

Motor starter

EMS2

Setting the motor protection in TwinCAT 3



BECKHOFF
TwinCAT®

Level 3

- 1 – Fundamental – No previous experience necessary
- 2 – Basic – Basic knowledge recommended
- 3 – Advanced – Reasonable knowledge required
- 4 – Expert – Good experience recommended

All brand and product names are trademarks or registered trademarks of their respective owners.

Services

Please contact your local representative:

[Eaton.com/contacts](https://www.eaton.com/contacts)

[Eaton.com/aftersales](https://www.eaton.com/aftersales)

Original Operating Instructions

The German language edition of this document is the original operating manual.

All editions of this document other than those in German language are translations of the original operating manual.

1st edition 2021, publication date 02/2021

2nd edition 2024, publication date 09/2024

© 2021 by Eaton Industries GmbH, 53115 Bonn

All rights, including those for translation, reserved.

No part of this manual may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, micro-filming, recording or otherwise, without the prior written permission of Eaton Industries GmbH, Bonn. Subject to modifications

Danger! - Dangerous electrical voltage!

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally retriggered.
- Verify isolation from the supply.
- Ground and short-circuit.
- Cover or enclose any neighboring live parts.
- Follow the installation instructions (IL) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or to the potential equalizing.
- The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the functions.
- Suitable safety hardware and software measures should be implemented so that a line or wire breakage on the signal side does not result in undefined states.
- Fluctuations or deviations in the mains voltage from the nominal value must not exceed the tolerance limits specified in the technical data, otherwise functional failures and hazardous conditions cannot be ruled out.
- Emergency power-off devices complying with IEC/EN 60204-1 must be effective in all operating modes. Unlatching the emergency power-off devices must not cause restart.
- Built-in devices for enclosures or cabinets must only be run and operated in an installed state.
- Wherever faults may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks, etc.).
- The surfaces of the motor starters may become hot during operation.
- The impermissible removal of the required cover, improper installation or incorrect operation of the motor or variable motor starter can cause the failure of the device and serious injury and/or material damage.
- Comply with all applicable national accident prevention regulations (e.g. BGV A3) when working with energized motor starters.
- The electrical installation must be carried out in accordance with the relevant regulations (e.g. cable cross-sections, fuse protections, protective conductor connection).
- All transport, installation, commissioning and maintenance work may only be carried out by qualified personnel.
- The work must be carried out by qualified personnel (in accordance with IEC 60364 or HD 384 or DIN VDE 0100 and national accident prevention regulations).
- Facilities in which motor starters are installed may have to be fitted with additional monitoring and protective devices in accordance with the applicable safety regulations, e. g. law on technical equipment, accident prevention regulations, etc.
- Keep all covers and doors closed during operation.
- When designing the machine, the user must incorporate mechanisms and measures that limit the consequences of a motor starter malfunction or failure (an increase in motor speed or the motor suddenly stopping) so as to prevent hazards to people and property, e. g.: Weitere unabhängige Einrichtungen zur Überwachung sicherheitsrelevanter Größen (Drehzahl,
 - Additional stand-alone devices for monitoring parameters that are relevant to safety (speed, travel, end positions, etc.).
 - Electrical and non-electrical safety devices (interlocks or mechanical locks) for mechanisms that protect the entire system.
 - Due to the possibility of there being capacitors that are still holding a charge, do not touch live device parts or terminals immediately after disconnecting the motor starters from the supply voltage. Heed the corresponding labels on the motor starter.

Disclaimer of Warranties and Limitation of Liability

The information, recommendations, descriptions, and safety notations in this document are based on Eaton Corp's experience and judgment and may not cover all contingencies.

If you require further information, please contact an Eaton sales office. The products described in this material are sold subject to the terms and conditions contained in Eaton's applicable sales guidelines or other contractual agreements between Eaton and the purchaser. There are no agreements, arrangements, warranties of any kind, express or implied, including any warranty of fitness for a particular purpose or marketability, except as expressly agreed in an existing contract between the parties. Any such contract states the entire obligation of Eaton.

The content of this document does not form part of any contract between the parties nor does it amend any such contract. As far as applicable mandatory law allows so, in no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability, or otherwise for any special, indirect, incidental, or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations, and descriptions contained herein. The information contained in this manual is subject to change without notice. The photographs and images contained in this document serve informational purposes only and do not create any obligation on the part of Eaton.

Contents

- 1 General2
- 2 Conditions when setting the motor protection.....2
- 3 Changing EMS... to EMS2...3
- 4 Power setting4
- 4.1 Material requirements4
- 4.2 TwinCAT 3 create sample project.....5
- 4.3 Creating a PLC project6
- 4.4 Creating a Master7
- 4.5 EU5C-SWD-ETHERCAT device description file8
- 4.6 Add Slave9
- 4.7 Project structure I/O10
- 4.8 Translating the configuration.....10
- 4.9 Activating the configuration.....11
- 5 Cross reference13
- 6 Bit assignment cross-reference.....14
- 7 References.....15

1 General

This documentation explains how to set up EtherCAT communication between an EtherCAT capable BECKHOFF PLC and the EATON EMS2-...-SWD.

The setting options via EtherCAT for the motor nominal current are explained below.

Setting the motor protection is part of the acyclical data.

Motor protection 1 (motor nominal current)

- Motor protection 1 is the safety-oriented value.
- Motor protection 1 always takes precedence over motor protection 2 even if both values are written by the PLC.
- Motor protection 1 must always be confirmed (with software or by pressing the RESET button).

To ensure the set value of motor protection 1 is applied, the RESET button must then be pressed or bit 2 (RESM) must be activated within byte 0 of the cyclical output data.

Motor protection 2 (motor nominal current)

- The value of motor protection 2 must always be less than or equal to the value of motor protection 1.
- Motor protection 2 does not need to be confirmed by a reset.

The value can be set and applied without activation on the device and without software.

Switching profiles requires advanced engineering knowledge!

EMS2-...-SWD devices have five profiles.

If you carry out a new initialisation process on the Gateway, the current values may change!

