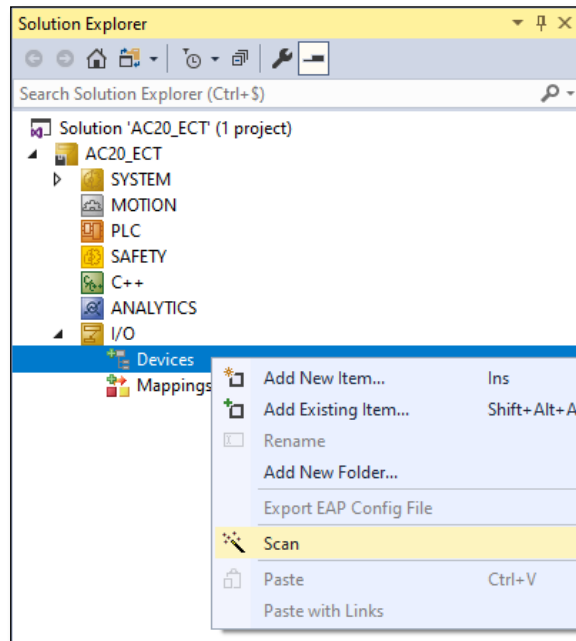
- Select the EtherCAT port and deselect any other Ethernet ports.
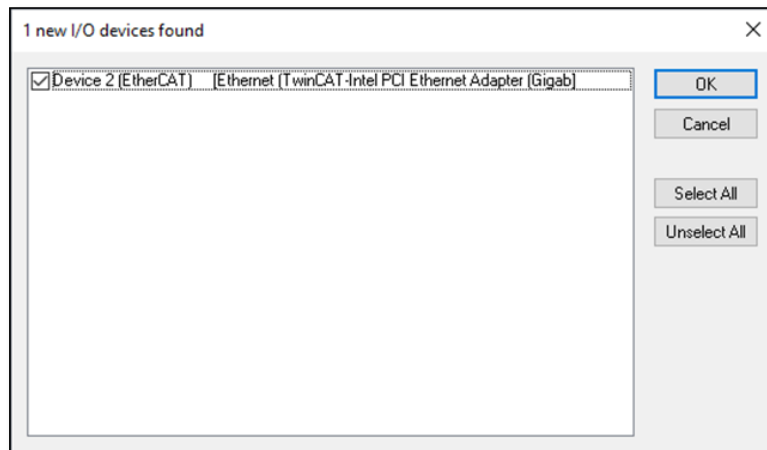
- Select **YES** to scan for connected EtherCAT devices.
- Select **YES** to activate Free Run mode. The FREE RUN mode is useful for testing the I/O and therefore checking the wiring without having to need to create a PLC program.
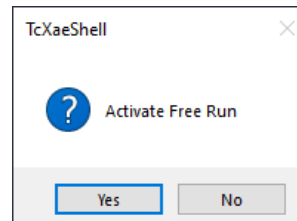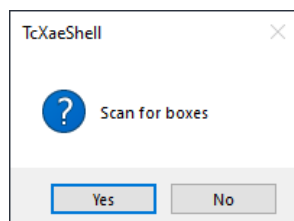
- Once the scan process has been completed, a tree structure corresponding to the order appears in the project under I/O / Devices.
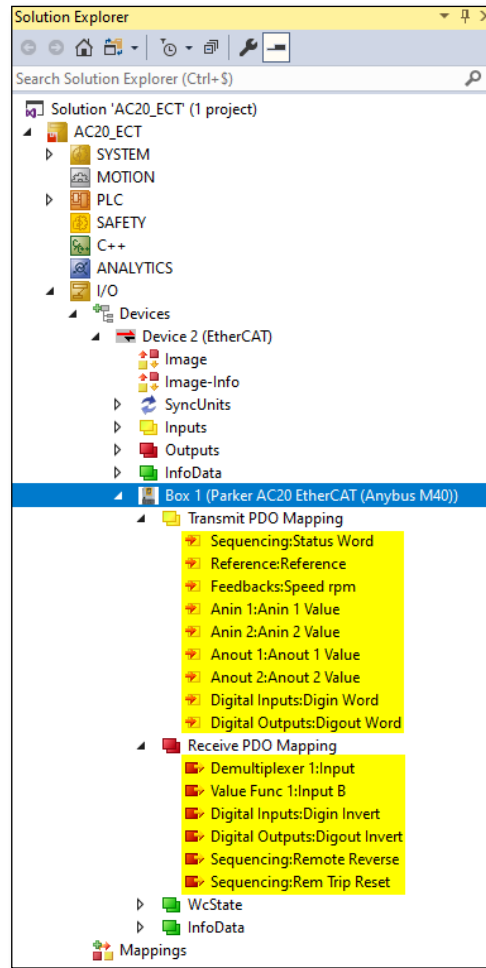
- If you change slave mapping table after the operation described above, you will need to click **AC20 slave** in the **TwinCAT I/O tree** to open device tabs, click on **process data**, Uncheck **PDO Configuration**, then click on **Load PDO info from device** to load the updated mapping table into the project.
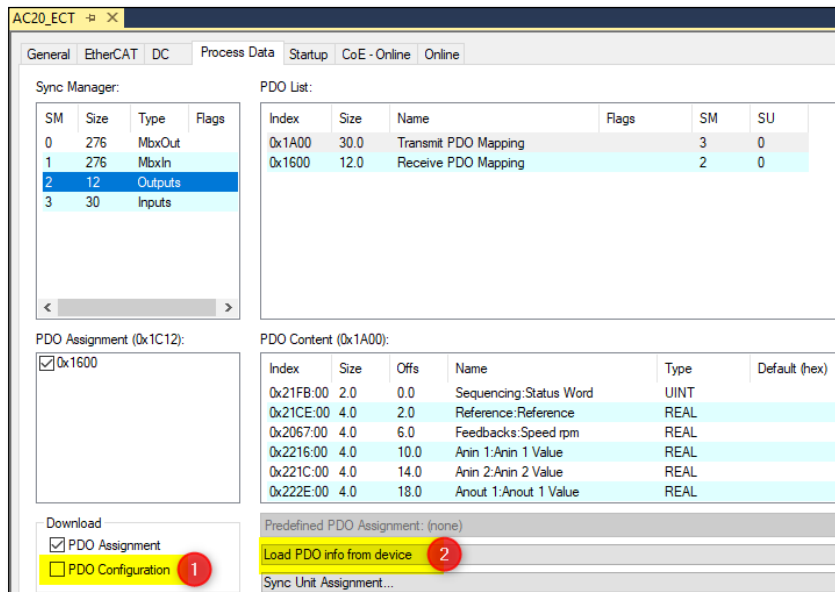
Option 2 : From PLC

