NORGREN

Operation & Service Manual

VR10 / VR15
With EtherCAT Interface

EtherCAT

IMI

Change history:

The change history reflects all changes of the Operation & Service Manual, which were done after the initial release.

Index	Chapters	Change description	Date	Name
001	All	New Release	27-Nov-2020	GG
002	All	Minor changes about pictures and texts	25-Jan-2021	GG
003	10	Conformance test record change	4-Feb-2021	GG
004	All	Minor changes to text	23-Mar-2021	JR

This Operation & Service Manual makes no claims of being complete as it does not cover all variants of the VR10 / VR15 valve islands.

Therefore, this document is subject to extensions or changes.

1 CONTENTS

2 ABOUT THIS DOCUMENTATION

This User Guide contains the information to set up and operate VR10 / VR15 valve island with EtherCAT Interface and to detect and resolve problems.

Note:

In addition to the specific information for the EtherCAT variants, all data sheets and VR10 / VR15 PROTOCOL / MULTIPOLE SERIES IP65 VERSION Operation & Service Manual are applicable and remain valid.

Refer also to the data sheets on the following web link:

- https://www.norgren.com

Refer also to the valve island installation instruction in the following document:

- "VR10 / VR15 PROTOCOL / MULTIPOLE SERIES IP65 VERSION Operation & Service Manual"
  - This manual can be found on https://www.norgren.com/uk/en/technical-support/installation-maintenance-instructions/valves

Basic information about EtherCAT can be found in the following documents:

- https://www.ethercat.org/download/documents/ETG_Brochure_EN.pdf
- https://www.ethercat.org/download/documents/EtherCAT_Device_Protocol_Poster.pdf

Installation guideline and diagnosis manual about EtherCAT can be found in the following documents:

- https://www.ethercat.org/download/documents/ETG1600_V1i0i2_G_R_InstallationGuideline.pdf
- https://www.ethercat.org/download/documents/EtherCAT_Diagnosis_For_Users.pdf

Further information about EtherCAT is available on ETG websites:

- https://www.ethercat.org
- https://www.ethercat.org/en/technology.html
- https://www.ethercat.org/en/downloads.html

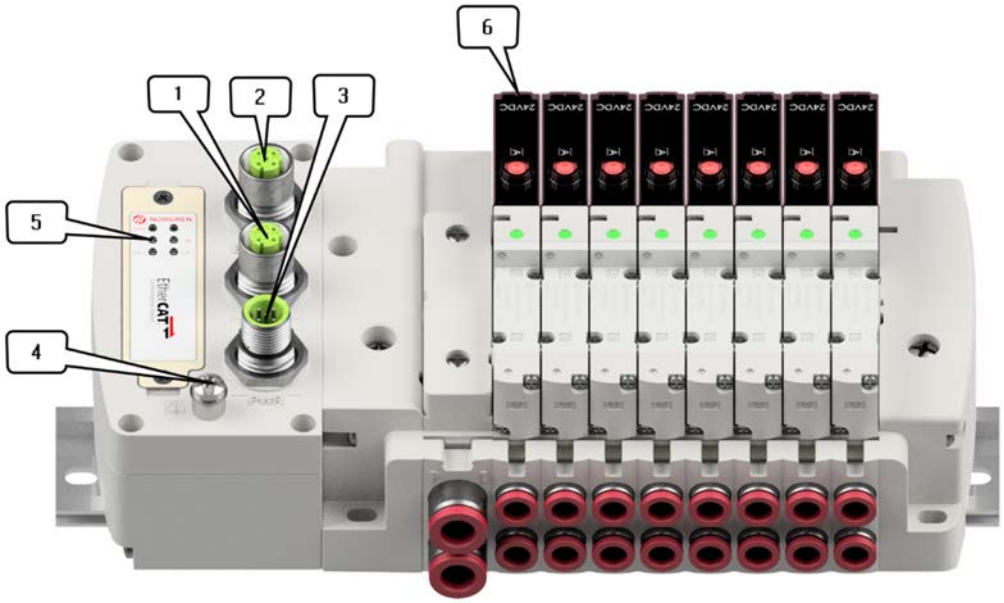
3 IMPORTANT HINTS

3.1 GROUNDING AND EQUIPOTENTIAL BONDING

Proper grounding and equipotential bonding are very important to protect against electromagnetic interferences in EtherCAT networks. In order to reduce potential impact, grounding of the EtherCAT cable screen should be done at both ends of every cable (i.e. at each device). Equipotential bonding ensures that the ground potential is identical throughout the entire EtherCAT network and is essential to avoid equipotential bonding currents, which can otherwise flow through the EtherCAT cable screen. Please refer for further details to the “ETG.1600 EtherCAT Installation Guide” provided by the EtherCAT user organization ETG (https://www.ethercat.org).

For proper grounding please use the earth screw (M4) on the upper side of the valve island. For easy reference see item 4 in chapter 4.

4 ELECTRICAL CONNECTIONS



1- Port 1: BUS IN for EtherCAT

(M12 x 1 | Female | 4 – pin | D – coded)

2- Port 2: BUS OUT for EtherCAT

(M12 x 1 | Female | 4 – pin | D – coded)

3- PWR: Power Supply to Control Module and Valves

(M12 x 1 | Male | 5 – pin | A – coded)

4- Earth screw (M4)

5- Status LEDs

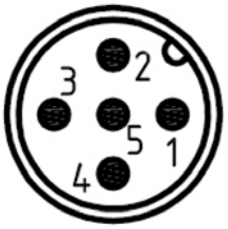
6- Valve status LEDs

4.1 EtherCAT PORT 1 & PORT 2

M12 / 4 pins / Female Connector / D-coded	
Pin No.	Function
1	Transmission Data + (TD +)
2	Receive Data + (RD +)
3	Transmission Data - (TD -)
4	Receive Data - (RD -)

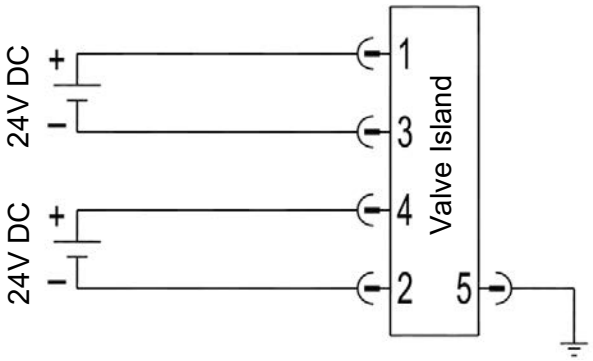
4.2 POWER SUPPLY CONNECTOR

- Pin allocating of power supply connector



M12 / 5 pins / Male Connector / A-coded	
Pin No.	Function
1	L1 (VB +) 24V electronics power supply
2	N2 (VA -) 0V valves power supply
3	N1 (VB -) 0V electronics power supply
4	L2 (VA +) 24V valves power supply
5	FE (functional earth)

- Power supply wiring diagram



Notes:

- Make sure electronics power, valves power and their polarities are connected to correct pins respectively before switching on.
- Select the appropriate cables to mate with the connectors mounted on the control module.
- Connect the earth screw to ground.

4.3 ELECTRICAL DATA

Specification		Remark
Valve voltage range (VA)	24VDC +10%/-5%	PELV
Electronics voltage range (VB)	24VDC +/-10%	PELV
Maximum currents	VA: n × 40 mA VB: < 100 mA	n = number of solenoids
Voltages are galvanic decoupled	Yes	---
Protection against polarity reversal	Yes	---
Overcurrent protection VB, VA	Irreversible	---
Output polarity	PNP	---

5 SOLENOID NUMBER, OUTPUT POINT & VALVE STATION MAPPING

5.1 MAPPING RULES FOR VALVE STATIONS ≤ 12

- If valve stations ≤ 12, 2 solenoid numbers are always reserved for each valve station. *
  Detailed allocation is shown as below:

Station	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
Solenoid A	Sol.01	Sol.03	Sol.05	Sol.07	Sol.09	Sol.11	Sol.13	Sol.15	Sol.17	Sol.19	Sol.21	Sol.23
(14 Solenoid)	Output 0	Output 2	Output 4	Output 6	Output 8	Output 10	Output 12	Output 14	Output 16	Output 18	Output 20	Output 22
Solenoid B	Sol.02	Sol.04	Sol.06	Sol.08	Sol.10	Sol.12	Sol.14	Sol.16	Sol.18	Sol.20	Sol.22	Sol.24
(12 Solenoid)	Output 1	Output 3	Output 5	Output 7	Output 9	Output 11	Output 13	Output 15	Output 17	Output 19	Output 21	Output 23

Notes:
*** For valve station with single solenoid, only Solenoid A (14 Solenoid) is connected. Consider the one which is closest to control module as 1st station (Station #1)**

5.2 MAPPING RULES FOR 12 < VALVE STATIONS ≤ 24

- If 12 < valve stations ≤ 24, special rules are required since only 1 solenoid number is allocated to valve station with single solenoid:

  - Sequence all solenoids following the rules below by starting from 1st station which is the station closest to control module:
    - If 1st station is with double solenoids, sequence solenoid A as Sol.01, solenoid B as Sol.02, following 2nd station solenoid A as Sol.03, solenoid B as Sol.04……
    - If 1st station is with single solenoid, sequence solenoid A as Sol.01, following 2nd station solenoid A as Sol.02, solenoid B as Sol.03……
    - If a station is originally configured as blank, always 2 solenoid numbers are allocated.
    - The rest of stations should also adhere to the sequence rules above.
  - A 16-station 24 solenoids valve island example is shown below:

	Double Solenoids	Double Solenoids	Single Solenoid	Single Solenoid	Double Solenoids	Double Solenoids	Single Solenoid	Double Solenoids	Single Solenoid	Double Solenoids	Single Solenoid	Double Solenoids	Single Solenoid	Single Solenoid	Double Solenoids	Single Solenoid
Station	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**	**#11**	**#12**	**#13**	**#14**	**#15**	**#16**
Solenoid A	Sol.01	Sol.03	Sol.05	Sol.06	Sol.07	Sol.09	Sol.11	Sol.12	Sol.14	Sol.15	Sol.17	Sol.18	Sol.20	Sol.21	Sol.22	Sol.24
(14 Solenoid)	Output 0	Output 2	Output 4	Output 5	Output 6	Output 8	Output 10	Output 11	Output 13	Output 14	Output 16	Output 17	Output 19	Output 20	Output 21	Output 23
Solenoid B	Sol.02	Sol.04	--*	--*	Sol.08	Sol.10	--*	Sol.13	--*	Sol.16	--*	Sol.19	--*	--*	Sol.23	--*
(12 Solenoid)	Output 1	Output 3			Output 7	Output 9		Output 12		Output 15		Output 18			Output 22	

Note:
*** For valve station with single solenoid, only Solenoid A (14 Solenoid) is allocated & connected. Consider the one which is closest to control module as 1st station (Station #1).**

6 COMMISSIONING

Notes:

1. The method of EtherCAT module installation strongly depends on the configuration software. Please refer to the configuration software manual, all examples in this document are made with Beckhoff PLC CX5130-0125 and TwinCAT v3.1.4024.7.