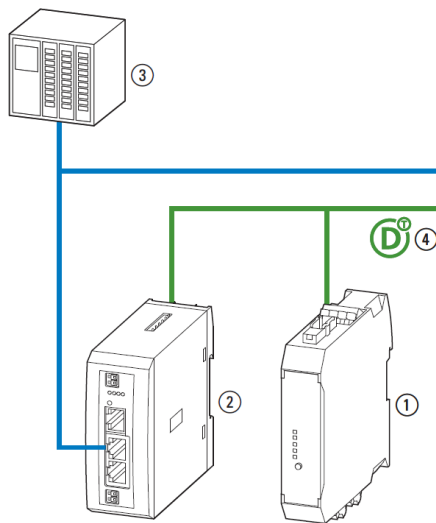
→ Detailed information is provided in the instructions listed in the reference.

2 Conditions when setting the motor protection

The following conditions must be met when setting the motor protection and displaying the set value:

- The device has a voltage supply (voltage via SWD or voltage to the terminals 1/L1, 3/L2, 5/L3).
- There is no start signal on the terminals ON, L or R.
- There are no errors.

3 Changing EMS... to EMS2...



- ① EMS2-...-SWD motor starter
- ② SWD gateway (EU5C-SWD-...)
- ③ Beckhoff PLC
- ④ SmartWireDT

To change the EMS... to the EMS2..., please proceed as follows:

1. Turn off the PLC or switch to OFFLINE.
2. Turn off the facility if necessary.
3. Disconnect the motor, power and control cables and SWD plug from the EMS...
4. Install EMS2....
5. Connect SWD plug to EMS2.
6. Connect motor and mains to EMS2..
7. Set the current (see chapter 4).
8. Reconfigure Gateway/PLC, if necessary adapt PLC program.
9. Ready to start.



Caution!

Before switching on, ensure that the motor cable is connected correctly.

4 Power setting

The EMS2-...-SWD device series no longer has a potentiometer!

The motor current is only set via the software!

The setting options via Twincat are shown below.

4.1 Material requirements

To realise the example communication between master (PLC) and variable frequency drive (slave), it is assumed that certain hardware and software components are available. The corresponding components are listed below:

Required hardware components

- PLC Beckhoff CPU with EtherCAT interface (e.g. C6920-0040)
- EMS2-...-SWD
- SWD Gateway EU5C-SWD-ETHERCAT
- Ethernet cable (CAT-5 cable)

Required software components

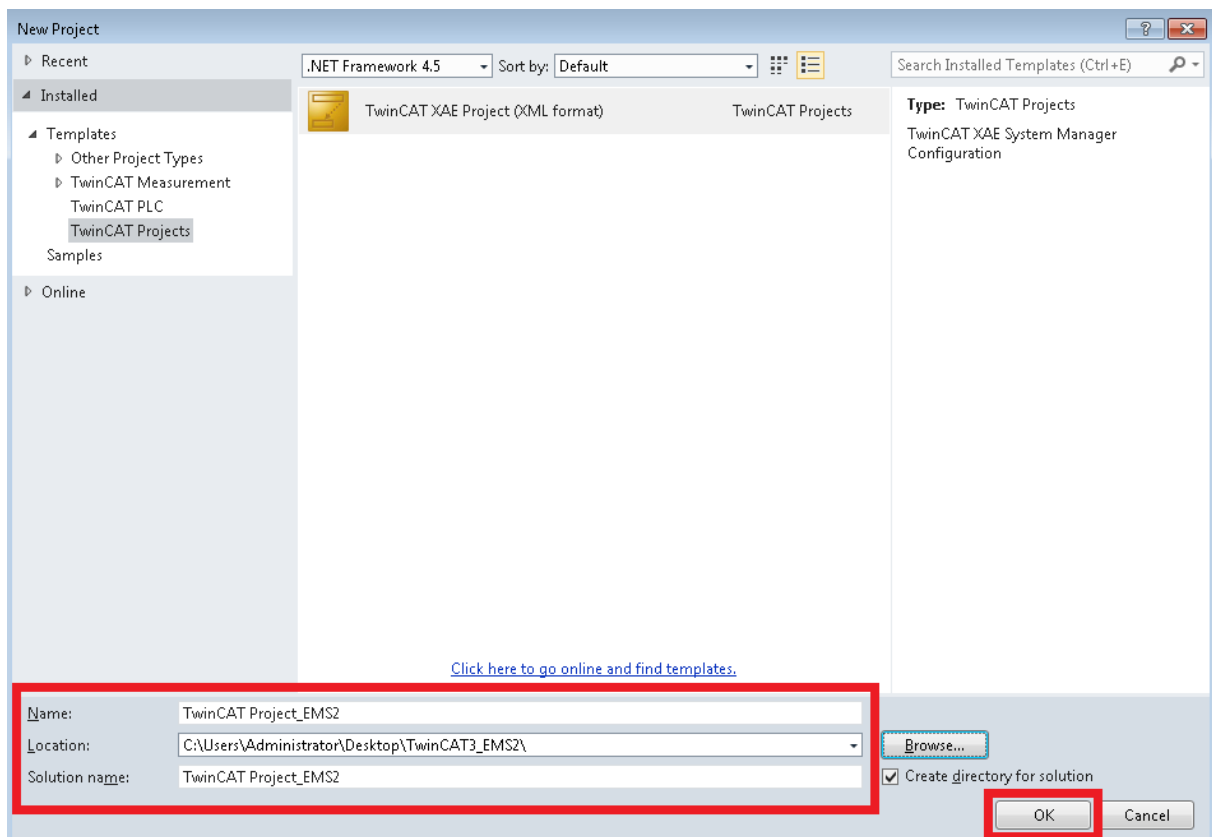
- TwinCAT 3
- Device description file (not absolutely necessary)

4.2 TwinCAT 3 create sample project

To create a new project, the menu item “New TwinCAT Project” must be selected after opening the TwinCAT 3 software.

