stepIM

Integrated Closed Loop Stepper Motor

User Manual

ORIGINAL DOCUMENT
Manual Revision 2.1

Revision History

Doc. Rev.	Date	Remarks
2.1	27 July 2021	Cover design, photo and logos updated.
2.0.1	4 Mar. 2021	STXI Motion updates.
2.0	1 Mar. 2021	Updated content for new model: NEMA 17 EtherCAT. Updated section Wiring Guidelines – Motor Brake, section Motor Brake, and section Connector Cables (IP65)
1.9	13 Oct. 2020	Updates: Ordering info. Brake control.
1.8	11 Jan. 2020	stepIM 23 dimensions correction (Figure 3.6)
1.7	Sept. 2019	Boot mode duration updated: 5 seconds. Fault FF07h added. USB to CAN adapter info added. Correct specifications for NEMA 23 EtherCAT.
1.6	9 Dec. 2018	Various corrections and updates.
1.5 [v.3]	21 June 2018	Minor corrections.
1.4	19 Mar. 2018	Release for distribution.
1.3	2 Oct. 2017	Release for distribution.
1.2.8	August 2017	Preliminary release.
1.1	April 2016	Minor corrections
1.0	April 2016	Initial release

Copyright Notice

© 2021 STXI Motion Ltd.

All rights reserved. No part of this work may be reproduced or transmitted in any form or by any means without prior written permission of STXI Motion.

Disclaimer

This product documentation was accurate and reliable at the time of its release. STXI Motion Ltd. reserves the right to change the specifications of the product described in this manual without notice at any time.

Trademarks

stepIM and ServoStudio 2 are trademarks of Servotronix Motion Control Ltd.
CANopen and CiA are registered trademarks of the CAN in Automation User's Group
EtherCAT is a registered trademark of Beckhoff Automation GmbH
Windows is a registered trademark of Microsoft Corporation

Contact Information

STXI Motion Ltd.
website: www.stxim.com

Contents

1 Introduction
1.1 stepIM Product Series ... 7
1.2 About This Manual ... 7
1.3 Documentation Set for stepIM ... 7
1.4 Ordering Information ... 8

2 Safety and Standards
2.1 Standards Compliance ... 9

3 Specifications
3.1 stepIM Product Models ... 10
3.2 stepIM Architecture ... 12
3.3 Dimensions and Mounting – CANopen Models ... 13
3.3.1 Dimensions – NEMA 17 (IP20) – CANopen ... 13
3.3.2 Dimensions – NEMA 23 (IP20) – CANopen ... 14
3.3.3 Dimensions – NEMA 23 (IP65) – CANopen ... 15
3.3.4 Dimensions – NEMA 34 (IP20) – CANopen ... 16
3.3.5 Dimensions – NEMA 34 (IP65) – CANopen ... 17
3.4 Dimensions and Mounting – EtherCAT Models ... 18
3.4.1 Dimensions – NEMA 17 (IP65) – EtherCAT ... 18
3.4.2 Dimensions – NEMA 23 (IP65) – EtherCAT ... 19
3.4.3 Dimensions – NEMA 34 (IP65) – EtherCAT ... 20
3.5 Mechanical and Electrical – CANopen Models ... 21
3.5.1 Mechanical and Electrical – NEMA 17 (IP20) – CANopen ... 21
3.5.2 Mechanical and Electrical – NEMA 23 (IP20) – CANopen ... 23
3.5.3 Mechanical and Electrical – NEMA 23 (IP65) – CANopen ... 25
3.5.4 Mechanical and Electrical – NEMA 34 (IP20) – CANopen ... 27
3.5.5 Mechanical and Electrical – NEMA 34 (IP65) – CANopen ... 29
3.6 Mechanical and Electrical – EtherCAT Models ... 31
3.6.1 Mechanical and Electrical – NEMA 17 (IP65) – EtherCAT ... 31
3.6.2 Mechanical and Electrical – NEMA 23 (IP65) – EtherCAT ... 33
3.6.3 Mechanical and Electrical – NEMA 34 (IP65) – EtherCAT ... 35
3.7 Power ... 37
3.8 Control ... 38
3.9 Communication ... 38
3.10 Protection and Environmental ... 39
3.11 Inputs/Outputs ... 40

4 Wiring
4.1 Wiring Guidelines ... 41
4.1.1 Wiring Guidelines – Power Supply ... 43
4.1.2 Wiring Guidelines – Auxiliary | CAN Power ... 44
4.1.3 Wiring Guidelines – Digital Inputs ... 45
4.1.4 Wiring Guidelines – Analog Input ... 45
4.1.5 Wiring Guidelines – Motor Brake ... 46
4.2 Wiring – CANopen Models ... 48
4.2.1 Wiring – NEMA 17 (IP20) – CANopen ... 48
Power Supply – NEMA 17 (IP20) ... 48
CAN – NEMA 17 (IP20) ... 48
I/Os – NEMA 17 (IP20) ... 49
4.2.2 Wiring – NEMA 23 (IP20) – CANopen ... 51

Power Supply – NEMA 23 (IP20) ... 51
CAN – NEMA 23 (IP20) ... 51
I/Os – NEMA 23 (IP20) ... 52
4.2.3 Wiring – NEMA 23 (IP65) – CANopen ... 54
Power Supply – NEMA 23 (IP65) ... 54
CAN – NEMA 23 (IP65) ... 54
I/Os – NEMA 23 (IP65) ... 55
4.2.4 Wiring – NEMA 34 (IP20) – CANopen ... 57
Power Supply – NEMA 34 (IP20) ... 57
CAN – NEMA 34 (IP20) ... 57
I/Os – NEMA 34 (IP20) ... 58
4.2.5 Wiring – NEMA 34 (IP65) – CANopen ... 60
Power Supply – NEMA 34 (IP65) ... 60
CAN – NEMA 34 (IP65) ... 60
I/Os – NEMA 34 (IP65) ... 61
4.3 Wiring – EtherCAT Models ... 63
4.4 Wiring – NEMA 17 (IP65) – EtherCAT ... 63
Power Supply – NEMA 17 (IP65) ... 63
EtherCAT – NEMA 17 (IP65) ... 63
I/Os – NEMA 17 (IP65) ... 65
4.4.1 Wiring – NEMA 23 (IP65) – EtherCAT ... 67
Power Supply – NEMA 23 (IP65) ... 67
EtherCAT – NEMA 23 (IP65) ... 67
I/Os – NEMA 23 (IP65) ... 69
4.4.2 Wiring – NEMA 34 (IP65) – EtherCAT ... 71
Power Supply – NEMA 34 (IP65) ... 71
EtherCAT – NEMA 23 (IP65) ... 71
I/Os – NEMA 34 (IP65) ... 73

5 Installation
5.1 Setup Overview ... 75
5.2 Mating Connector Kits (IP20) ... 76
5.3 Connector Cables (IP65) ... 76
5.4 USB to CAN Adapter ... 78
5.5 Host Computer System ... 78
5.5.1 Software ... 78
5.5.2 USB-CAN Interface ... 78
8devices USB2CAN USB-CAN Adapter ... 79
Kvaser Leaf USB-CAN Adapter ... 79
5.6 Files for Fieldbus Devices (CANopen/EtherCAT) ... 80
5.7 Power Up ... 80

6 CANopen Communication
6.1 CANopen Termination ... 81
6.2 CANopen Network Management ... 81
6.3 CANopen Node ID ... 82
Setting a New Node ID ... 82
Setting New Node IDs for Multiple Drives ... 82
6.4 CANopen Baud Rate ... 83

7 EtherCAT Communication
7.1 EtherCAT Network Management ... 84

8 Configuration
8.1 stepIM Control Loop ... 85

8.2 Drive Configuration ... 86
8.2.1 Setting Safety Limits ... 86
8.2.2 Setting Velocity Loop Gains ... 87
8.2.3 Setting Position Loop Gains ... 88

9 Device Control
9.1 Operation Enabled State ... 89
9.2 Drive State Machine ... 90
9.3 Operation Modes ... 93
9.4 Profile Position Operation Mode (1) ... 94
9.4.1 Point-to-Point Movement ... 95
9.4.2 Begin Motion On Time ... 96
9.4.3 Backlash Compensation ... 97
9.5 Velocity Operation Mode (2) ... 98
9.6 Profile Velocity Operation Mode (3) ... 99
9.7 Profile Torque Operation Mode (4) ... 100
9.8 Cyclic Synchronous Position Operation Mode (8) ... 101
9.9 Homing (6) ... 102
9.9.1 Position Backup and Restore ... 103
9.10 Analog Torque Operation Mode (-4) ... 104
9.11 Analog Velocity Operation Mode (-3) ... 105
9.12 Scripted Motion Operation Mode (-5) ... 106
9.13 Active Disable ... 107
9.13.1 Exceptions to Active Disable ... 109
9.14 Motor Brake ... 111

10 I/O Operation
10.1 Digital Input Modes ... 113
10.2 Homing Triggered by Digital Input ... 114
10.3 Motion Triggered by Digital Inputs ... 114
10.3.1 Input Triggers Scripted Motion ... 115
10.3.2 Binary Value of Inputs Triggers Scripted Motion ... 116
10.4 Virtual Inputs ... 117
10.5 Digital Output Modes ... 118
10.6 Motion Controlled by Analog Output ... 119

11 Recorder
11.1 General ... 120
11.2 Programming the Recorder ... 120
11.3 Triggering the Recorder ... 120
11.4 Starting the Recorder ... 121
11.5 Retrieving the Results ... 121

12 Working with stepIM and Controllers
12.1 Configuring Beckhoff Controller for stepIM – EtherCAT ... 122
12.1.1 Establishing Communication between Controller and PC ... 123
12.1.2 Establishing Communication between Controller and Drive ... 129
12.1.3 Generating Motion ... 132
Generating Motion in Cyclic Synchronous Position Mode ... 140
Generating Absolute and Relative Motion ... 142

13 Firmware Upgrade
13.1 Firmware Upgrade – CANopen Models ... 144
13.1.1 Firmware Upgrade via ServoStudio 2 – CANopen ... 144
13.1.2 Firmware Upgrade over CANopen ... 146

13.2 Firmware Upgrade – EtherCAT Models 148
13.2.1 Firmware Upgrade via ServoStudio 2 – EtherCAT 148
13.2.2 Firmware Upgrade via TwinCAT – EtherCAT 150

14 Troubleshooting
14.1 LEDs – CANopen Models 152
14.2 LEDs – EtherCAT Models 153
14.3 Built-in Protection 155
14.4 Faults 155
14.5 Network Communication Issues 159

1 Introduction

1.1 stepIM Product Series

The stepIM is an integrated closed-loop stepper motor – a single unit comprising motor, drive electronics and position sensor. The electronic control board is attached to the motor and includes control electronics, power stage and magnetic encoder.

The combination of an integrated stepper solution with closed-loop commutation and control provides a number of advantages for machine builders:

- Reduces wiring and assembly time.
- Frees space and reduces heat in the cabinet.
- Reduces machine complexity since fewer components and part numbers, and a smaller cabinet, are used.
- Enhances machine design and flexibility due to the modular structure.
- Provides the high performance of a servo motor at the low cost of a stepper motor.

1.2 About This Manual

This documentation describes the stepIM integrated closed-loop stepper motor.

It provides the information required for installation, configuration and basic operation of the stepIM.

This documentation is intended for persons who are qualified to assemble, commission, and maintain the equipment described herein.

1.3 Documentation Set for stepIM

This manual is part of a documentation set, which consists of the following:

- **stepIM User Manual**. Hardware installation, configuration and operation.
- **stepIM EtherCAT and CANopen Reference Manual**. Implementation of CANopen protocol in stepIM.
- **stepIM ServoStudio 2 Reference Manual**. Guide for graphical software interface.
- **stepIM Technical Training Manual**. For use with stepIM Demo Kit and ServoStudio 2 software.

1.4 Ordering Information

IS T - 23M 1 2 CO 1 0 - 0

	Integrated Stepper Motor
	Type
T	High torque
	Frame Size and Length
17S	NEMA 17 Short
17M	NEMA 17 Medium
17L	NEMA 17 Long
23S	NEMA 23 Short
23M	NEMA 23 Medium
23L	NEMA 23 Long
34M	NEMA 34 Medium
34L	NEMA 34 Long
	Shaft
1	Single flat (Frame size 17 and 23 only)
2	Double flat (Frame size 34 only)
3	Keyway
4	Full round
	Connector and Degree of Protection
2	Crimp connectors, IP20
6	M-connectors, IP65 (Frame size 23, 34 only)
	Communication
CO	CANopen (Frame size 17, IP20 only)
EC	EtherCAT (Frame size 17, IP65 only)
	Feedback
1	Standard – 12-bit absolute single turn
	Brake
0	No brake
1	With brake (Frame size 23, 34 only)
	Options
0	Standard: NEMA 17, 14–48V, 1.8A NEMA 23, 14–48V, 4.5A NEMA 34, 14–75V, 7A
1	NEMA 34, 14–48V, 4.5A (IP20 only)

Brake options – contact vendor for details.
Gearbox options – contact vendor for details.

2 Safety and Standards

Only qualified persons may perform the installation procedures. You do not need to be an expert in motion control to install and operate the stepIM. However, you must have a basic understanding of electronics, computers, mechanics, and safety practices.

The stepIM utilizes hazardous voltages.
Be sure the drive is properly grounded.

Before you install the stepIM, review the safety instructions in this manual.

Failure to follow the safety instructions may result in personal injury or equipment damage.

2.1 Standards Compliance

The stepIM has been tested and certified according to the following standards.

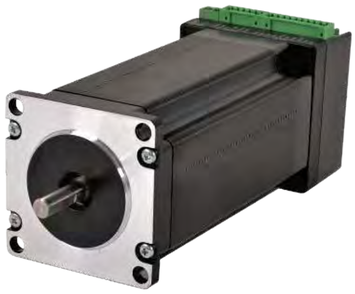
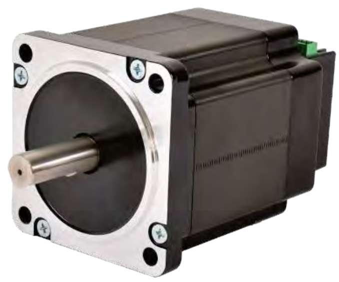
Table 2-1. Standards Compliance

Standard	Directive/Description	Certif. Mark
IEC 61800-3	Electromagnetic Compatibility (EMC) Directive 2004/108/E Adjustable speed electrical power drive systems.	CE
EN 50581:2012	European Regulations 2011/65/EU RoHS (Restriction of Hazardous Substances) Technical documentation required for declaring compliance with the applicable substance restrictions.	CE
IEC International Electrotechnical Commission EN European Standard (Euro Norm)		

3 Specifications

3.1 stepIM Product Models

Model	IP20	IP65
NEMA 17 Short		
NEMA 17 Medium		
NEMA 17 Long		
NEMA 23 Short		
NEMA 23 Medium		

Model	IP20	IP65
NEMA 23 Long		
NEMA 34 Medium		
NEMA 34 Long		

3.2 stepIM Architecture

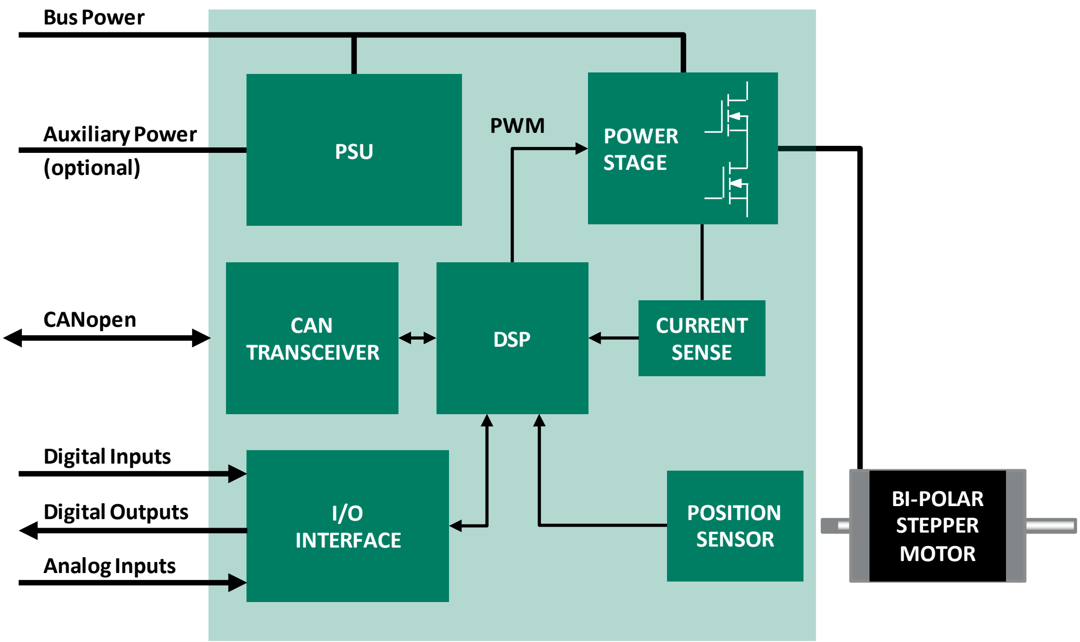


Figure 3-1. stepIM CANopen Hardware

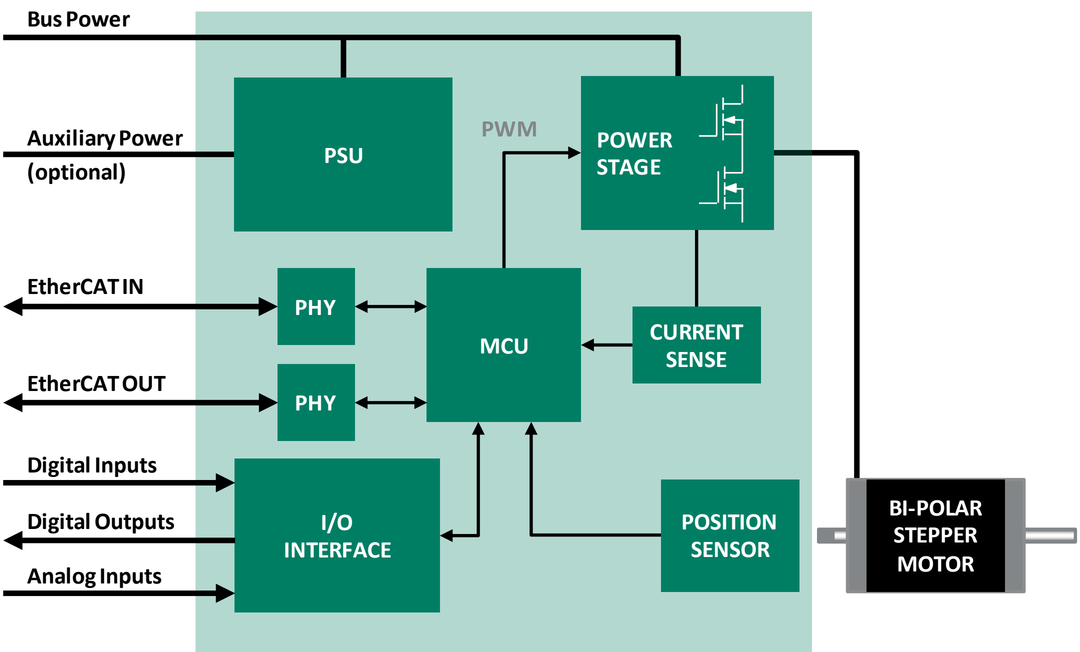


Figure 3-2. stepIM EtherCAT Hardware

3.3 Dimensions and Mounting – CANopen Models

3.3.1 Dimensions – NEMA 17 (IP20) – CANopen

Table 3-1. stepIM NEMA 17 (IP20) – Dimensions

Model	L (mm)
IST-17S12CO10-0	75.3
IST-17M12CO10-0	83.8
IST-17L12CO10-0	97.8

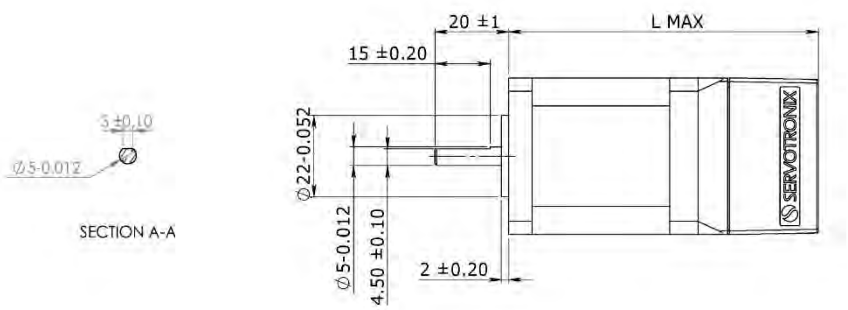


Figure 3-3. stepIM NEMA 17 (IP20) – Dimensions (mm)

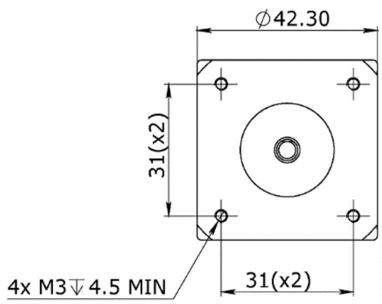


Figure 3-4. stepIM NEMA 17 (IP20) – Mounting (mm)

3.3.2 Dimensions – NEMA 23 (IP20) – CANopen

Table 3-2. stepIM NEMA 23 – IP20 – Dimensions

Model	L (mm)
IST-23S12CO10-0	86.4
IST-23M12CO10-0	108.4
IST-23L12CO10-0	145.4

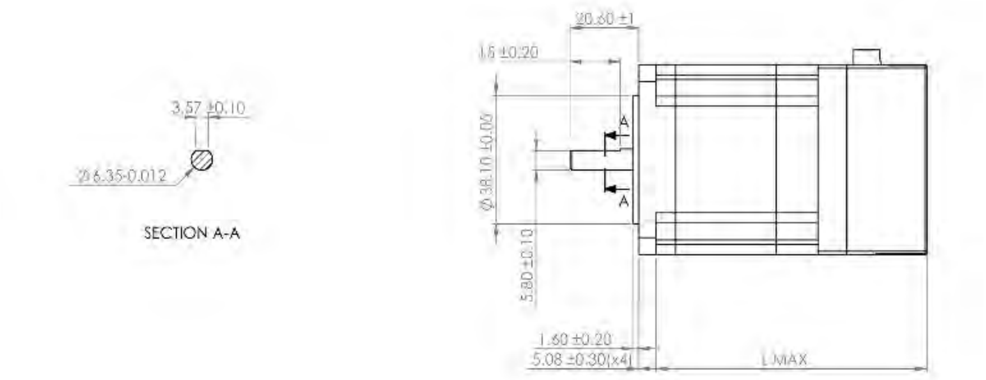


Figure 3-5. stepIM NEMA 23 (IP20) – Dimensions (mm)

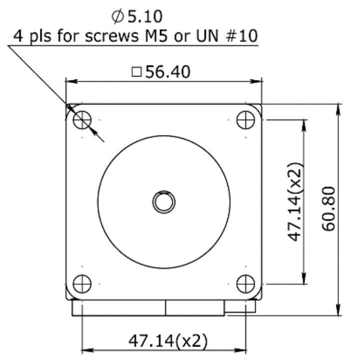


Figure 3-6. stepIM NEMA 23 (IP20) – Mounting (mm)

3.3.3 Dimensions – NEMA 23 (IP65) – CANopen

Table 3-3. stepIM NEMA 23 (IP65) – Dimensions

Model	L (mm)
IST-23S16CO10-0	91.4
IST-23M16CO10-0	112.4
IST-23L16CO10-0	148.4

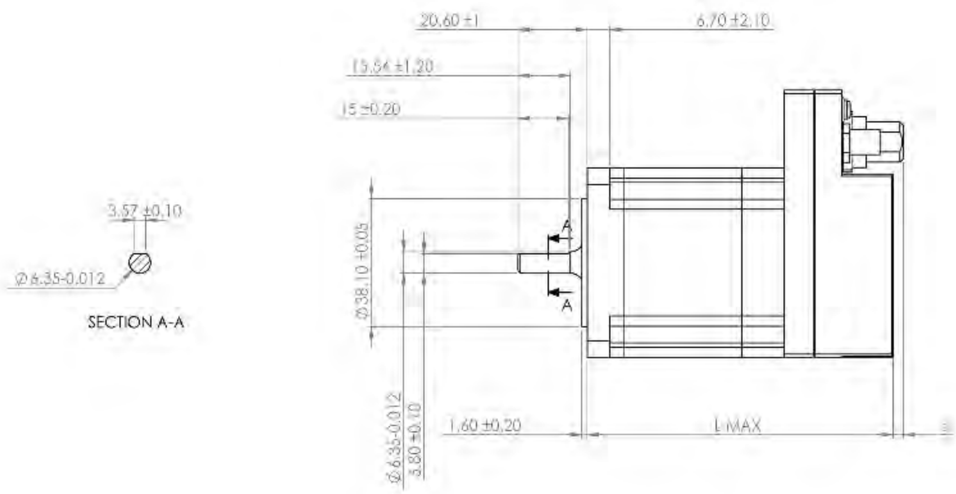


Figure 3-7. stepIM NEMA 23 (IP65) – Dimensions (mm)

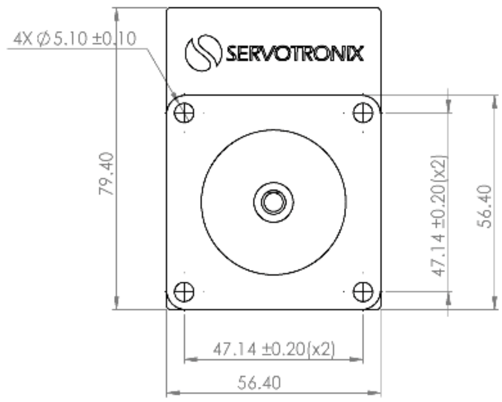


Figure 3-8. stepIM NEMA 23 (IP65) – Mounting (mm)

3.3.4 Dimensions – NEMA 34 (IP20) – CANopen

Table 3-4. stepIM NEMA 34 (IP20) – Dimensions

Model	L (mm)
IST-34M22CO10-1	133.9
IST-34L22CO10-1	163.4

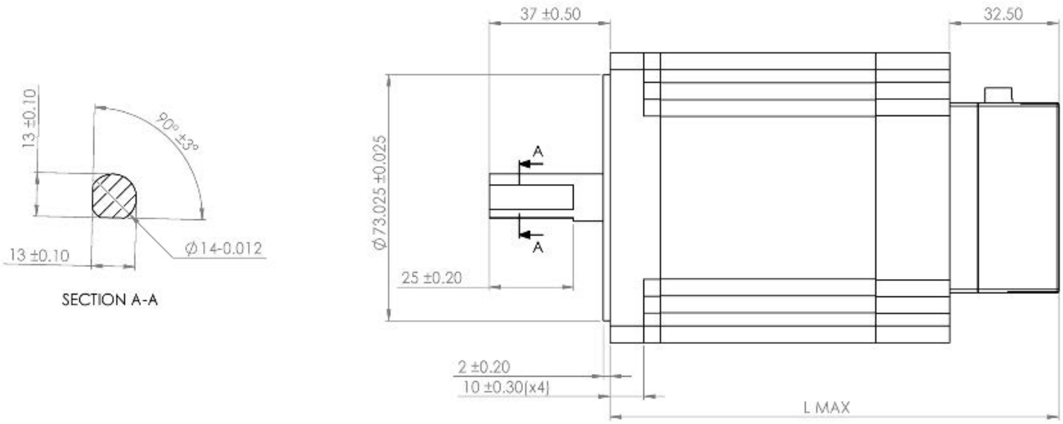


Figure 3-9. stepIM NEMA 34 (IP20) – Dimensions (mm)