6.1 ESI FILE INSTALLATION

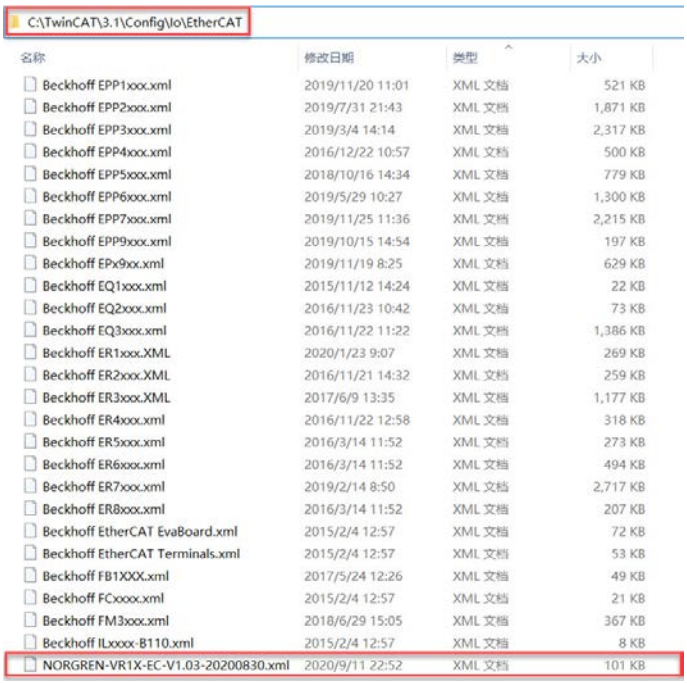
A device description file is needed for configuration of valve island. The ESI (EtherCAT Slave Information) file is an XML based file and can be used for all variants VR10 / VR15:

- "NORGREN-VR1X-EC-Vxx-JJJJMMDD.xml"

Note: "JJJJMMDD" (JJJJ-year, MM-month, DD-day) is date of release, "Vxx" is version number of the file.

The ESI file must be put into the following folder before starting TwinCAT software:

- C:\TwinCAT\3.1\Config\Io\EtherCAT



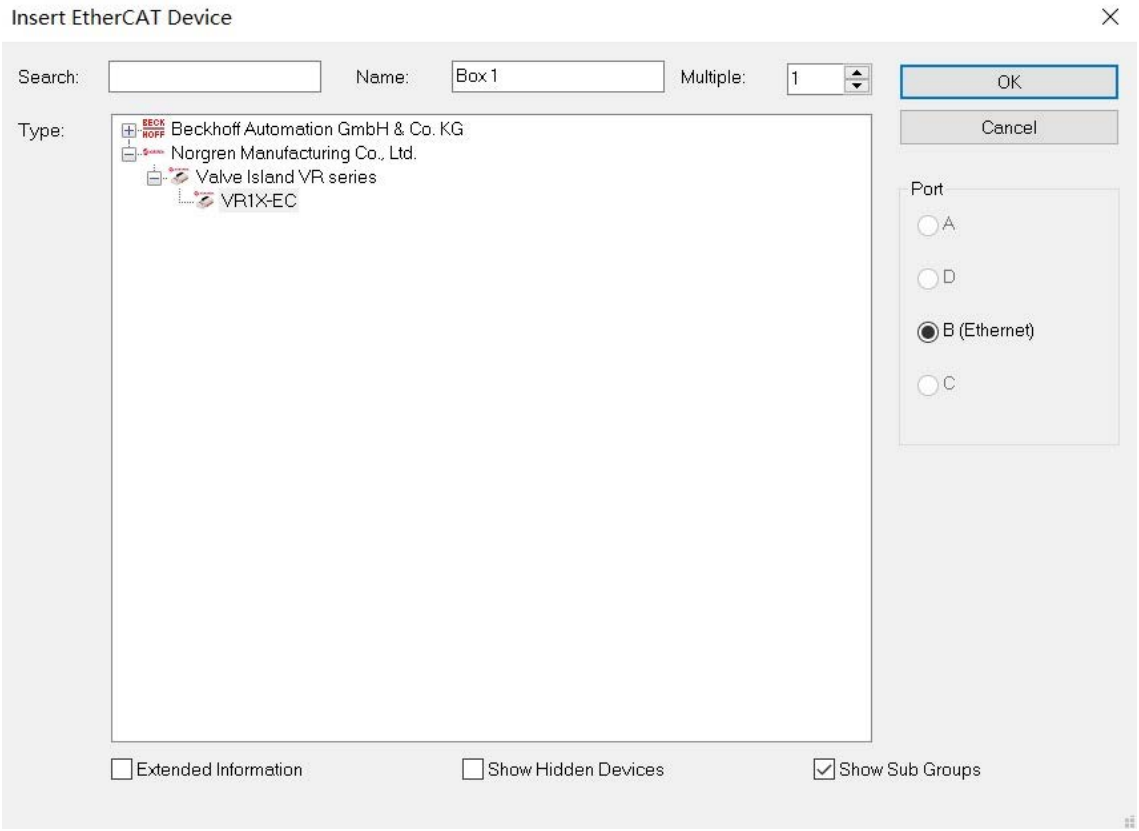
Note: If putting the ESI file into the folder when TwinCAT is running, you must restart TwinCAT to update hardware catalog.

The ESI file is available from the following web link:

- https://www.norgren.com/uk/en/technical-support/software

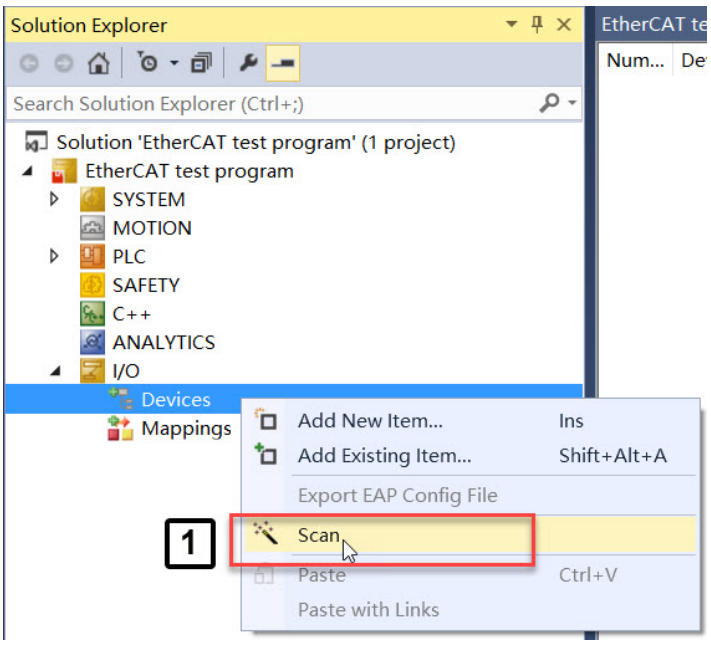
6.2 HARDWARE CONFIGURATION

After the successful installation of the ESI file the VR10 / VR15 is listed in the hardware catalogue.

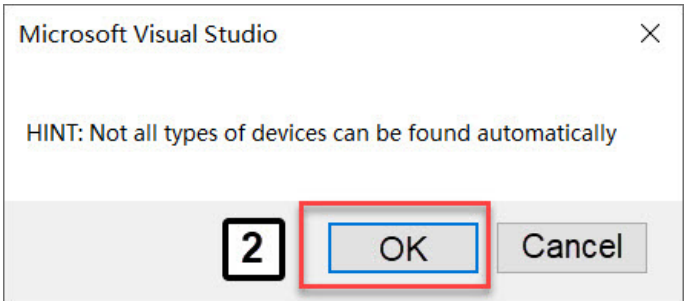


6.2.1 Configuration by “Scan” Option (Recommended)

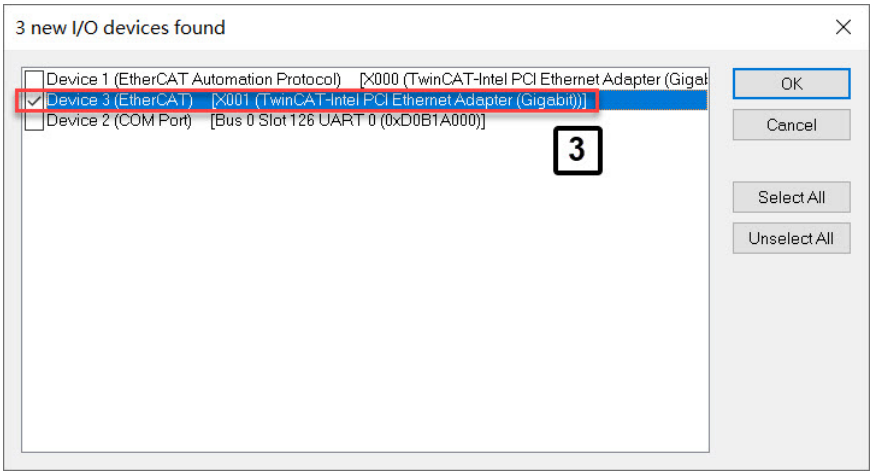
- Connect valve islands to the PLC and power on, make sure the engineering tool connects to PLC.
- In the engineering tool, right click “Devices” in the I/O tree and select “Scan”. (Tag 1)

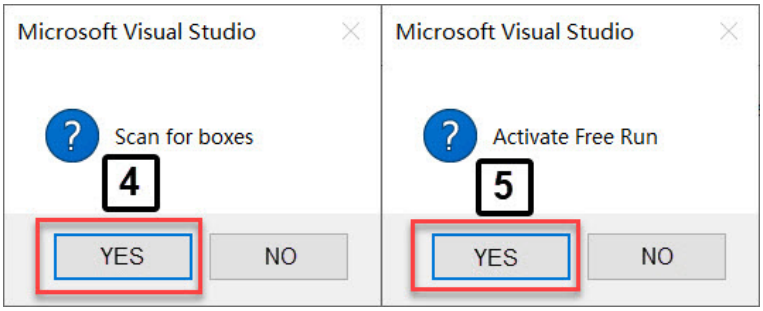


- Click the “OK” button on the popup window. (Tag 2)