- The parameter **2566 MASTERMAPPING** must be set to TRUE to allow the PLC to transfer the mapping to the AC20.
- In TwinCAT, from project tree right-click "**I/O > Devices**" and **scan the network**, to add EtherCAT master and AC20 device.
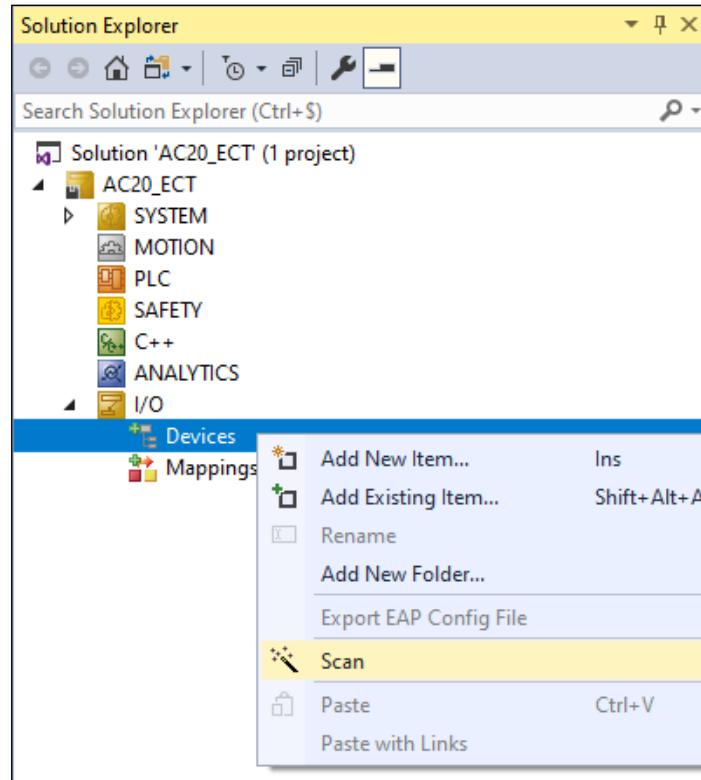
- Click on **Box 1 (Parker AC20 EtherCAT (Anybus M40))**, select **Process data**, make sure **PDO Configuration** is checked.
- In the **PDO list** Pane, select **Transmit PDO Parameter** or **Receive PDO Parameter**, then in **PDO Content**, right click a row and select item from object directory in the opened Tab. Click **OK**.
- Repeat this task to add all parameters required. *(see Codesys example above data for mapping table).*

- Right click **PLC**

- Add the standard PLC and define properties
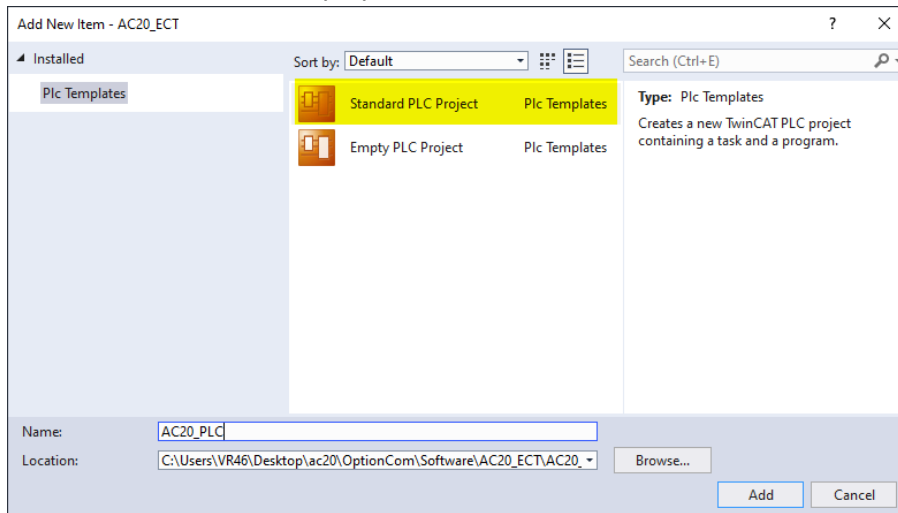
- Enter type and address of the variable (**AT%I* : Input / AT%Q: Output**). Right click **AC20_PLC Project** select **Add > Global Variable List…** and edit variables that should be linked to the AC20 I/O module.
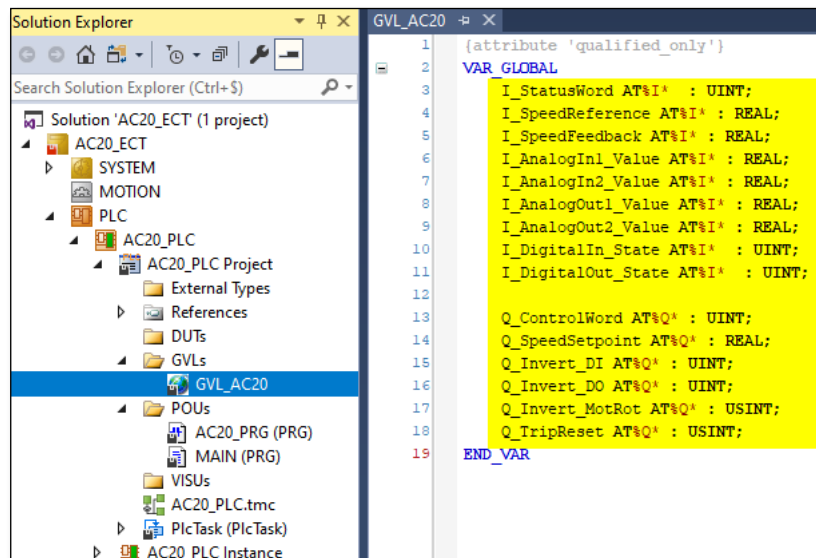
- Right click **AC20_PLC Project** select **Add > POU** to add a ladder program, Edit program and call it from the main routine.
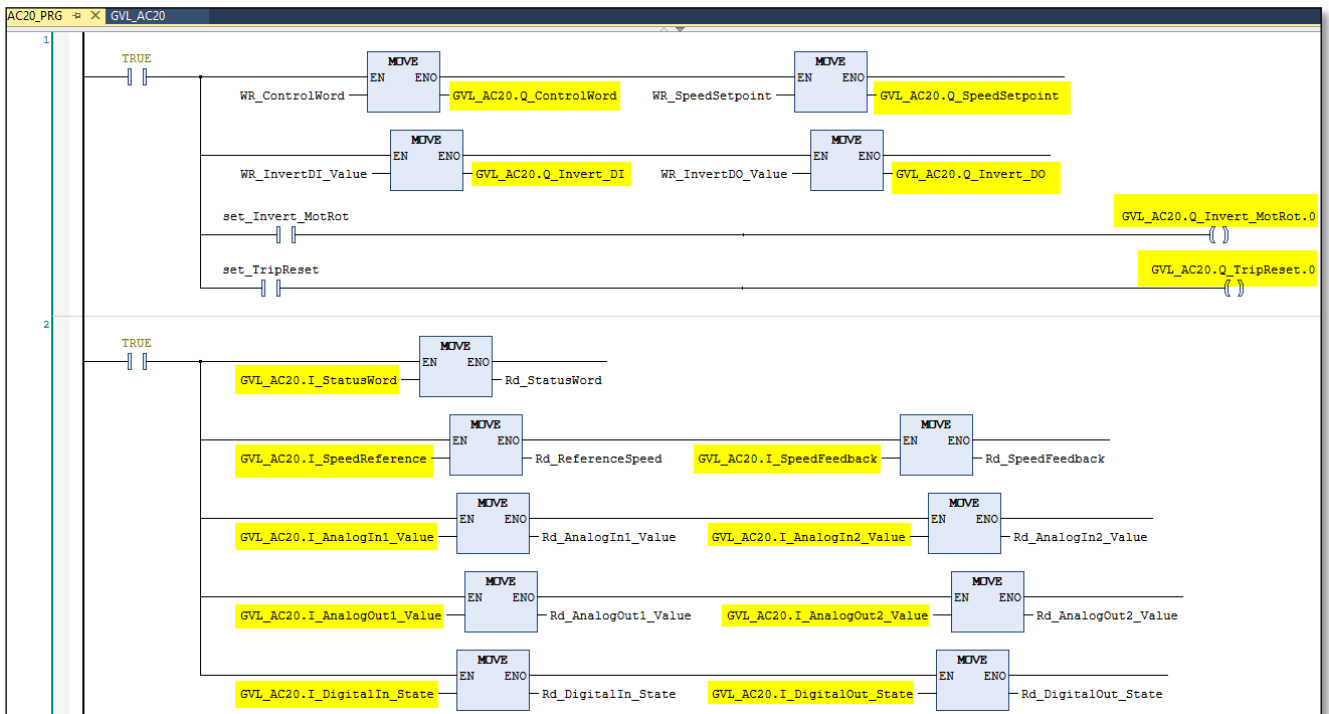
- **Save All** and build