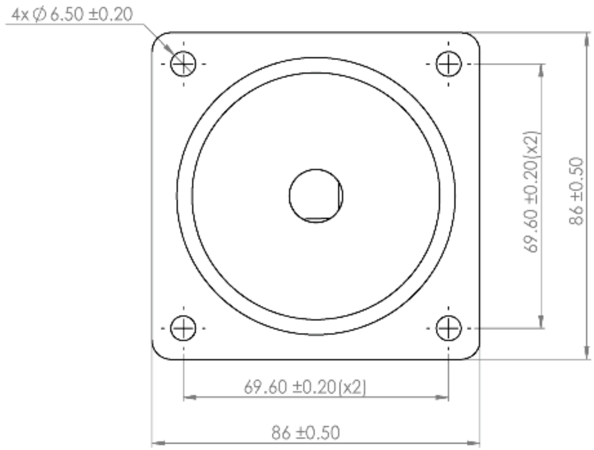


Figure 3-10. stepIM NEMA 34 (IP20) – Mounting (mm)

3.3.5 Dimensions – NEMA 34 (IP65) – CANopen

Table 3-5. stepIM NEMA 34 (IP65) – Dimensions

Model	L (mm)
IST-34M26CO10-0	135.5
IST-34L26CO10-0	165

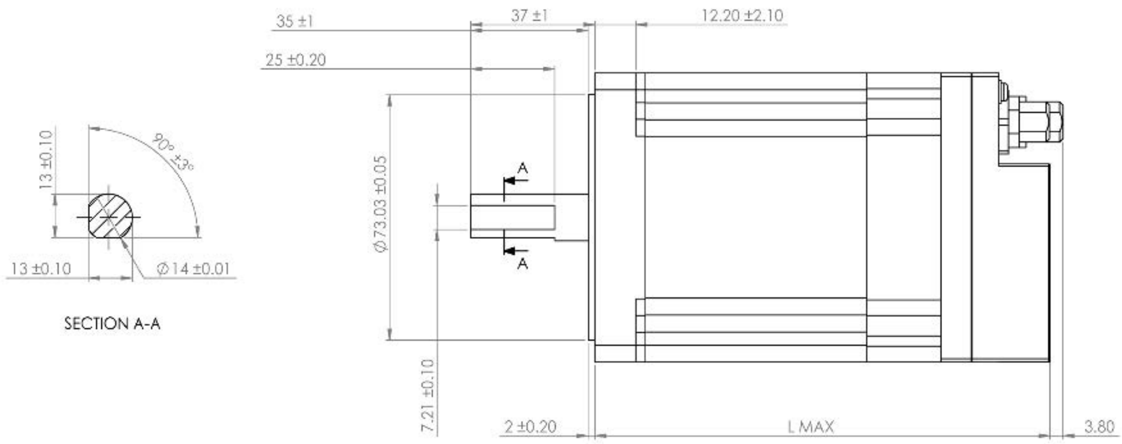


Figure 3-11. stepIM NEMA 34 (IP65) – Dimensions (mm)

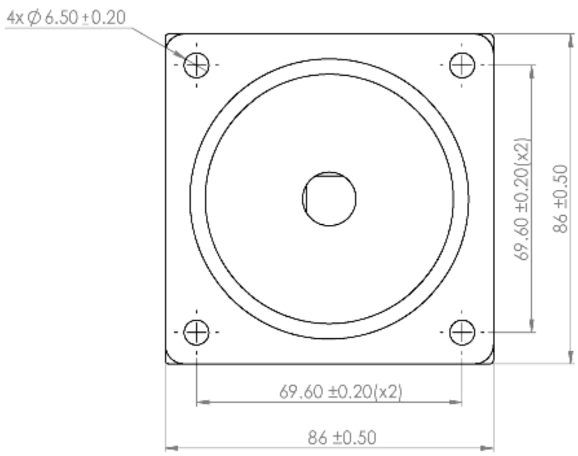


Figure 3-12. stepIM NEMA 34 (IP65) – Mounting (mm)

3.4 Dimensions and Mounting – EtherCAT Models

3.4.1 Dimensions – NEMA 17 (IP65) – EtherCAT

Table 3-6. stepIM NEMA 17 (IP65) – Dimensions

Model	L (mm)
IST-17S16EC10-0	44
IST-17M16EC10-0	52.5
IST-17L16EC10-0	67

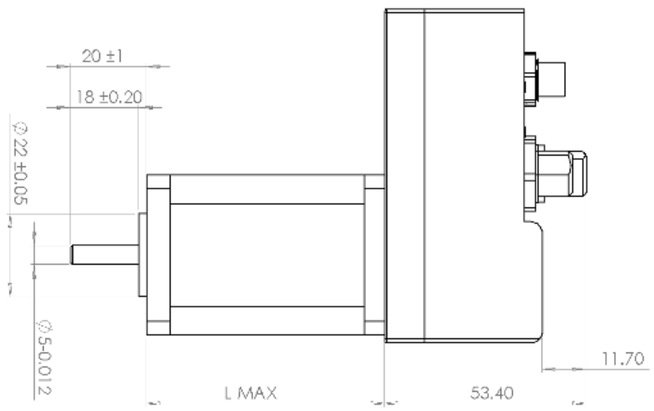


Figure 3-13. stepIM NEMA 17 (IP65) – Dimensions (mm)

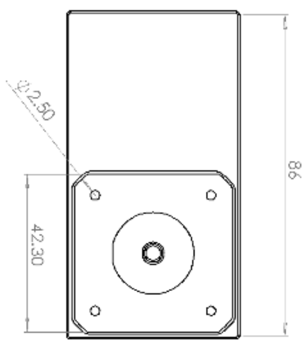


Figure 3-14. stepIM NEMA 17 (IP65) – Mounting (mm)

3.4.2 Dimensions – NEMA 23 (IP65) – EtherCAT

Table 3-7. stepIM NEMA 23 (IP65) – Dimensions

Model	L (mm)
IST-23S16EC10-0	91
IST-23M16EC10-0	112
IST-23L16EC10-0	148

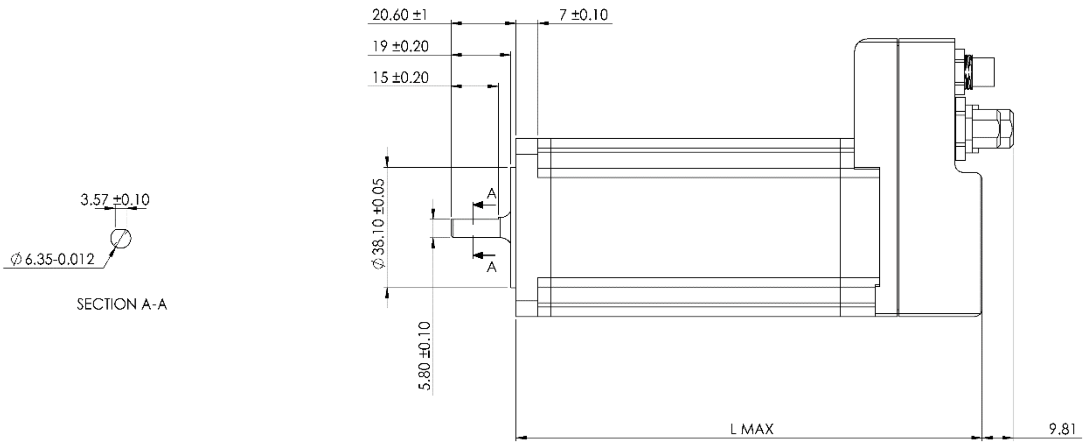


Figure 3-15. stepIM NEMA 23 (IP65) – Dimensions (mm)

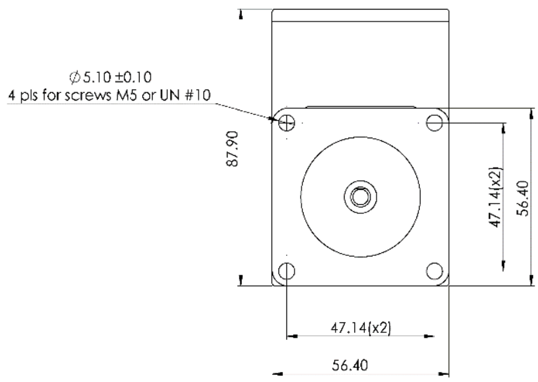


Figure 3-16. stepIM NEMA 23 (IP65) – Mounting (mm)

3.4.3 Dimensions – NEMA 34 (IP65) – EtherCAT

Table 3-8. stepIM NEMA 34 (IP65) – Dimensions

Model	L (mm)
IST-34M26EC10-0	135.5
IST-34L26EC10-0	165

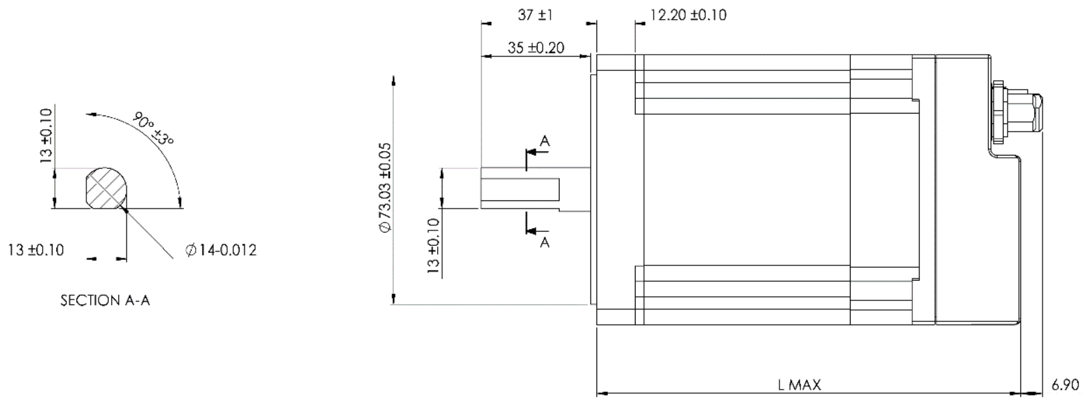


Figure 3-17. stepIM NEMA 34 (IP65) – Dimensions (mm)

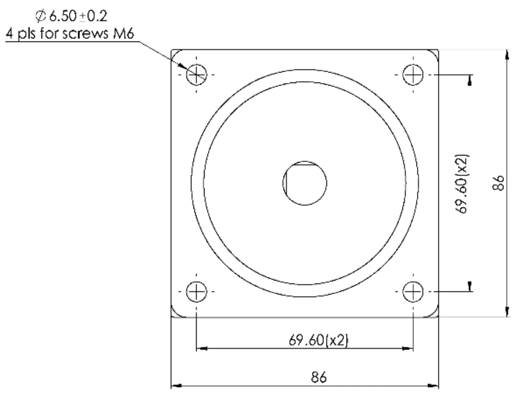


Figure 3-18. stepIM NEMA 34 (IP65) – Mounting (mm)

3.5 Mechanical and Electrical – CANopen Models

3.5.1 Mechanical and Electrical – NEMA 17 (IP20) – CANopen

Table 3-9. stepIM NEMA 17 (IP20) – Mechanical and Electrical

NEMA		17S	17M	17L
Input Power, Nominal (±10%)	VDC	14–48	14–48	14–48
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1	1
Detent Torque	mNm	15	25	25
Thrust Load Limit	kg	0.28	0.36	0.6
Overhung Load Limit (from shaft end)	N	20	20	20
Rotor Inertia	g·cm2	57	82	123
Holding Torque at Continuous Current	Nm	0.35	0.45	0.65
Holding Torque at Peak Current	Nm	0.5	0.6	1.05
Continuous Output Current	A	1.8	1.8	1.8
Peak Output Current (application dependent)	A	3.5	3.5	3.5
Step Angle	deg	1.8	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096	4096
Circuit Loss	W	6	6	6
Weight	kg	0.37	0.44	0.59
Connection Hardware Screw Size/Torque	Nm	0.63	0.63	0.63
Under-Voltage Trip, Nominal	VDC	Logic		
Over-Voltage Trip	VDC	Logic		

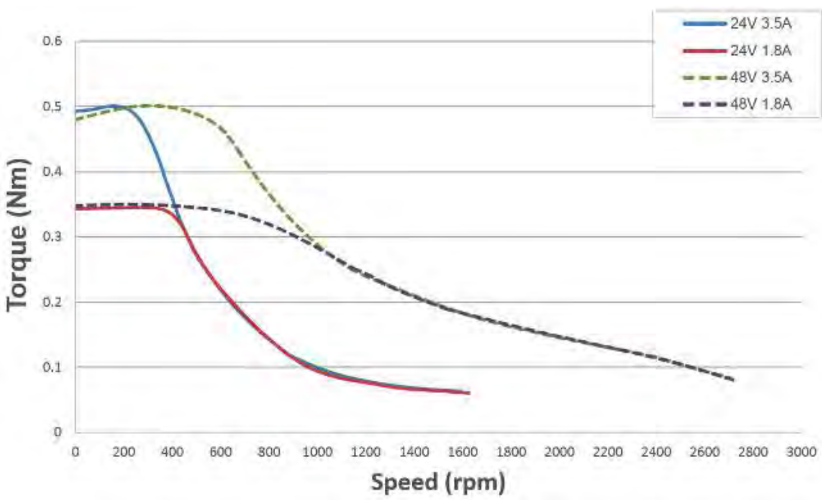


Figure 3-19. Speed/Torque – NEMA 17 Short

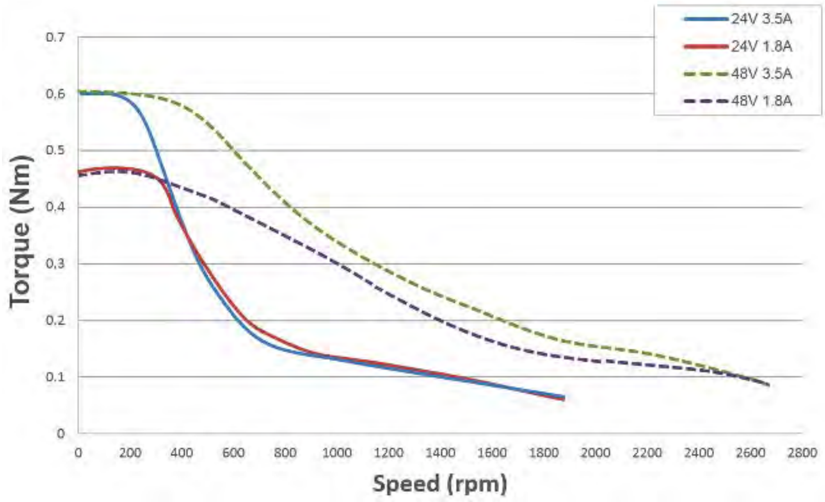


Figure 3-20. Speed/Torque – NEMA 17 Medium

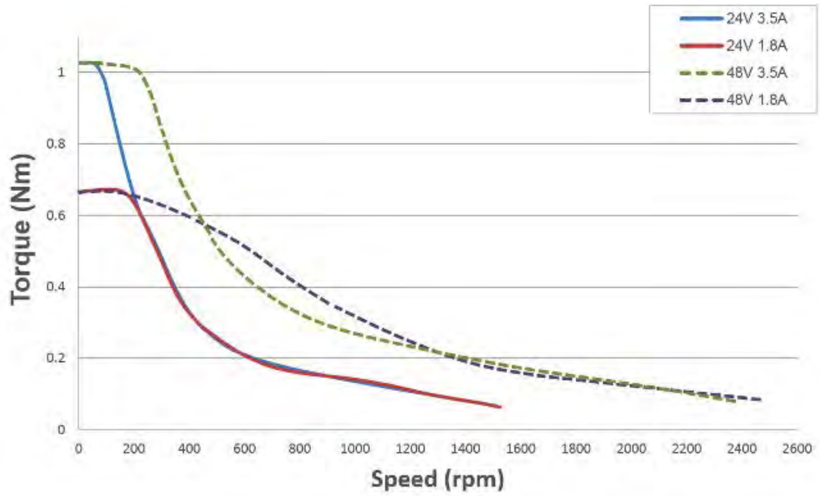


Figure 3-21. Speed/Torque – NEMA 17 Long

3.5.2 Mechanical and Electrical – NEMA 23 (IP20) – CANopen

Table 3-10. stepIM NEMA 23 (IP20) – Mechanical and Electrical

NEMA		23S	23M	23L
Input Power, Nominal (±10%)	VDC	14–48	14–48	14–48
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1	1
Detent Torque	mNm	40	70	120
Thrust Load Limit	kg	0.6	1.0	1.5
Overhung Load Limit (from shaft end)	N	50	50	50
Rotor Inertia	g·cm2	260	460	750
Holding Torque at Continuous Current	Nm	1.1	1.8	2.6
Holding Torque at Peak Current	Nm	1.3	2.1	3.25
Continuous Output Current	A	4.5	4.5	4.5
Peak Output Current (application dependent)	A	6.5	6.5	6.5
Step Angle	deg	1.8	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096	4096
Circuit Loss	W	6	6	6
Weight	kg	0.80	1.13	1.75
Connection Hardware Screw Size/Torque	Nm	3	3	3
Under-Voltage Trip, Nominal	VDC	Logic		
Over-Voltage Trip	VDC	Logic		

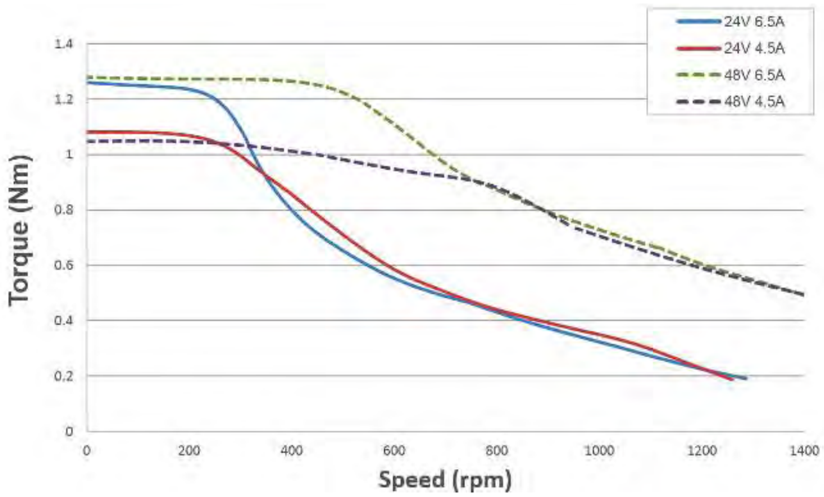


Figure 3-22. Speed/Torque – NEMA 23 (IP20) Short

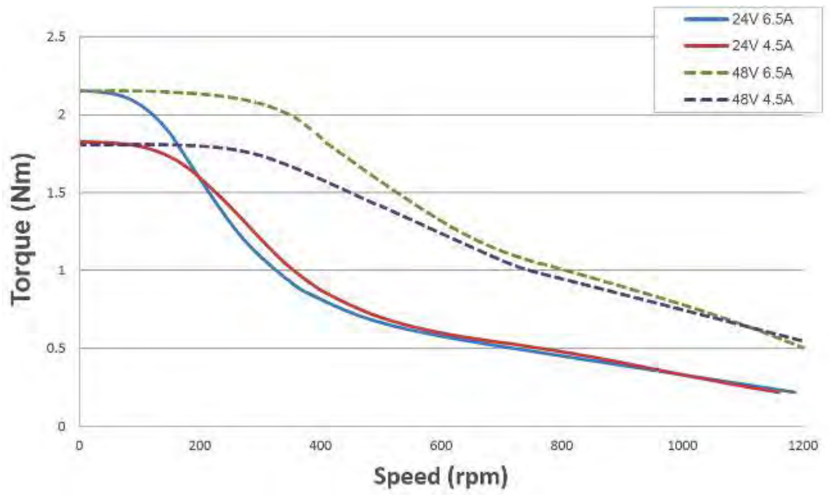


Figure 3-23. Speed/Torque – NEMA 23 (IP20) Medium

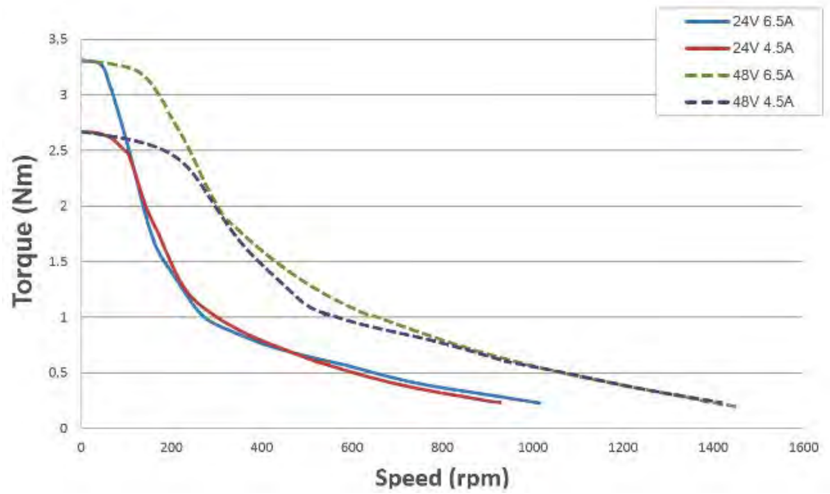


Figure 3-24. Speed/Torque – NEMA 23 (IP20) Long

3.5.3 Mechanical and Electrical – NEMA 23 (IP65) – CANopen

Table 3-11. stepIM NEMA 23 (IP65) – Mechanical and Electrical

NEMA		23S	23M	23L
Input Power, Nominal (±10%)	VDC	14–48	14–48	14–48
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1	1
Detent Torque	mNm	40	70	120
Thrust Load Limit	kg	0.6	1.0	1.5
Overhung Load Limit (from shaft end)	N	50	50	50
Rotor Inertia	g·cm2	260	460	750
Holding Torque at Continuous Current	Nm	1.1	1.8	2.6
Holding Torque at Peak Current	Nm	1.3	2.1	3.25
Continuous Output Current	A	4.5	4.5	4.5
Peak Output Current (application dependent)	A	6.5	6.5	6.5
Step Angle	deg	1.8	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096	4096
Circuit Loss	W	6	6	6
Weight	kg	0.84	1.18	1.83
Connection Hardware Screw Size/Torque	Nm	3	3	3
Under-Voltage Trip, Nominal	VDC	Logic		
Over-Voltage Trip	VDC	Logic		

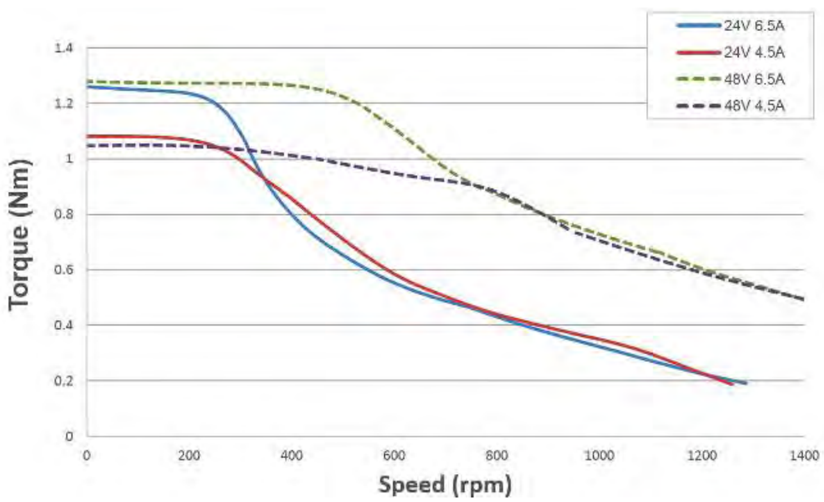


Figure 3-25. Speed/Torque – NEMA 23 (IP65) Short

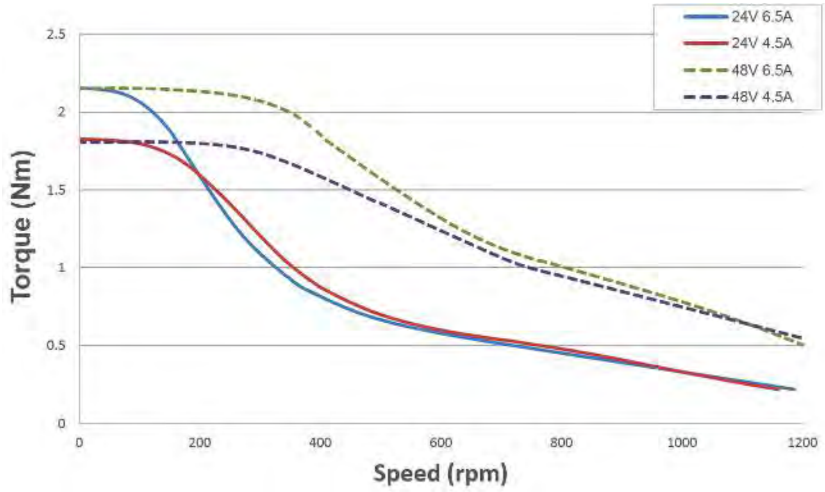


Figure 3-26. Speed/Torque – NEMA 23 (IP65) Medium

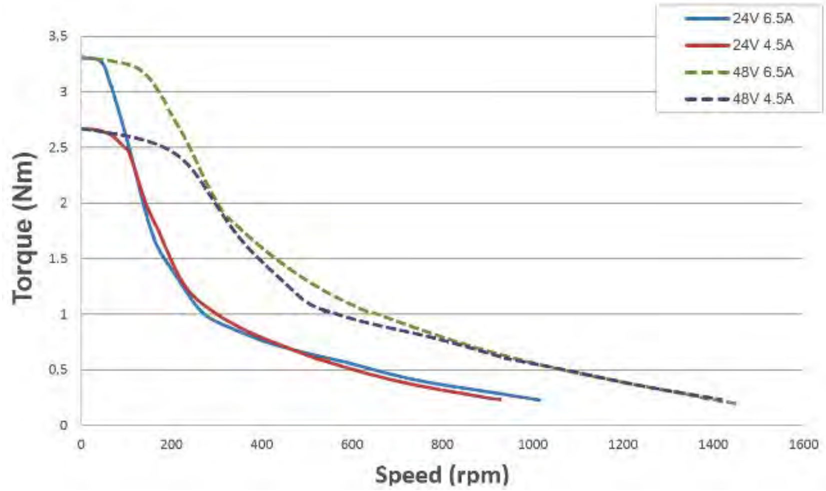


Figure 3-27. Speed/Torque – NEMA 23 (IP65) Long

3.5.4 Mechanical and Electrical – NEMA 34 (IP20) – CANopen

Table 3-12. stepIM NEMA 34 (IP20) – Mechanical and Electrical

NEMA		34M	34L
Input Power, Nominal (±10%)	VDC	14–48	14–48
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1
Detent Torque	mNm	250	350
Thrust Load Limit	kg	2.7	3.8
Overhung Load Limit (from shaft end)	N	260	260
Rotor Inertia	g·cm2	1850	2750
Holding Torque at Continuous Current	Nm	3.5	5.5
Holding Torque at Peak Current	Nm	4.5	7
Continuous Output Current	A	4.5	4.5
Peak Output Current (application dependent)	A	6.5	6.5
Step Angle	deg	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096
Circuit Loss	W	6	6
Weight	kg	3.05	4.30
Connection Hardware Screw Size/Torque	Nm	5.2	5.2
Under-Voltage Trip, Nominal	VDC	Logic	
Over-Voltage Trip	VDC	Logic	