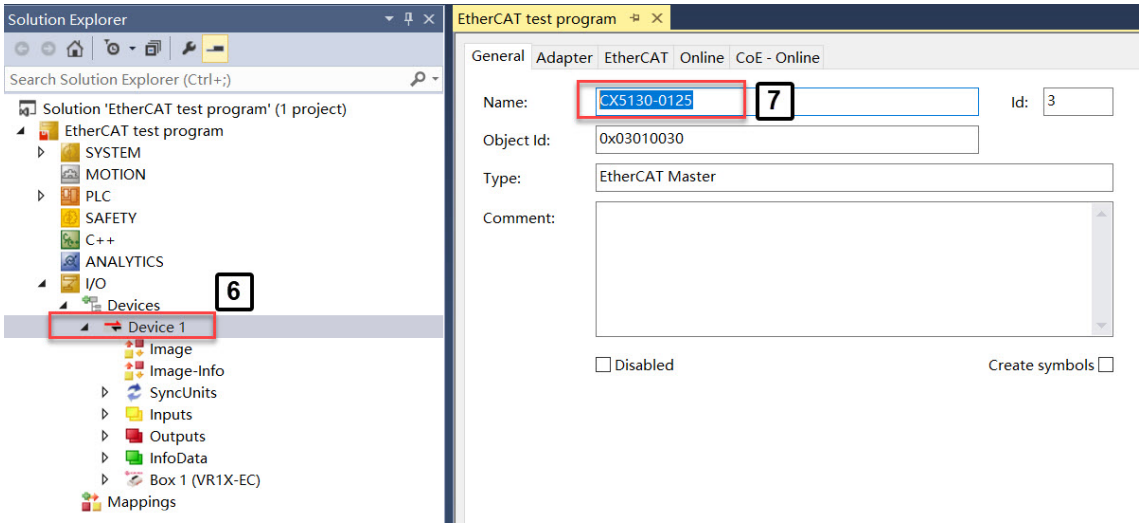


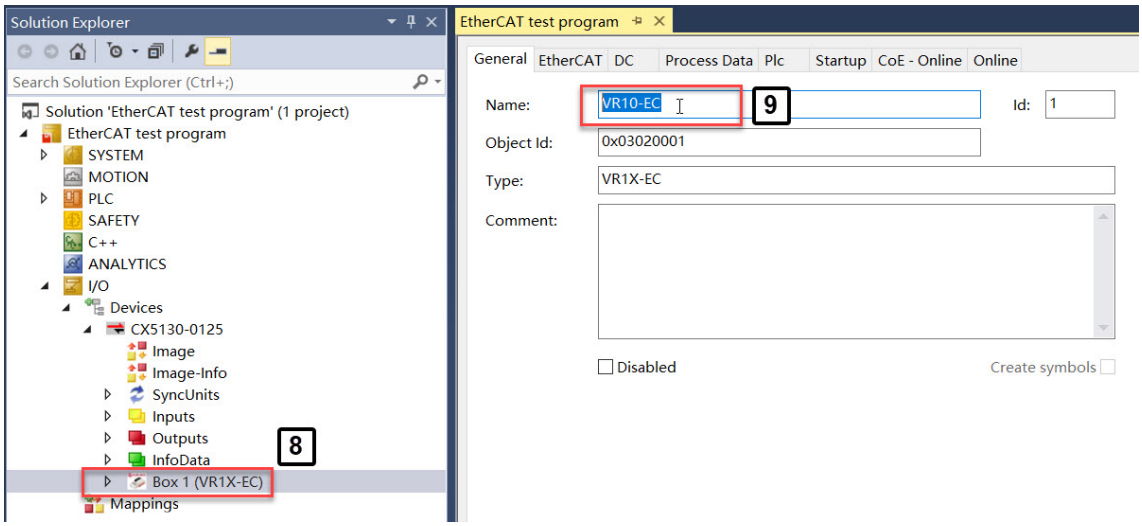
- Select the Device and Ethernet Adapter that is connected to the valve island. (Tag 3)
- Click “OK”. (Tag 4)
- Click “YES” button on popup window. (Tag 5)





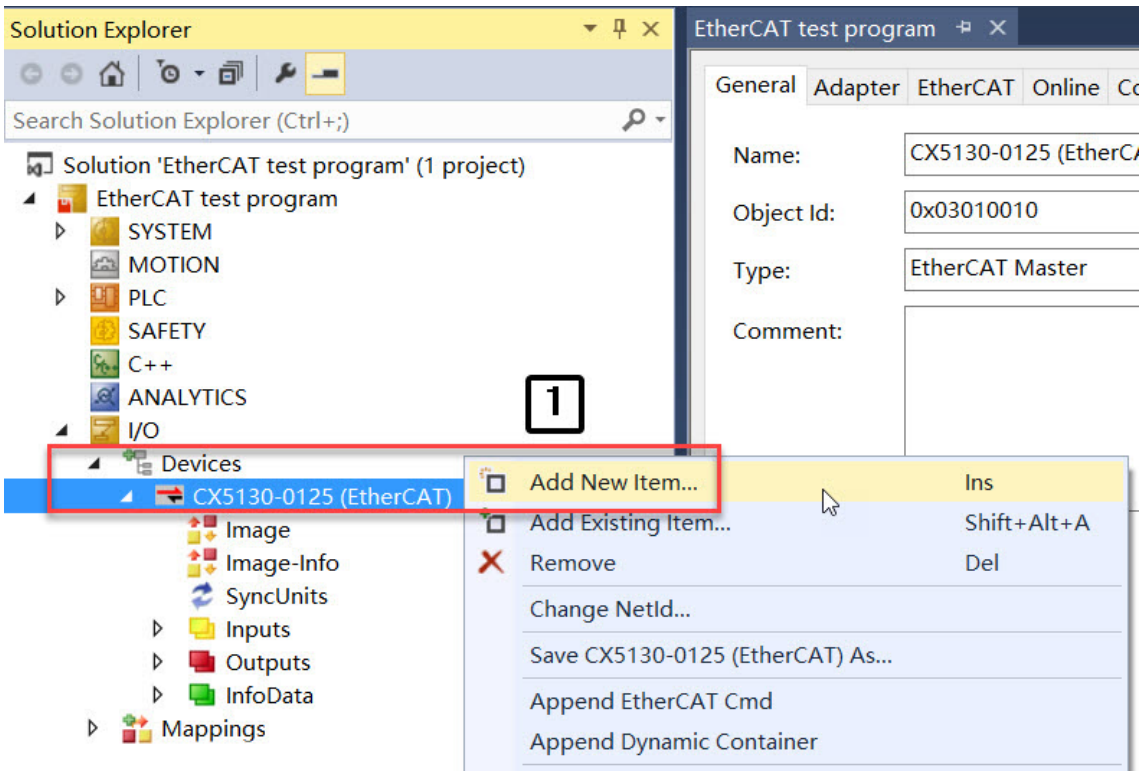
- After successfully finishing the scan, both the EtherCAT Master and the valve island are listed in the I/O tree.
- Click EtherCAT Master and rename it as required. (Tag 6-7)
- Click valve island and rename it as required. (Tag 8-9)



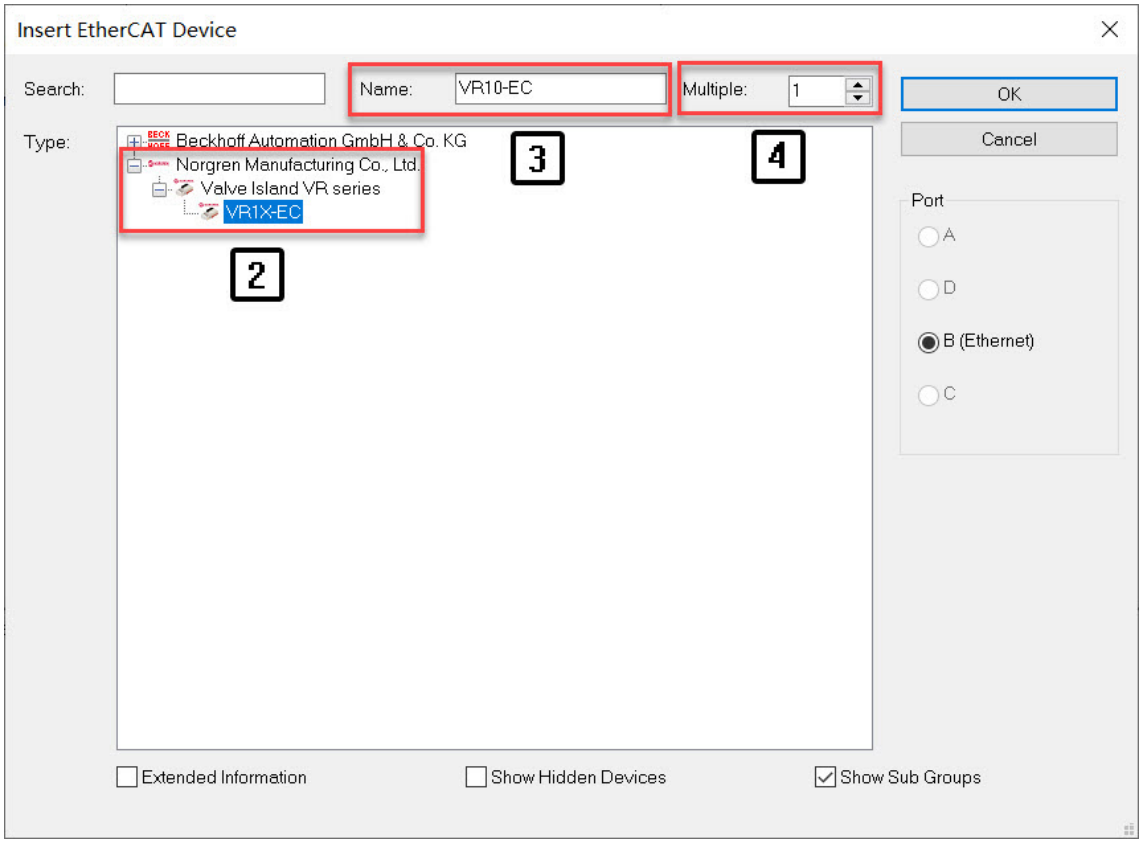


6.2.2 Configuration by “Add New Item” Option

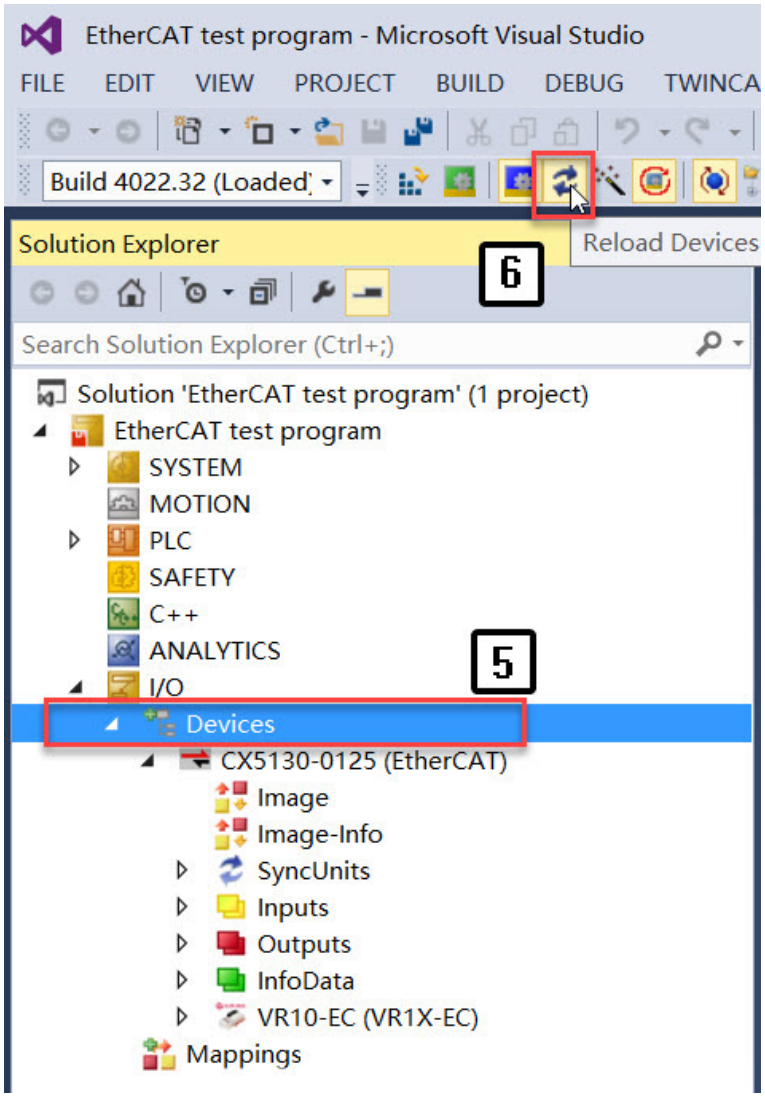
- Right click the existing master and select “Add New Item”. (Tag 1)