Link AC20 I/O to the PLC

- From I/O tree double-click AC20 Input or output module, select **Linked to…** then select the variable from the list: Link to the physical Input or Output module.
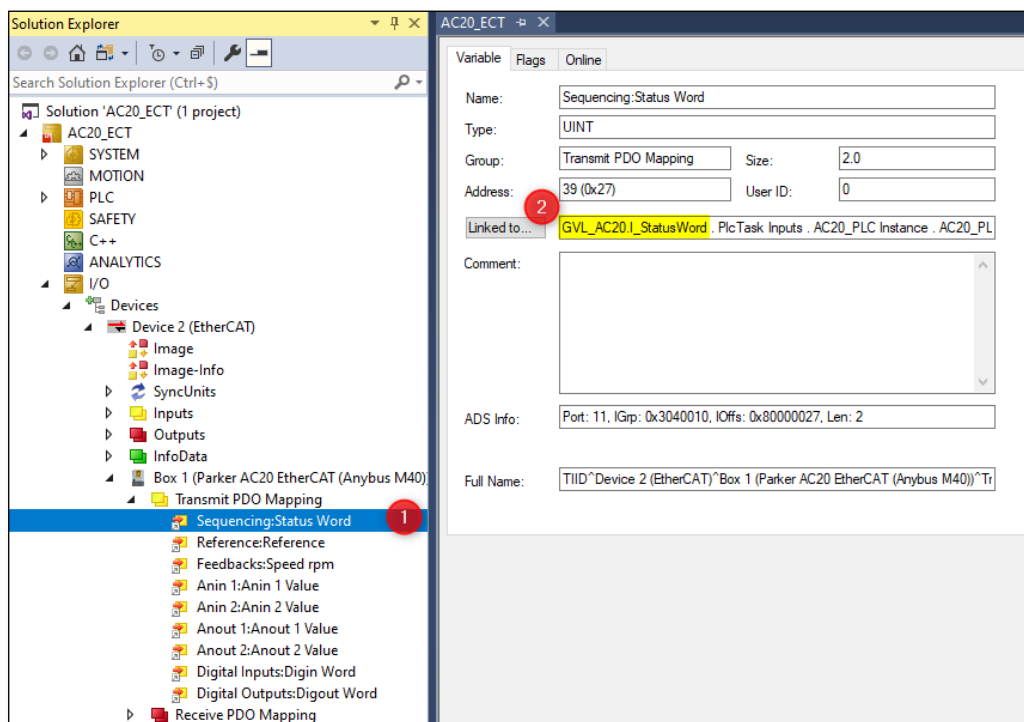
- Perform the steps above for all the AC20 I/O objects.

Read / Write parameters Acyclically

The acyclic read / Write services can be achieved using the functions **FB_EcCoESdoRead** and **FB_EcCoESdoWrite.**