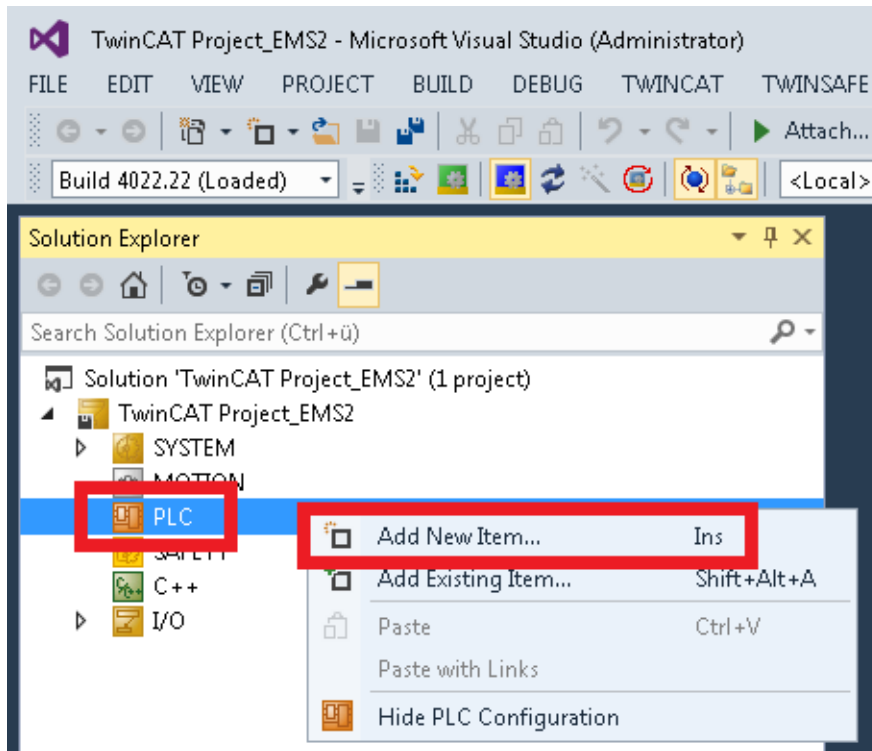


A storage name, the storage directory and the project name must then be entered in the “New Project” window. By clicking “OK”, the window closes and the new project is created.

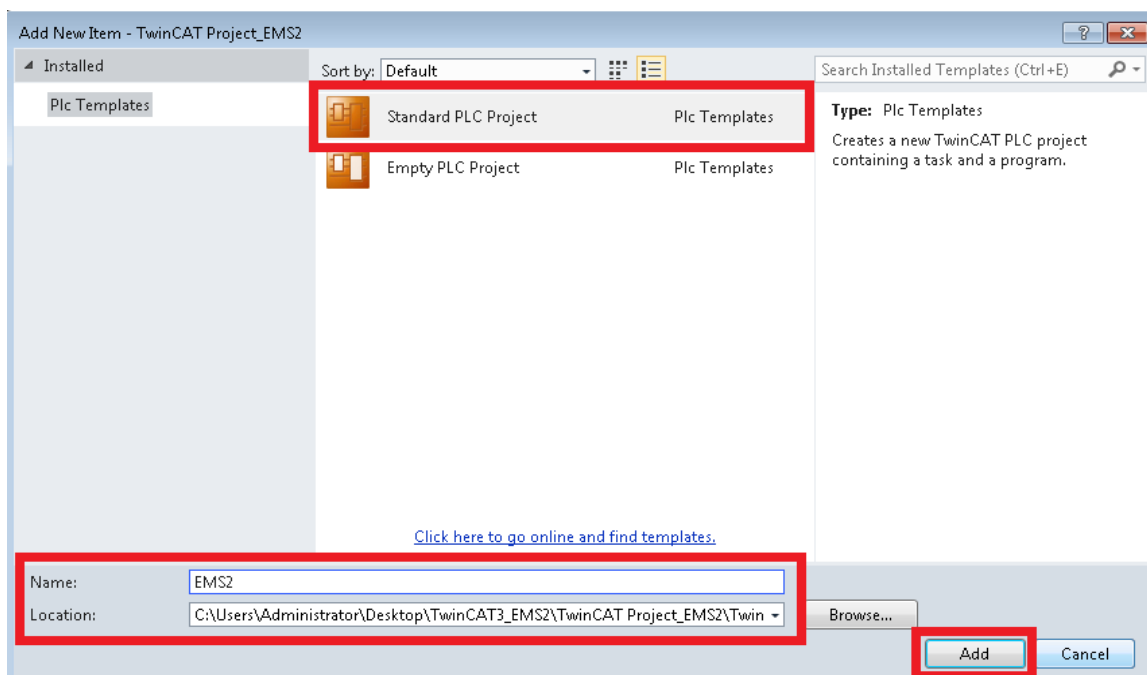


4.3 Creating a PLC project

The figure below shows the TwinCAT 3 project environment. To configure a PLC, firstly the project sub-item "PLC" must be selected on the left-hand side of the Explorer window. Right click on PLC to open a selection menu, then select "Add New Item".