- Select “VR1X-EC” in Norgren Manufacturing CO., Ltd. tree to add valve island. (Tag 2)
- Rename valve island as required. (Tag 3)
- Set valve island quantities that need to be added in the Multiple cell. (Tag 4)

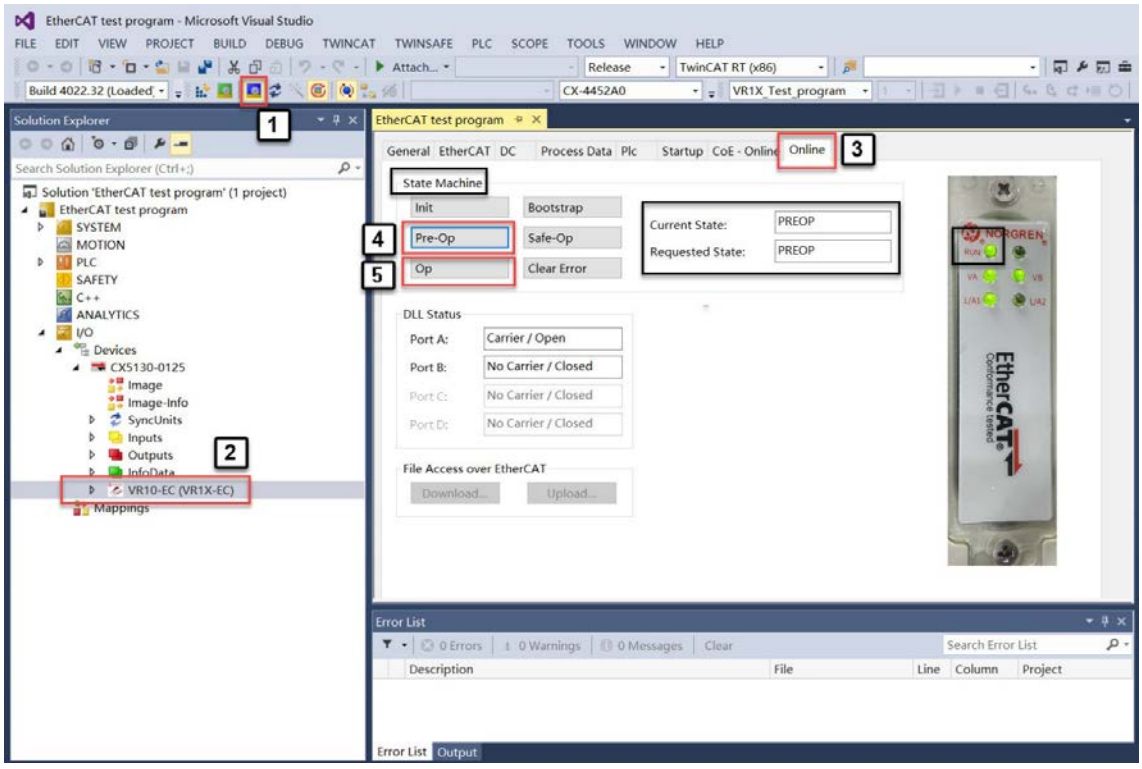


- Make sure all valve islands are connected to PLC and power on.
- Click “Devices” in I/O tree. (Tag 5)
- Click “Reload Devices” button to make valve islands online. (Tag 6)

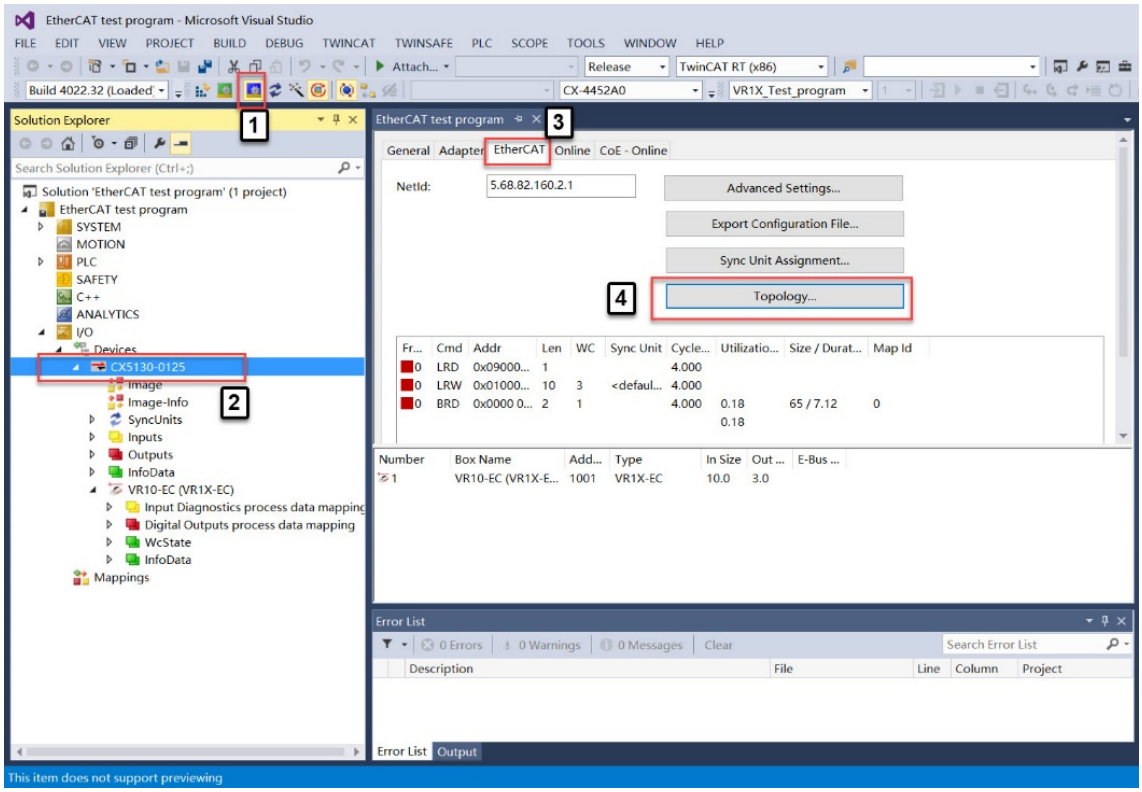


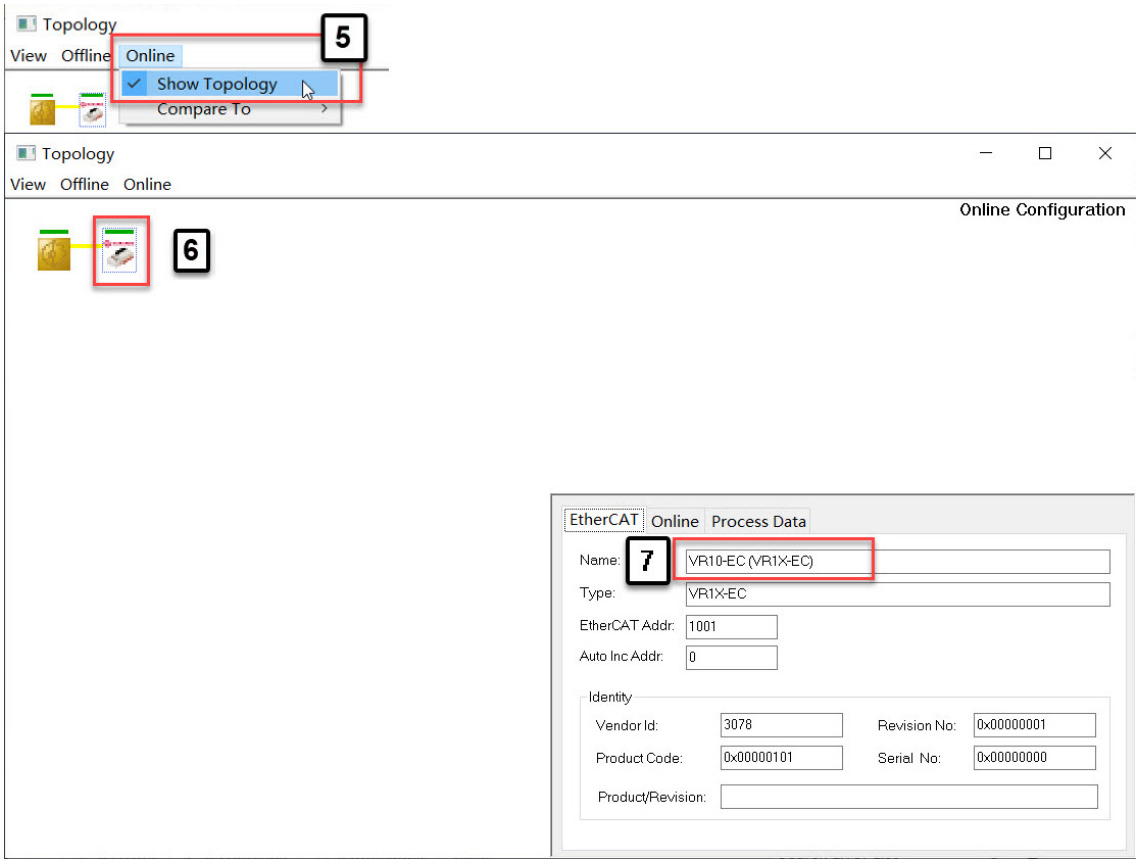
6.2.3 Identifying Valve Islands in Network

- Blink Test
  - Blinking Run LED can help to identify valve islands in the network.
  - Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
  - Set PLC to Config Mode. (Tag 1)
  - Click the one valve island that you want to identify in the I/O tree. (Tag 2)
  - Open “Online” at the right side. (Tag 3)
  - Click “Pre-Op” button in State Machine, make sure the current state is “PREOP”. (Tag 4)
  - Run LED will be blinking slowly, and this blinked valve island is the one identified.
  - After Identifying, click “Op” button in State Machine, to reset the current state to “OP” before driving valve islands. (Tag 5)
  - Repeat the steps to identify other valve islands.