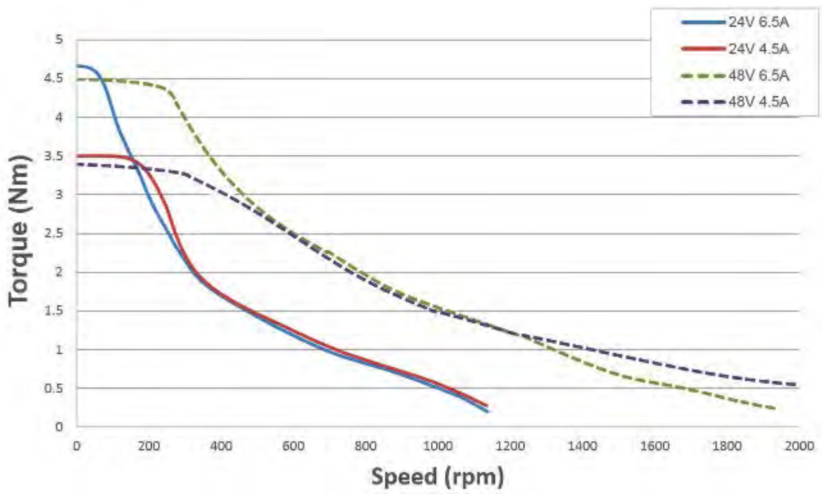


Figure 3-28. Speed/Torque – NEMA 34 (IP20) Medium

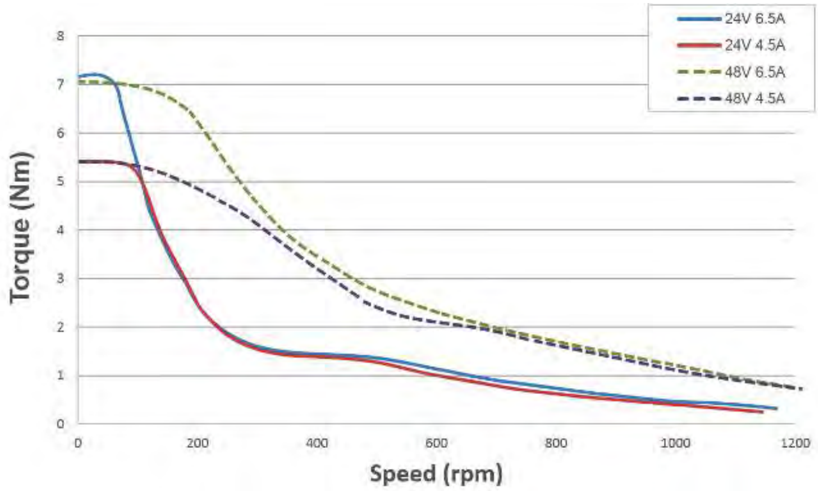


Figure 3-29. Speed/Torque – NEMA 34 (IP20) Long

3.5.5 Mechanical and Electrical – NEMA 34 (IP65) – CANopen

Table 3-13. stepIM NEMA 34 (IP65) – Mechanical and Electrical

NEMA		34M	34L
Input Power, Nominal (±10%)	VDC	14–75	14–75
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1
Detent Torque	mNm	250	350
Thrust Load Limit	kg	2.7	3.8
Overhung Load Limit (from shaft end)	N	260	260
Rotor Inertia	g·cm2	1850	2750
Holding Torque at Continuous Current	Nm	5	7.7
Holding Torque at Peak Current	Nm	6.3	9
Continuous Output Current	A	7	7
Peak Output Current (application dependent)	A	11.5	11.5
Step Angle	deg	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096
Circuit Loss	W	6	6
Weight	kg	3.30	4.50
Connection Hardware Screw Size/Torque	Nm	5.2	5.2
Under-Voltage Trip, Nominal	VDC	Logic	
Over-Voltage Trip	VDC	Logic	

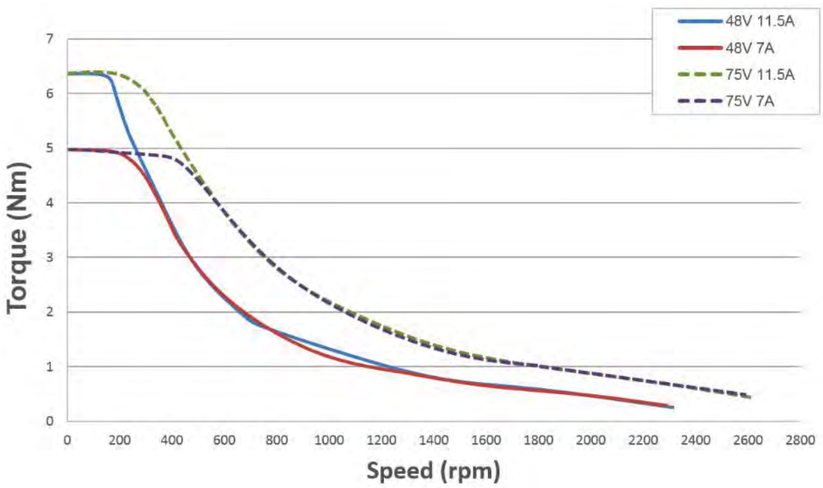


Figure 3-30. Speed/Torque – NEMA 34 (IP65) Medium

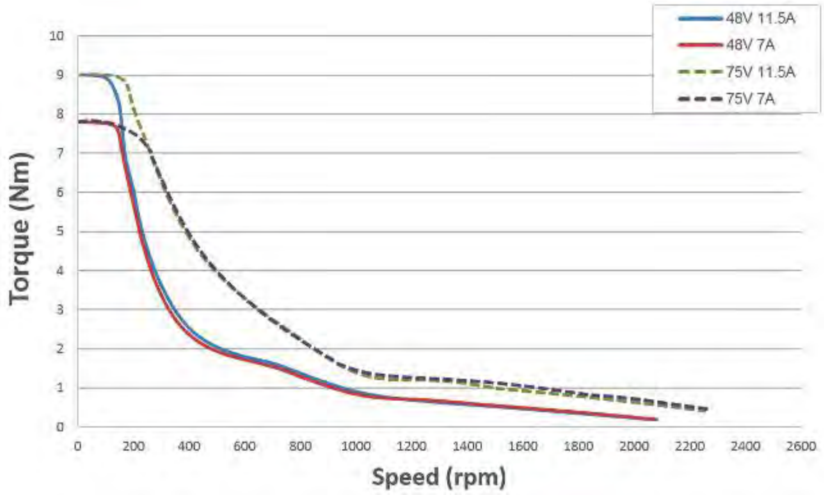


Figure 3-31. Speed/Torque – NEMA 34 (IP65) Long

3.6 Mechanical and Electrical – EtherCAT Models

3.6.1 Mechanical and Electrical – NEMA 17 (IP65) – EtherCAT

Table 3-14. stepIM NEMA 17 (IP65) – Mechanical and Electrical

NEMA		17S	17M	17L
Input Power, Nominal (±10%)	VDC	14–48	14–48	14–48
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1	1
Detent Torque	mNm	15	25	25
Thrust Load Limit	kg	0.28	0.36	0.6
Overhung Load Limit (from shaft end)	N	20	20	20
Rotor Inertia	g·cm2	57	82	123
Holding Torque at Continuous Current	Nm	0.35	0.45	0.65
Holding Torque at Peak Current	Nm	0.5	0.6	1.05
Continuous Output Current	A	1.8	1.8	1.8
Peak Output Current (application dependent)	A	3.5	3.5	3.5
Step Angle	deg	1.8	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096	4096
Circuit Loss	W	6	6	6
Weight	kg	0.37	0.44	0.59
Connection Hardware Screw Size/Torque	Nm	0.63	0.63	0.63
Under-Voltage Trip, Nominal	VDC	Logic		
Over-Voltage Trip	VDC	Logic		

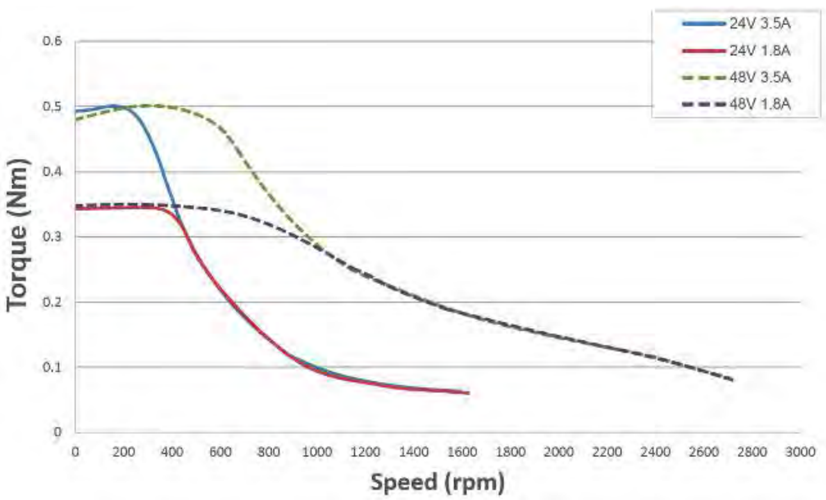


Figure 3-32. Speed/Torque – NEMA 17 Short

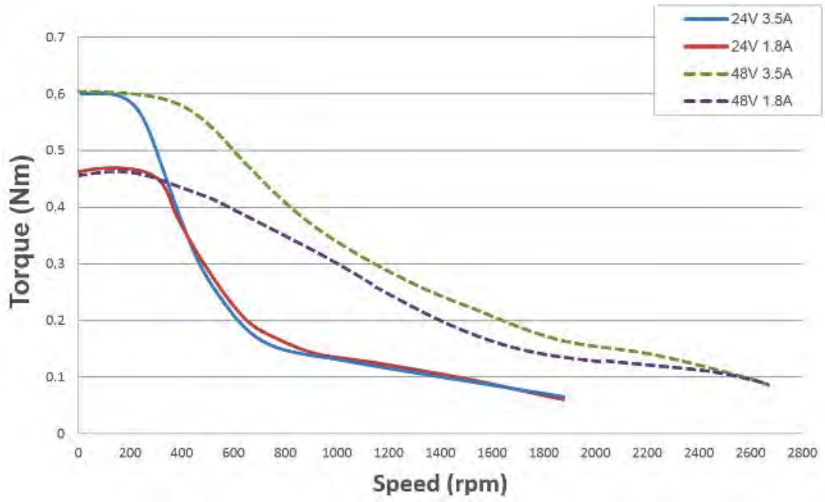


Figure 3-33. Speed/Torque – NEMA 17 Medium

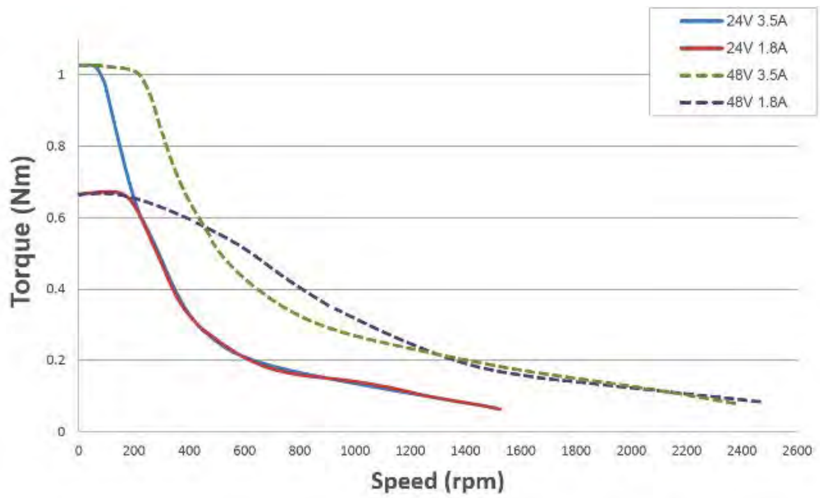


Figure 3-34. Speed/Torque – NEMA 17 Long

3.6.2 Mechanical and Electrical – NEMA 23 (IP65) – EtherCAT

Table 3-15. stepIM NEMA 23 (IP65) – Mechanical and Electrical

NEMA		23S	23M	23L
Input Power, Nominal (±10%)	VDC	14–60	14–60	14–60
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1	1
Detent Torque	mNm	40	70	120
Thrust Load Limit	kg	0.6	1.0	1.5
Overhung Load Limit (from shaft end)	N	50	50	50
Rotor Inertia	g·cm2	260	460	750
Holding Torque at Continuous Current	Nm	1.1	1.8	2.6
Holding Torque at Peak Current	Nm	1.3	2.1	3.25
Continuous Output Current	A	4.5	4.5	4.5
Peak Output Current (application dependent)	A	6.5	6.5	6.5
Step Angle	deg	1.8	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096	4096
Circuit Loss	W	6	6	6
Weight	kg	0.88	1.22	1.90
Connection Hardware Screw Size/Torque	Nm	3	3	3
Under-Voltage Trip, Nominal	VDC	Logic		
Over-Voltage Trip	VDC	Logic		

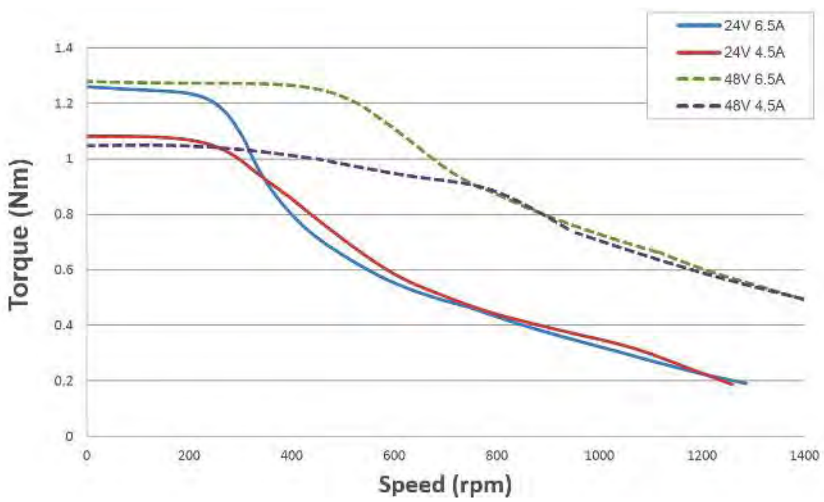


Figure 3-35. Speed/Torque – NEMA 23 (IP65) Short

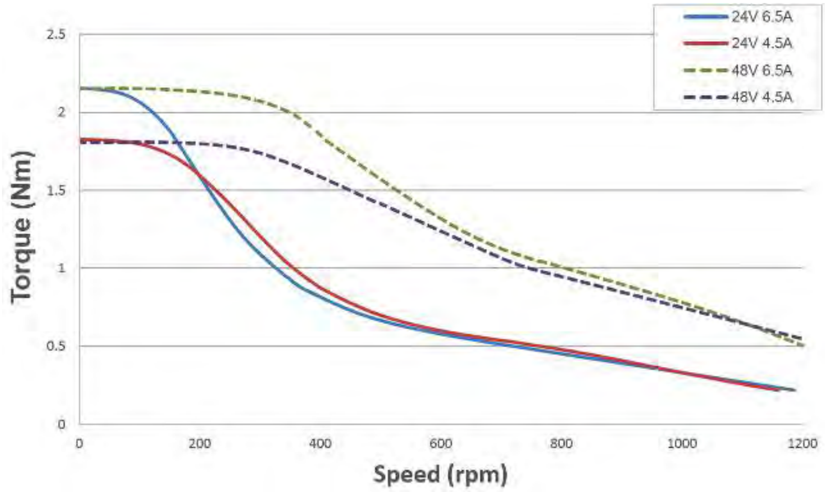


Figure 3-36. Speed/Torque – NEMA 23 (IP65) Medium

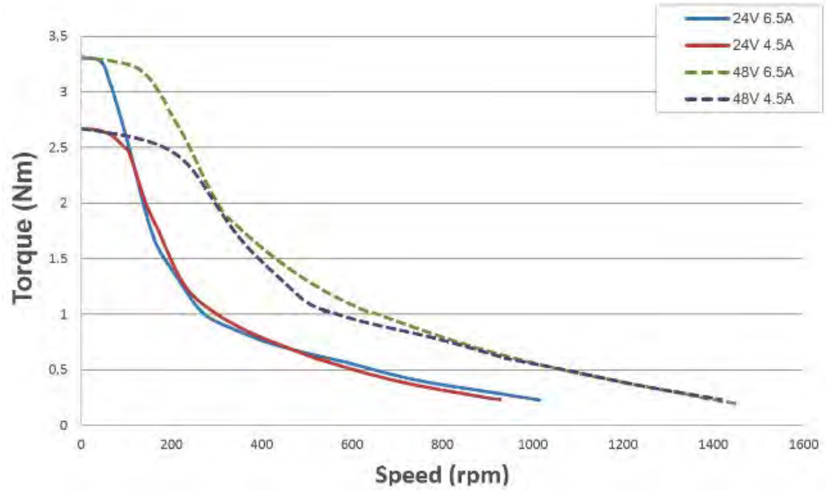


Figure 3-37. Speed/Torque – NEMA 23 (IP65) Long

3.6.3 Mechanical and Electrical – NEMA 34 (IP65) – EtherCAT

Table 3-16. stepIM NEMA 34 (IP65) – Mechanical and Electrical

NEMA		34M	34L
Input Power, Nominal (±10%)	VDC	14–75	14–75
Auxiliary Input Power, Nominal (±10%)	VDC	6–24	6–24
Auxiliary Input Power, Maximum	W	1	1
Detent Torque	mNm	250	350
Thrust Load Limit	kg	2.7	3.8
Overhung Load Limit (from shaft end)	N	260	260
Rotor Inertia	g·cm2	1850	2750
Holding Torque at Continuous Current	Nm	5	7.7
Holding Torque at Peak Current	Nm	6.3	9
Continuous Output Current	A	7	7
Peak Output Current (application dependent)	A	11.5	11.5
Step Angle	deg	1.8	1.8
Magnetic Encoder, Resolution	ppr	4096	4096
Circuit Loss	W	6	6
Weight	kg	3.30	4.50
Connection Hardware Screw Size/Torque	Nm	5.2	5.2
Under-Voltage Trip, Nominal	VDC	Logic	
Over-Voltage Trip	VDC	Logic	

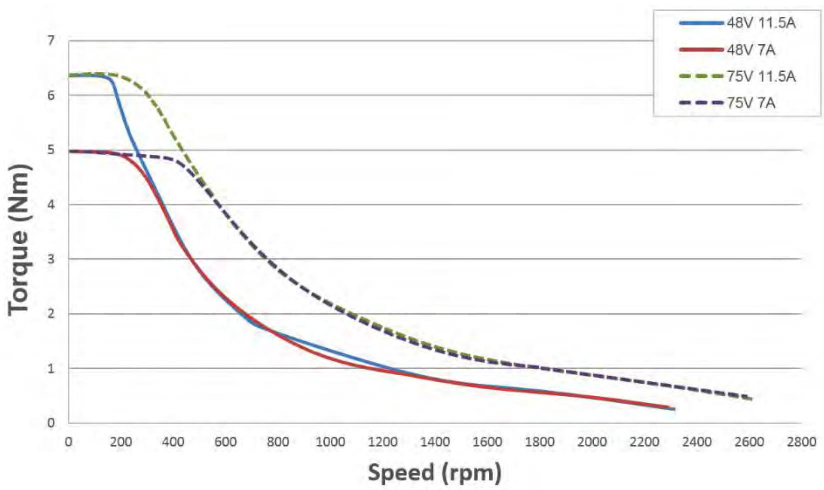


Figure 3-38. Speed/Torque – NEMA 34 (IP65) Medium

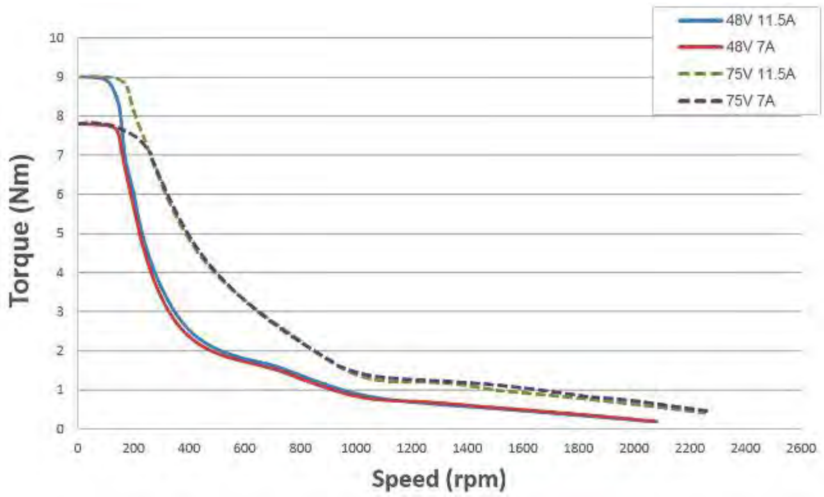


Figure 3-39. Speed/Torque – NEMA 34 (IP65) Long

3.7 Power

Table 3-17. Power Specifications

Feature		Specification			
		NEMA 23 (IP20, IP65) CANopen **NEMA 34 (IP20) CANopen**	**NEMA 17 (IP20) CANopen**	**NEMA 23 (IP65) EtherCAT**	**NEMA 34 (IP65) CANopen** **NEMA 34 (IP65) EtherCAT**
Supply voltage range	VDC	14 – 48	14 – 48	14 – 60	14 – 75
Auxiliary supply voltage range	VDC	6 – 24	6 – 24	6 – 24	6 – 24
Maximum continuous phase current	A	4.5	1.8	4.5	7
Maximum peak phase current	A	6.5	3.5	6.5	11.5

Table 3-18. Over-Current Protection and Group Installation

Model	Description	Fuse Rating [A]	Fuse Class	Maximum Units for Group Installation Under One Fuse*	Voltage [VDC] (minimal)
IST-17xxx	stepIM NEMA 17 models; CANopen, IP20	6	RK1	4	125
IST-23xxx	stepIM NEMA 23 models; CANopen or EtherCAT, IP20 or IP65	12	G	4	125
IST-34xxx	stepIM NEMA 34 models; CANopen or EtherCAT, IP20 or IP65	15	G	4	125

*** Notes**

- When using 100% duty cycle, the maximum number of slaves per fuse is limited to 3 stepIM units.
- Fuse size depends on the actual stepIM model.

Caution!

During continuous motor operation, the motor body and the drive's power stage heat up.

As a precaution against damage to the product, use proper airflow or connect the stepIM to a cooling metal plate to prevent the temperature from reaching 100˚C on the motor or the drive's power stage.

The drive will shut down when the power stage temperature reaches 105˚C.

The drive's power stage temperature can be read from object 2044h.

3.8 Control

Table 3-19. Control Specifications

Feature	Specification	
Operation Modes	Selectable	Profile position mode, Velocity mode, Profile velocity mode, Profile torque mode, Cyclic synchronous position mode, Homing. Other modes defined by manufacturer (refer to *Scripted Motion Operation Mode*).
Display		LEDs
Software Tools	User Interface	ServoStudio 2 Windows-based application; TwinCAT3.
	Functions	Connection settings, Drive info, Power info, I/O configuration, Motion settings and tuning, Fault history/display.
Rotary Units	Position	counts
	Velocity	rpm/100
	Acceleration/ Deceleration	rpm/s

3.9 Communication

Table 3-20. Communication Specifications

Feature	Specification	Default value
Baud rate	10 Kbps – 1 Mbps	1 Mbps
CAN ID	1 –127	101
CANopen	CiA 301 application layer and CiA 402 device profile for drives and motion control Heartbeat producer, SDO, PDO (variable mapping)	

3.10 Protection and Environmental

Table 3-21. Protection and Environmental Specifications

Feature	Specification
Protective Functions	I2T limit, Over-voltage, Under-voltage, Drive over-temperature, Over-speed, Velocity error, Position error, Magnet missing, Power stage fault, PLL lock lost, Position command error, Acceleration / deceleration violation
Standards	CE
Environment	Ambient temperature: Operation 0 – 40°C, Storage 0 – 70°C Heat sink max. temperature: 100°C Motor max. temperature: 100°C
	Humidity: 10 – 90%
	Altitude: If in accordance with specified clearances, per IEC 61800-5-1, the stepIM is rated for use at altitudes up to 2000m
	Vibration: under review
Operating Conditions	Protection class: IP20 and IP65 Pollution degree: 2 as per IEC 60664-1 Do not use where the following are present: corrosive gases, flammable gases, water, oil, chemicals, dust (including iron dust and salts)
Configuration	Flange mounting

Caution!

During continuous motor operation, the motor body and the drive's power stage heat up.

As a precaution against damage to the product, use proper airflow or connect the stepIM to a cooling metal plate to prevent the temperature from reaching 100˚C on the motor or the drive's power stage.

The drive will shut down when the power stage temperature reaches 105˚C.

The drive's power stage temperature can be read from object 2044h.

3.11 Inputs/Outputs

Table 3-22. I/O Specifications

Feature	Specification	
1x Analog Input	Signal	Analog ±10 VDC differential
	Functions	User defined
	Input Resolution	12 bit
	Input Impedance	94 kΩ
	Bandwidth (-3 db)	8 kHz
4x Digital Input **Exception:** 3x Digital Input on NEMA 23 IP65 CANopen	Signal	Configurable opto-isolated. User defined by wiring; compatibility with sinking or sourcing input. Exception: Sinking input only on NEMA 17.
	Functions	Homing, limit switch, remote enable, start motion command for profiled position operation mode
	Voltage High Level Input	30 V
	Min. High Level Input	11 V
	Max. Low Level Input	5 V
	Input Resistance	2.2 kΩ Exception: 24 kΩ NEMA 17 IP20
	Max. Input Frequency	1 kHz
	Isolation Voltage	2500 Vrms
	Max. Input Current	According to max. voltage level, input current is not limited, drive limits the input current
	Propagation Delay Time	1 ms
2x Digital Output **Exception:** 1x Digital Output on NEMA 23 IP65 CANopen	Signal	Configurable open collector. User defined by wiring; compatibility with opto-isolated sinking output
	Functions	Motor speed set, Current, Motor speed set clear, Regen resistor control, Motion completed, In position, Zero speed, Software position limit switch, Active, User selectable.
	Voltage	30 V
	Max. Current	500 mA
	Min. Load Resistance	60 Ω
	Output Voltage	0.25 V
	Min. Propagation Delay Time	1 ms (may be longer if load current is lower)

4 Wiring

4.1 Wiring Guidelines

Note	The figures in this section show a NEMA 23 model. Although functionality and placement of connectors are similar in all models, the actual number and definition of the pins differ among models.