- From project tree, double-click on **References** to open the Library manager, then Click on **add Library** select the **Tc2_EtherCAT** Library and press **OK** to Add.
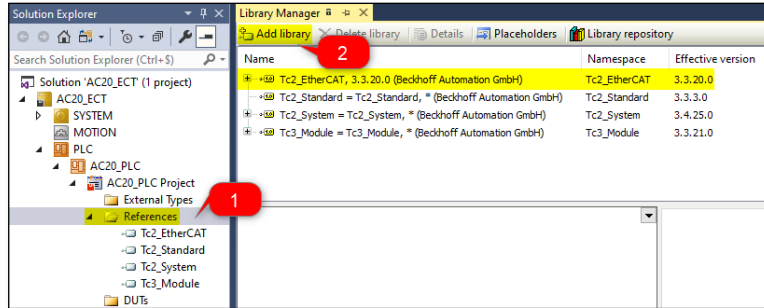
- Example: Read parameter **0056 Current Limit Out** (2038h).
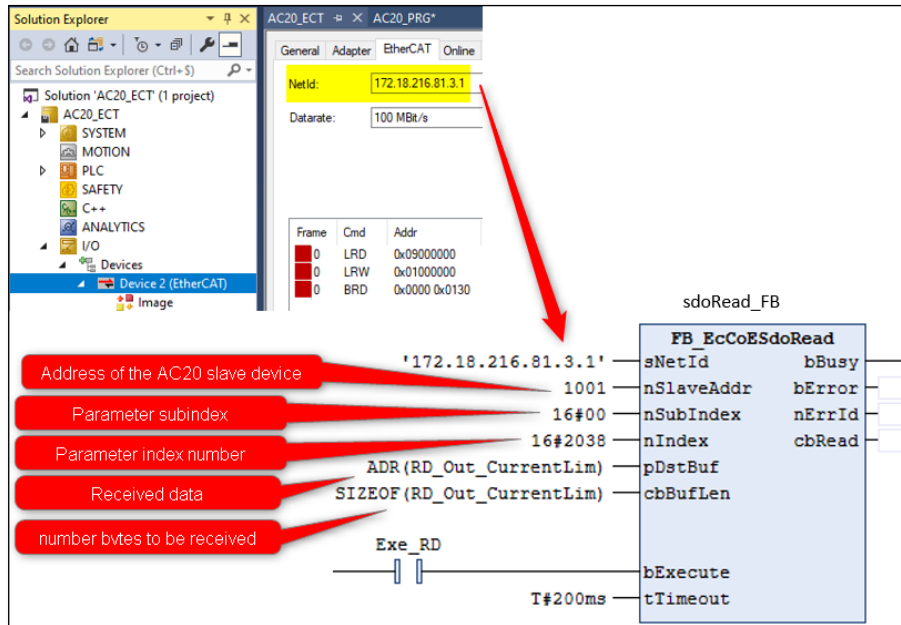
- Example: Write parameter 0457 Motor Max Speed (21C9h).
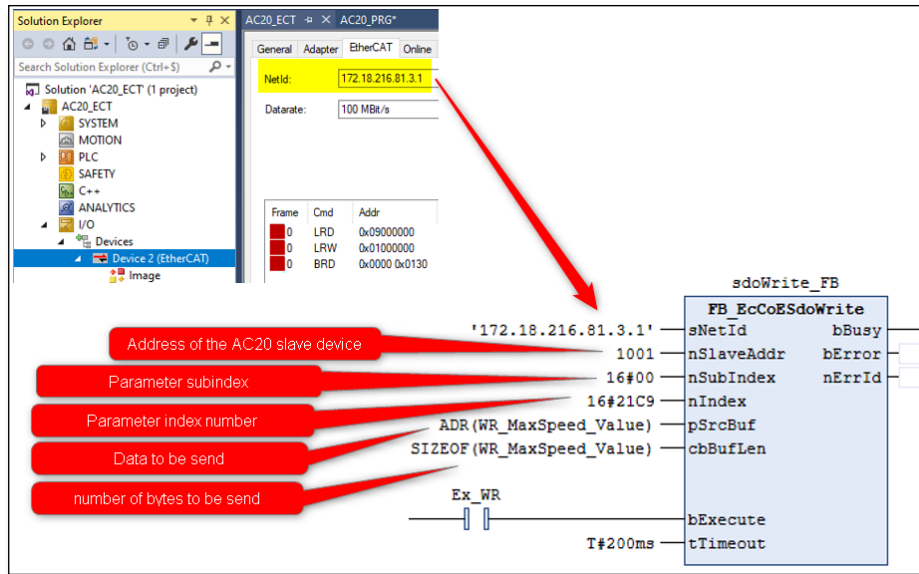
Start TwinCAT Runtime

- Enable Config: Press **Activate Configuration.**
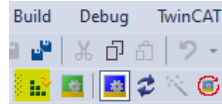
- Wait and verify Run Mode

- Build the PLC and Login
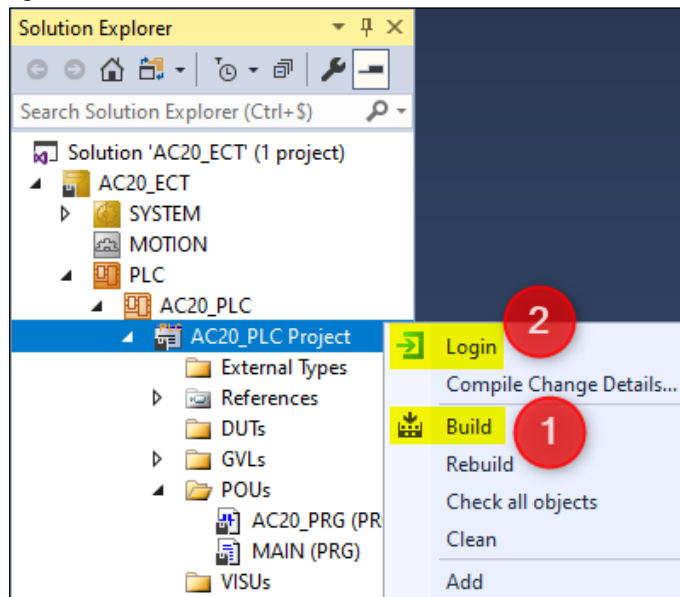
10 Lost Communication Trip

Supervised Parameter:

The **0777 Comms Supervised** parameter indicates that the EtherCAT network participation is supervised by another EtherCAT device.

The Supervised parameter value is set to TRUE when either:

   The heartbeat consumer and Heartbeat producer is enabled and error free.

   Node guarding is enabled and error free.

Note that the watchdog will not be available if the Read Process data size is zero, in which case the Supervised parameter will be FALSE.

Comms Break Trip

The drive will trip when there is a loss of communications between the master and the drive.

A COMMS BREAK trip will occur if the **0777 Comms Supervised** parameter transitions from TRUE to FALSE and the drive is in the operational state.

The trip may be disabled by clearing the respective bit in the parameter **0870 Enable Trips Lo**. The parameter Enable Trip Lo is a 32-bit word, the bit number 27 is used to disable or to enable the trip.