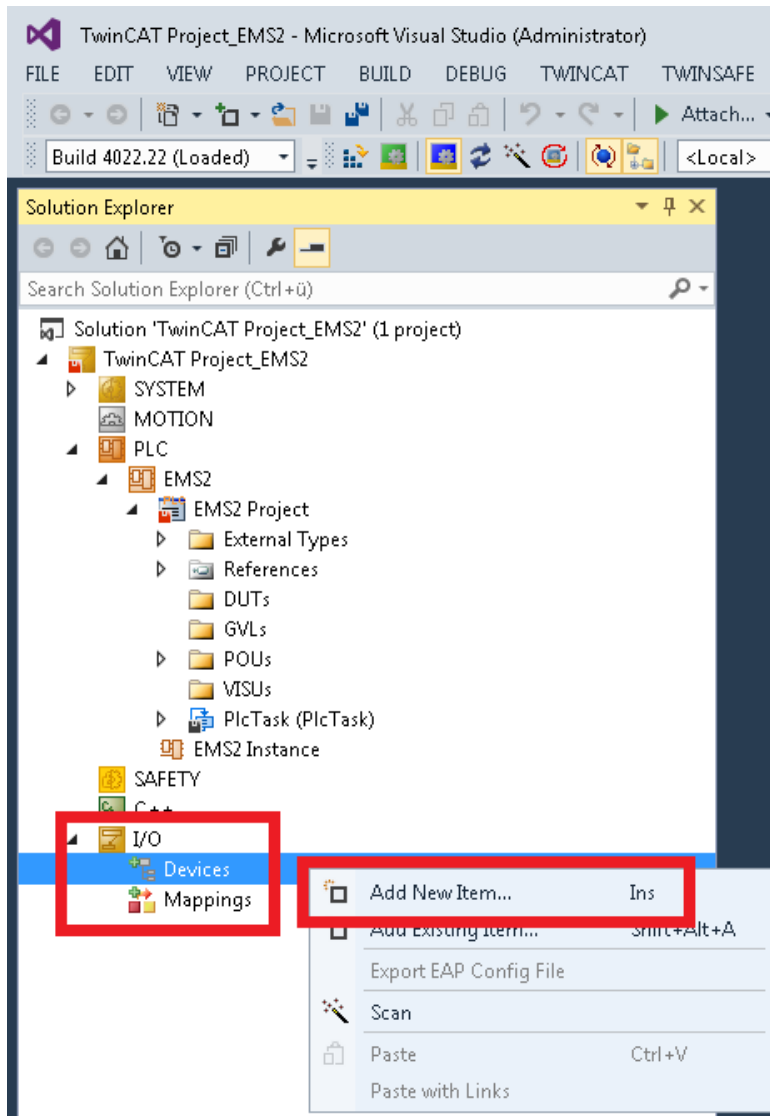


Under "Add New Item", you can choose between an empty and a standard PLC project. A standard project is selected for the sample program. Once a relevant name and the desired directory path have been entered, the configuration must be confirmed by clicking "Add". This is how the PLC project is created. The PLC is not selected until later.

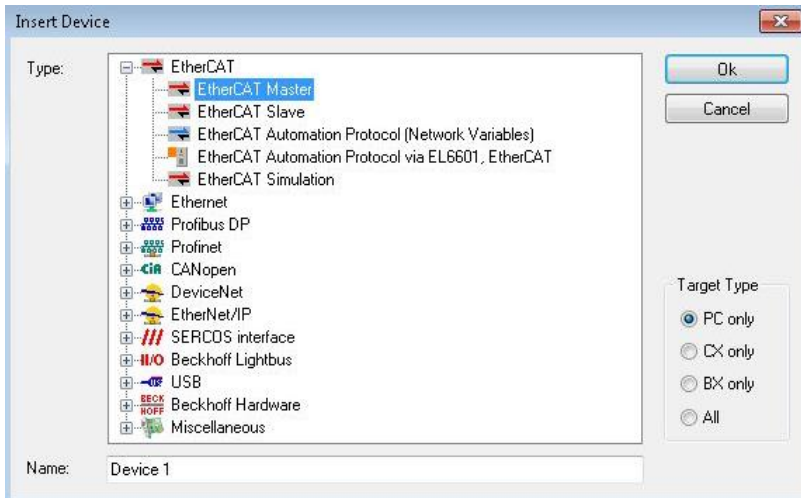


4.4 Creating a Master

In TwinCAT, the I/O menu item must be used to specify the devices to use for communication. To insert a Master, right-click on “Devices” under the “I/O” menu item. “Add New Item” must then be selected from the options displayed. The Insert Device window opens.



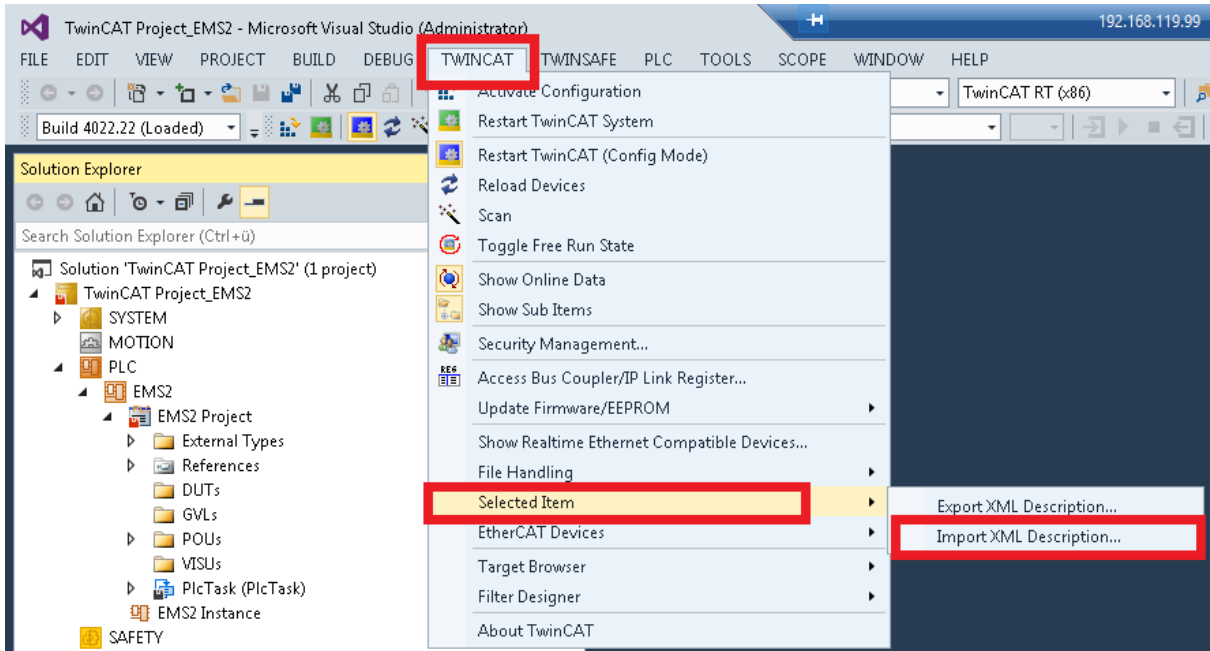
Under the EtherCAT menu item, "EtherCAT Master" must be selected and then confirmed with OK. In the TwinCAT project environment, the master can then be found under the I/ODevices-Device 1 (EtherCAT) menu item.