- Topology view
  - Topology view also can help to identify valve islands in the network more directly.
  - Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
  - Set PLC to Config Mode. (Tag 1)
  - Click EtherCAT Master in I/O tree. (Tag 2)
  - Open “EtherCAT” at the right side. (Tag 3)
  - Click “Topology” button to open topology view. (Tag 4)
  - Tick “Show Topology” in Online menu. (Tag 5)
  - Click one positioning valve island icon in topology view. (Tag 6)
  - Find unique valve island name in the dialogue. (Tag 7)
  - Repeat the steps to identify other valve islands.



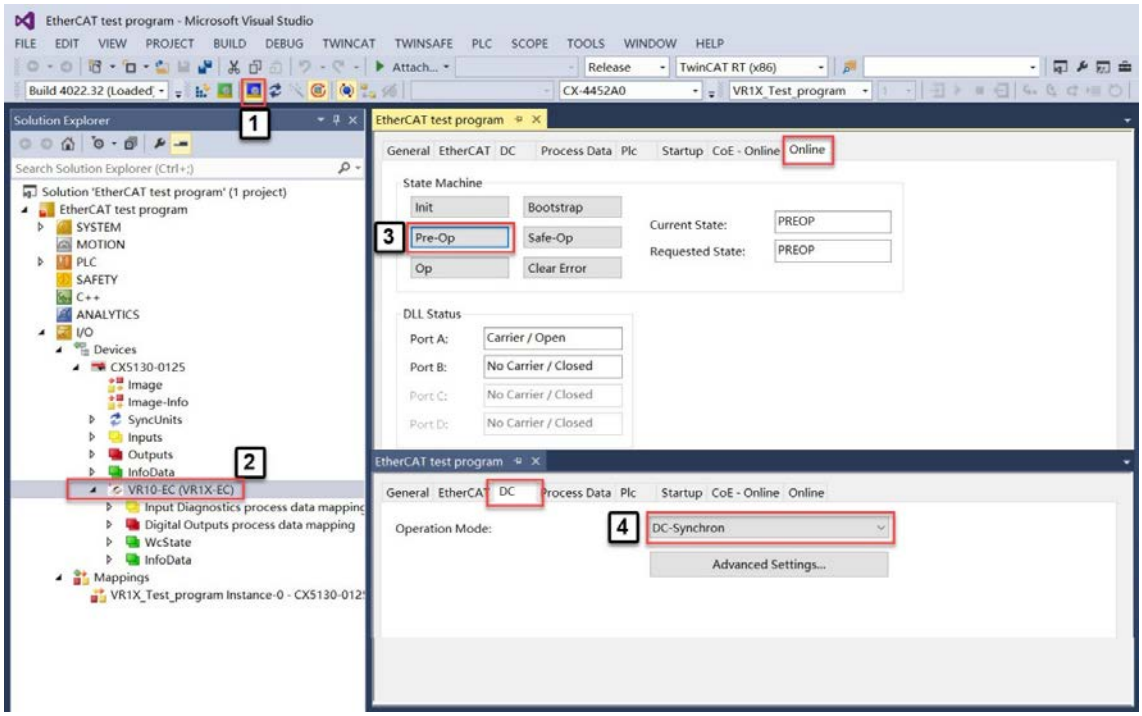

Topology
View Offline Online
5
Show Topology
Compare To
Topology
View Offline Online
Online Configuration
6
EtherCAT Online Process Data
Name:
7
VR10-EC (VR1X-EC)
Type:
VR1X-EC
EtherCAT Addr:
1001
Auto Inc Addr:
0
Identity
Vendor Id:
3078
Revision No:
0x00000001
Product Code:
0x00000101
Serial No:
0x00000000
Product/Revision:

6.3 PARAMETERIZATION

6.3.1 DC (Distributed Clock) Operation Mode Setting

VR10 / VR15 valve island supports DC operation mode.

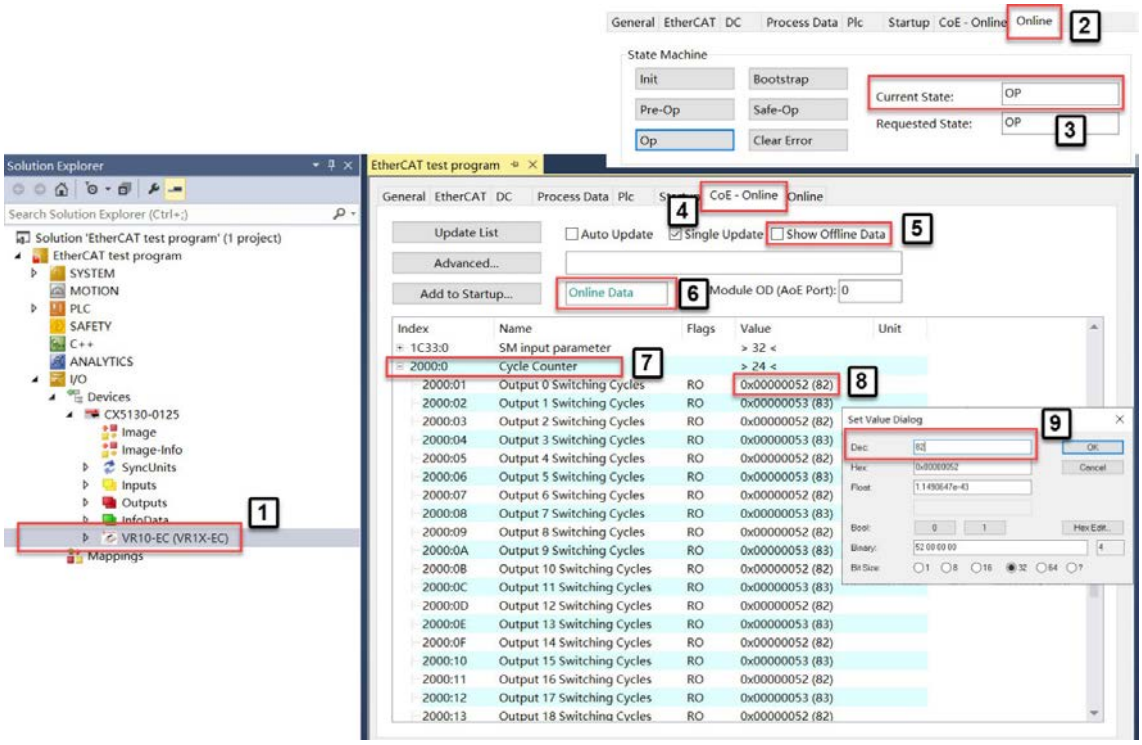
- Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
- Set PLC to Config Mode. (Tag 1)
- Click valve island in I/O tree. (Tag 2)
- Open “Online” at the right side.
- Click “Pre-Op” button to set valve island to PREOP state. (Tag 3)
- Open “DC” tab.
- Select Operation Mode to DC-Synchron. (Tag 4)
- After successful setting, valve island will work under DC-Synchron mode.



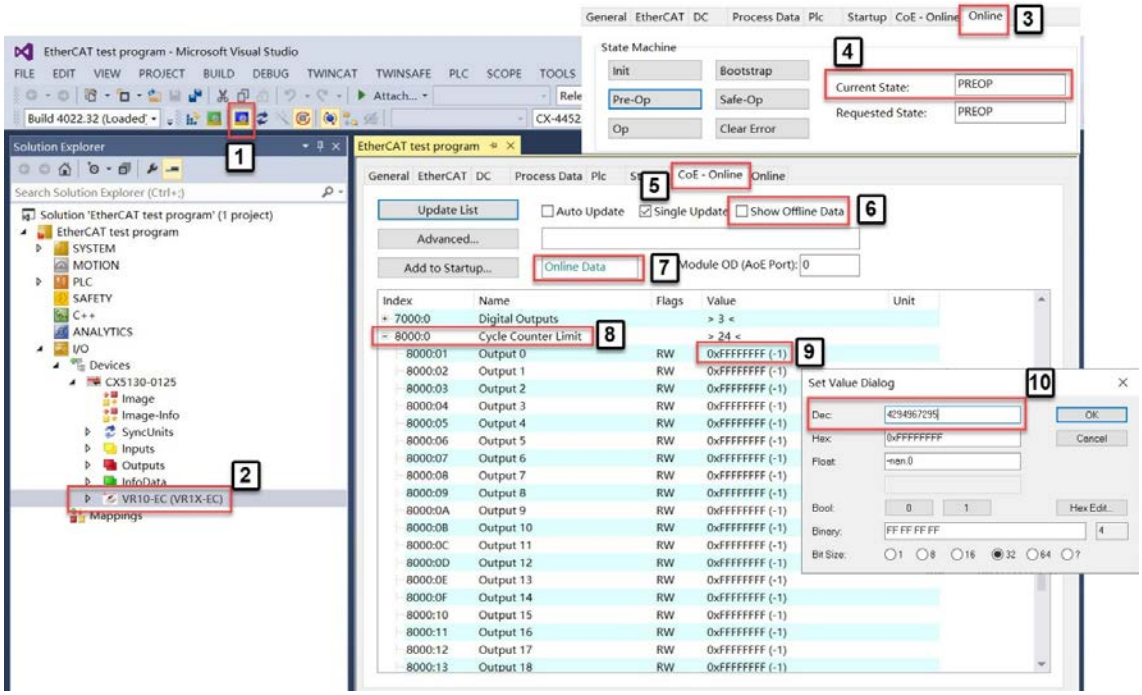
6.3.2 Cycle Counter Setting and Resetting

VR10 / VR15 valve island supports cycle counting, count limit set and counter reset for each solenoid.