Comms state

The parameter **0774 Comms State** indicates 'PROCESS_ACTIVE' when the EtherCAT communication is active. The table below describes how the comms state relates to the EtherCAT network:

Comms State	Comments
WAIT_PROCESS	INIT, BOOTSTRAP or PRE-Operational
IDLE	SAFE-OPERATIONAL
PROCESS_ACTIVE	Operational: the network process data channel is active
ERROR	(Error Ind'-bit in 'AL-Status' is set)
EXCEPTION	EtherCAT interface is forced to INIT state, and the master is informed that a power cycle is required to resume communication

11 Diagnostic Event

Configuration problems can often be identified by looking at the Run and Error LEDs and from the EtherCAT State and Comms Diagnostic **0775 parameters.** Under normal operating conditions the Comms diagnostic parameter should indicate **OK**. Other values are summarized in the Diagnostic Parameters section.

Hardware Mismatch

> Diagnostic = HARDWARE MISMATCH:
> The required option does not match the actual fitted option.
> No option is fitted but one is required.

Invalid Configuration

> Diagnostic = INVALID CONFIGURATION:
> Invalid read or write process data mapping
> Invalid communication settings

Diagnostic = MAPPING FAILED:
> Attempting to map a parameter that does not exist.
> Attempting to map a configuration parameter.
> Attempting to map a read-only parameter to the read process data.

Other Diagnostics

> Diagnostic = EXCEPTION :
> Module has gone into an unrecoverable exception state

> Diagnostic = UNSUPPORTED OPTION:
> The fitted option is not supported by the drive

> Diagnostic = NOT RESPONDING:
> no initial response from the option

When a diagnostic event is entered a new entry is created in object entry 1003h (pre-defined error field) The Error Register (object 1001h) is set with the corresponding bit information.

High Byte		Low Byte	
Not used	Not used	Event Code	00h

The EMCY Object is sent to the network with the following information:

Byte 0	Byte 1	Byte 2	Byte 3 Byte7
00h	Event Code	Event Register (1001h)	Not used

EMCY Error Code	Description
8110h	CAN controller signaled a lost message
8120h	CAN controller reached the warning limit due to error frames.
8210h	A received PDO was smaller than specified by the valid mapping table
8220h	The DLC of a received PDO exceeded the length specified by the mapping table.
8130h	An error control event has occurred (either a life guarding or heartbeat event).
8140h	CAN controller has recovered from a BUS OFF state.
8150h	COB-ID collision detected.
FF01h	Process data remap was NAKed by the host application. No valid process data map available.

APPENDIX A: Data types

The relationship between AC20 parameter and CANopen data type is given in the table below.

AC20 Parameter		CIP	
Data Type	**Description**	**Data Type**	**Bytes**
BOOL	Boolean	BOOL	1
SINT	Short integer	SINT	1
INT	Integer	INT	2
DINT	Double integer	DINT	4
USINT	Unsigned short integer	USINT	1
UINT	Unsigned integer	UINT	2
UDINT	Unsigned double integer	UDINT	4
REAL	Floating point	FLOAT	4
TIME	Duration	UDINT	4
DATE	Date	UDINT	4
TIME_OF_DAY	Time of day	UDINT	4
DATE_AND_TIME	Date and time of day	UDINT	4
STRING	String	SHORT_STRING**	n
BYTE	Bit string length 8	USINT	1
WORD	Bit string length 16	UINT	2
DWORD	Bit string length 32	UDINT	4

Arrays

Some parameters have multiple elements and are classified as parameter arrays. A parameter array has a parameter number that accesses the *whole* of the array. It also has parameter numbers that represent each *element* of the array.

Array Example: A parameter array called **VHZ_USER FREQ** has 11 elements.

Parameter Number	Parameter - VHZ_USER FREQ
0145	whole array
0146	index 0
0147	index 1
…	…
0157	index 10

If the parameter number of the whole array is 0145, then the parameter number of the element index 0 of the array will be 0134, the parameter number of the element index 01 will be 0147, etc.

String

A string parameter may be accessed via its parameter number.

APPENDIX B: Parameters

Function Block Inputs

Parameter Name	No.	Default Value	Range	Units	Type	Writable
COMMS REQUIRED	691	1: None	0: Unknown 1: None 2: CANopen 3: EtherCAT 4: Ethernet IP 5: Modbus RTU 6: Profibus 7: Profinet		ENUM	CONFIG
Communications option required.						
ADDR ASSIGNMENT	758	0: External	0: External 1: Fixed 2: DHCP		ENUM	CONFIG
Method for assigning the IP address.						
SET IP ADDRESS	759	0			ADDR	CONFIG
Ethernet option IP address						
SET SUBNET MASK	760	0			ADDR	CONFIG
Ethernet option subnet mask.						
SET GATEWAY ADDR	761	0			ADDR	CONFIG
Ethernet option gateway address.						
ACCESS	762	31: 31	0: IP Config Enable 1: Web Enable 2: Web Parameters Enable 3: FTP Enable 4: FTP Admin Mode		WORD	CONFIG
Ethernet access using comms option (bitwise)						
NODE ADDRESS	763	0			USINT	CONFIG
Communications node address.						
CANOPEN BAUD	764	9: Auto	0: 10 kbps 1: 20 kbps 2: 50 kbps 3: 100 kbps 4: 125 kbps 5: 250 kbps 6: 500 kbps 7: 800 kbps 8: 1000 kbps 9: Auto 10: Lss		ENUM	CONFIG
Required baud Rate for CANopen.						
MODBUS BAUD RATE	765	4: 19200 BPS	0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps 5: 38400 bps 6: 57600 bps 7: 76800 bps 8: 115200 bps		ENUM	CONFIG
Required baud Rate for Modbus RTU						
PARITY	766	0: Even 1 Stop	0: Even 1 Stop 1: Odd 1 Stop 2: None 2 Stop 3: None 1 Stop		ENUM	CONFIG
Modbus parity and stop bits						
HIGH WORD FIRST	767	FALSE			BOOL	CONFIG
For 32-bit values high word comes first if set to TRUE.						
ACTIVE TIMEOUT	768	0	0 to 65		TIME	CONFIG
Process active timeout period.						

Parameter Name	No.	Default Value	Range	Units	Type	Writable
MASTERMAPPING	2566	TRUE			BOOL	CONFIG
Switch to choose how the PROFInet, EtherCAT, PROFIbus and CanOpen PDO mapping is defined: If TRUE the bus master sets/configures the PDO mapping. The drive mapping parameters 692...757 are cleared (set to zero) and made invisible (GKP and website) as this the required condition. If FALSE the mapping parameters 692...757 are visible (Keypad and webserver) can be used to define the PDO mapping from drive side (which the bus master then can upload). The switch is considered during drive startup (stopped -> operational transition).						