4.5 EU5C-SWD-ETHERCAT device description file

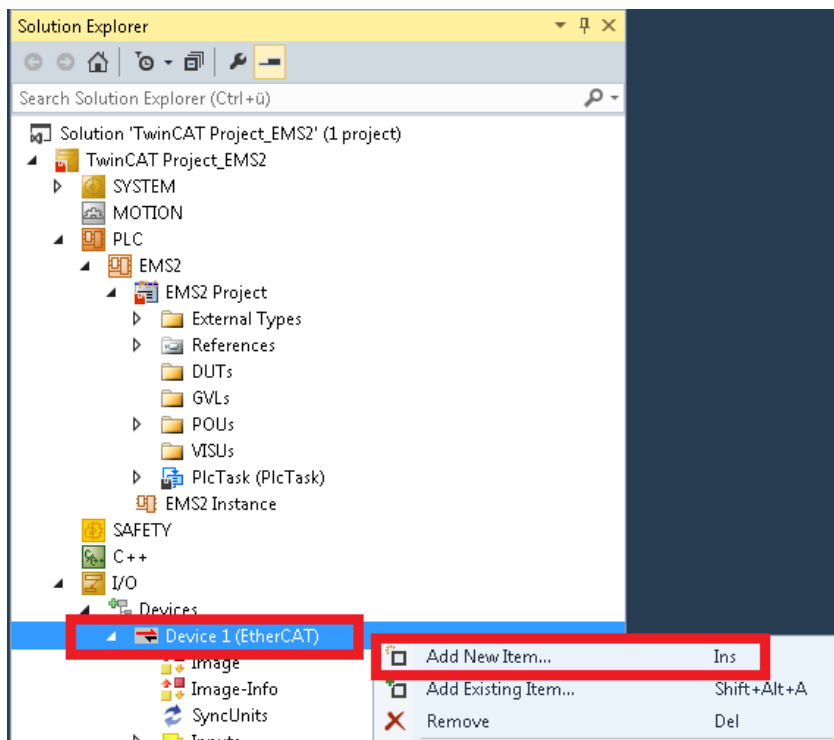
Before adding the EMS2 as a slave, the device description file for the EU5C-SWD-ETHERCAT must be installed in TwinCAT 3.

The corresponding XML can be inserted by clicking on the TWINCAT Select Item Import XML Description tab.

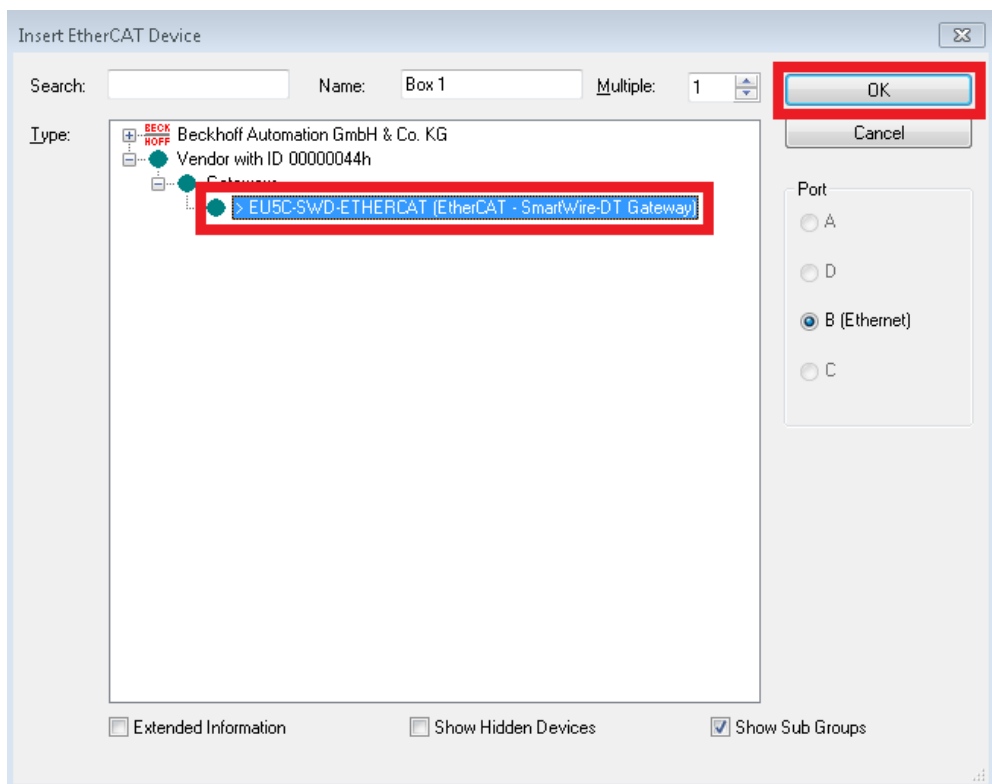


4.6 Add Slave

To add the slave, firstly right-click on device 1 (EtherCAT). The “Add New Item” selection item opens the “Insert EtherCAT Device” window.

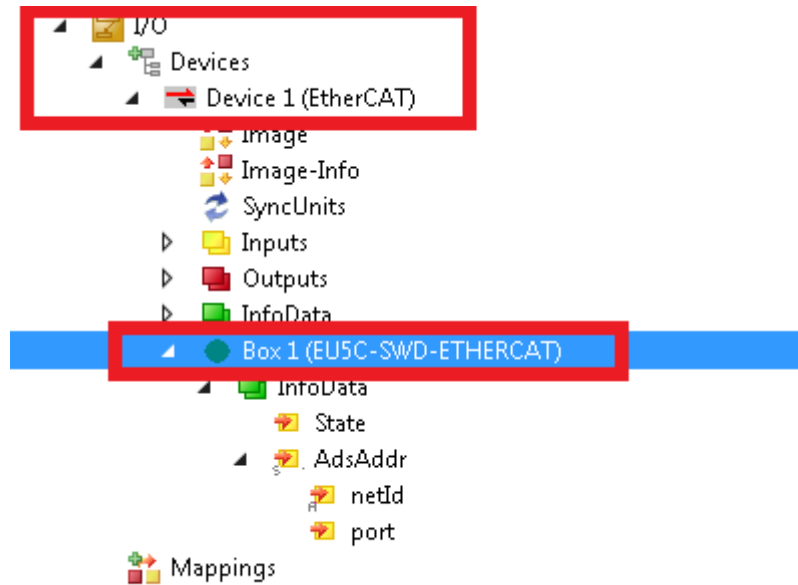


EU5C-SWD-ETHERCAT can now be selected in the “Insert EtherCAT Device” window. Click “OK” to confirm the selection.