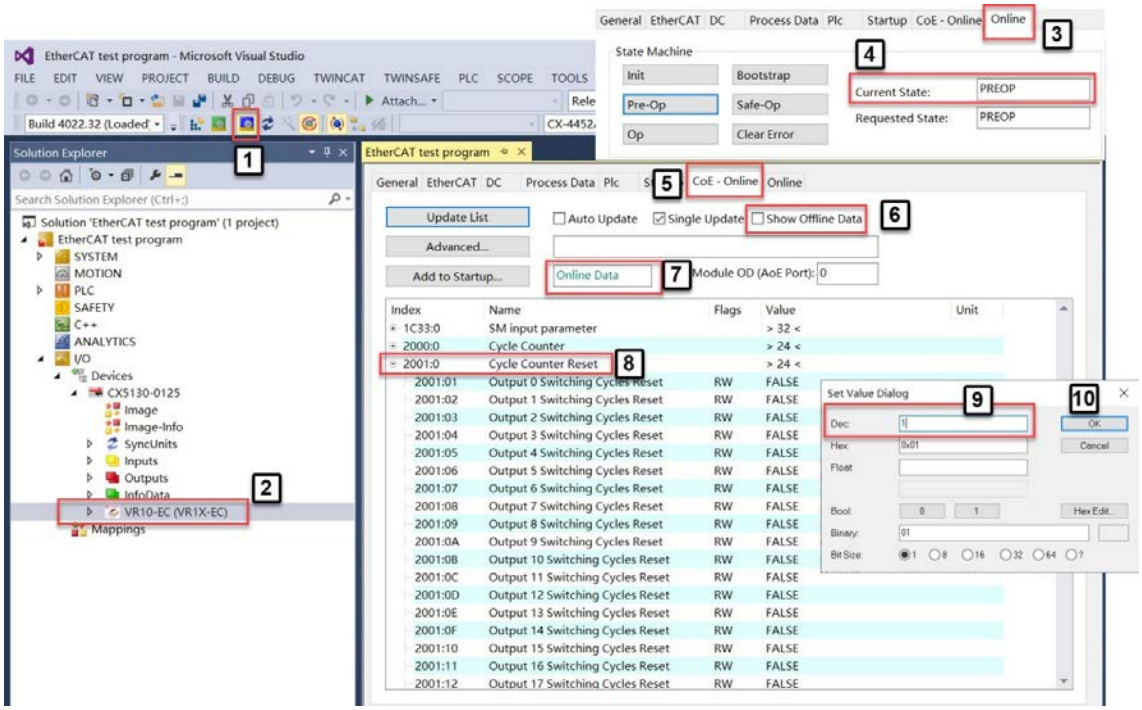
- Cycle counting
  - Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
  - Click valve island in I/O tree. (Tag 1)
  - Open “Online” tab and make sure current state is “OP” or “PREOP”. (Tag 2-3)
  - Open “CoE-Online” tab and make sure no tick “Show Offline Data”. (Tag 4-5)
  - Make sure “Online Data” activated. (Tag 6)
  - Expand Index “2000:0” and find the cycle value for each solenoid. (Tag 7)
  - Solenoid number, output point and valve station mapping relation see Chapter 5.
  - The value displays in hexadecimal and decimal. (Tag 8)
  - Double click specified solenoid and find the decimal cycles in first row. (Tag 9)



- Count limit set
  - Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
  - Set PLC to Config Mode. (Tag 1)
  - Click valve island in I/O tree. (Tag 2)
  - Open “Online” tab and make sure current state is “PREOP”. (Tag 3-4)
  - Open “CoE-Online” tab and make sure no tick “Show Offline Data”. (Tag 5-6)
  - Make sure “Online Data” activated. (Tag 7)
  - Expand Index “8000:0” and find the cycle counter limit value for each solenoid. (Tag 8)
  - Solenoid number, output point and valve station mapping relation see Chapter 5.
  - The value displays & set in hexadecimal and decimal.
  - Double click specified solenoid and input the decimal cycles limit as required in first row. (Tag 9-10)
  - The max. limit is 0xFFFFFFFF in hexadecimal.
  - If the count cycles are beyond the count limit, an EtherCAT cycle overrun diagnostic with error code and channel number appears. This diagnostic function cannot be disabled.



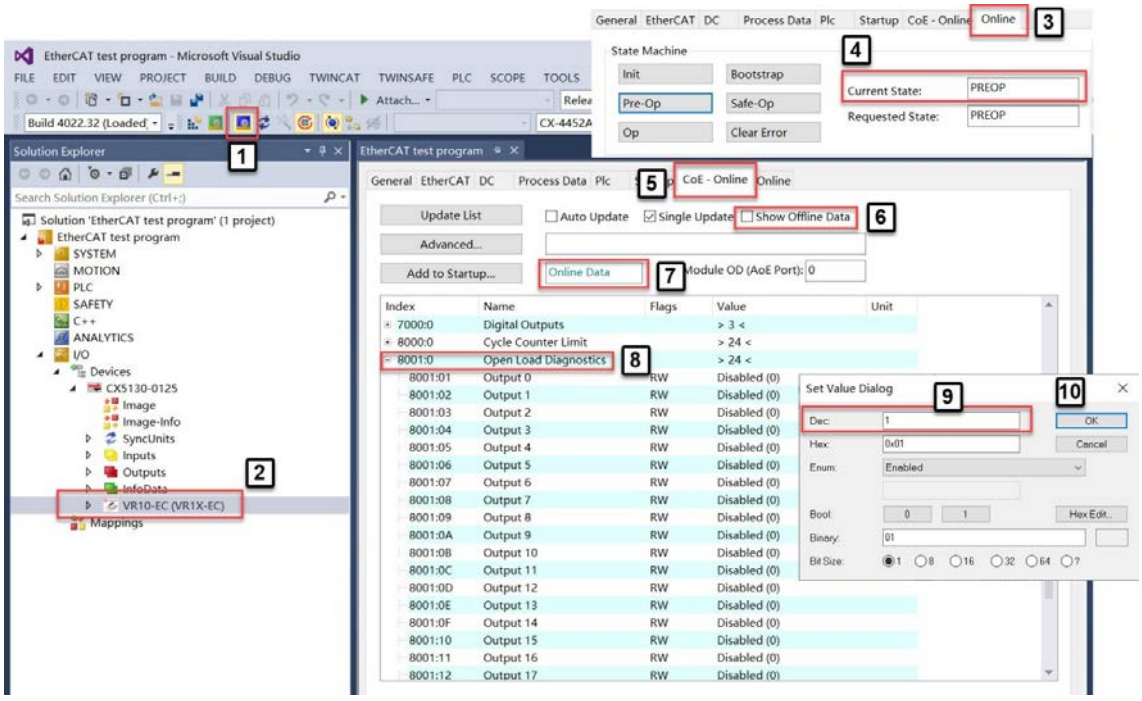
- Counter Reset
  - Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
  - Set PLC to Config Mode. (Tag 1)
  - Click valve island in I/O tree. (Tag 2)
  - Open “Online” tab and make sure current state is “PREOP”. (Tag 3-4)
  - Open “CoE-Online” tab and make sure “Show Offline Data” is not checked. (Tag 5-6)
  - Make sure “Online Data” activated. (Tag 7)
  - Expand Index “2001:0” and find cycle reset for each solenoid. (Tag 8)
  - Solenoid number, output point and valve station mapping relation see Chapter 5.
  - Double click specified solenoid and input “1” in first row. (Tag 9)
  - Click “OK” button and reset counter to zero. (Tag 10)



6.3.3 Open Load Diagnostics Setting

It is possible for VR10 / VR15 valve island to enable / disable the open load diagnostics for each solenoid. If disabled, no EtherCAT open load diagnostic error code appears. Otherwise an EtherCAT channel diagnostic with error code and channel number appears.

- Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
- Set PLC to Config Mode. (Tag 1)
- Click valve island in I/O tree. (Tag 2)
- Open “Online” tab and make sure current state “PREOP”. (Tag 3-4)
- Open “CoE-Online” tab and make sure no tick “Show Offline Data”. (Tag 5-6)
- Make sure “Online Data” activated. (Tag 7)
- Expand Index “8001:0” and find open load set for each solenoid. (Tag 8)
- For solenoid number, output point and valve station mapping relationships see Chapter 5.
- Double click specified solenoid and input “1” in first row. (Tag 9)
- Click “OK” button and enable the open load diagnostics. (Tag 10)
- To disable the open load diagnostics, input “0” in first row.
- Default setting for all solenoids is disabled.



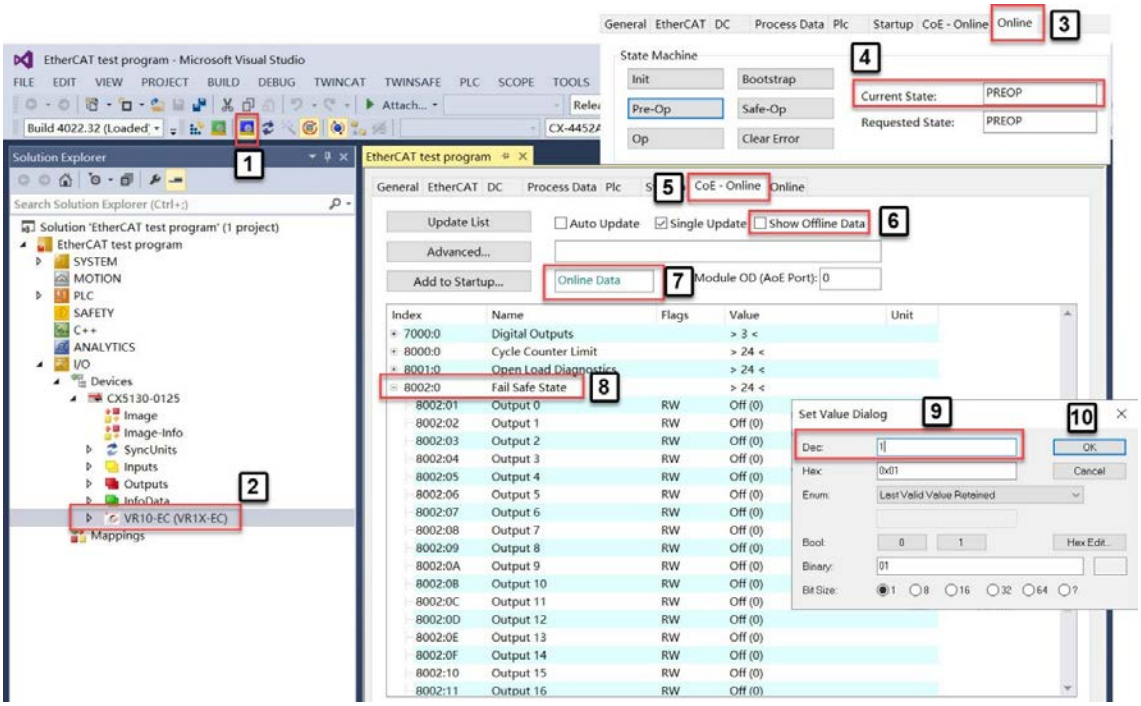
6.3.4 Fail Safe State Setting

It is possible to define the behaviour of the outputs in case of broken EtherCAT communication. The following two states can be defined by the outputs:

1) Output — Off

2) Output — Last Valid Value Retained

- Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
- Set PLC to Config Mode. (Tag 1)
- Click valve island in I/O tree. (Tag 2)
- Open “Online” tab and make sure current state is “PREOP”. (Tag 3-4)
- Open “CoE-Online” tab and make sure “Show Offline Data” is not checked. (Tag 5-6)
- Make sure “Online Data” activated. (Tag 7)
- Expand Index “8002:0” and find fail safe state set for each solenoid. (Tag 8)
- For solenoid number, output point and valve station mapping relationships see Chapter 5.
- Double click specified output and input “1” in first row. (Tag 9)
- Click “OK” button and set fail safe state to “Last Valid Value Retained”. (Tag 10)
- To set fail safe state to “Off”, input “0” in first row.
- Default setting for all outputs is “Off”.



6.3.5 Voltage and Short Circuit Diagnostics

VR10 / VR15 valve island supports voltage diagnostics for both electronic power and valve power and short circuit diagnostics for each solenoid. These two diagnostic functions cannot be disabled.