Function Block Outputs

Parameter Name	No.	Default Value	Range	Units	Type	Writable
COMMS FITTED	769	0: Unknown	0: Unknown 1: None 2: CANopen 3: EtherCAT 4: Ethernet IP 5: Modbus RTU 6: Profibus 7: Profinet		ENUM	NOT
Communications option fitted.						
COMMS VERSION[0]	770	0			USINT	NOT
Firmware version of the comms module.						
COMMS VERSION[1]	770	0			USINT	NOT
Firmware version of the comms module.						
COMMS SERIAL NUM	773	0			DWORD	NOT
Serial number of the comms module.						
COMMS STATE	774	8: None	0: Setup 1: NW Init 2: Wait Process 3: Idle 4: Process Active 5: Error 6: Reserved 7: Exception 8: None		ENUM	NOT
State of the option comms.						
DIAGNOSTIC	775	0: Ok	0: Ok 1: Hardware Mismatch 2: Invalid Configuration 3: Mapping Failed 4: Exception 5: Unsupported Option 6: Not Responding		ENUM	NOT
Diagnostic for the comms option.						
EXCEPTION CODE	776	0			WORD	NOT
Diagnostic code on option entering exception state. The MSB is the exception code and the LSB is the exception info.						
COMMS SUPERVISED	777	FALSE			BOOL	NOT
Indicates a master has made a connection to the device.						
MAPPING CHANGED	778	FALSE			BOOL	NOT
The PLC has changed the process data mapping from that set by the drive.						
STATION NAME	779				STRING	NOT
Current PROFINET station name.						
IP ADDRESS	787	0			ADDR	NOT
Current Ethernet option IP address.						
SUBNET MASK	788	0			ADDR	NOT
Current Ethernet option subnet mask.						
GATEWAY ADDRESS	789	0			ADDR	NOT
Current Ethernet option gateway address.						

Parameter Name	No.	Default Value	Range	Units	Type	Writable
ACTUAL BAUD RATE	790	0: 10 kbps	0: 10 kbps 1: 20 kbps 2: 50 kbps 3: 100 kbps 4: 125 kbps 5: 250 kbps 6: 500 kbps 7: 800 kbps 8: 1000 kbps 9: Auto 10: lss		ENUM	NOT
Actual CANopen baud rate.						

APPENDIX C: DSE Lite Quick Start Guide

Follow the steps below to configure the AC20 via DSE Lite PC-Tool.

The block diagram of the AC20 may be accessed through the onboard webserver or DSE Lite.

DSE Lite is recommended.