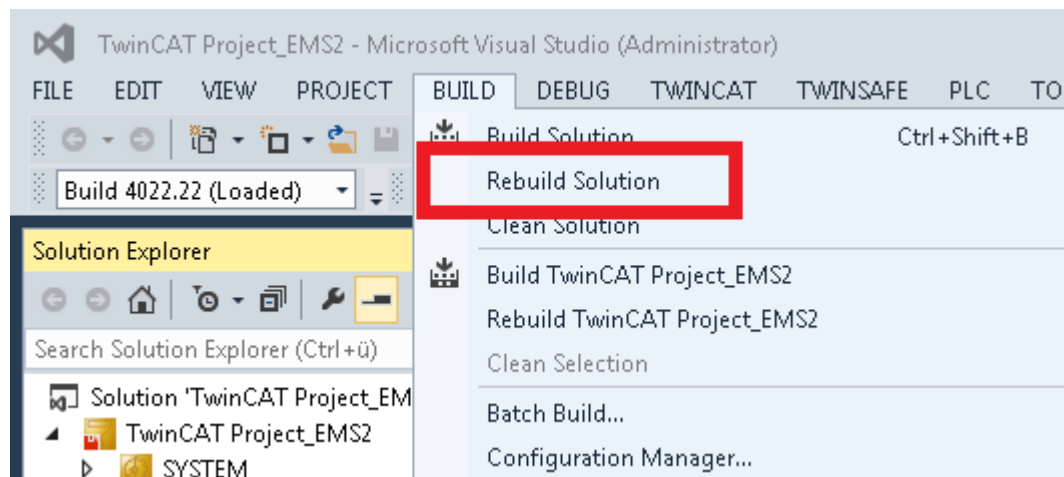
4.7 Project structure I/O

EU5C-SWD-ETHERCAT is now added as a slave. In the below section of the TwinCAT project environment, it is located hierarchically below the master.



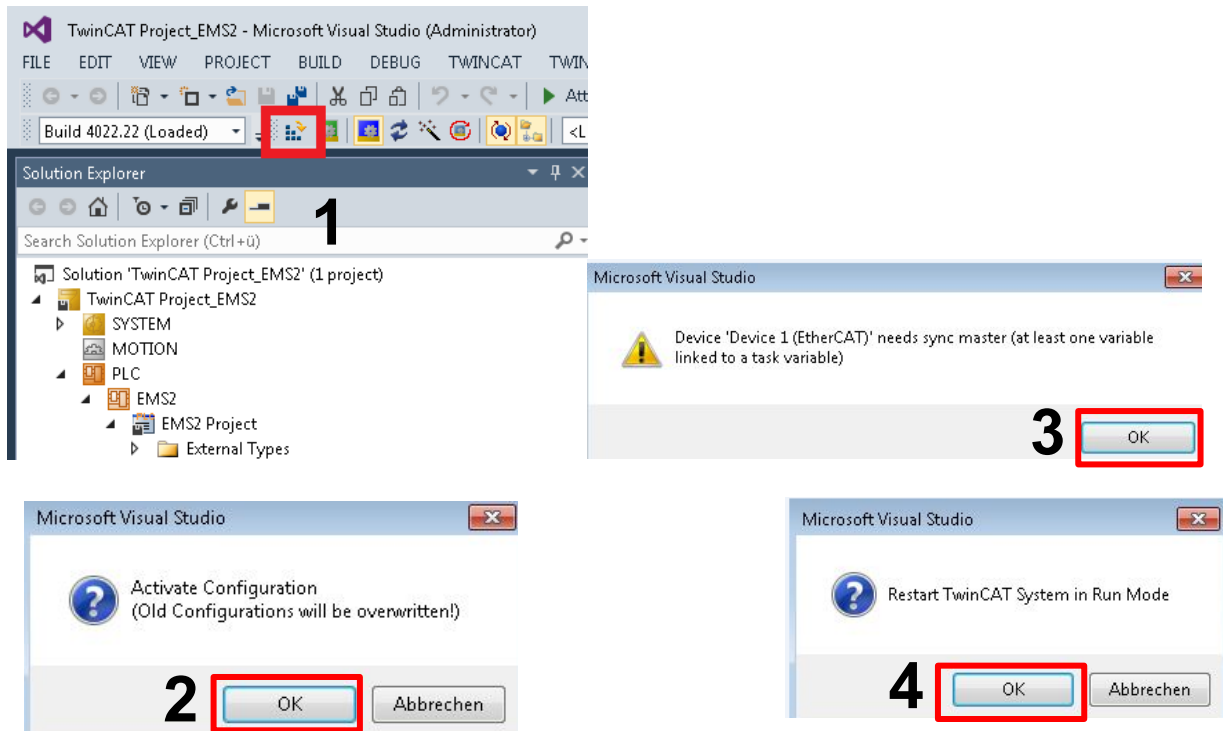
4.8 Translating the configuration

The set configuration is translated via the BUILDRebuild Solution tab.

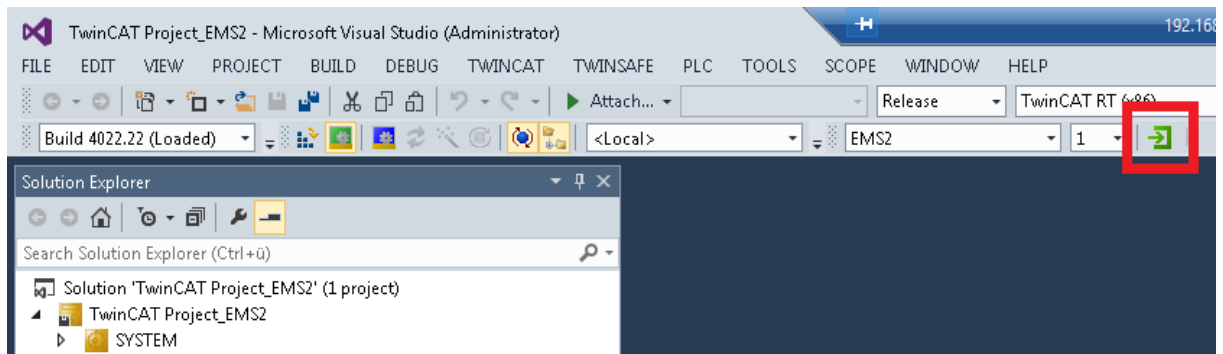


4.9 Activating the configuration

To activate the configuration, “Activate Configuration” must firstly be clicked in the TwinCAT 3 project environment. The information windows that appear must be clicked on as shown below.