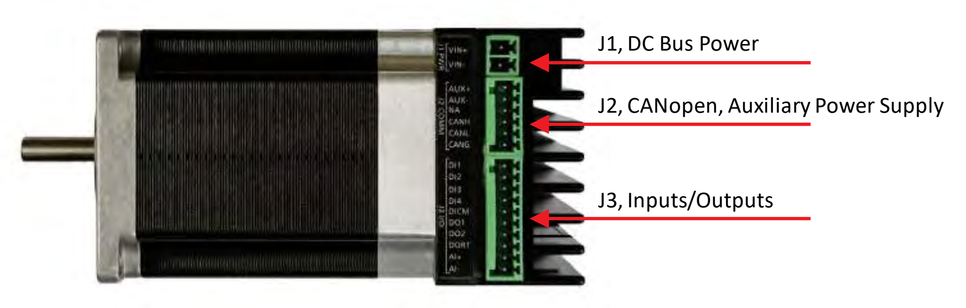


Figure 4-1. stepIM (IP20) CANopen – Connectors

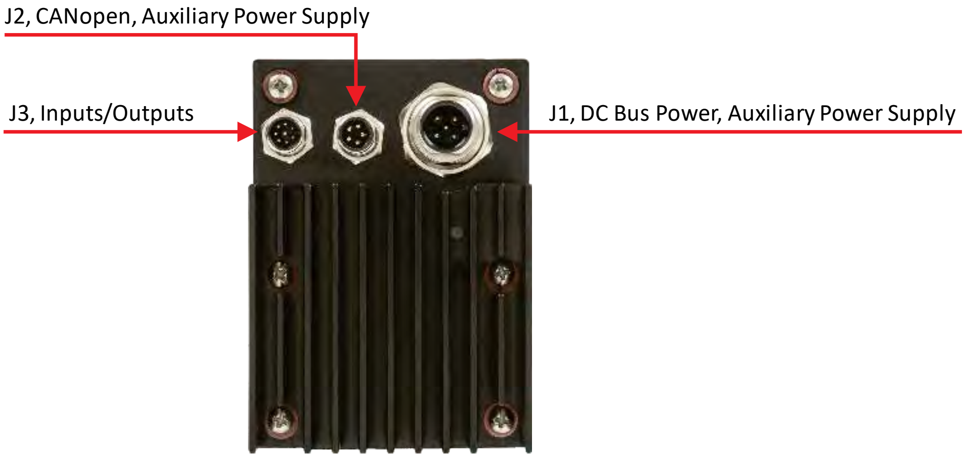


Figure 4-2. stepIM (IP65) CANopen – Connectors

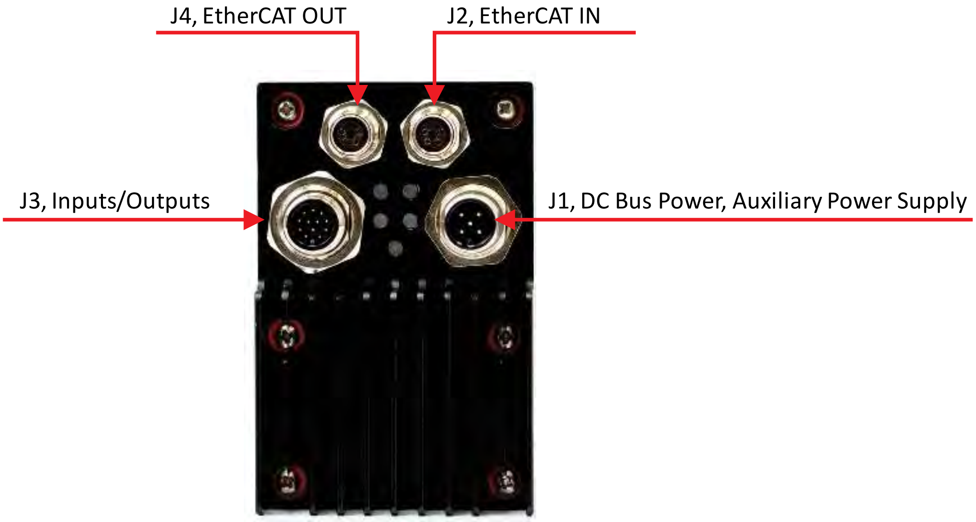


Figure 4-3. stepIM (IP65) EtherCAT – Connectors

To ensure proper performance, wiring must be in accordance with the following guidelines:

- Use and connect components and cables according to manufacturer specifications.
- Use the shortest cables possible.
- To reduce the effects of EMI, use twisted pairs for the following cables:
  - Power supply
  - CANopen or EtherCAT communication
- Twisting must be maintained as close as possible to both ends of the cable.
- Shielding must be maintained at both ends of the cable.
- If connecting the power supply unit (PSU) to more than one stepIM, use either a star or a bus connection, as shown in the following figures.

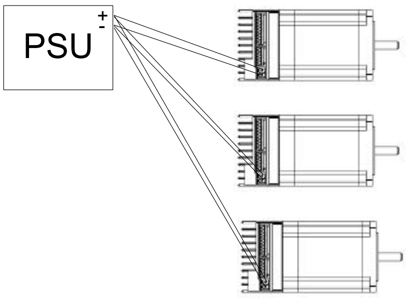


Figure 4-4. Star Connection

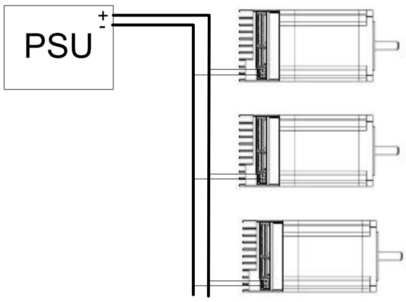


Figure 4-5. Bus Connection

Warning: *Do not daisy chain input voltage from one stepIM to the next.*

4.1.1 Wiring Guidelines – Power Supply

The stepIM has two separate power supply inputs.

The **Bus** power supply can be used exclusively to supply power to both the control electronics and the motor.

The **Auxiliary** power supply is optional. It supplies power to the control electronics, but not the motor.

Warning: *Use separate power sources for the Bus and the Auxiliary power supplies. Do not connect the VIN+ and VAUX to the same power source.*

To ensure proper performance, wiring must be in accordance with the following guidelines:

- Use twisted pair cables to reduce EMI.
- When bus voltage is greater than 32 VDC, use an isolated power supply source for UL compliance.

Warning: *No reverse polarity protection on supply input. Incorrect wiring can cause severe damage to the stepIM.*

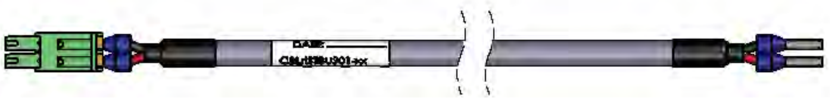


Figure 4-6. Bus Power Cable Example

Regeneration

During forced deceleration, the motor becomes a generator. The free-wheeling diodes inside the power chip rectify the sinusoidal BEMF voltage into DC current that flows back to the power supply. Not all power supplies can handle regeneration energy. The amount of power also depends on the inertia and speed.

Since the stepIM does not have means of absorbing this energy, a suitable power supply or special accessory is required.

4.1.2 Wiring Guidelines – Auxiliary | CAN Power

The auxiliary power supply is optional. The stepIM logic voltage is derived from the bus voltage, and can work with the main bus supply only.

If auxiliary voltage is connected, it will power the stepIM digital components, allowing communication and diagnostics if bus voltage is disconnected.

Warning: *Use separate power sources for the Bus and the Auxiliary power supplies. Do not connect the VIN+ and VAUX to the same power source.*

To ensure proper performance, wiring must be in accordance with the following guidelines:

- For CANopen termination, connect an external 120Ω/0.25W resistor between CAN_H and CAN_L terminals (pins 4 and 5 on interface J2).
- In addition, use a termination resistor on the host side.

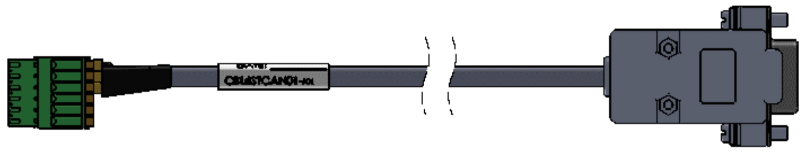


Figure 4-7. CANopen Cable Example

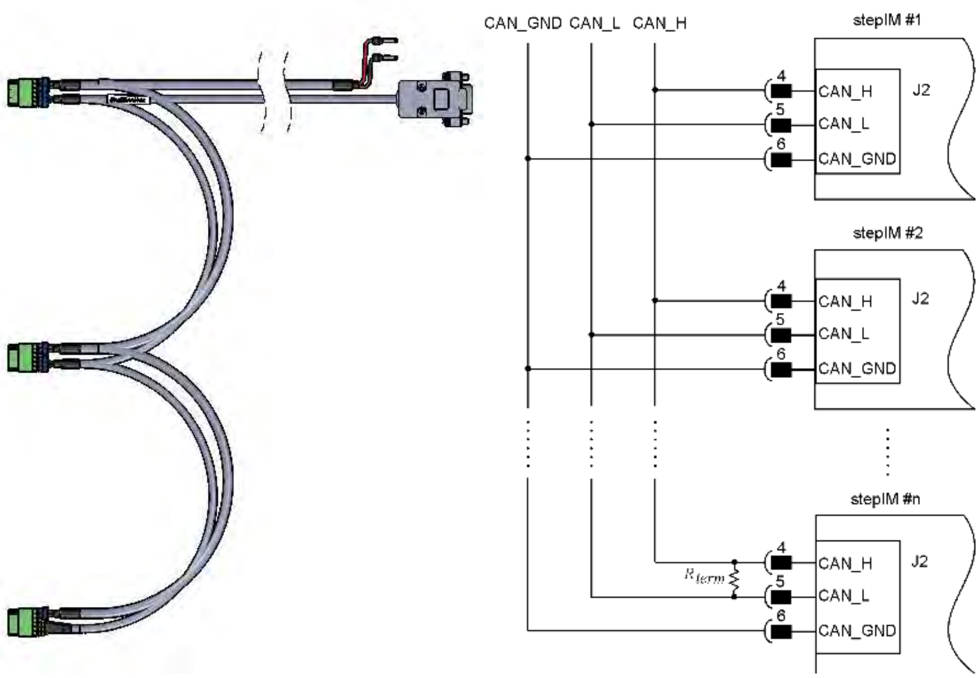


Figure 4-8. CANopen Chaining Option

Note Refer to Application Note for wiring cable colors.

4.1.3 Wiring Guidelines – Digital Inputs

The stepIM has 4 digital inputs, with 1 common port that can be used as common ground or common supply.

Follow the I/O specifications for using this interface properly.

4.1.4 Wiring Guidelines – Analog Input

Note Do not use analog control modes if the analog input pins are not connected.

The analog input can interface two kinds of analog interfaces – single-ended and differential:

- Single-ended: **AN_IN-** is connected to the controller's ground and **AN_IN+** is connected to the controller's single-ended output in the range of ±10V.
- Differential: **AN_IN+** is connected to the controller's positive output and **AN_IN-** is connected to the negative output.
- Use a shielded, twisted pair cable for the analog signal.
-

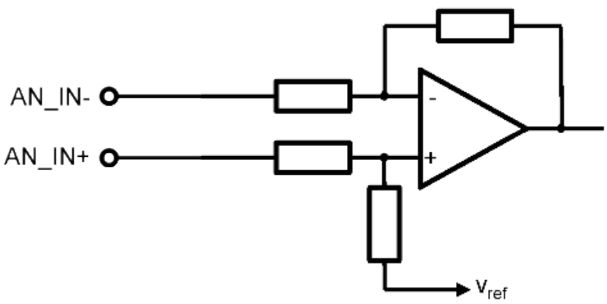


Figure 4-9. Analog Input Interface Scheme

4.1.5 Wiring Guidelines – Motor Brake

In stepIM models equipped with a mechanical brake, a digital output is internally configured, and dedicated, for brake control. In these models, the following conditions are in effect:

- In all CANopen models, digital output 1 is configured internally for brake control, and cannot be used for another device. Accordingly, nothing else can be connected to output 1 on these models. However, digital output 2 can be connected to an external device.
- In NEMA 23 EtherCAT models, digital output 2 is configured internally for brake control, and cannot be used for another device. Accordingly, nothing else can be connected to output 2 on these models. However, digital output 1 can be connected to an external device.
- In NEMA 34 EtherCAT models, digital outputs 1 and 2 are both available for use, because these models have a separate internal output that is configured for brake control.
- The auxiliary functionality can still be used.

The required operation voltage for the brake is 24 VDC. It must be supplied from a power supply other than that of the stepIM. Brake consumption for NEMA 23 models is 0.5A, and for NEMA 34 models it is 1A.

The power supply connections for the mechanical brake are shown in the following tables.

Table 4-1. stepIM NEMA 23, NEMA 34 IP20 CANopen

Pin	J2. CAN | Auxiliary Power Interface	Brake PSU (24 VDC)
1	AUX+	V+
2	AUX-	V-

Table 4-2. stepIM NEMA 23 IP65 CANopen/EtherCAT

Pin	J1. Bus Power Interface | Auxiliary Power Interface	Brake PSU (24 VDC)
3	AUX+	V+
4	AUX-	V-

Table 4-3. stepIM NEMA 34 IP65 CANopen

Pin	J2. CAN | Auxiliary Power Interface	Brake PSU (24 VDC)
2	AUX+	V+
3	GND	V-

Table 4-4. stepIM NEMA 34 IP65 EtherCAT

Pin	J1. Bus Power Interface | Auxiliary Power Interface	Brake PSU (24 VDC)
3	AUX+	V+
2	GND	V-

In addition to the wiring connections, the digital output that controls the brake must be defined either by ServoStudio 2 or your controller. For more information, refer to the section *Motor Brake*.

When connecting a second digital output in addition to the brake output, the second output must be connected to DO1 or DO2, and to DORT on the I/O interface, where DORT (V- of the output) also functions as V- of the brake. Note that this is not relevant for NEMA 34 EtherCAT.

Refer to the diagrams and tables in sections *Wiring – CANopen Models* and *Wiring – EtherCAT Models*.

4.2 Wiring – CANopen Models

4.2.1 Wiring – NEMA 17 (IP20) – CANopen

Refer to *Mating Connector Kits (IP20)*.

Power Supply – NEMA 17 (IP20)

Table 4-5. stepIM NEMA 17 (IP20) – J1. Bus Power Interface

Connector on drive	JST S02B-PASK-2(LF)(SN)
Pitch	2 mm
Pinout	1: VIN+
	2: VIN-
Mating connector	Housing: JST PAP-02V-S Crimp: JST SPHD-001T-P0.5
Wire gauge	22 AWG

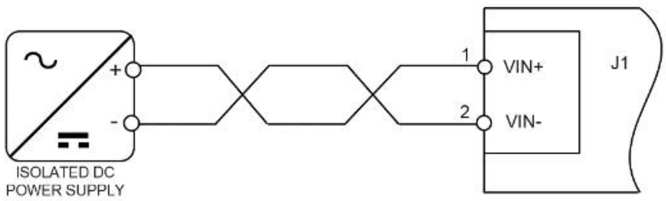


Figure 4-10. stepIM NEMA 17 (IP20) Bus Power Wiring

CAN – NEMA 17 (IP20)

Table 4-6. stepIM NEMA 17 (IP20) – J2. CAN | Auxiliary Power Interface

Connector on drive	JST S06B-PASK-2(LF)(SN)	
Pitch	2 mm	
Pinout	1	AUX+
	2	AUX-
	3	PE
	4	CANH
	5	CANL
	6	CANG
Mating connector	Housing: JST PAP-06V-S Crimp: JST SPHD-001T-P0.5	
Wire gauge	22 – 26 AWG	

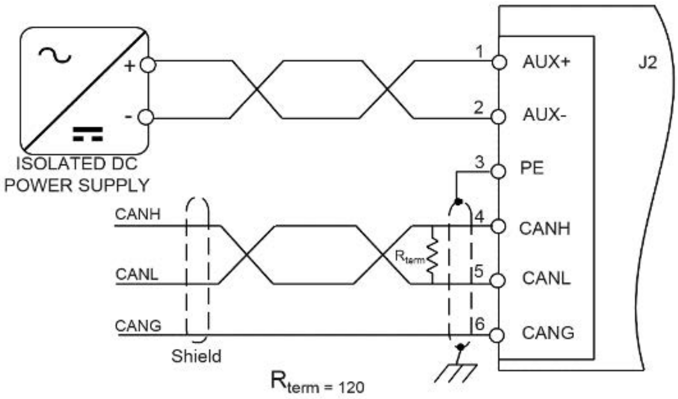


Figure 4-11. stepIM NEMA 17 (IP20) CAN | Auxiliary Power Wiring

I/Os – NEMA 17 (IP20)

Table 4-7. stepIM NEMA 17 (IP20) – J3. I/O Interface

Connector on drive	JST SM10B-ZPDSS-TF	
Pitch	1.5 mm	
Pinout	1	DI1
	2	DI2
	3	DI3
	4	DI4
	5	DICM
	6	DO1
	7	DO2
	8	DORT
	9	AI+
	10	AI-
Mating connector	Housing: JST ZPDR-10V-S Crimp: JST SZPD002T-P0.3	
Wire gauge	24–28 AWG	

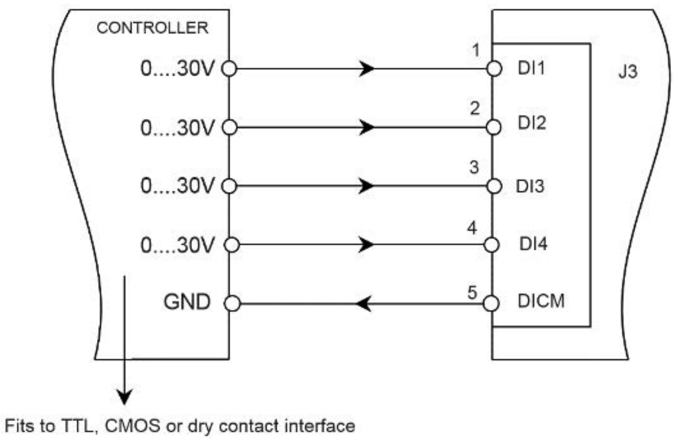


Figure 4-12. stepIM NEMA 17 (IP20) Digital Inputs SINK Wiring

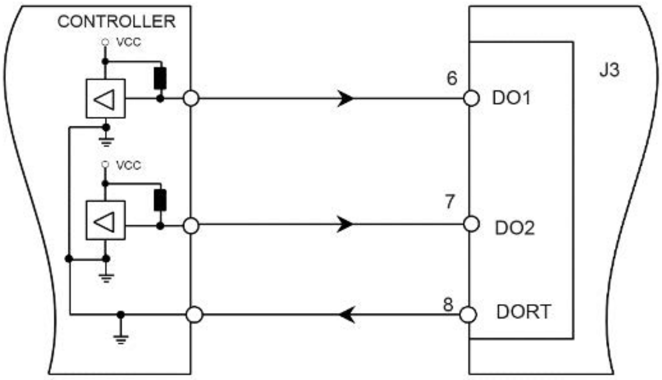


Figure 4-13. stepIM NEMA 17 (IP20) Digital Outputs Wiring

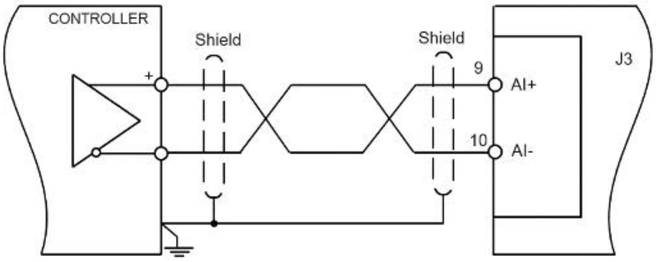


Figure 4-14. stepIM NEMA 17 (IP20) Analog Input DIFFERENTIAL Wiring

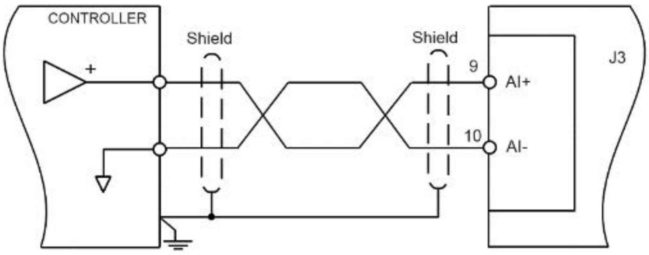


Figure 4-15. stepIM NEMA 17 (IP20) Analog Input SINGLE-ENDED Wiring

4.2.2 Wiring – NEMA 23 (IP20) – CANopen

Refer to *Mating Connector Kits (IP20)*.

Power Supply – NEMA 23 (IP20)

Table 4-8. stepIM NEMA 23 (IP20) – J1. Bus Power Interface

Connector on drive	Phoenix Contact 1803277
Pitch	3.81 mm
Pinout	1: VIN+
	2: VIN-
Mating connector	Phoenix Contact: 1851041 (spring) or Phoenix Contact: 1803578 (screw)
Wire gauge	16 – 28 AWG

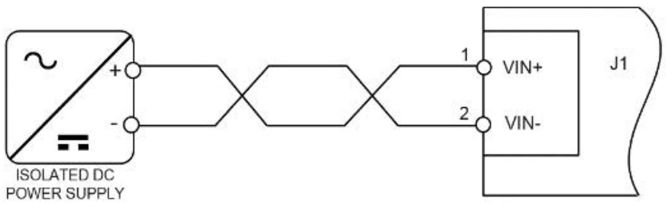


Figure 4-16. stepIM NEMA 23 (IP20) Bus Power Wiring

CAN – NEMA 23 (IP20)

Table 4-9. stepIM NEMA 23 (IP20) – J2. CAN | Auxiliary Power Interface

Connector on drive	Phoenix Contact 1881480	
Pitch	2.5 mm	
Pinout	1	AUX+
	2	AUX-
	3	PE
	4	CANH
	5	CANL
	6	CANG
Mating connector	Phoenix Contact: 1881367	
Wire gauge	20 – 28 AWG	

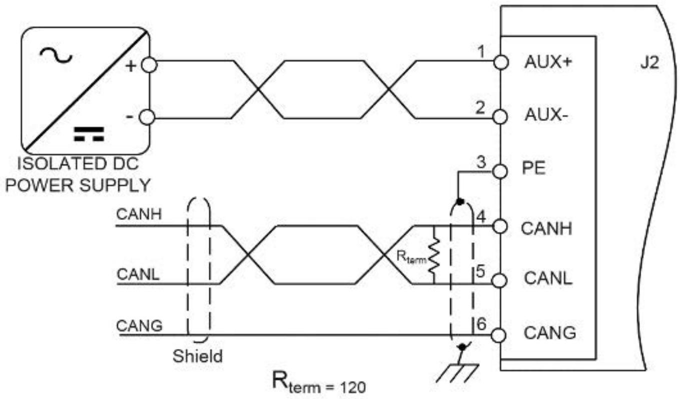


Figure 4-17. stepIM NEMA 23 (IP20) CAN | Auxiliary Power Wiring

I/Os – NEMA 23 (IP20)

Table 4-10. stepIM NEMA 23 (IP20) – J3. I/O Interface

Connector on drive	Phoenix Contact 1881529	
Pitch	2.5 mm	
Pinout	1	DI1
	2	DI2
	3	DI3
	4	DI4
	5	DICM
	6	DO1
	7	DO2
	8	DORT
	9	AI+
	10	AI-
Mating connector	Phoenix Contact 1881406	
Wire gauge	20–28 AWG	

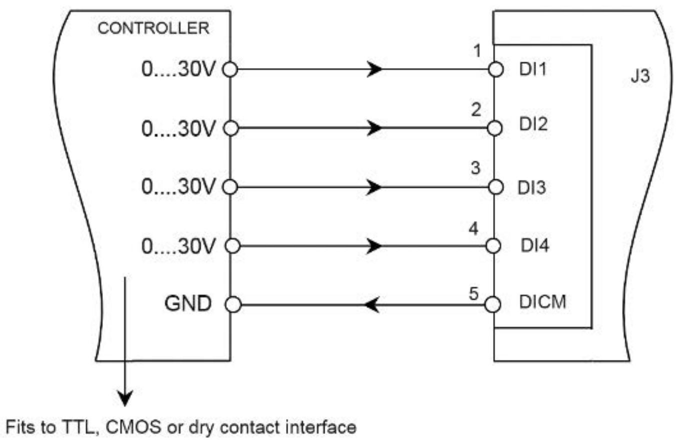


Figure 4-18. stepIM NEMA 23 (IP20) Digital Inputs SINK Wiring

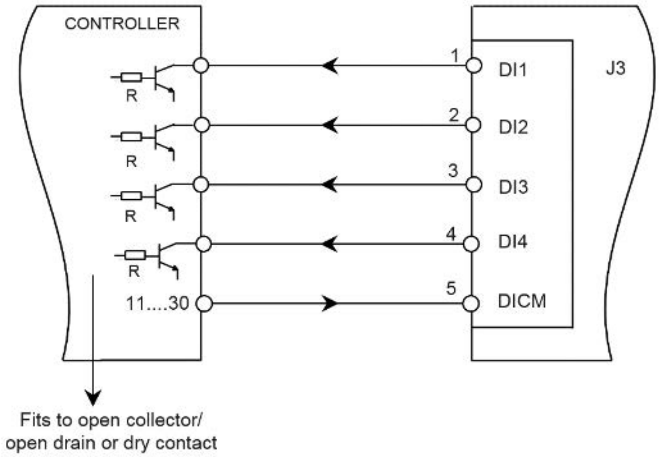


Figure 4-19. stepIM NEMA 23 (IP20) Digital Inputs SOURCE Wiring

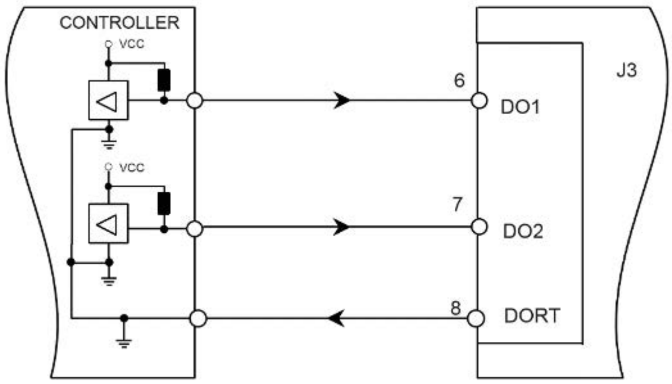


Figure 4-20. stepIM NEMA 23 (IP20) Digital Outputs Wiring

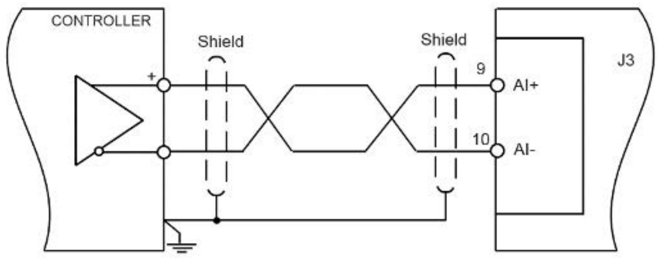


Figure 4-21. stepIM NEMA 23 (IP20) Analog Input DIFFERENTIAL Wiring

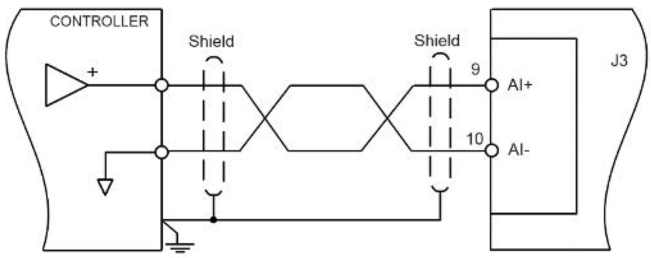


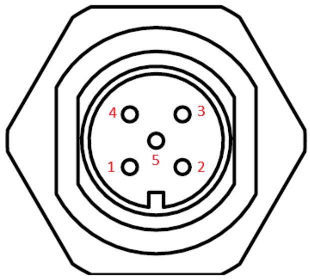
Figure 4-22. stepIM NEMA 23 (IP20) Analog Input SINGLE-ENDED Wiring

4.2.3 Wiring – NEMA 23 (IP65) – CANopen

Refer to *Connector Cables (IP65)*.