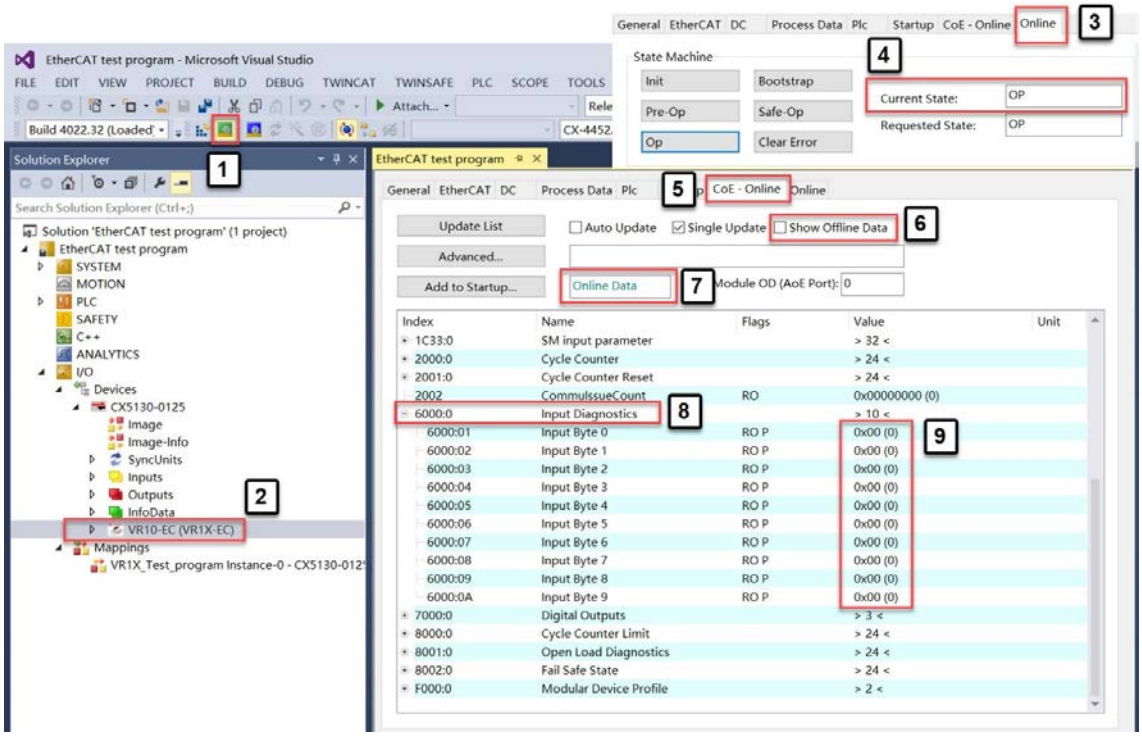
- In case of over / under voltage an EtherCAT module diagnostic with error code appears and the related LEDs on the valve island change colour from green to red.
- In case of short circuit an EtherCAT channel diagnostic with error code and channel number appears.

7 DIAGNOSTICS

7.1 DIAGNOSTICS INFORMATION PORTAL

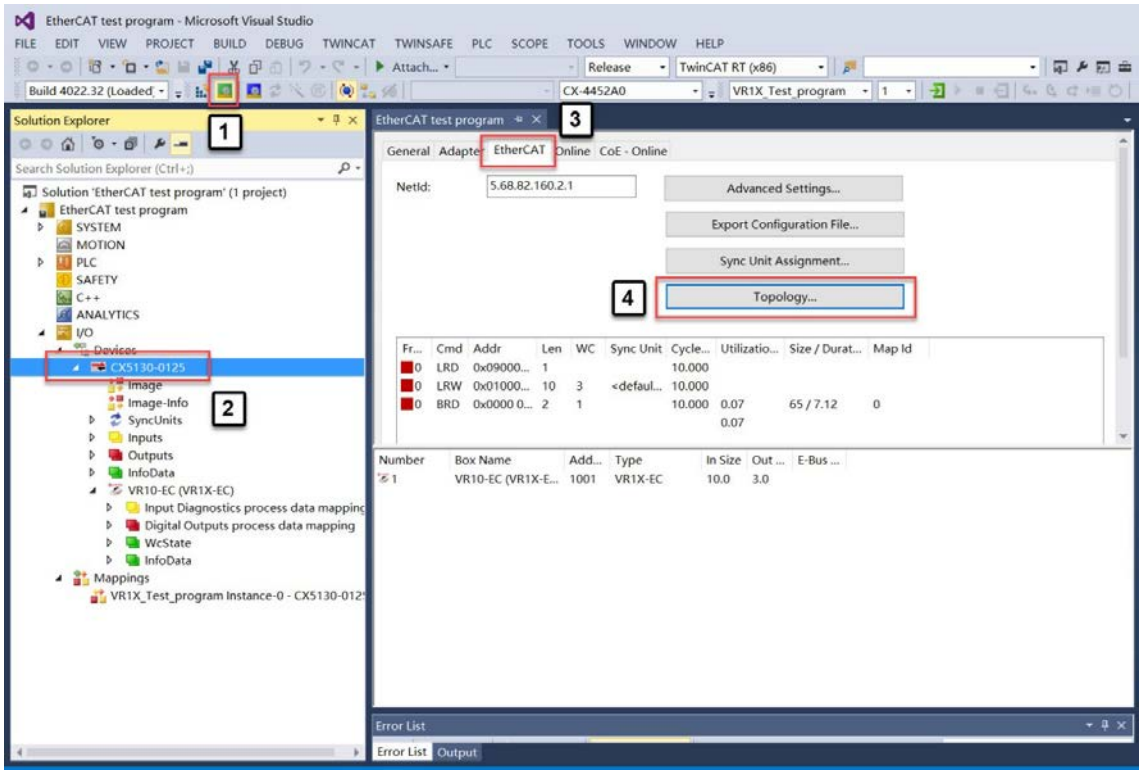
7.1.1 CoE-Online Portal

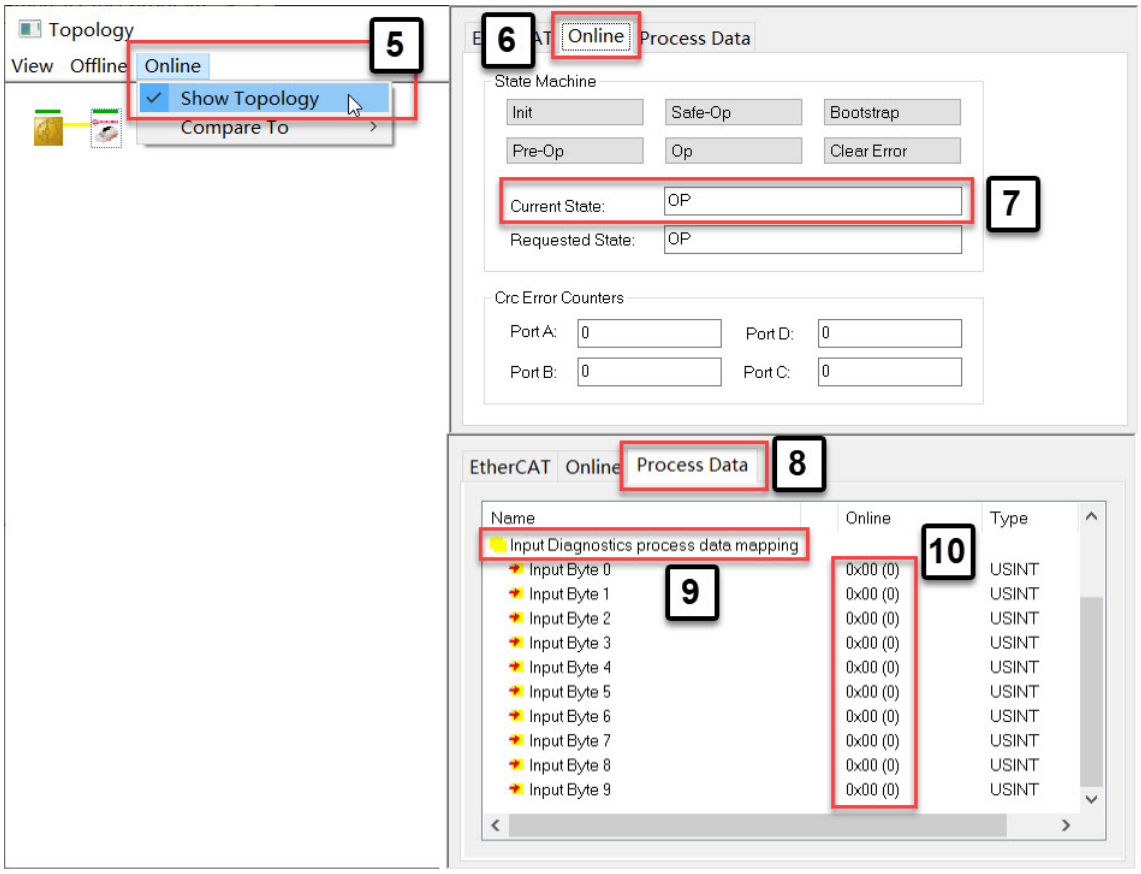
- Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
- Set PLC to Run Mode. (Tag 1)
- Click valve island in I/O tree. (Tag 2)
- Open “Online” tab and make sure current state “OP”. (Tag 3-4)
- Open “CoE-Online” tab and make sure no tick “Show Offline Data”. (Tag 5-6)
- Make sure “Online Data” activated. (Tag 7)
- Expand Index “6000:0” and find all diagnostics information, all error codes will be reported here from “**Input Byte 0**” to “**Input Byte 9**”. (Tag 8-9)



7.1.2 Topology View Portal

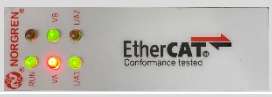
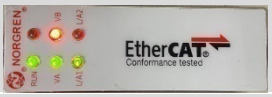
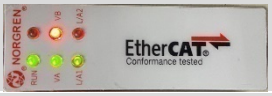
- Make sure all valve islands are all online, if offline please refer to Section 6.2.2, “Reload Device” step.
- Set PLC to Run Mode. (Tag 1)
- Click EtherCAT Master in I/O tree. (Tag 2)
- Open “EtherCAT” tab at the right side. (Tag 3)
- Click “Topology” button to open topology view. (Tag 4)
- Tick “Show Topology” in Online menu. (Tag 5)
- Click on valve island icon in topology view.
- Open “Online” tab and make sure current state “OP”. (Tag 6-7)
- Open “Process Data” tab to see all diagnostics information. All error codes will be reported here from “**Input Byte 0**” to “**Input Byte 9**” in Input Diagnostics process data mapping list. (Tag 8-10)




Topology
View
Offline
Online
Show Topology
Compare To
5
6
Online
Process Data
State Machine
Init
Safe-Op
Bootstrap
Pre-Op
Op
Clear Error
Current State:
OP
Requested State:
OP
7
Crc Error Counters
Port A:
0
Port D:
0
Port B:
0
Port C:
0
EtherCAT
Online
Process Data
8
Name
Online
Type
Input Diagnostics process data mapping
9
10
Input Byte 0
Input Byte 1
Input Byte 2
Input Byte 3
Input Byte 4
Input Byte 5
Input Byte 6
Input Byte 7
Input Byte 8
Input Byte 9
0x00 (0)
USINT

7.2 OVERALL STATUS DIAGNOSTICS

- VR10 / VR15 valve island module status will be shown in real-time.
- The diagnostic module status includes:
  - Over voltage diagnostics for valve power
  - Under voltage diagnostics for valve power
  - Over voltage diagnostics for electronic power
  - Under voltage diagnostics for electronic power
  - Cycle overrun diagnostics (cycles beyond the count limit)
  - Short circuit diagnostics
  - Open load diagnostics (e.g. wire break of solenoid)
- Fault error codes will be reported by "**Input Byte 0**".
- Fault error codes are displayed in hexadecimal and decimal.
- Common fault error codes are shown below:

Fault type	Error code	Associated LED & Remark
Over voltage diagnostics for valve power *Abbreviation: OV-VA*	0x01 (1)	"VA" LED, red 
Under voltage diagnostics for valve power *Abbreviation: UV-VA*	0x02 (2)	"VA" LED, flashing red 
Over voltage diagnostics for electronic power *Abbreviation: OV-VB*	0x04 (4)	"VB" LED, red 
Under voltage diagnostics for electronic power *Abbreviation: UV-VB*	0x08 (8)	"VB" LED, flashing red 
Cycle overrun diagnostics *Abbreviation: COR*	0x10 (16)	Count cycles are beyond the count limit (Section 6.3.2)
Short circuit diagnostics *Abbreviation: SC*	0x20 (32)	Section 6.3.5
Open load diagnostics *Abbreviation: OC*	0x40 (64)	Need to enable open load diagnostics (Section 6.3.3)

- Binary value and fault type mapping relationships are shown in the table below. 0 is no fault, 1 is fault found.