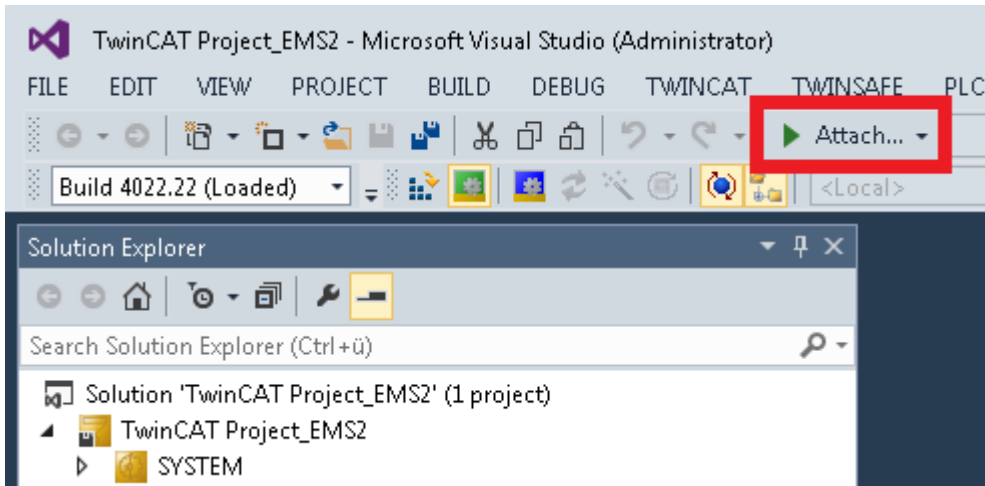
After the configuration has been activated, you must log in to the PLC. To do so, click on “Log in” as shown below.



Since there is no program on the PLC, the “TwinCAT PLC Control” window opens with the notification as shown below. Click “Yes” to load the project onto the PLC.



Click on the play icon to switch to online mode.



The nominal current can now be set in the "Startup" tab

- The numbering from 0 to 15 represents coded values. The current values can be found in Table 1 on the next page.
- Then save and download the configuration
- The "PWR" LED on the EMS2 motor starter flashes. The LEDs below indicate the value sent for the motor protection (see table below).
- Press the set button on the front of the EMS2 motor starter. This leads the transmitted value to be accepted by the device (only for motor protection 1)
- After this, the "PWR" LED lights up permanently

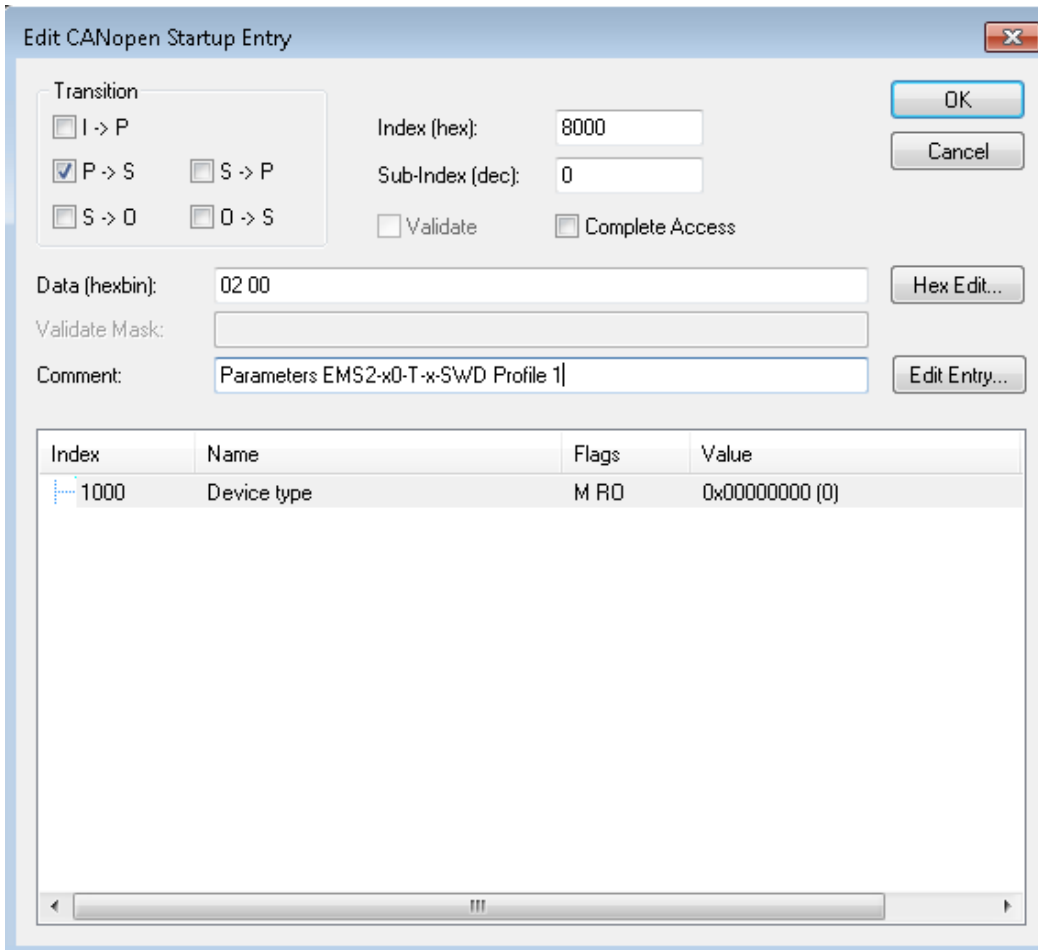


Table 1: Current input in the PLC

SWD	Codex				Setting value I _n [A]	
	SWD	ERR	L	R / ON	I _e = 3 A	I _e = 9 A
0	0	0	0	0	0,18	1,5
1	0	0	0	1	0,30	2,0
2	0	0	1	0	0,44	2,5
3	0	0	1	1	0,60	3,0
4	0	1	0	0	0,68	3,5
5	0	1	0	1	0,88	4,0
6	0	1	1	0	1,0	4,5
7	0	1	1	1	1,1	5,0
8	1	0	0	0	1,2	5,5
9	1	0	0	1	1,5	6,0
10	1	0	1	0	1,6	6,5
11	1	0	1	1	1,9	7,0
12	1	1	0	0	2,1	7,5
13	1	1	0	1	2,4	8,0
14	1	1	1	0	2,7	8,5
15	1	1	1	1	3,0	9,0

Examples for 3/9A:

- Value 15 (F) + 02 = 3842 (decimal)



5 Cross reference

The EMS cross reference list for EMS2 can be found in the table below.