Power Supply – NEMA 23 (IP65)

Table 4-11. stepIM NEMA 23 (IP65) – J1. Bus Power Interface | Auxiliary Power Interface

Connector on drive	M12, 5 pins male, A-code		Connector on drive
Pinout	1	VIN+	
	2	VIN-	
	3	AUX+	
	4	AUX-	
	5	PE	

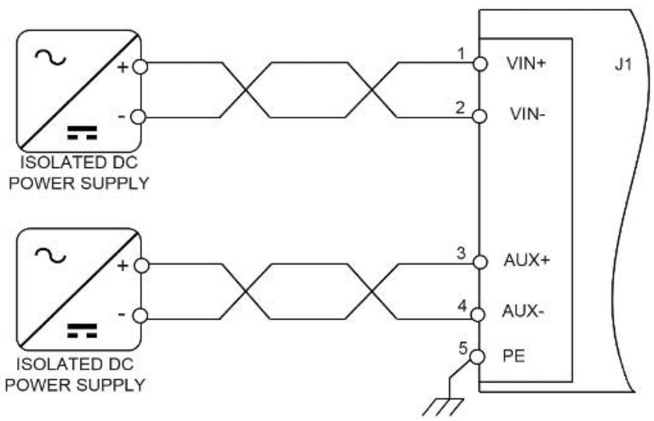
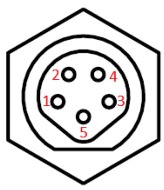


Figure 4-23. stepIM NEMA 23 (IP65) Bus Power Wiring | Auxiliary Power Wiring

CAN – NEMA 23 (IP65)

Table 4-12. stepIM NEMA 23 (IP65) – J2. CAN | Auxiliary Power Interface

Connector on drive	M8, 5 pins male, B-code		Connector on drive
Pinout	1	PE	
	2	AUX+	
	3	GND	
	4	CANH	
	5	CANL	

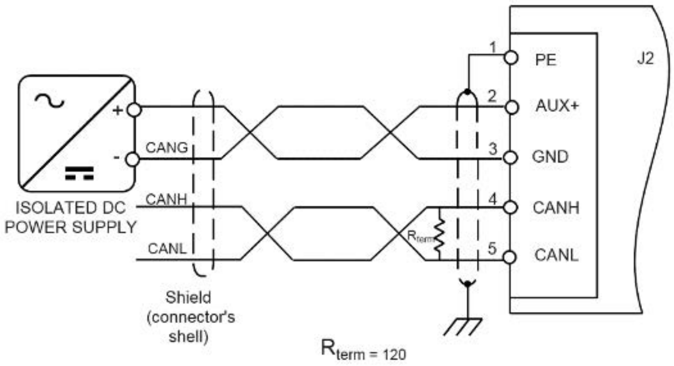
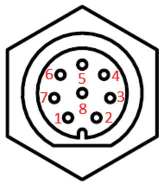


Figure 4-24. stepIM NEMA 23 (IP65) CAN | Auxiliary Power Wiring

I/Os – NEMA 23 (IP65)

Table 4-13. stepIM NEMA 23 (IP65) – J3. I/O Interface

Connector on drive	M8, 8 pins male A-code		Connector on drive 
Pinout	1	DI3	
	2	DI1	
	3	AI-	
	4	AI+	
	5	DO1	
	6	DORT	
	7	DICM	
	8	DI2	

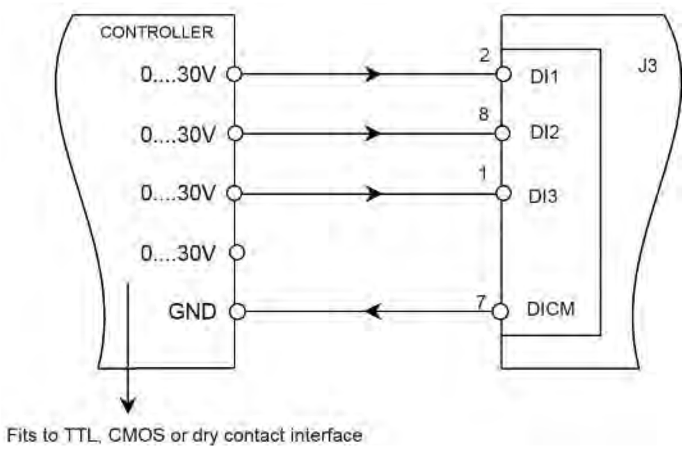


Figure 4-25. stepIM NEMA 23 (IP65) Digital Inputs SINK Wiring

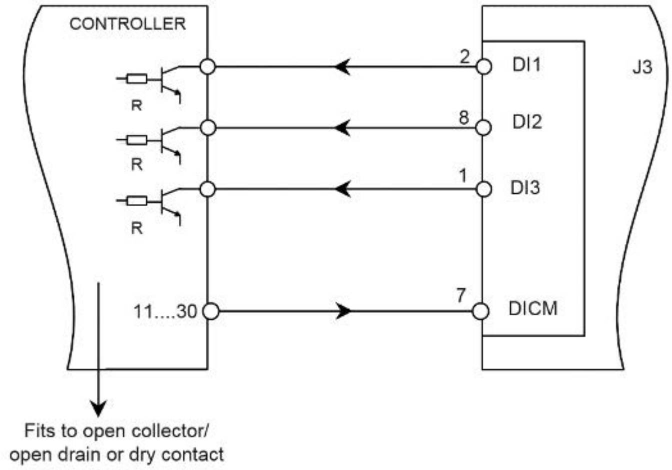


Figure 4-26. stepIM NEMA 23 (IP65) Digital Inputs SOURCE Wiring

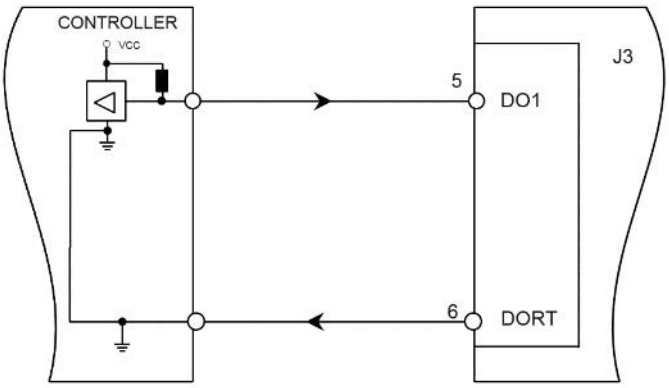


Figure 4-27. stepIM NEMA 23 (IP65) Digital Outputs Wiring

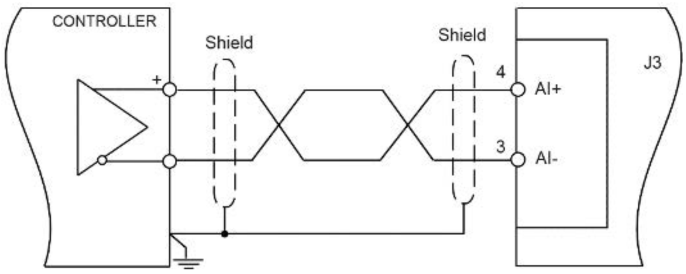


Figure 4-28. stepIM NEMA 23 (IP65) Analog Input DIFFERENTIAL Wiring

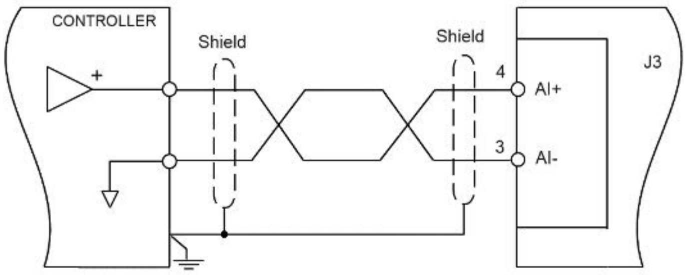


Figure 4-29. stepIM NEMA 23 (IP65) Analog Input SINGLE-ENDED Wiring

4.2.4 Wiring – NEMA 34 (IP20) – CANopen

Refer to *Mating Connector Kits (IP20)*.

Power Supply – NEMA 34 (IP20)

Table 4-14. stepIM NEMA 34 (IP20) – J1. Bus Power Interface

Connector on drive	Phoenix Contact 1803277
Pitch	3.81 mm
Pinout	1: VIN+
	2: VIN-
Mating connector	Phoenix Contact: 1851041 (spring) or Phoenix Contact: 1803578 (screw)
Wire gauge	16 – 28 AWG

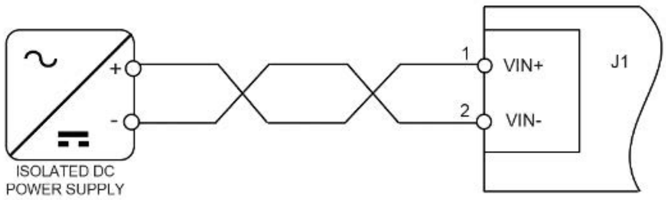


Figure 4-30. stepIM NEMA 34 (IP20) Bus Power Wiring

CAN – NEMA 34 (IP20)

Table 4-15. stepIM NEMA 34 (IP20) – J2. CAN | Auxiliary Power Interface

Connector on drive	Phoenix Contact 1881480	
Pitch	2.5 mm	
Pinout	1	AUX+
	2	AUX-
	3	PE
	4	CANH
	5	CANL
	6	CANG
Mating connector	Phoenix Contact: 1881367	
Wire gauge	20 – 28 AWG	

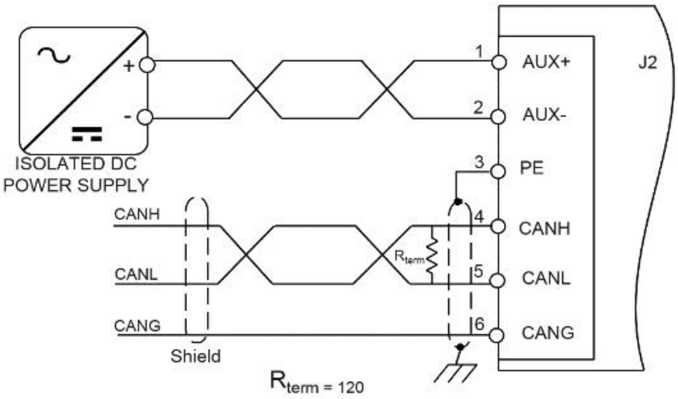


Figure 4-31. stepIM NEMA 34 (IP20) CAN | Auxiliary Power Wiring

I/Os – NEMA 34 (IP20)

Table 4-16. stepIM NEMA, 34 (IP20) – J3. I/O Interface

Connector on drive	Phoenix Contact 1881529	
Pitch	2.5 mm	
Pinout	1	DI1
	2	DI2
	3	DI3
	4	DI4
	5	DICM
	6	DO1
	7	DO2
	8	DORT
	9	AI+
	10	AI-
Mating connector	Phoenix Contact 1881406	
Wire gauge	20–28 AWG	

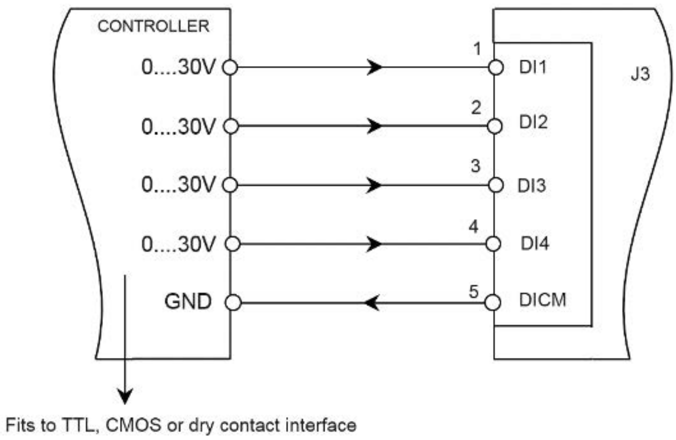


Figure 4-32. stepIM NEMA 34 (IP20) Digital Inputs SINK Wiring

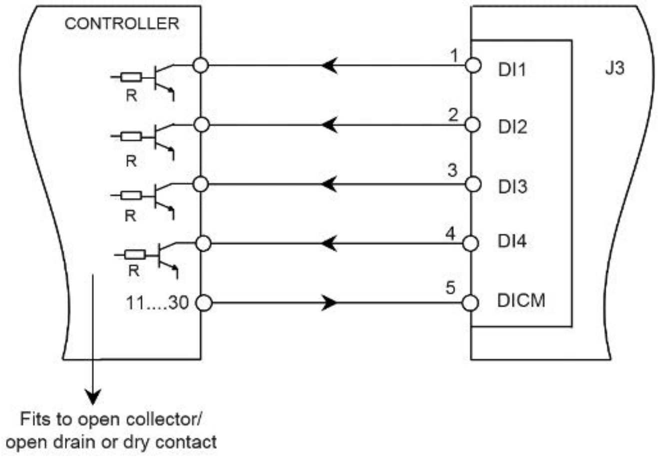


Figure 4-33. stepIM NEMA 34 (IP20) Digital Inputs SOURCE Wiring

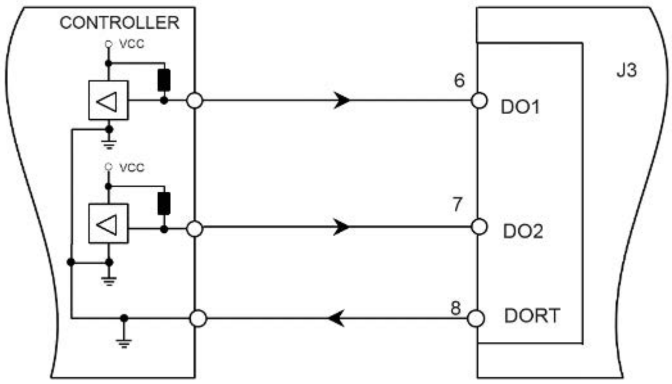


Figure 4-34. stepIM NEMA 34 (IP20) Digital Outputs Wiring

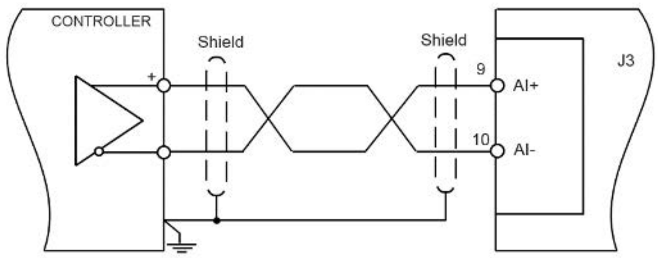


Figure 4-35. stepIM NEMA 34 (IP20) Analog Input DIFFERENTIAL Wiring

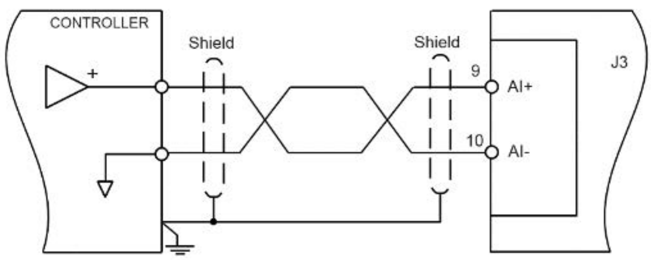


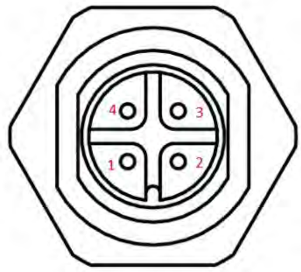
Figure 4-36. stepIM NEMA 34 (IP20) Analog Input SINGLE-ENDED Wiring

4.2.5 Wiring – NEMA 34 (IP65) – CANopen

Refer to *Connector Cables (IP65)*.

Power Supply – NEMA 34 (IP65)

Table 4-17. stepIM NEMA 34 (IP65) – J1. Bus Power Interface

Connector on drive	M12, 4 pins male, A-code		Connector on drive
Pinout	1	VIN-	
	2	VIN+	
	3	VIN+	
	4	VIN-	

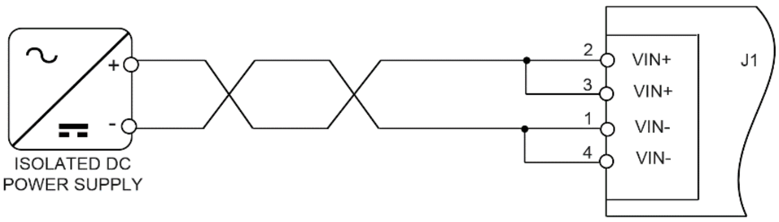


Figure 4-37. stepIM NEMA 34 (IP65) Bus Power Wiring

CAN – NEMA 34 (IP65)

Table 4-18. stepIM NEMA 34 (IP65) – J2. CAN | Auxiliary Power Interface

Connector on drive	M8, 5 pins male, B-code		Connector on drive
Pinout	1	PE	
	2	AUX+	
	3	GND	
	4	CANH	
	5	CANL	

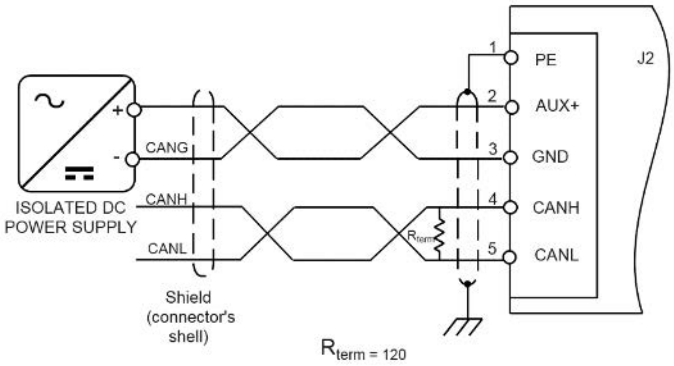
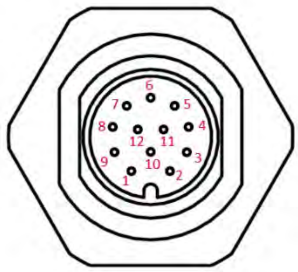


Figure 4-38. stepIM NEMA 34 (IP65) CAN | Auxiliary Power Wiring

I/Os – NEMA 34 (IP65)

Table 4-19. stepIM NEMA 34 (IP65) – J3. I/O Interface

Connector on drive	M12, 12 pins, male, A-code		Connector on drive
Pinout	1	DO1	
	2	DI4	
	3	DI3	
	4	DI1	
	5	Reserved	
	6	Reserved	
	7	AI-	
	8	AI+	
	9	DORT	
	10	DICM	
	11	DI2	
	12	DO2	

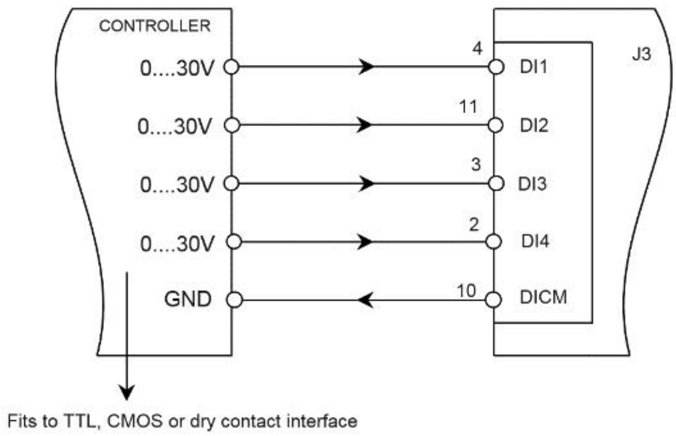


Figure 4-39. stepIM NEMA 34 (IP65) Digital Inputs SINK Wiring

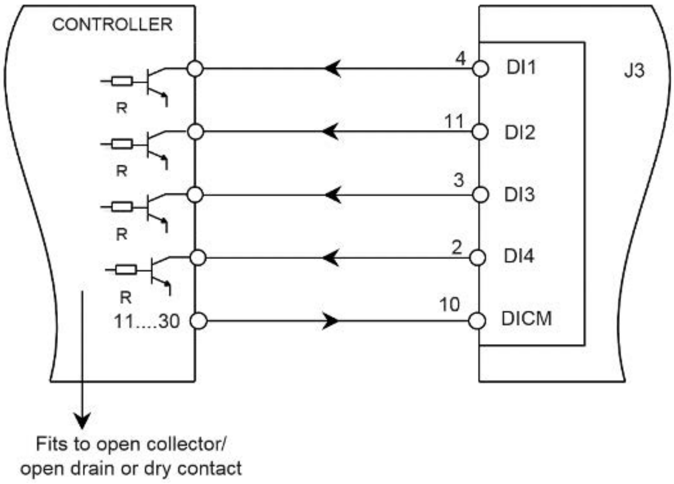


Figure 4-40. stepIM NEMA 34 (IP65) Digital Inputs SOURCE Wiring

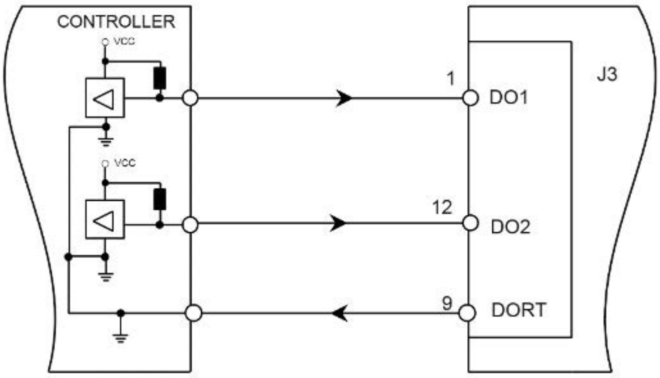


Figure 4-41. stepIM NEMA 34 (IP65) Digital Outputs Wiring

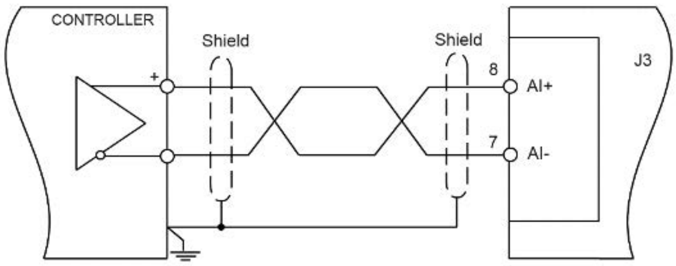


Figure 4-42. stepIM NEMA 34 (IP65) Analog Input DIFFERENTIAL Wiring

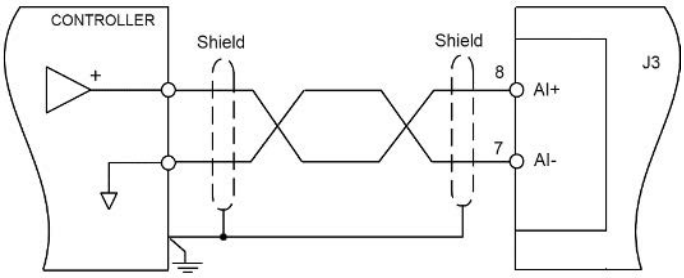


Figure 4-43. stepIM NEMA 34 (IP65) Analog Input SINGLE-ENDED Wiring

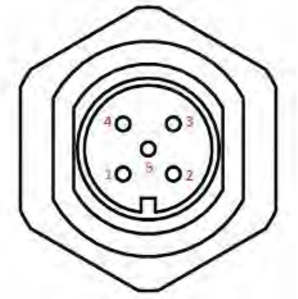
4.3 Wiring – EtherCAT Models

4.4 Wiring – NEMA 17 (IP65) – EtherCAT

Refer to *Connector Cables (IP65)*.