The IP address of the AC20 is in the range 169.254.xx.xx by default. Therefore, the user's PC network adapter must be configured to this range as shown below (IPv4 is used for communication).
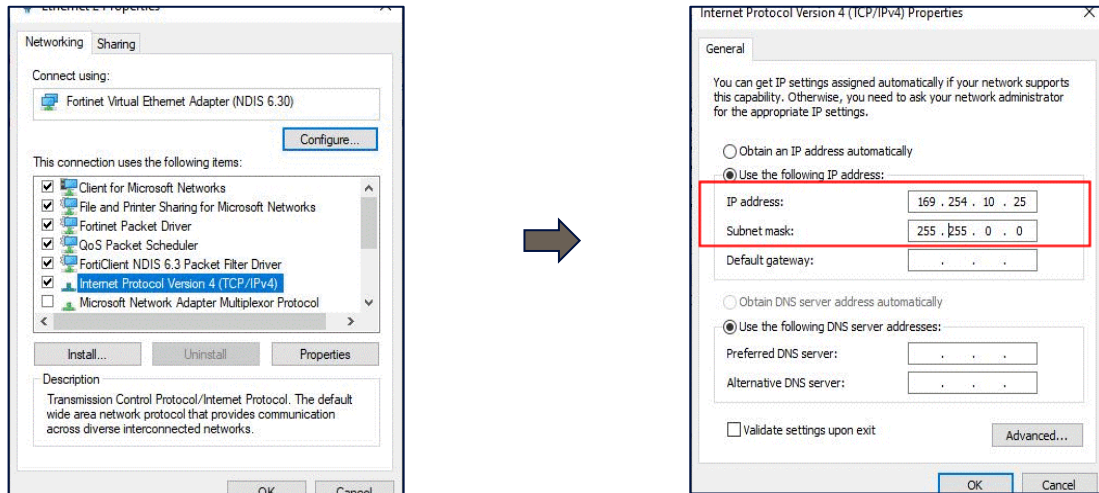
Alternatively, the IP address of the drive may be changed to suit the settings of the PC network adapter. The IP address of the drive can be configured using the DCT function, accessible from within DSE Lite by selecting Command -> Install AC15/AC20 Firmware.
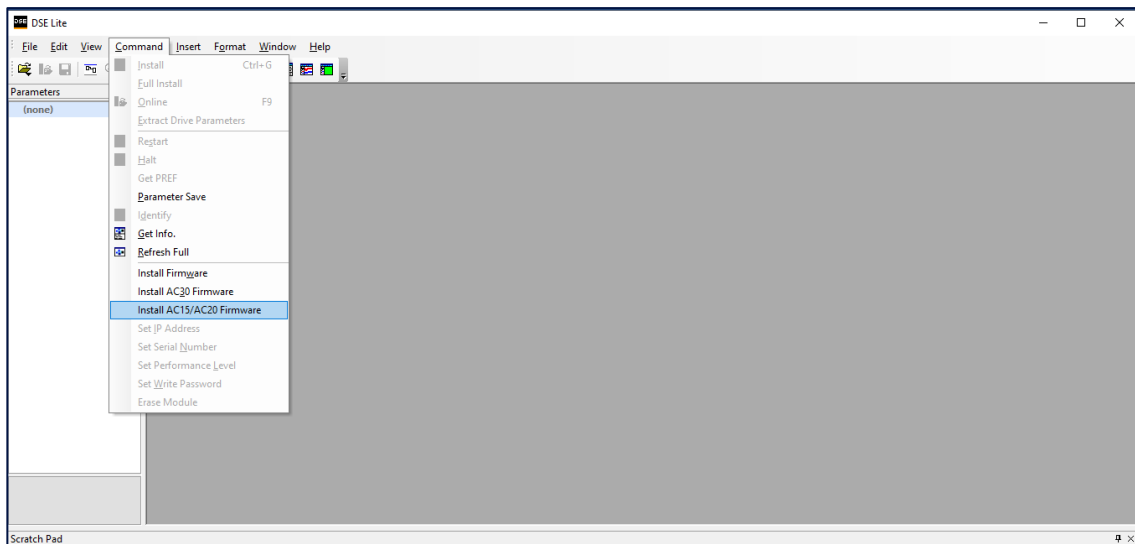
Once the network scan is completed, then the drive settings can be edited.
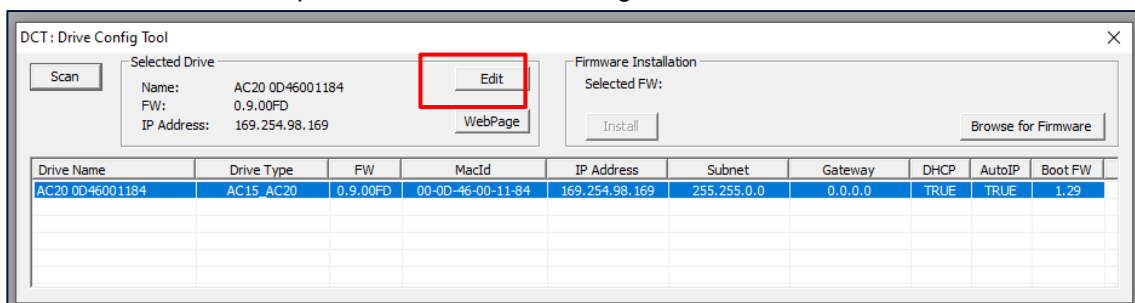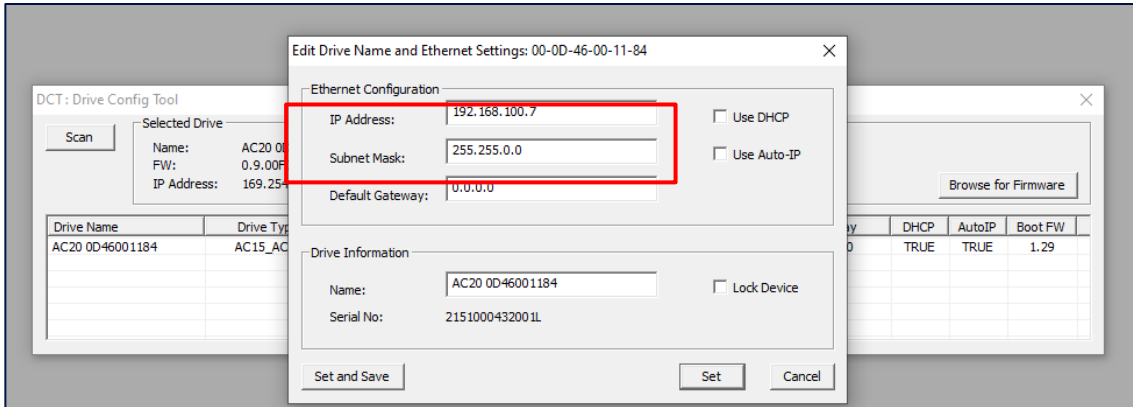
If the drive is not found by DSE lite, or a new drive is connected to the Ethernet port, a network scan must be performed again, as blow.
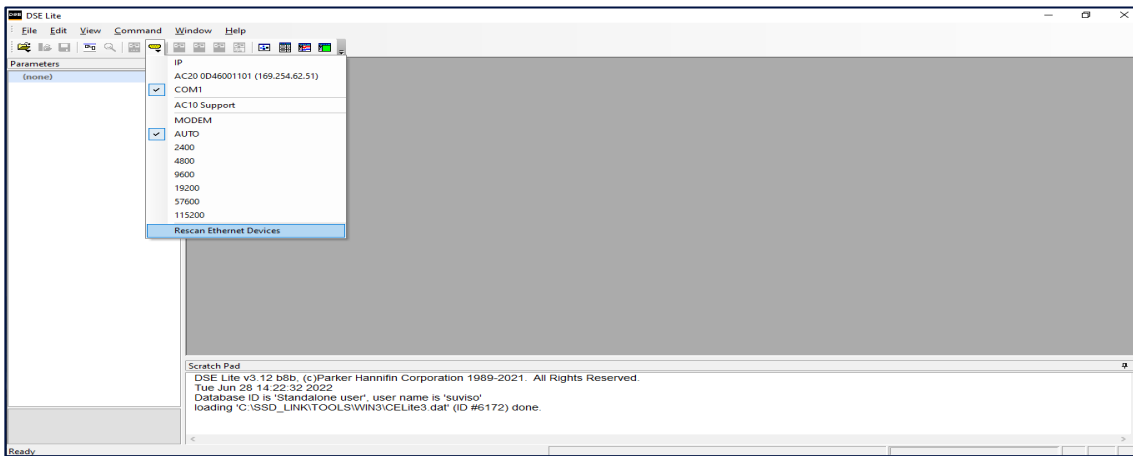
Once the network scan has been performed, any AC20 connected to the network will appear and DSE lite can connect to the drive.
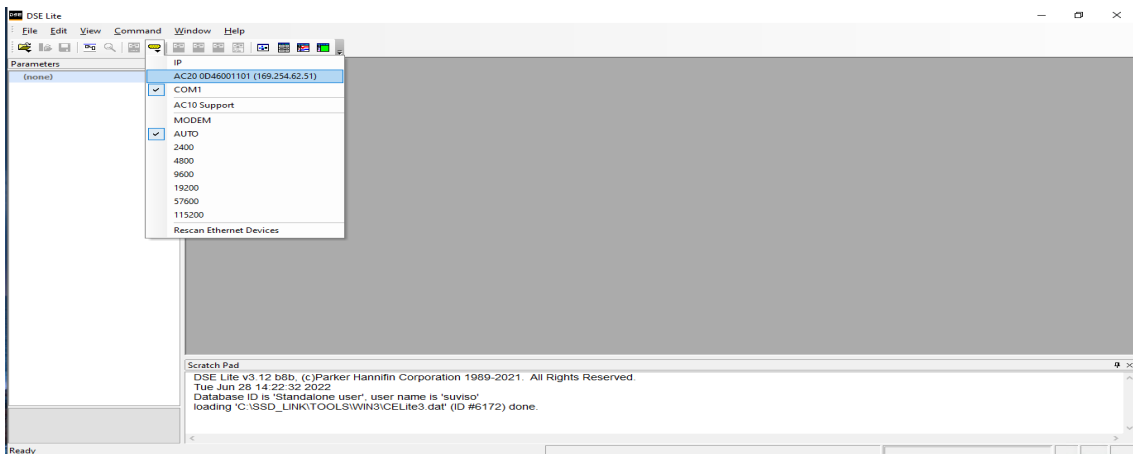
When connected to a drive, this is shown in the scratch pad.
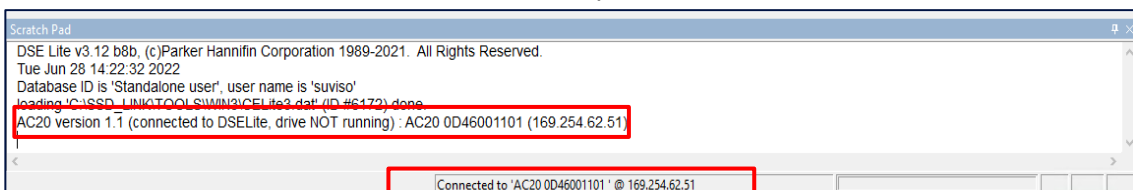
APPENDIX D: Object directory (CANopen over EtherCAT) Standard