EMS-SWD (Old)	EMS SWD (old) Type Bits (0.1.2.3)	EMS2-SWD (NEW)	EMS2 SWD Type Bits (0.1.2.3)
EMS-DO-T-2,4-SWD	0000	EMS2-DO-T-3-SWD	0100
EMS-RO-T-2,4-SWD	0001	EMS2-RO-T-3-SWD	0101
EMS-DOS-T-2,4-SWD	0010	EMS2-DOS-T-3-SWD	0110
EMS-ROS-T-2,4-SWD	0011	EMS2-ROS-T-3-SWD	0111
EMS-DO-T-9-SWD	0100	EMS2-DO-T-9-SWD	1000
EMS-RO-T-9-SWD	0101	EMS2-RO-T-9-SWD	1001
EMS-DOS-T-9-SWD	0110	EMS2-DOS-T-9-SWD	1010
EMS-ROS-T-9-SWD	0111	EMS2-ROS-T-9-SWD	1011

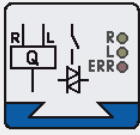
6 Bit assignment cross-reference

The bit assignment is shown below as an example. The SWD-Assist software can be used for support.

EMS-...-SWD profile 5

Device information
Device parameters


EMS-RO-T-9-SWD - (Reversing starter 9A)



Comment:

Description: Electronic motor starter with motor protection function for DOL and reversing starting with maximum rated operational current of 9 A / motor current of 6.5 A

Distance to previous module: 2 m
Position on the bus: 2 m
Current consumption 15V: 50 mA
AUX current consumption: 120 mA



Inputs: 7 Byte

Des.	Description	Data type	Offset
ERR	Fault detection	BIT	0.0
DIRR	Operating direction right	BIT	0.1
DIDL	Operating direction left	BIT	0.2
DIAG	Group diagnostics	BIT	0.4
PRSNT	Module present	BIT	0.6
SUBST	Universal module	BIT	0.7
IR	Set value Ir	BYTE (4 Bit)	1.0
TRIPR	Trip Reason	BYTE (3 Bit)	1.4
ACKR	Overload needs to be reset	BIT	1.7
I_REL	Motor current [%]	BYTE	2.0
TH	Thermal motor image [%]	BYTE	3.0
TYPE	Module type	BYTE (4 Bit)	4.0
OVLD	Overload pre-warning (>=105%)	BIT	4.7
I_ABS	Motor current [A]	WORD	5.0

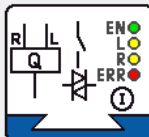
Outputs: 1 Byte

Des.	Description	Data type	Offset
SDIRR	Start Forward	BIT	0.0
SDIRL	Start Reverse	BIT	0.1
RESM	Manual reset	BIT	0.2
RESA	Automatic reset	BIT	0.3

EMS2-...-SWD Profile 5

Device information
Device parameters


EMS2-RO-T-9-SWD - (Electronic reversing starter 9 A)



Comment:

Description: Electronic reversing starter 9 A

Distance to previous module: 10 cm
Position on the bus: 2.10 m
Current consumption 15V: 50 mA
AUX current consumption: 120 mA



Inputs: 7 Byte

Des.	Description	Data type	Offset
ERR	Errors	BIT	0.0
DIRR	Forward	BIT	0.1
DIDL	Counter-dockwise	BIT	0.2
EN	Enable	BIT	0.3
DIAG	Group diagnostics	BIT	0.4
PRSNT	Module present	BIT	0.6
SUBST	Universal module	BIT	0.7
IR	Set value Ir	BYTE (4 Bit)	1.0
TRIPR	Trip Reason	BYTE (3 Bit)	1.4
ACKR	Overload needs to be reset	BIT	1.7
I_REL	Motor current [%]	BYTE	2.0
TH	Thermal motor image [%]	BYTE	3.0
TYPE	Module type	BYTE (4 Bit)	4.0
DEV_OK	Module OK	BIT	4.4
NET_FAIL	Power failure	BIT	4.6
OVLD	Overload warning	BIT	4.7
I_AMP	Motor current [A] (in 10 mA)	WORD	5.0

Outputs: 1 Byte

Des.	Description	Data type	Offset
SDIRR	Start Forward	BIT	0.0
SDIRL	Start Reverse	BIT	0.1
RESM	Manual reset	BIT	0.2
RESA	Automatic reset	BIT	0.3
TSDIRL	A rising edge will start anticlockwise operation	BIT	0.5
TSSTOP	A rising edge will stop the motor	BIT	0.6
TSDIRR	A rising edge will start clockwise operation	BIT	0.7

7 References

Dokumentation	Dokument	Link
EMS2 manual	MN034003	Link
EMS2-...SWD manual	MN120008	Link
EMS2 instruction leaflet	IL034064ZU	Link
EMS2-...SWD instruction leaflet	IL120004ZU	Link
EMS-...SWD manual	MN034002	Link
EMS instruction leaflet	IL03407198Z	Link
EMS-...SWD instruction leaflet	IL120002ZU	Link
EMS product page		Link
Download Center		Link

Eaton is an intelligent power management specialist company dedicated to improving the quality of life and protecting the environment for people everywhere. Our products are used at data centers, utility companies, industry, trade, machine building, residential construction, aerospace and mobility. We are guided by our commitment to do business right, to operate sustainably and to help our customers manage power – today and in the future. We are focusing on the global growth trends of electrification and digitalization to accelerate the transition to renewable energy, help solve the world's most pressing power management challenges and make society more sustainable for this and future generations.

Eaton was founded in 1911 and has been listed on the New York Stock Exchange for over a century. In 2023, we generated sales of 23.2 billion US dollars and are represented in over 160 countries. For more information, visit www.eaton.com. Follow us on [LinkedIn](#).