Power Supply – NEMA 17 (IP65)

Table 4-20. stepIM NEMA 17 (IP65) – J1. Bus Power Interface | Auxiliary Power Interface

Connector on drive	M12, 5 pins male, A-code		Connector on drive 
Pinout	1	VIN+	
	2	VIN-	
	3	AUX+	
	4	AUX-	
	5	PE	

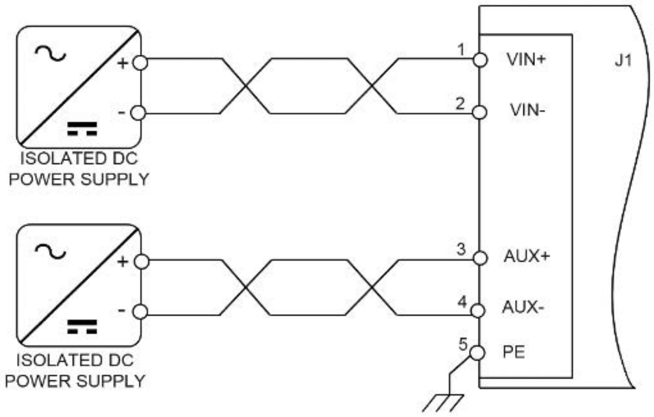


Figure 4-44. stepIM NEMA 17 (IP65) Bus Power Wiring | Auxiliary Power Interface

EtherCAT – NEMA 17 (IP65)

Table 4-21. stepIM NEMA 17 (IP65) – J2. EtherCAT IN

Connector on drive	M8, 4 pins female, A-code		Connector on drive 
Pinout	1	ECAT_IN_Tx+	
	2	ECAT_IN_Rx+	
	3	ECAT_IN_Rx-	
	4	ECAT_IN_Tx-	

Table 4-22. stepIM NEMA 17 (IP65) – J4. EtherCAT OUT

Connector on drive	M8, 4 pins female, A-code		
Pinout	1	ECAT_OUT_Tx+	
	2	ECAT_OUT_Rx+	
	3	ECAT_OUT_Rx-	
	4	ECAT_OUT_Tx-	

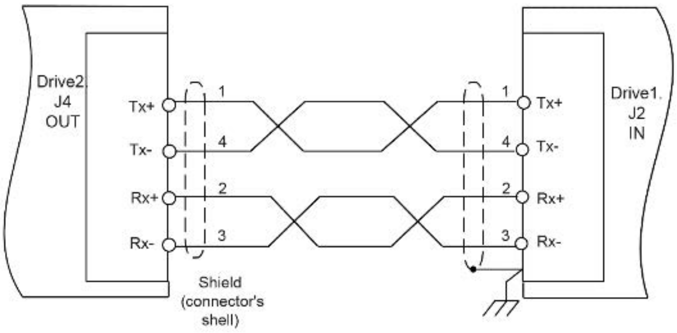


Figure 4-45. stepIM NEMA 17 (IP65) EtherCAT Node-to-Node Connection

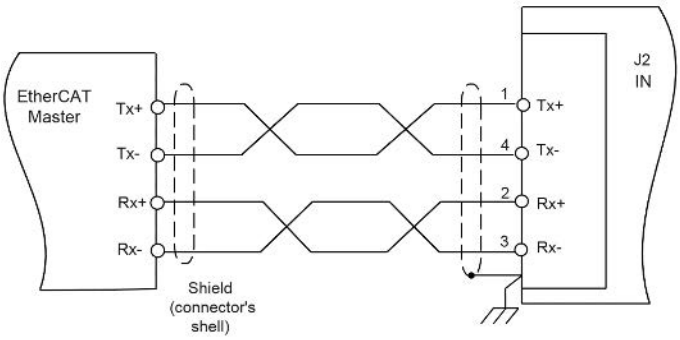
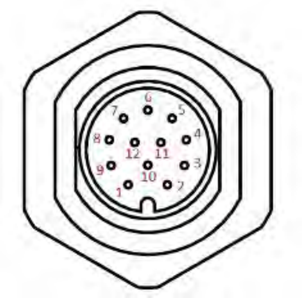


Figure 4-46. stepIM NEMA 17 (IP65) EtherCAT Master–Slave Connection

I/Os – NEMA 17 (IP65)

Table 4-23. stepIM NEMA 17 (IP65) – J3. I/O Interface

Connector on drive	M12, 12 pins male A-code		Connector on drive
Pinout	1	DO1	
	2	DI4	
	3	DI3	
	4	DI1	
	5	Reserved	
	6	Reserved	
	7	AI-	
	8	AI+	
	9	DORT	
	10	DICM	
	11	DI2	
	12	DO2	

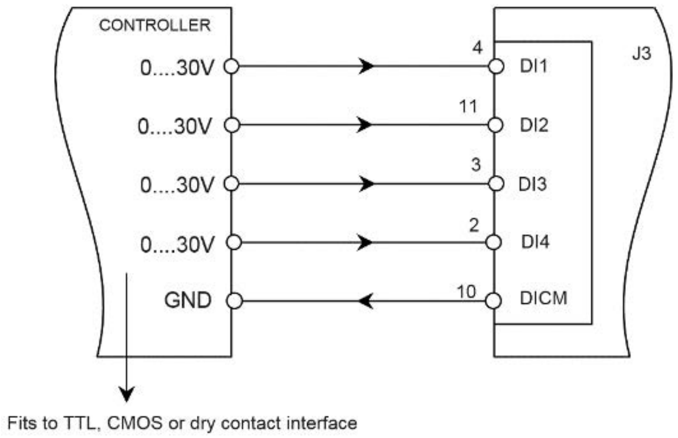


Figure 4-47. stepIM NEMA 17 (IP65) Digital Inputs SINK Wiring

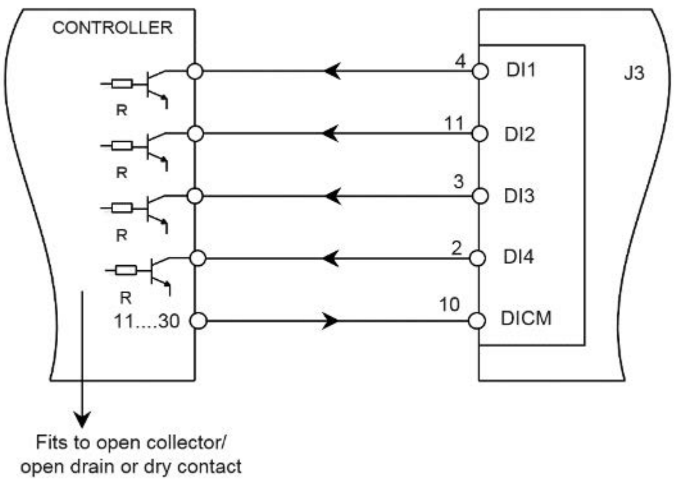


Figure 4-48. stepIM NEMA 17 (IP65) Digital Inputs SOURCE Wiring

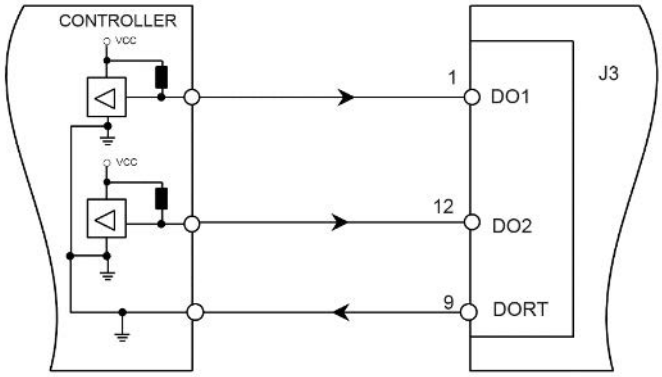


Figure 4-49. stepIM NEMA 17 (IP65) Digital Outputs Wiring

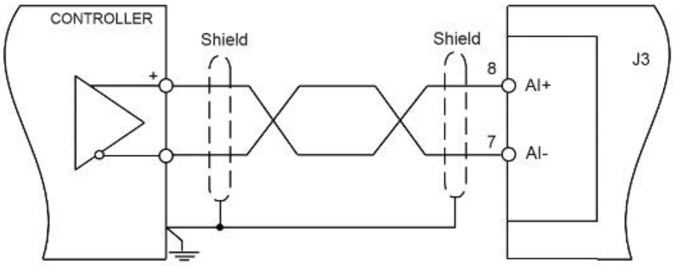


Figure 4-50. stepIM NEMA 17 (IP65) Analog Input DIFFERENTIAL Wiring

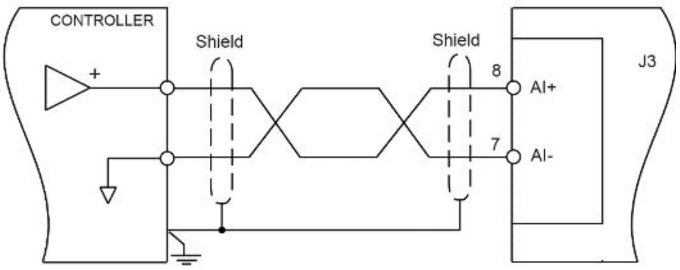


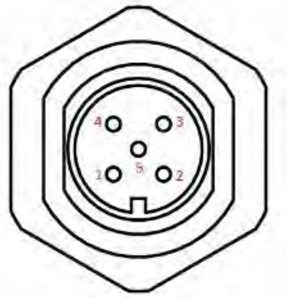
Figure 4-51. stepIM NEMA 17 (IP65) Analog Input SINGLE-ENDED Wiring

4.4.1 Wiring – NEMA 23 (IP65) – EtherCAT

Refer to *Connector Cables (IP65)*.

Power Supply – NEMA 23 (IP65)

Table 4-24. stepIM NEMA 23 (IP65) – J1. Bus Power Interface | Auxiliary Power Interface

Connector on drive	M12, 5 pins male, A-code		Connector on drive 
Pinout	1	VIN+	
	2	VIN-	
	3	AUX+	
	4	AUX-	
	5	PE	

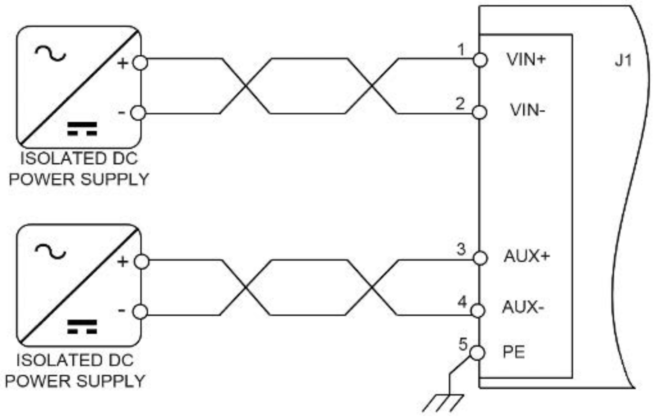


Figure 4-52. stepIM NEMA 23 (IP65) Bus Power Wiring | Auxiliary Power Interface

EtherCAT – NEMA 23 (IP65)

Table 4-25. stepIM NEMA 23 (IP65) – J2. EtherCAT IN

Connector on drive	M8, 4 pins female, A-code		Connector on drive 
Pinout	1	ECAT_IN_Tx+	
	2	ECAT_IN_Rx+	
	3	ECAT_IN_Rx-	
	4	ECAT_IN_Tx-	

Table 4-26. stepIM NEMA 23 (IP65) – J4. EtherCAT OUT

Connector on drive	M8, 4 pins female, A-code		
Pinout	1	ECAT_OUT_Tx+	
	2	ECAT_OUT_Rx+	
	3	ECAT_OUT_Rx-	
	4	ECAT_OUT_Tx-	

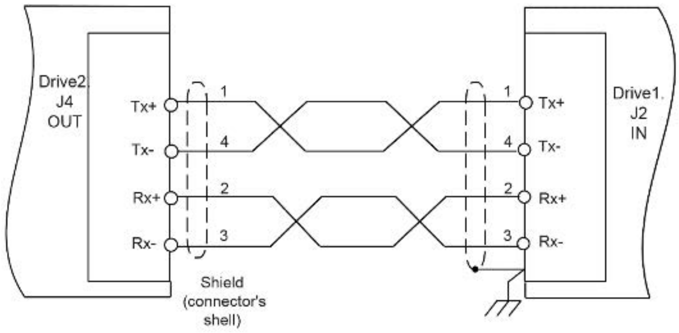


Figure 4-53. stepIM NEMA 23 (IP65) EtherCAT Node-to-Node Connection

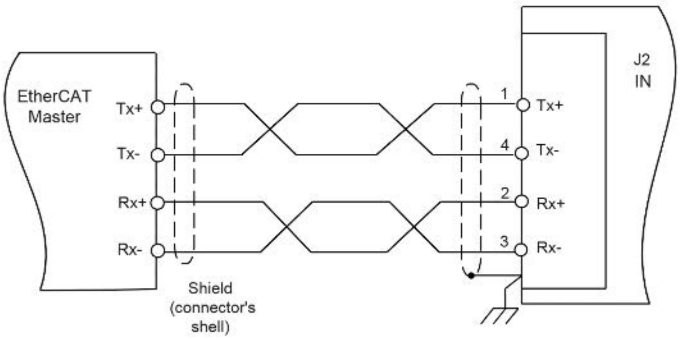
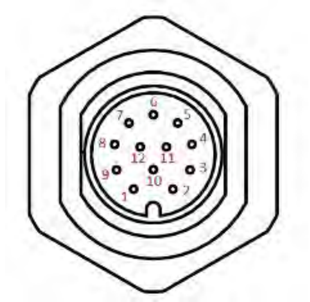


Figure 4-54. stepIM NEMA 23 (IP65) EtherCAT Master–Slave Connection

I/Os – NEMA 23 (IP65)

Table 4-27. stepIM NEMA 23 (IP65) – J3. I/O Interface

Connector on drive	M12, 12 pins male A-code		Connector on drive
Pinout	1	DO1	
	2	DI4	
	3	DI3	
	4	DI1	
	5	Reserved	
	6	Reserved	
	7	AI-	
	8	AI+	
	9	DORT	
	10	DICM	
	11	DI2	
	12	DO2	

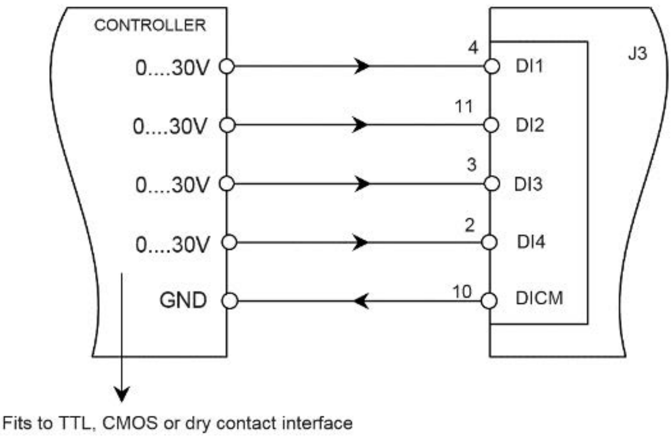


Figure 4-55. stepIM NEMA 23 (IP65) Digital Inputs SINK Wiring

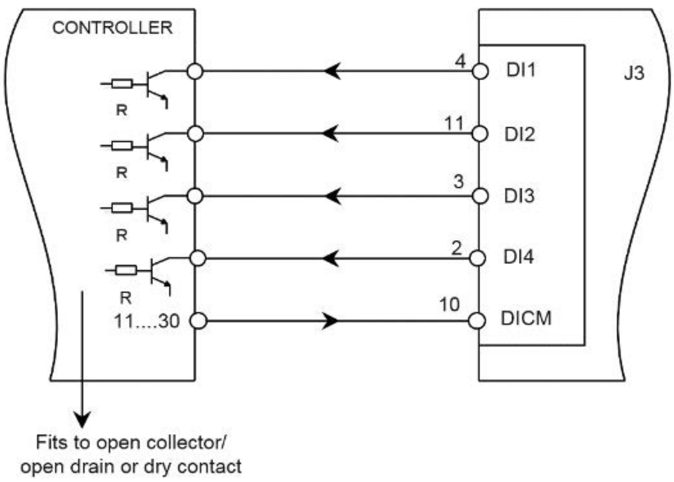


Figure 4-56. stepIM NEMA 23 (IP65) Digital Inputs SOURCE Wiring

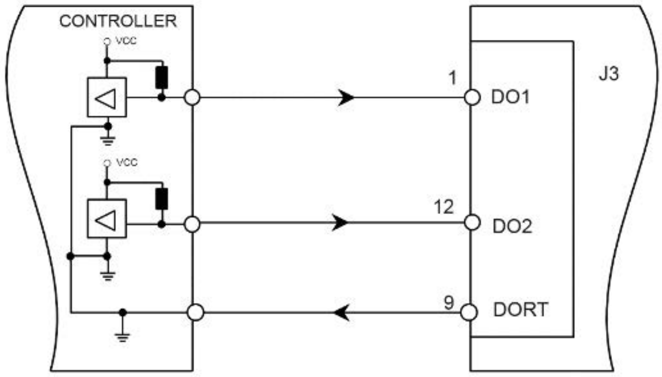


Figure 4-57. stepIM NEMA 23 (IP65) Digital Outputs Wiring

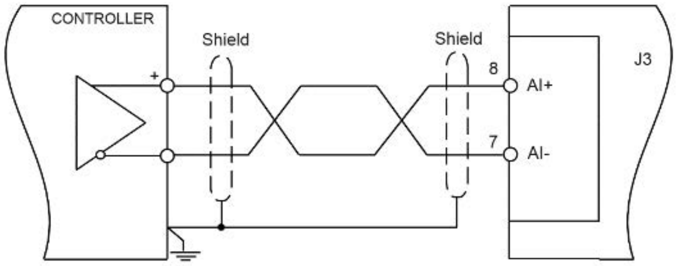


Figure 4-58. stepIM NEMA 23 (IP65) Analog Input DIFFERENTIAL Wiring

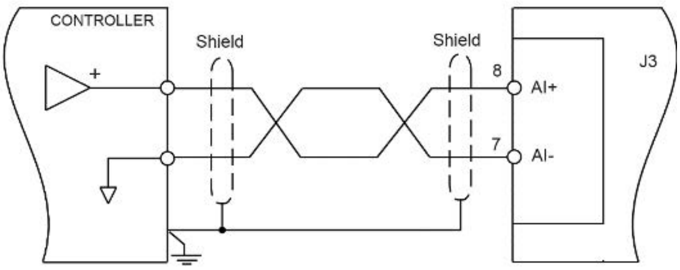


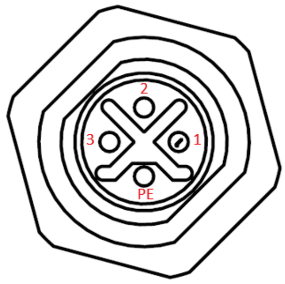
Figure 4-59. stepIM NEMA 23 (IP65) Analog Input SINGLE-ENDED Wiring

4.4.2 Wiring – NEMA 34 (IP65) – EtherCAT

Refer to *Connector Cables (IP65)*.

Power Supply – NEMA 34 (IP65)

Table 4-28. stepIM NEMA 34 (IP65) – J1. Bus Power Interface | Auxiliary Power Interface

Connector on drive	M12, 3+PE Pins male, S-code		Connector on drive
Pinout	1	VIN+	
	2	GND	
	3	AUX+	
	4	PE	

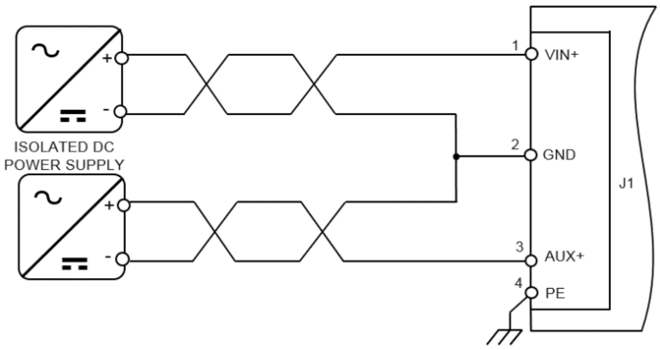


Figure 4-60. stepIM NEMA 34 (IP65) Bus Power Wiring

EtherCAT – NEMA 23 (IP65)

Table 4-29. stepIM NEMA 34 (IP65) – J2. EtherCAT IN

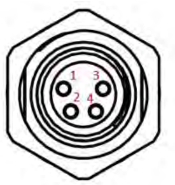
Connector on drive	M8, 4 pins female, A-code		Connector on drive
Pinout	1	ECAT_IN_Tx+	
	2	ECAT_IN_Rx+	
	3	ECAT_IN_Rx-	
	4	ECAT_IN_Tx-	

Table 4-30. stepIM NEMA 34 (IP65) – J4. EtherCAT OUT

Connector on drive	M8, 4 pins female, A-code		Connector on drive
Pinout	1	ECAT_OUT_Tx+	
	2	ECAT_OUT_Rx+	
	3	ECAT_OUT_Rx-	
	4	ECAT_OUT_Tx-	

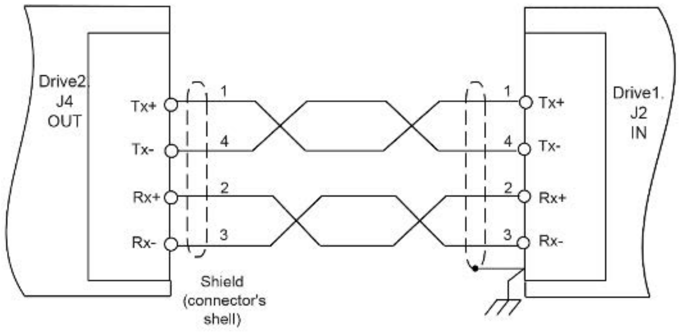


Figure 4-61. stepIM NEMA 34 (IP65) EtherCAT Node-to-Node Connection

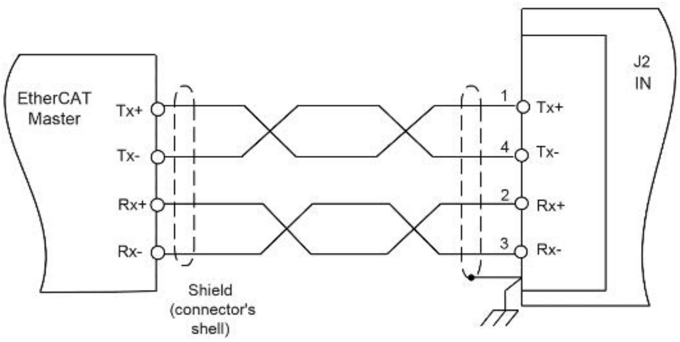
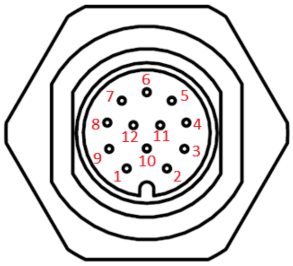


Figure 4-62. stepIM NEMA 34 (IP65) EtherCAT Master–Slave Connection

I/Os – NEMA 34 (IP65)

Table 4-31. stepIM NEMA 34 (IP65) – J3. I/O Interface

Connector on drive	M12, 12 pins male A-code		Connector on drive
Pinout	1	DO1	
	2	DI4	
	3	DI3	
	4	DI1	
	5	Reserved	
	6	Reserved	
	7	AI-	
	8	AI+	
	9	DORT	
	10	DICM	
	11	DI2	
	12	DO2	

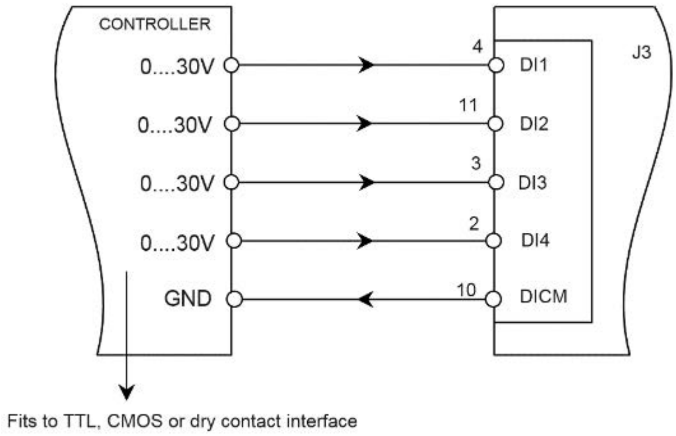


Figure 4-63. stepIM NEMA 34 (IP65) Digital Inputs SINK Wiring

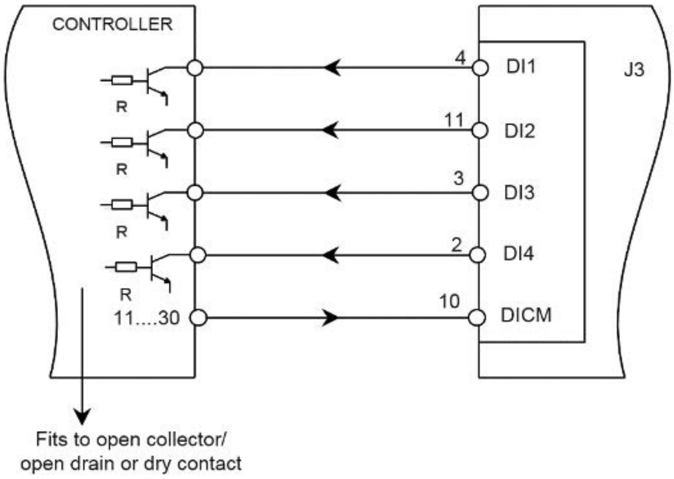


Figure 4-64. stepIM NEMA 34 (IP65) Digital Inputs SOURCE Wiring

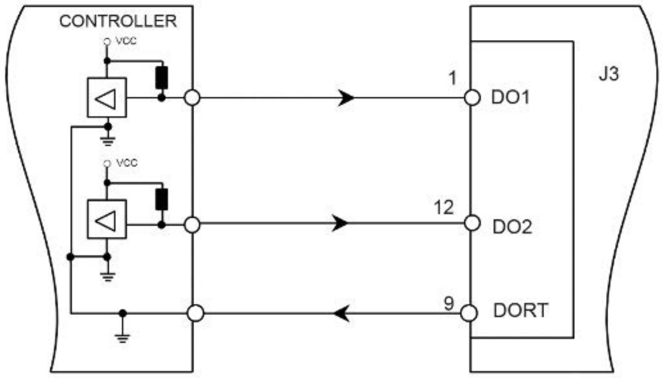


Figure 4-65. stepIM NEMA 34 (IP65) Digital Outputs Wiring

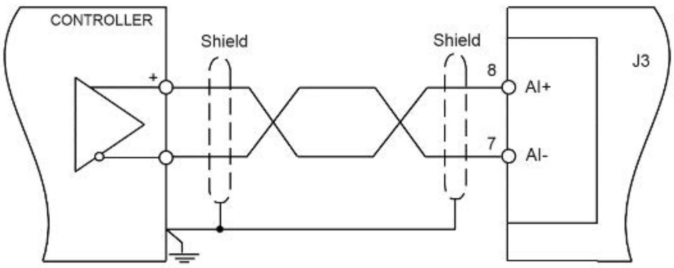


Figure 4-66. stepIM NEMA 34 (IP65) Analog Input DIFFERENTIAL Wiring

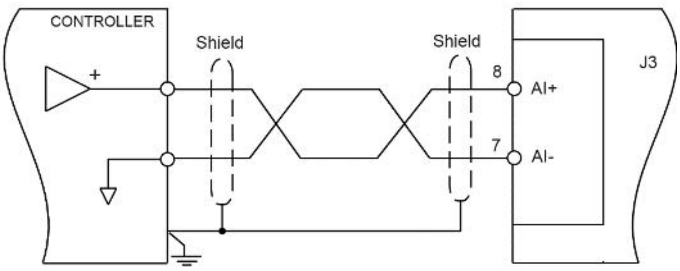


Figure 4-67. stepIM NEMA 34 (IP65) Analog Input SINGLE-ENDED Wiring

5 Installation

5.1 Setup Overview

Perform the following steps to install a stepIM system.