The standard object dictionary is implemented according to the DS301 communication profile. Note that certain object entries correspond to settings in the EtherCAT Object (F5h), and the Diagnostic Object (02h).

| Index	Object Name	Sub-Index	Description	Type	Access	Note
1000h	Device Type	00h	Device Type	U32	RO	EtherCAT Object
1001h	Error Register	00h	Error Register	U8	RO	Diagnostic Object
1003h	Pre-define error field	00h	Number of errors	U8	RW	Diagnostic Object
		01h..06h	Error field	U32	RO	
1008h	Manufacturer device name	00h	Manufacturer device name	Visible string	RO	EtherCAT Object
1009h	Manufacturer hardware version	00h	Manufacturer hardware version	Visible string	RO	EtherCAT Object
100Ah	Manufacturer software version	00h	Manufacturer software version	Visible string	RO	
1011h	Restore parameters	00h	Largest sub index supported	U8	RO	01h
		01h	Restore all default parameters	U32	RW	-
1018h	Identify object	00h	Number of entries	U8	RO	Number of entries
		01h	Vendor ID	U32	RO	EtherCAT Object
		02h	Product Code	U32	RO	
		03h	Revision Number	U32	RO	
		04h	Serial Number	U32	RO	
1600h – 1xxxh	Receive PDO mapping	00h	No. of mapped application objects in PDO	U8	RO/RW	0..254
		01h	Mapped object #1	U32	RO/RW	-
		…	…	…	…	-
		NNh	Mapped object #NN	U32	RO/RW	-

Index	Object Name	Sub-Index	Description	Type	Access	Note
1A00h – 1xxxh	Transmit PDO mapping	00h	No. of mapped application objects in PDO	U8	RO/RW	0..254
		01h	Mapped object #1	U32	RO/RW	-
		…	…	…	…	…
		NNh	Mapped object #NN	U32	RO/RW	-
1C00h	Sync Manager Communication Type	00h	Number of entries	U8	RO	4
		01h	Mailbox wr	U8	RO	1
		02h	Mailbox rd	U8	RO	2
		03h	Process Data Out	U8	RO	3
		04h	Process Data In	U8	RO	4
1C12h	Sync Manager Rx PDO Assign	00h	No. of assigned PDOs	U8	RO/RW	Only writable in PREOP device state
		01h-NNh	Assigned PDO	U16	RO/RW	
1C13h	Sync Manager Tx PDO Assign	00h	No. of assigned PDOs	U8	RO/RW	Only writable in PREOP device state
		01h-NNh	Assigned PDO	U16	RO/RW	

Index	Object Name	Sub-Index	Description	Type	Access	Note
1C32h	Output SyncManager Parameter	00h	Number of entries	U8	RO	12 (0Bh)
		01h	Synchronization Type	U16	RO/RW	00h: Free Run 02h: DC Sync0
		02h	Cycle Time	U32	RW	Cycle time in nanoseconds
		03h	Shift Time	U32	RW	Shift time in nanoseconds
		04h	Synchronization Types supported	U16	RO	Bit 0 set: FREE_RUN supported Bit 2 set: DC Sync0 Supported. Bit 5 set: Output shift with local timer All other bits are set to 0
		05h	Minimum Cycle Time	U32	RO	Minimum cycle time in nanoseconds.
		06h	Calc and Copy Time	U32	RO	Output Calc and Copy Time in nanoseconds.
		09h	Delay Time	U32	RO	Delay time in nanonseconds. Always set to 0.
		0Ch	Cycle Time Too Small	U16	RO	Cycle time to small
1C33h	Input SyncManager Parameter	00h	Number of entries	U8	RO	12 (0Bh)
		01h	Synchronization Type	U16	RO/RW	00h: Free Run 02h: DC Sync0
		02h	Cycle Time	U32	RO	Cycle time in nanoseconds.
		03h	Shift Time	U32	RW	Shift time in nanoseconds.
		04h	Synchronization Types supported	U16	RO	Bit 0 set: FREE_RUN supported Bit 2 set: DC Sync0 supported. Bit 5 set: Input shift with local timer All other bits are set to 0
		05h	Minimum Cycle Time	U32	RO	Minimum cycle time in nanoseconds,
		06h	Input Calc and Copy Time	U32	RO	Input Calc and Copy Time in nanoseconds.
		0Ch	Cycle Time Too Small	U16	RO	Cycle time to small,

Manufacturer Specific Objects

The exact representation of a parameter depends on its number of elements. In the following example, Parameter no. 0002h and 0004h only contain one element each, causing them to be represented as simple variables rather than arrays. The other parameters have more than 1 element (of the same data type), causing them to be represented as arrays. If a parameter has more than 1 element of different data types, it will be represented as a record.

The offset between the Parameter no. and the object index is always 2000h.

Index	Object Name	Sub-Index	Description	Type	Access
2001h	Parameter 0001h	00h	Number of entries (NNh)	U8	RO
		01h	Parameter value	-	-
		...			
		...			
		NNh			
2002h	Parameter 0002h	00h	Parameter value	-	-
2003h	Parameter 0003h	00h	Number of entries (NNh)	U8	RO
		01h	Parameter value	-	-
		...			
		...			
		NNh			
2004h	Parameter 0004h	00h	Parameter value	-	-
...	...	...	...	...	...
5FFFh	Parameter 3FFFh	00h	Number of entries (NNh)	U8	RO
		01h	Parameter value	-	-
		...			
		...			
		NNh			

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