Input Byte 0								
Fault type		OC	SC	COR	UV-VB	OV-VB	UV-VA	OV-VA
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

7.3 CHANNEL DIAGNOSTICS

- VR10 / VR15 valve island channel status will be shown in real-time.
- The diagnostic channel status includes:
  - Short circuit diagnostics per solenoid
  - Open load diagnostics per solenoid (e.g. wire break of solenoid)
  - Cycle overrun diagnostics per solenoid (cycles beyond the count limit)

7.3.1 Short Circuit Diagnostics

- Short circuit fault error codes will be reported by "**Input Byte 1**", "**Input Byte 2**" and "**Input Byte 3**".
- Fault error codes are displayed in hexadecimal and decimal.
- Common short circuit fault error codes are shown in table:

Byte	Solenoid	Error code
Input Byte 1	Sol.01	0x01 (1)
	Sol.02	0x02 (2)
	Sol.03	0x04 (4)
	Sol.04	0x08 (8)
	Sol.05	0x10 (16)
	Sol.06	0x20 (32)
	Sol.07	0x40 (64)
	Sol.08	0x80 (128)
Input Byte 2	Sol.09	0x01 (1)
	Sol.10	0x02 (2)
	Sol.11	0x04 (4)
	Sol.12	0x08 (8)
	Sol.13	0x10 (16)
	Sol.14	0x20 (32)
	Sol.15	0x40 (64)
	Sol.16	0x80 (128)
Input Byte 3	Sol.17	0x01 (1)
	Sol.18	0x02 (2)
	Sol.19	0x04 (4)
	Sol.20	0x08 (8)
	Sol.21	0x10 (16)
	Sol.22	0x20 (32)
	Sol.23	0x40 (64)
	Sol.24	0x80 (128)

- Binary value and solenoid number mapping relationships are shown in the table below. 0 is no fault, 1 is fault found.

Input Byte 1								
Solenoid	Sol.08	Sol.07	Sol.06	Sol.05	Sol.04	Sol.03	Sol.02	Sol.01
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

Input Byte 2								
Solenoid	Sol.16	Sol.15	Sol.14	Sol.13	Sol.12	Sol.11	Sol.10	Sol.09
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

Input Byte 3								
Solenoid	Sol.24	Sol.23	Sol.22	Sol.21	Sol.20	Sol.19	Sol.18	Sol.17
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

7.3.2 Open Load Diagnostics

- Open load fault error codes will be reported by "**Input Byte 4**", "**Input Byte 5**" and "**Input Byte 6**".
- Fault error codes are displayed in hexadecimal and decimal.
- To enable open load diagnostics refer to Section 6.3.3.
- Common open load fault error codes are shown in table below:

Byte	Solenoid	Error code
Input Byte 4	Sol.01	0x01 (1)
	Sol.02	0x02 (2)
	Sol.03	0x04 (4)
	Sol.04	0x08 (8)
	Sol.05	0x10 (16)
	Sol.06	0x20 (32)
	Sol.07	0x40 (64)
	Sol.08	0x80 (128)
Input Byte 5	Sol.09	0x01 (1)
	Sol.10	0x02 (2)
	Sol.11	0x04 (4)
	Sol.12	0x08 (8)
	Sol.13	0x10 (16)
	Sol.14	0x20 (32)
	Sol.15	0x40 (64)
	Sol.16	0x80 (128)
Input Byte 6	Sol.17	0x01 (1)
	Sol.18	0x02 (2)
	Sol.19	0x04 (4)
	Sol.20	0x08 (8)
	Sol.21	0x10 (16)
	Sol.22	0x20 (32)
	Sol.23	0x40 (64)
	Sol.24	0x80 (128)

- Binary valueand solenoid number mapping relationships are shown in the table below. 0 is no fault, 1 is fault found.

Input Byte 4								
Solenoid	Sol.08	Sol.07	Sol.06	Sol.05	Sol.04	Sol.03	Sol.02	Sol.01
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

Input Byte 5								
Solenoid	Sol.16	Sol.15	Sol.14	Sol.13	Sol.12	Sol.11	Sol.10	Sol.09
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

Input Byte 6								
Solenoid	Sol.24	Sol.23	Sol.22	Sol.21	Sol.20	Sol.19	Sol.18	Sol.17
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

7.3.3 Cycle Overrun Diagnostics

- Cycle overrun fault error codes will be reported by "**Input Byte 7**", "**Input Byte 8**" and "**Input Byte 9**".
- Fault error codes are displayed in hexadecimal and decimal.
- It is necessary to set valid count limit so that this diagnostic function is effective (Section 6.3.2).
- Common cycle overrun fault error codes are shown in table:

Byte	Solenoid	Error code
Input Byte 7	Sol.01	0x01 (1)
	Sol.02	0x02 (2)
	Sol.03	0x04 (4)
	Sol.04	0x08 (8)
	Sol.05	0x10 (16)
	Sol.06	0x20 (32)
	Sol.07	0x40 (64)
	Sol.08	0x80 (128)
Input Byte 8	Sol.09	0x01 (1)
	Sol.10	0x02 (2)
	Sol.11	0x04 (4)
	Sol.12	0x08 (8)
	Sol.13	0x10 (16)
	Sol.14	0x20 (32)
	Sol.15	0x40 (64)
	Sol.16	0x80 (128)
Input Byte 9	Sol.17	0x01 (1)
	Sol.18	0x02 (2)
	Sol.19	0x04 (4)
	Sol.20	0x08 (8)
	Sol.21	0x10 (16)
	Sol.22	0x20 (32)
	Sol.23	0x40 (64)
	Sol.24	0x80 (128)

- Binary value and solenoid number mapping relationships are shown in the table below. 0 is no fault, 1 is fault found.

Input Byte 7								
Solenoid	Sol.08	Sol.07	Sol.06	Sol.05	Sol.04	Sol.03	Sol.02	Sol.01
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

Input Byte 8								
Solenoid	Sol.16	Sol.15	Sol.14	Sol.13	Sol.12	Sol.11	Sol.10	Sol.09
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

Input Byte 9								
Solenoid	Sol.24	Sol.23	Sol.22	Sol.21	Sol.20	Sol.19	Sol.18	Sol.17
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Binary value	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1

8 DIAGNOSTICS & OUTPUTS MAPPING OBJECT

- Programming languages comply with IEC 61131-3:2013.

Overall status diagnostics	**Input Byte 0**								
	Fault type		OC	SC	COR	UV-VB	OV-VB	UV-VA	OV-VA
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Short circuit diagnostics	**Input Byte 1**								
	Solenoid	Sol.08	Sol.07	Sol.06	Sol.05	Sol.04	Sol.03	Sol.02	Sol.01
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Input Byte 2								
	Solenoid	Sol.16	Sol.15	Sol.14	Sol.13	Sol.12	Sol.11	Sol.10	Sol.09
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Input Byte 3								
	Solenoid	Sol.24	Sol.23	Sol.22	Sol.21	Sol.20	Sol.19	Sol.18	Sol.17
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Open load diagnostics	**Input Byte 4**								
	Solenoid	Sol.08	Sol.07	Sol.06	Sol.05	Sol.04	Sol.03	Sol.02	Sol.01
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Input Byte 5								
	Solenoid	Sol.16	Sol.15	Sol.14	Sol.13	Sol.12	Sol.11	Sol.10	Sol.09
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Input Byte 6								
	Solenoid	Sol.24	Sol.23	Sol.22	Sol.21	Sol.20	Sol.19	Sol.18	Sol.17
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Cycle overrun diagnostics	**Input Byte 7**								
	Solenoid	Sol.08	Sol.07	Sol.06	Sol.05	Sol.04	Sol.03	Sol.02	Sol.01
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Input Byte 8								
	Solenoid	Sol.16	Sol.15	Sol.14	Sol.13	Sol.12	Sol.11	Sol.10	Sol.09
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Input Byte 9								
	Solenoid	Sol.24	Sol.23	Sol.22	Sol.21	Sol.20	Sol.19	Sol.18	Sol.17
	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Output Byte 0								
Solenoid	Sol.08	Sol.07	Sol.06	Sol.05	Sol.04	Sol.03	Sol.02	Sol.01
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Output Byte 1								
Solenoid	Sol.16	Sol.15	Sol.14	Sol.13	Sol.12	Sol.11	Sol.10	Sol.09
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Output Byte 2								
Solenoid	Sol.24	Sol.23	Sol.22	Sol.21	Sol.20	Sol.19	Sol.18	Sol.17
Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

9 LED STATUS DESCRIPTION

Symbol	LED Status	Description
RUN	Off	Valve island in INIT state
	Flashing green	Valve island in PREOP state
	Flashing green with longer pause	Valve island in SAFEOP state
	Green on	Valve island in OP state
L/A 1	Off	Link Connection Not Established
	Green on	Link Connection Established
	Flashing green	Link Communication Active
L/A 2	Off	Link Connection Not Established
	Green on	Link Connection Established
	Flashing green	Link Communication Active
VA **(Valve Power Supply)**	Green on	Voltage OK
	Flashing red	Undervoltage
	Red	Overvoltage
VB **(Electronics Power Supply)**	Green on	Voltage OK
	Flashing red	Undervoltage
	Red	Overvoltage

10 TECHNICAL DATA EtherCAT INTERFACE

Specification		Remark
Number of ports	2	---
Transfer speed	100Mbit/s	---
Duplex mode	Full Duplex	---
EtherCAT mode	Direct Mode (No MAC address)	---
DC mode	Supported	Distributed clocks
Conformance test record	1.2.8	---
Addressing mode	Manual setting is not required, automatically set	---
ESI Language	EN	---

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