1. Mount the stepIM.
2. Make all wiring and cable connections, as required by your application:
   - DC bus voltage (J1)
   - CANopen | EtherCAT IN (J2)
   - Digital inputs, digital outputs, analog input (J3)
   - In EtherCAT version only: EtherCAT OUT (J4)
   - Optional: Auxiliary power supply
3. Connect the stepIM to the host PLC.

   Optional: Connect the stepIM to the host computer.
4. Power on the power supply that feeds the stepIM.

   Optional: If using the auxiliary power supply, power it on.
5. Using the host PLC and CANopen protocol, configure and test the stepIM.

   Optional: Download and install ServoStudio 2 software for stepIM on the host computer, and use it to configure and test the stepIM.

Caution!

During continuous motor operation, the motor body and the drive's power stage heat up.

As a precaution against damage to the product, use proper airflow or connect the stepIM to a cooling metal plate to prevent the temperature from reaching 100˚C on the motor or the drive's power stage.

The drive will shut down when the power stage temperature reaches 105˚C.

The drive's power stage temperature can be read from object 2044h.

5.2 Mating Connector Kits (IP20)

Table 5-1. Mating Connector Kits for stepIM IP20 Models

stepIM Barcode	Barcode
IST-17S12CO10-0	KIT-IS17-C20-00
IST-17M12CO10-0	
IST-17L12CO10-0	
IST-23S12CO10-0	KIT-IS23-C20-00
IST-23M12CO10-0	
IST-23L12CO10-0	
IST-34M22CO10-1	KIT-IS34-C20-00
IST-34L22CO10-1	

5.3 Connector Cables (IP65)

Note Refer to Application Note for wiring cable colors.

Table 5-2. Bus Power Cable Cables for stepIM IP65 Models

stepIM Barcode	Barcode
IST-17S16EC10-0	CBLrM1205APW-0x
IST-17M16EC10-0	
IST-17L16EC10-0	
IST-23S16CO10-0	CBLrM1205APW-0x
IST-23M16CO10-0	
IST-23L16CO10-0	
IST-23S16EC10-0	CBLrM1205APW-0x
IST-23M16EC10-0	
IST-23L16EC10-0	
IST-34M26CO10-0	CBLrM1204APW-0y
IST-34L26CO10-0	
IST-34M26EC10-0	CBLrM1204SPW-0x
IST-34L26EC10-0	

x = 1 or 5 (meter): cable length
y = 5 (meter): cable length

Table 5-3. CAN | Aux. Power Cable for stepIM IP65 Models

stepIM Barcode	Barcode
IST-23S16CO10-0	CBLrM0805BCO-0x

IST-23M16CO10-0	
IST-23L16CO10-0	
IST-34M26CO10-0	CBLrM0805BCO-0x
IST-34L26CO10-0	

x = 1 or 5 (meter): cable length

Table 5-4. EtherCAT Cables for stepIM IP65 Models

stepIM Barcode	Node-to-Node Cable Barcode	Master-Slave Cable Barcode
IST-17S16EC10-0	CBLrM0804AEC-0x	CBLrM08RJAEC-0x
IST-17M16EC10-0		
IST-17L16EC10-0		
IST-23S16EC10-0		
IST-23M16EC10-0		
IST-23L16EC10-0		
IST-34M26EC10-0		
IST-34L26EC10-0		

x = 1 or 5 (meter): cable length

Table 5-5. I/O Cables for stepIM IP65 Models

stepIM Barcode	Barcode
IST-17S16EC10-0	CBLrM1212AIO-0y
IST-17M16EC10-0	
IST-17L16EC10-0	
IST-23S16CO10-0	CBLrM0808AIO-0x
IST-23M16CO10-0	
IST-23L16CO10-0	
IST-23S16EC10-0	CBLrM1212AIO-0y
IST-23M16EC10-0	
IST-23L16EC10-0	
IST-34M26CO10-0	CBLrM1212AIO-0y
IST-34L26CO10-0	
IST-34M26EC10-0	
IST-34L26EC10-0	

x = 1 or 5 (meter): cable length
y = 5 (meter): cable length

5.4 USB to CAN Adapter

Table 5-6. USB to CAN Adapter Cable

stepIM Barcode	Barcode
All CANopen (CO) models	CVRr0USB2CAN-00

5.5 Host Computer System

A computer system and software are required if you intend to use ServoStudio 2 and/or another Window-based software interface for commissioning the stepIM, upgrading firmware, and other configuration tasks. ServoStudio 2 requires the following computer system:

- 2 GHz CPU
- 1 MB RAM
- 1000 MB available on hard drive (after .net 4 is installed)
- USB port
- Operating system: Windows XP-SP3, Windows 7, Windows 8, Windows 10.
  32-bit or 64-bit.
- Recommended screen resolution for ServoStudio 2 is 1280x800.
  Minimal resolution is1024x768.
- .Net4 (for details, refer to .NET Framework System Requirements).
  If .NET 4 is not installed on the computer, ServoStudio 2 will guide you through the installation, but will not install it automatically.

Note A serial RS232 or USB connection is required for commissioning the drive through ServoStudio 2. Once the drive is configured, you can then connect it to a PLC or controller over an EtherCAT or CANopen network.

5.5.1 Software

stepIM is supported by the following Windows-based software interfaces:

- ServoStudio 2.
- TwinCAT by Beckhoff (EtherCAT stepIM version).

5.5.2 USB-CAN Interface

stepIM supports two types of USB-CAN interfaces, which are used to connect the stepIM to the host computer to enable communication with ServoStudio 2 software.

8devices USB2CAN USB-CAN Adapter

The USB2CAN adapter can be purchased directly from the STXI Motion website or contact Technical Support. Refer to the section USB to CAN Adapter.

1. Before attaching the USB2CAN converter to the host computer, install the device driver.
   - Go the product website (https://www.8devices.com/products/usb2can), and download the driver.
   - Install the driver according to the on-screen instructions.
2. Connect the USB2CAN cable to the USB port on the computer.
   - The Found New Hardware Wizard will detect and complete the driver installation.
   - Confirm hardware installation by opening the Control Panel > Device Manager > Universal Serial Bus devices. Make sure USB2CAN converter is listed.
3. Connect the D9 male connector on the USB2CAN cable to the female D9 connector on the RJ45 cable.
4. In the ServoStudio 2 Communication screen, select **8devices USB2CAN** to define the CANopen Adapter.
5. The status LED on the USB2CAN converter will switch from red to green when communication is established.

Kvaser Leaf USB-CAN Adapter

1. Before attaching Kvaser Leaf converter to the host computer, install the Kvaser driver.
   - Go the Kvaser website, and download the driver.
   - Install the driver according to the on-screen instructions.
2. Connect the Kvaser Leaf cable to the USB port on the computer.
   - The Found New Hardware Wizard will detect and complete the driver installation.
   - Confirm hardware installation by opening the Control Panel > **Kvaser Hardware.** Make sure **Kvaser Virtual CAN driver** appears in the Devices tab.
3. Make sure the green light (PWR) on the Kvaser cable is lit.
4. Connect the D9 male connector on the Kvaser cable to the female D9 connector on the RJ45 cable.

5.6 Files for Fieldbus Devices (CANopen/EtherCAT)

- If using CAN protocol, an EDS (electronic data sheet) file for stepIM must be loaded on the host computer or PLC controller. Download from the STXI Motion website or contact Technical Support.
- If using EtherCAT protocol, an XML file for stepIM must be loaded on the host computer or PLC controller. Download from the STXI Motion website or contact Technical Support.

5.7 Power Up

After completing the hardware connections and software installations, turn on power to the stepIM.

Note If logic and bus AC supplies are separate, it is recommended that logic AC be turned on before bus AC.

6 CANopen Communication

6.1 CANopen Termination

In a CANopen network, a 120Ω termination resistor is required on the last node in the chain.

To implement the termination, connect an external 120Ω/0.25W resistor between the CANH and CANL terminals (pins 4 and 5 on connector **J2**) on the stepIM.

6.2 CANopen Network Management

CANopen network nodes and states are controlled by network management (NMT) messages. The following diagram shows the network states and transitions.

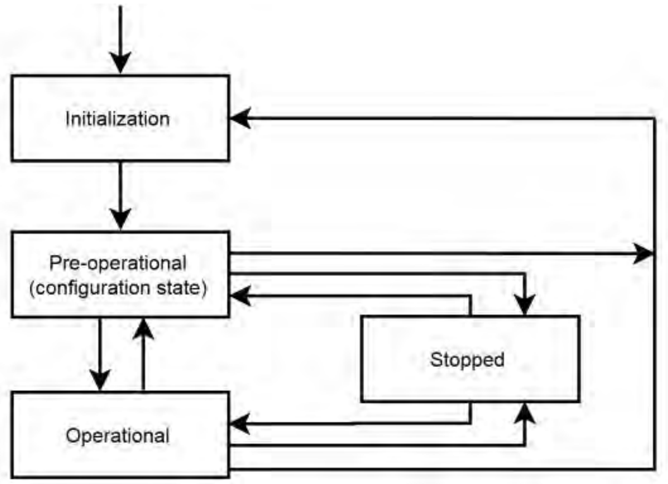


Figure 6-1. CANopen Network Management (NMT) States

- **Pre-operational state**. This state is used primarily for configuration of the CANopen device; therefore, the exchange of process date via PDOs is not possible in this state, and the device cannot be enabled in this state.
- **Operation state**. In this state the transmission of process data via PDOs is possible. This is the only state in which a device can be enabled.
- **Stopped**. A node cannot transmit or receive any other messages in this state. A device cannot be enabled when in this state.

6.3 CANopen Node ID

Note It is also possible to configure CANopen Node IDs using ServoStudio 2.

Setting a New Node ID

Default Node ID is 101.

Node IDs are set by object 2F1Bh.

Node ID setting procedure:

1. Write the new Node ID value to object 2F1Bh
1. Save the new Node ID value to EEPROM in object 1010h (Store Parameter Field).
2. Cycle the stepIM power. The new Node ID will be set upon power-up.

Setting New Node IDs for Multiple Drives

When multiple stepIM drives with the same CAN ID are connected to the CANopen network, the following procedure will set a new Node ID for each drive:

1. Set the serial number of the stepIM to be configured in object 2F7Dh (Configured Serial Number).
2. Set the new Node ID in object 2F7Eh (New CAN ID Configuration).
3. Activate the update of the new Node ID within a specific serial number by writing 0 to object 2F7Fh (Operation CAN ID Configuration).
4. Save the new CAN ID in the stepIM EEPROM by writing 1 to object 2F7Fh (Operation CAN ID Configuration).
5. At the next power-up, the new Node ID is in object 2F1Bh (Drive Address).

Note The serial number of the stepIM is contained in object 1018h (Identity object), sub-index 4; it also appears on the stepIM label. When using the serial number that appears on the label, remove the hyphen (-) from the serial number.

6.4 CANopen Baud Rate

Baud rate can be defined using the following procedure:

1. Set the new baud rate value in object 2F1Fh (CANopen Baud Rate).
2. Save the new baud rate to EEPROM in object 1010h (Store Parameter Field).
3. Cycle the stepIM power. The new baud rate will be set upon power-up.

7 EtherCAT Communication

7.1 EtherCAT Network Management

EtherCAT network nodes and states are controlled by network management (NMT) messages. The following diagram shows the network states and transitions.

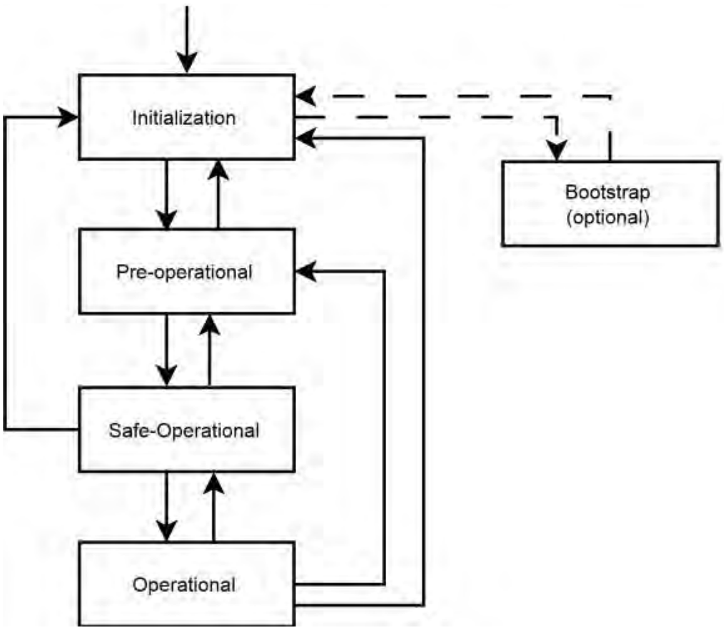


Figure 7-1. EtherCAT Network Management (NMT) States

- **Init**. No communication on the application layer is available. The master has access only to the DL-information registers.
- **Pre-operational.** Mailbox communication on the application layer available, but no process data communication available
- **Safe-operational**. Mailbox communication on the application layer, process (input) data communication available. In SafeOp only inputs are evaluated; outputs are kept in ‘safe’ state.
- **Operational**. Process data inputs and outputs are valid.
- **Bootstrap**. Optional but recommended if firmware updates are required. No process data communication. Communication only via mailbox on Application Layer. Special mailbox configuration is possible, e.g. larger mailbox size. In this state the FoE protocol is usually used for firmware download

8 Configuration

8.1 stepIM Control Loop

The following diagram shows the control loop of the stepIM.

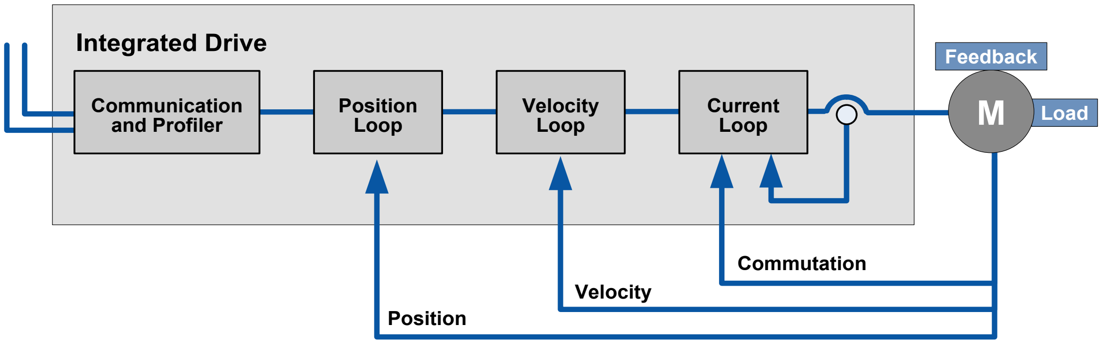


Figure 8-1. stepIM Control Loop

8.2 Drive Configuration

Drive functionality is configured by means of CANopen SDO objects. Some objects allow on-the-fly modification while the motor is in motion and the drive is enabled.

General setup procedure steps:

1. Setting safety limits
2. Setting velocity loop gains
3. Setting position loop gains

8.2.1 Setting Safety Limits

Set drive safety limits parameters, if needed:

Object	Name	Description
Object 2F0Ah	Velocity Over-Speed	Velocity limit that trips the over-speed protection fault.
Object 20EEh	Velocity Limit	Software limit on the velocity command to the velocity loop.
Object 2036h	Peak Current	Current value that trips the over-current protection fault.
Object 6073h	Max Current	Software limit on the current command to the current loop.
Object 607Dh, sub-index 1	Minimum Software Position Limit	Minimum position limit in position loop (activated by object 20AC).
Object 607Dh, sub-index 2	Maximum Software Position Limit	Maximum position limit in position loop (activated by object 20AC).
Object 20AC	Software Position Limit Mode	Enables software position limit protection when the object value is 1.
Object 6065h	Following Error Window	A limit on the position error that trips the position error fault.
Object 6083h	Profile Acceleration	Limits the acceleration in position and velocity modes.
Object 6084h	Profile Deceleration	Limits the deceleration in position and velocity modes.
Object 60C5h	Max. Acceleration	Generates a fault if acceleration or deceleration exceeds this value.

8.2.2 Setting Velocity Loop Gains

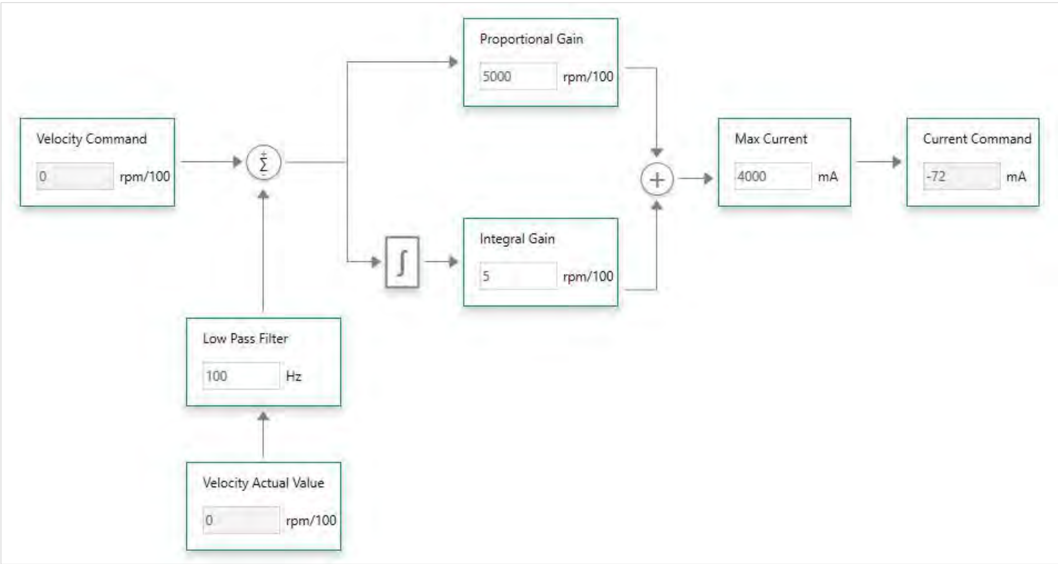


Figure 8-2. Velocity Loop Gains

The following parameters can be configured by user:

Object	Description
Object 2026h	Velocity Integral Gain
Object 2027h	Velocity Proportional Gain
Object 20D9h	Velocity Loop Input Filter. The low pass filter cutoff frequency for the velocity loop. It is recommended to set the filter to a cutoff frequency of 100 Hz.
Object 6073h	Maximum Current. The maximum allowed torque-creating current in the motor.

8.2.3 Setting Position Loop Gains

The position loop is a type of PID controller, with acceleration and velocity feedforward.

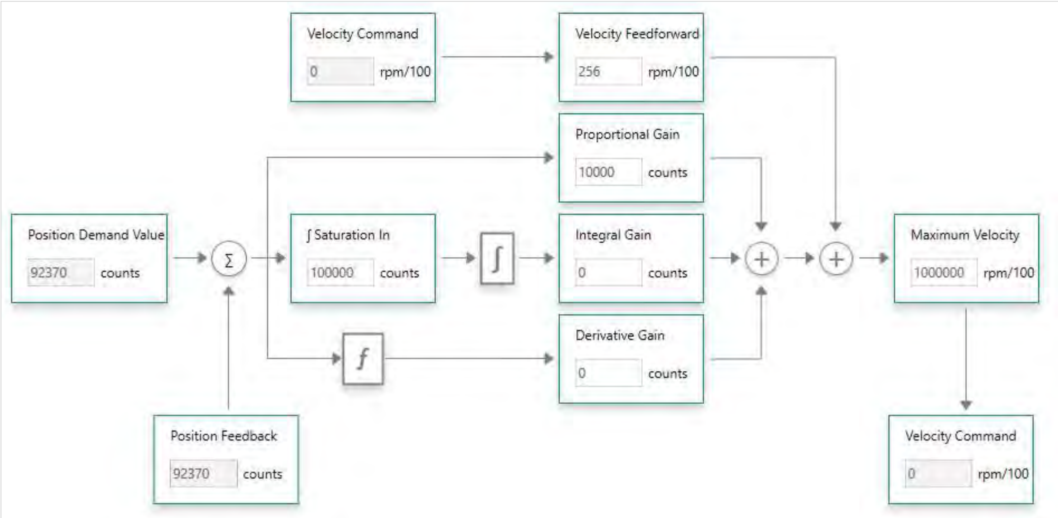


Figure 8-3. Position Loop Gains

The following parameters can be configured by user:

Object	Description
Object 2022h	Position Loop Proportional Gain
Object 2020h	Position Loop Integral Gain
Object 201Eh	Position Loop Derivative Gain
Object 2023h	Position Loop Velocity Feedforward Gain
Object 2077h	Position Integral Input Saturation
Object 20EEh	Velocity Limit. This object indicates the maximum velocity for a drive and motor.

6.

9 Device Control

9.1 Operation Enabled State

1. Before enabling operation, the network node state (NMT) must be Operational. Refer to the section *CANopen Network Management*.
2. First clear any faults by generating a rising edge in bit 7.
3. To enable operation, write the following command sequence to object 6040h (Controlword):

   06h: Shut down

   07h: Switch on

   0Fh: Switch on and enable operation

9.2 Drive State Machine

The drive state machine controls the sequencing of power-up and motion. It also provides the ability to respond to faults and to disable the drive if needed.

The drive device is controlled primarily by object 6040h (Controlword) with fault and status feedback provided by object 6041h (Statusword)

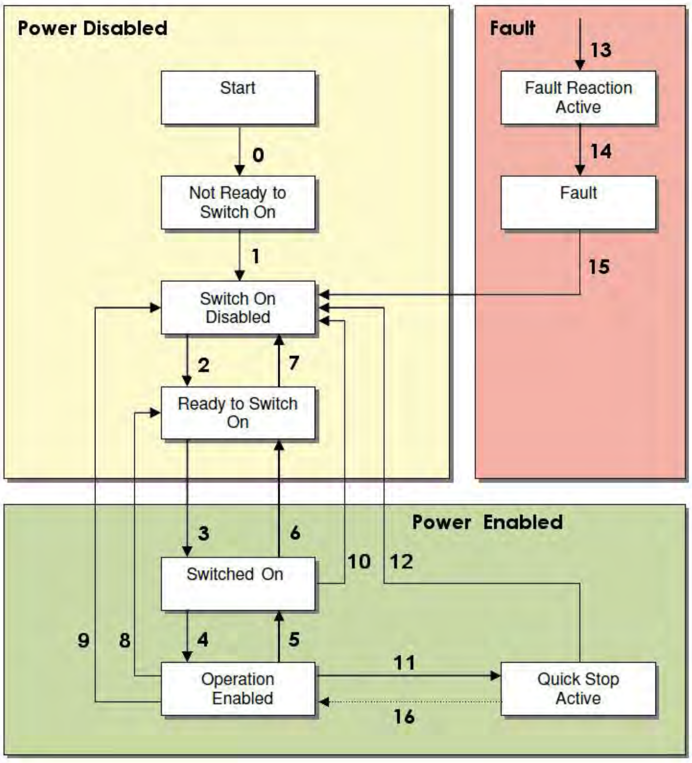


Figure 9-1. Operating States and Transitions

Diagram Notes

Not Ready to Switch On	“Not ready to operate” received from the controller.
Switch On Disabled	Ready to operate. Can read and write parameters. Motion functionality cannot be executed.
Ready to Switch On	Ready to operate. Can read and write parameters. Motion functionality cannot be executed. Bus voltage must be switched on.
Operation Enabled	Drive power stage is enabled. No fault is present. Motion functionality can be executed.
Quick Stop Active	Drive was stopped using controlled stop. Power stage is enabled. Motion functionality cannot be executed.
Fault Reaction Active	A fault has occurred. Drive is now ramping down to 0 velocity.
Fault	A fault has occurred. Power stage is disabled.

The bits in object 6040h (Controlword) are used to initiate state transitions.

The bits in object 6041h (Statusword) indicate the current state of the state machine. The state reflected by object 6041h is updated when the transition has been completed.

Table 9-1. 6040h – Controlword – State Transition Command Bits

		Bit of Controlword	7	3	2	1	0
		Definition	Fault Reset	Enable Operate	Quick Stop	Enable Voltage	Switch On
Fieldbus Command	**Transitions**	**To State**					
Shut Down	2, 6, 8	Ready To Switch On	0	X	1	1	0
Switch On	3	Switched On	0	0	1	1	1
Disable Voltage	7, 9, 10, 12	Switch On Disabled	0	X	X	0	X
Quick Stop	7, 10, 11	Switch On Disabled Quick Stop Active	0	X	0	1	X
Disable Operation	5	Switched On	0	0	1	1	1
Enable Operation	4, 16	Operation Enabled	0	1	1	1	1
Fault Reset	15	Switch On Disabled	0 » 1 (rising edge)	X	X	X	X

Bit	Definition
Bits 4–6, 9	Operation-mode specific
Bit 8	Halt
Bits 10–15	Manufacturer-specific, configured in object 2F87h

Table 9-2. 6041h – Statusword – Bits

Bit	6	5	3	2	1	0
Definition	**Switch On Disabled**	**Quick Stop**	**Fault**	**Operation Enabled**	**Switch On**	**Ready to Switch On**
State						
Not Ready To Switch On	0	X	0	0	0	0
Switch On Disabled	1	X	0	0	0	0

Bit	6	5	3	2	1	0
Definition	**Switch On Disabled**	**Quick Stop**	**Fault**	**Operation Enabled**	**Switch On**	**Ready to Switch On**
State						
Ready To Switch On	0	1	0	0	0	1
Switched On	0	1	0	0	1	1
Operation Enabled	0	1	0	1	1	1
Quick Stop Active	0	0	0	1	1	1
Fault Reaction Active	0	X	1	1	1	1
Fault	0	X	1	0	0	0

Bit	Definition
Bit 0	Ready to Switch On (1=ready to switch on)
Bit 1	Switched On (1=switched on)
Bit 2	Operation Enabled (1=enabled)
Bit 3	Fault (1=fault)
Bit 4	Voltage Enabled (1=enabled)
Bit 5	Quick Stop (0=drive is responding to a quick stop request)
Bit 6	Switch On Disabled
Bit 7	Warning
Bit 8	Manufacturer-specific
Bit 9	Remote
Bit 10	Target Reached (1=axis motion ended)
Bit 11	Internal Limit Active
Bit 12	Operation-mode specific
Bit 13	Operation-mode specific
Bit 14	Manufacturer-specific
Bit 15	Manufacturer-specific

9.3 Operation Modes

The stepIM supports the following CANopen modes of operation:

1: Profile Position

2: Velocity

3: Profile Velocity

4: Profile Torque

6: Homing

8: Cyclic Synchronous Position

In addition, the stepIM has a manufacturer-specific operation mode:

-3: Analog Torque

-4: Analog Velocity

-5: Scripted Motion

Note Do not use analog control modes if the analog input pins are not connected.

The stepIM must be disabled prior to changing the operation mode, except when switching from Homing to another mode.

Object 6060h is used to set the operation mode. Changed settings become active immediately.

9.4 Profile Position Operation Mode (1)

In the Profile Position operation mode, movements to specified target positions are performed.

The motion ends when one of the following conditions is met:

- Target position reached
- Stop caused by Halt or Quick Stop
- Stop caused by an error

Bits 10 and 12—15 in object 6041h indicate the status of the movement.

Bit	Value
Bit 10: Target reached	0 = Target position not reached 1 = Target position reached
Bit 12: Target value acknowledge	0 = New position possible 1 = New target position accepted
Bit 13: Following error bit	0 = No following error 1 = Following error
Bit 14: Manufacturer-specific	
Bit 15: Manufacturer-specific	

9.4.1 Point-to-Point Movement

To initiate a point-to-point movement command, do the following:

1. Switch to Profile Position operation mode by writing 1 to object 6060h.
2. Enable operation.
3. Set the distance to the target position in object 607Ah.
4. Set the profile velocity in object 6081h.
5. Set the acceleration and the deceleration in objects 6083h and 6084h, respectively.
6. Define the type of movement in object 6040h:
   - Incremental move: set bit 6
   - Absolute move: clear bit 6
7. Define whether motion starts immediately or after previous motion in object 6040h:
   - Immediate: set bit 5
   - After previous: clear bit 5
8. Start motion by generating a rising edge in bit 4 in object 6040h.
9. Up to ten additional motion commands can be issued by using the available buffer.

9.4.2 Begin Motion On Time

The Begin Motion On Time function is applicable in Profile Position operation mode. It enables a synchronized start of motion for several axes at a pre-defined time.

This function uses the object 1013h (High Resolution Time Stamp), extended by drive PLL to allow precise time-keeping between time stamp updates.

The PLL is enabled by setting object 2F82h to 2.

To start motion at a specific time, do the following:

1. Switch to Profile Position operation mode by writing 1 to object 6060h.
2. Enable operation.
3. Set start time in object 2F83h.
4. Determine which bit in object 6040 will be used for the Begin On Time.
5. In object 2F87h, write 2 to the sub-index that correlates to the bit in object 6040h.
6. Set distance in object 607Ah (Target Position).
7. Set profile velocity in object 6081h (Profile Velocity).
8. Set the acceleration and the deceleration in objects 6083h and 6084h, respectively.
9. Define the type of movement in object 6040h:
   - Incremental move: set bit 6
   - Absolute move: clear bit 6
10. Set the selected bit in object 6040h to begin motion at the defined start time.

9.4.3 Backlash Compensation

A backlash compensation distance is applicable in Profile Position operation mode.

The stepIM has two types of backlash compensation:

- **Type 1**. Prior to starting the first movement after enable, and upon every direction change, the backlash compensation distance is added to the target position. Upon the first movement after enable, the stepIM will first move the backlash compensation distance in the opposite direction of the move command, and then it will execute the move command.
- **Type 2**. At the end of every movement in the direction of the backlash, the backlash compensation distance is added to the target position.

The following objects are used for this function.

Object	Name	Description
Object 2F88h	Backlash Compensation Mode	Defines the type of backlash compensation: 0 = Type 1 1 = Type 2
Object 2F84h	Backlash Compensation Distance	Sets the backlash compensation distance.

9.5 Velocity Operation Mode (2)

In the Velocity operation mode, a movement is made according to a specified velocity.

To initiate a velocity-controlled movement, do the following:

1. Switch the operation mode to Velocity mode by writing 2 to object 6060h.
2. Enable operation.
3. Start motion by setting the target velocity in object 60FFh.
4. If needed, clear bit 8 in object 6040h to start motion.
5. Target velocity can be changed on-the-fly during motion.

The motion ends when one of the following conditions is met:

- Target velocity is set to 0
- Stop caused by Halt or Quick Stop
- Stop caused by an error

9.6 Profile Velocity Operation Mode (3)

In the Profile Velocity operation mode, the movement profile is defined by velocity and acceleration/decelerations commands.

To initiate a velocity-controlled profile:

1. Switch the operation mode to Profile Velocity mode by writing 3 to object 6060h.
2. Enable operation.
3. Set acceleration/deceleration in object 6083/6084h, respectively.
4. Start motion by setting the target velocity in object 60FFh.
5. If needed, clear bit 8 in object 6040h to start motion.
6. Target velocity can be changed on-the-fly during motion.

The motion ends when one of the following conditions is met:

- Target velocity is set to 0
- Stop caused by Halt or Quick Stop
- Stop caused by an error

Bits 10, 12, 14 and 15 in object 6041h indicate the status of the movement.

Bit	Value
Bit 10 = Target reached	0 = Target velocity not reached 1 = Target velocity reached
Bit 12 = Velocity	0 = Velocity > 0 1 = Velocity = 0
Bit 14 = Manufacturer-specific	
Bit 15 = Manufacturer-specific	

9.7 Profile Torque Operation Mode (4)

In the Profile Torque operation mode, a movement is made with a specified target torque.

To initiate a torque-controlled movement:

1. Switch the operation mode to Profile Torque mode by writing 4 to object 6060h.
2. Enable operation.
3. Start motion by setting the target torque in object 6071h.
4. If needed, clear bit 8 in object 6040h to start motion.
5. Target torque can be changed on-the-fly during motion.

The motion ends when one of the following conditions is met:

- Target torque is set to 0
- Stop caused by Halt or Quick Stop
- Stop caused by an error

9.8 Cyclic Synchronous Position Operation Mode (8)

In the Cyclic Synchronous Position operation mode, a movement to a specified target position is performed according to the value of the synchronous cyclic time.

To initiate a synchronized move command:

1. Change the operation mode to Cyclic Synchronous Position mode by writing 8 to object 6060h.
2. Enable operation.
3. Set the distance to the target position in object 607Ah.
4. Send the sync command (80h) to execute.
5. Repeat steps (3) and (4).
6. PDO may be used to synchronously update the position command in object 607Ah.

The sync command is updated periodically, as defined in object 1006h (Communication Cycle Period).

9.9 Homing (6)

In the Homing operation mode, a movement is performed in order to reach a specific reference point. The point and the path are determined by object 6098h (home type).

In addition to the 35 standard CANopen homing method, the following homing methods are also available:

-4 = homing on hard stop in positive direction with index

-3 = homing on hard stop in negative direction with index

-2 = homing on hard stop in positive direction

-1 = homing on hard stop in negative direction

To initiate homing:

1. Change the operation mode to Homing mode by writing 6 to object 6060h.
2. Enable operation.
3. Set the homing method in object 6098h.
4. Set the homing velocity fast and slow speeds in object 6099h.
5. Set the homing acceleration in object 609Ah.
6. Optional: set the homing offset in object 607Ch.
7. Start motion by generating a rising edge in bit 4 in object 6040h.

Bits 10 and 12—15 in object 6041h indicate the status of the homing.

Bit	Value
Bit 10: Target reached	0 = Homing not completed 1 = Homing completed
Bit 12: Homing attained	1 = Homing successfully completed
Bit 13: Homing error	1 = Homing error

9.9.1 Position Backup and Restore

The stepIM backup provides a position backup/restore function that saves the actual position value to non-volatile memory when power is shut off, and restores it at the next power up.

The following objects are used for this function.

Object	Name	Description
Object 2F86h	Save Actual Position Value On Power Off	This object defines whether the actual position value (object 6063h) is saved in EEPROM when the bus voltage power is shut off, and restored at the next power on. 1 = Save enabled 0 = Save disabled This function is not applicable to the shutdown of the auxiliary power supply.
Object 2F89h	Position Backup Restore Window	This object sets the position restore verification window. It is applicable only when object 2F86h is set to 1. On bootup, the restored encoder position and actual encoder position are compared. If the difference is within the window, the Position Backup Restore Status (object 2F8Ah) is set to 1.
Object 2F8Ah	Position Backup Restore Status	This object indicates whether or not the position data was restored correctly. 0 = Position was not restored correctly 1 = Position was restored correctly

9.10 Analog Torque Operation Mode (-4)

In the Analog Torque operation mode, a movement is made according to a torque value generated by an analog input.

To initiate an analog torque controlled movement, do the following:

1. Switch the operation mode to Analog Torque mode by writing -4 to object 6060h.
2. Set the analog input offset (object 20F6h) value. If suitable, you can use the Set to Zero function.
3. Set the scaling value of the analog current command from the analog input (object 20F4).
4. Enable operation.
5. Start, stop and control motion by changing the voltage level on the analog input.

The following objects are used for Analog Torque operation mode.

Object	Name	Description
Object 20F2h	Analog Input	This object returns the value of the analog input.
Object 20F4h	Analog Input Current Scaling	This object defines the scaling value of the analog current command from the analog input. Current scaling affects how the motor current will vary as a result of any change in voltage at the analog velocity command.
Object 20F6h	Analog Input Offset	This object defines a voltage value to be added to the analog input to the drive, to compensate for the analog input signal offset or drift. The analog input offset can be automatically set to the current analog input value by invoking the Analog Input Zero function (object 20F8h).
Object 20F8h	Analog Input Zero	This object sets the value of the analog input offset (object 20F6h) so that the value of the analog input becomes zero. The offset value is calculated from an average of 64 samples of the drive analog input. To perform the zeroing, the object must be written with the value that represents the analog input number; for example, writing 1 to this object zeros analog input 1.

9.11 Analog Velocity Operation Mode (-3)

In the Analog Velocity operation mode, a movement is made according to a velocity value generated by an analog input.

To initiate an analog velocity controlled movement, do the following:

1. Switch the operation mode to Analog Velocity mode by writing -3 to object 6060h.
2. Set the analog input offset (object 20F6h) value. If suitable, you can use the Set to Zero function.
3. Set the scaling value of the analog velocity command from the analog input (object 20F7).
4. Enable operation.
5. Start, stop and control motion by changing the voltage level on the analog input.

The following objects are used for Analog Velocity operation mode.

Object	Name	Description
Object 20F2h	Analog Input	This object returns the value of the analog input.
Object 20F7h	Analog Input Velocity Scaling	This object defines the scaling value of the analog velocity command from the analog input. Velocity scaling affects how the motor speed will vary as a result of any change in voltage at the analog velocity command.
Object 20F6h	Analog Input Offset	This object defines a voltage value to be added to the analog input to the drive, to compensate for the analog input signal offset or drift. The analog input offset can be automatically set to the current analog input value by invoking the Analog Input Zero function (object 20F8h).
Object 20F8h	Analog Input Zero	This object sets the value of the analog input offset (object 20F6h) so that the value of the analog input becomes zero. The offset value is calculated from an average of 64 samples of the drive analog input. To perform the zeroing, the object must be written with the value that represents the analog input number; for example, writing 1 to this object zeros analog input 1.

9.12 Scripted Motion Operation Mode (-5)

In the Scripted Motion operation mode, a movement is performed according to a set of **segments**, each of which is defined by its own object; the object sub-indices define the controlword, target position, acceleration, deceleration, cruise velocity, delay, number of iterations, and the next path segment to be executed.

The stepIM provides ten objects for defining 10 different motion segments.

Object	Description
Objects 2F90h – 2F99h	**Motion Segments,** numbered from 0 to 9
Sub-index 1	**Target position**
Sub-index 2	**Cruise velocity**
Sub-index 3	**Acceleration**
Sub-index 4	**Deceleration**
Sub-index 5	**Controlword.** A digital input can be used to initiate motion if the corresponding index in object 20E0h is set to 6. This controlword will be executed after the value in sub-indices 1–4 have been set.
Sub-index 6	Delay. This is the duration of the pause after the motion has been completed, until the next iteration or the next segment begins.
Sub-index 7	**Number of iterations**
Sub-index 8	**Next segment index**
Object 2F9Ah	**Motion Segment Index** The index of the motion segment that is currently being executed. Writing to this object will cause path execution to jump to the specific segment.

To initiate a scripted motion command, do the following:

1. Configure at least one segment, starting at segment 0, in object 2F90h.
2. Switch to Scripted Motion operation mode by writing **-5** to object 6060h.
3. Enable operation.
4. Start motion by generating a rising edge in bit 4 in object 6040h.

9.13 Active Disable

The Active Disable mechanism provides a means for bringing the motor to a controlled stop when motor power is disabled. Active Disable stops the motor through a controlled ramp down to zero velocity, and then disables the drive.

The CANopen standard has several transitions during which disabling occurs, as indicated by the red circles in the following diagram.

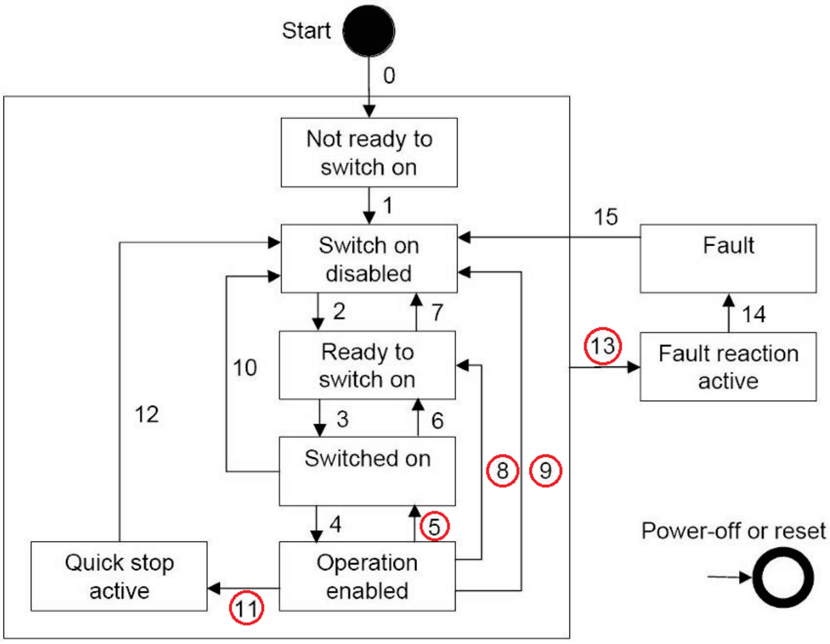


Figure 9-2. Power Drive System State

Depending on the transition during which disabling occurs, you need to configure how deceleration will be executed.

Each transition has a dedicated object (605Ah, 605Bh, 605Ch or 605Eh) that defines the profile movement. Setting a specific value for each object determines how the motor will decelerate to a standstill when motor power disable occurs.

The actual method for disabling is in accordance with object 6060h.

Quick Stop procedure (object 605Ah) – Transition 11

Value	CANopen Definition	Result
0	Disable drive function	Disable drive function before initiating full stop. Disable motor power immediately.
1	Slow down on slow down ramp and transition to Switch On Disabled	Deceleration according to profile deceleration (object 6084h)
2	Slow down on quick stop ramp and transition to Switch On Disabled	Deceleration according to quick stop deceleration (object 6085h)

Value	CANopen Definition	Result
3	Slow down on current limit and transition to Switch On Disabled	Deceleration according to maximum deceleration (130,000 rpm/100s)
4	Slow down on voltage limit and transition to Switch On Disabled	Deceleration according to maximum deceleration (130,000 rpm/100s)

Shutdown procedure (object 605Bh) – Transitions 2, 6, 8, 9

Value	CANopen Definition	Result
-1		Decelerating according to quick stop deceleration (object 6085h)
0	Disable drive function (switch off the drive power stage)	Disable drive function before initiating full stop. Disable motor power immediately
1	Slow down with slow down ramp; disable of the drive function	Decelerating according to profile deceleration (object 6084h)

Disable Operation procedure (object 605Ch) – Transition 5

Value	CANopen Definition	Result
-1		Decelerating according to quick stop deceleration (object 6085h)
0	Disable drive function (switch off the drive power stage)	Disable drive function before initiating full stop. Disable motor power immediately
1	Slow down with slow down ramp; disable of the drive function	Decelerating according to profile deceleration (object 6084h)

Fault Reaction procedure (object 605Eh) – transition 13

Value	CANopen Definition	Result
0	Disable drive function, motor is free to rotate	Disable drive function before initiating full stop. Disable motor power immediately.
1	Slow down on slow down ramp	Deceleration according to profile deceleration (object 6084h)
2	Slow down on quick stop ramp	Deceleration according to quick stop deceleration (object 6085h)
3	Slow down on current limit	Deceleration according to maximum deceleration (130,000 rpm/100 s)
4	Slow down on voltage limit	Deceleration according to maximum deceleration (130,000 rpm/100 s)

Active Disable is defined by object 2FF2h and its two sub-indexes.

- 2FF2h, sub-index 1 – **Zero Speed**

  This sub-index defines the velocity range in which the motor is considered to be at a standstill. Default value is 100 rpm/100.

- 2FF2h, sub-index 2 – **Total Disable Time**

  This sub-index defines the time frame during which the entire action must occur. The time frame is from the moment a disable motor power command is issued until the motor is at a standstill and the power is disabled. Default value is 0, meaning the drive will calculate the time.

  If the duration of Total Disable Time is too short to perform the stop (velocity within the given range), the drive will become disabled and will initiate a fault (object FF01h).

9.13.1 Exceptions to Active Disable

Faults Requiring Immediate Disable

Faults that require immediate disable (to prevent drive damage) and feedback faults that might cause a commutation error (runaway motor condition) cannot trigger the Active Disable mechanism.

The following faults will cause the drive to disable motor power immediately.

- Over-voltage (error code 3110h)
- Over-current (error code 2214h)
- Power stage fault (error code FF04h)
- Power stage over-temperature (error code FF0Ah)
- Encoder failure (error code FF05h)
- Gate drive voltage failure (error code FF06h)

Torque Operation Modes

In Profile Torque operation mode (4) and in Analog Torque operation mode (-3), the deceleration objects are not used.

In these modes, if object 2FF2h sub-index 2 (total disable time) is set to 0, the drive will automatically become disabled after 3000 ms, and then come to a complete stop.

If a motor brake exists, it will lock as soon as the total disable time elapses, and the drive will then become disabled.

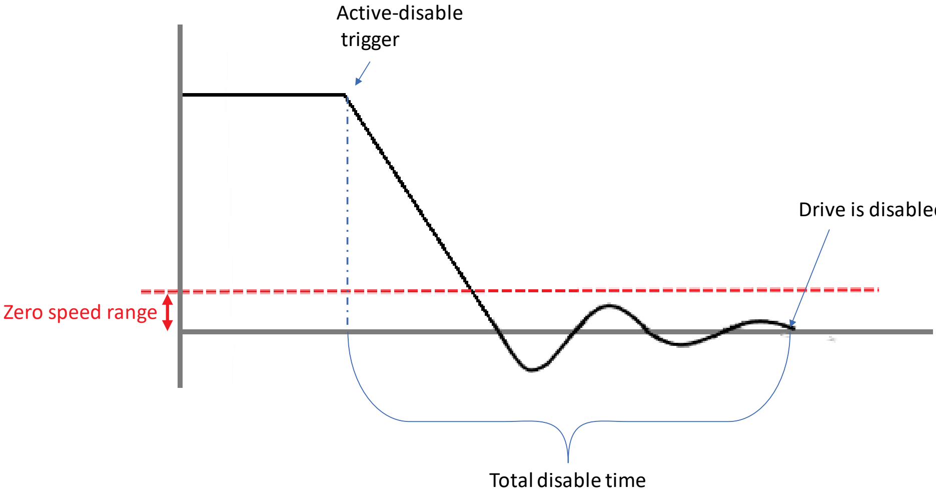


Figure 9-3. Active Disable without Brake

9.14 Motor Brake

In stepIM models equipped with a mechanical brake, a digital output is internally configured, and dedicated, for brake control.

The brake needs to be connected (through the auxiliary connector) to a 24 VDC power supply that is separate from the stepIM power supply. Brake consumption for NEMA 23 models is 0.5A, and for NEMA 34 models it is 1A.

In addition to the wiring connections, the brake (digital output) must be defined. Use either ServoStudio 2 or your controller to set object 209Ch, as follows:

- In CANopen models set object 209Ch index 1 to value 12.
- In NEMA 23 EtherCAT models set object 209Ch index 2 to value 12.
- In NEMA 34 EtherCAT models, it is not necessary to configure the brake (digital output) because these models have a dedicated brake output that is configured internally.

After configuration for brake control, turning on the designated digital output releases the brake, and allows the motor shaft to rotate.

For more information, refer to the section *Wiring Guidelines – Motor Brake*.

When a digital output is configured as a mechanical brake, the value of objects 605Ah, 605Bh, 605Ch, 605Eh cannot be 0; this means the drive must go through active disabling.

If any one of objects 605Ah, 605Bh, 605Ch or 605Eh has a value of 0 (disable motor power immediately), a digital output cannot be configured as a mechanical brake.

Brake control is defined by object 2FF1h and its two sub-indexes.

- 2FF1h, sub-index 1 – **Brake Engage Time**

  This sub-index configures the time it takes for the brake to engage. Once the motor is at a standstill, the drive signals the brake output and waits this time before disabling the motor power. Default time is 50 ms.

  If the duration of the total disable time (object 2FF2 sub-index 2) is too short, the drive will become disabled and the brake will lock, and the drive will then initiate a fault (FF01h).

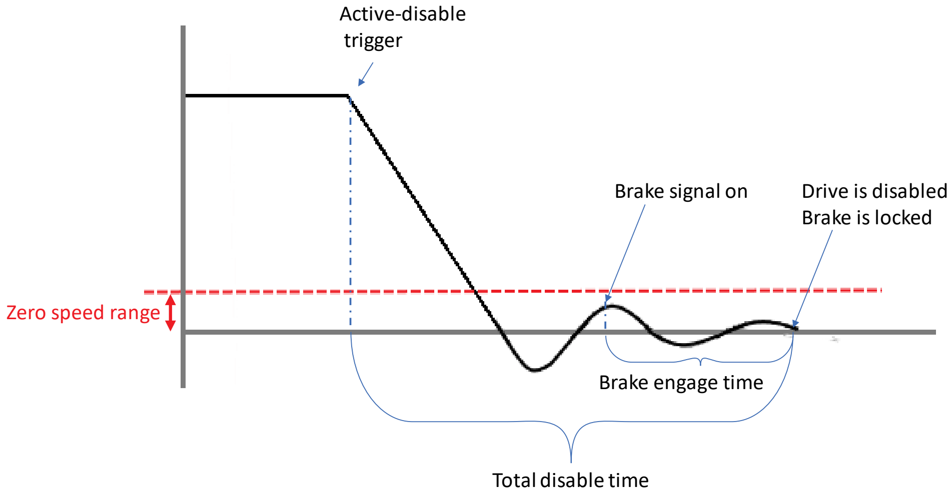


Figure 9-4. Active Disable with Brake

- 2FF1h, sub-index 2 – **Brake Disengage Time**

  This sub-index configures the time it takes to release the motor brake and start motion after an enable command is issued. Default time is 50 ms.

  Once the brake disengage time has elapsed, the drive will signal the brake to unlock and will enable power to the motor. The drive will then become enabled and accept motion commands.

10 I/O Operation

10.1 Digital Input Modes

Object 20E0h is used to set the functionality of the stepIM digital inputs, such as start, execute, and stop pre-defined motions. Object 20E0h has four sub-indices that are used to define the functionality of the stepIM digital inputs:

- Sub-index 1 = Functionality of digital input 1
- Sub-index 2 = Functionality of digital input 2
- Sub-index 3 = Functionality of digital input 3
- Sub-index 4 = Functionality of digital input 4

The state (on/off) of each digital input can be read in object 60FDh.

Digital input functionality modes are listed in the table below.

Mode	Functionality
0	Disabled
1	General
2	Home Switch
3	Positive Limit Switch
4	Negative Limit Switch
5	Remote Enable
6	Start Motion (Profile Position operation mode)
7	Touch Probe 1
8	Touch Probe 2
9	Motion Segment 0
10	Motion Segment 1
11	Motion Segment 2
12	Motion Segment 3
13	Motion Start (Scripted Motion operation mode)
14	Motion Stop
15	Emergency Run (enable drive in Analog Velocity operation mode and allow motion)
16	Homing Command

10.2 Homing Triggered by Digital Input

Object 20E0h can be used to define one of the digital inputs as a homing command trigger.

Switching on the input results in the following:

1. The drive switches to Homing operation mode and becomes enabled.
2. The drive issues the homing command according to the defined homing mode.
3. When homing completed, the input must be switched off (by user/master controller).
4. The drive reverts to the operation mode that was in effect prior to the homing trigger.

10.3 Motion Triggered by Digital Inputs

Objects 2F90h–2F99h are used to configure motion segments. Object 2F90h is motion segment 0, object 2F91h is motion segment 1, and so forth. Refer to the section *Scripted Motion Operation Mode*.

Motion segments (objects 2F90h–2F99h) can be defined as digital inputs (modes 9–12 for object20E0h. Refer to the section *Digital Input Modes*.

Each motion segment has sub-indices that refer to the properties of the motion segment, such as target position, velocity, acceleration, and so on.

Object 2FC8h toggles the functionality of digital inputs as motion triggers.

10.3.1 Input Triggers Scripted Motion

If the value of **object 2FC8h=1** (input triggers motion), each of the four stepIM digital inputs can trigger one predefined (scripted) motion segment (0, 1, 2 or 3).

A rising edge on an input causes the stepIM to attempt to enable the motor and execute the motion segment.

- A rising edge on digital input 1 triggers execution of motion segment 0, as defined in object 2F90h.
- A rising edge on digital input 2 triggers execution of motion segment 1, as defined in object 2F91h.
- A rising edge on digital input 3 triggers execution of motion segment 2, as defined in object 2F92h.
- A rising edge on digital input 4 triggers execution of motion segment 3, as defined in object 2F93h.

Digital inputs can serve as motion triggers when the stepIM is operating in Profile Position, Profile Velocity or Scripted Motion modes. Depending on the operation mode in effect, the various parameters defined by the sub-indices will be applied to the motion segments, as shown in the table below.

		Operation Modes (object 6060h)		
Objects 2F90h–2F99h Sub-index	**Description**	**Profile Position 6060h=1**	**Profile Velocity 6060h=2**	**Scripted Motion 6060h=-5**
Sub-index 1	Target position	Y	N	Y
Sub-index 2	Cruise velocity	Y	Y	Y
Sub-index 3	Acceleration	Y	Y	Y
Sub-index 4	Deceleration	Y	Y	Y
Sub-index 5	Controlword	Y	N	Y
Sub-index 6	Delay	N	N	Y
Sub-index 7	Number of iterations	N	N	Y
Sub-index 8	Next segment index	N	N	Y

When operating in Scripted Motion operation mode (-5), sub-index 7 (number of iterations) must be set. If set to a value of 1, the motion segment will occur only once. To repeat the segment, set the value of sub-index 7 to the number of required iterations.

When operating in Profile Position and Scripted Motion modes, the cruise velocity value (sub-index 2 in objects 2F90h—2F99h) must be positive.

When operating in Profile Velocity mode, the cruise velocity value can be positive, negative or zero for stopping the motion.

10.3.2 Binary Value of Inputs Triggers Scripted Motion

If the value of **object 2FC8h=0** (input binary value triggers motion), the binary value of three inputs determines the predefined (scripted) motion segment to be executed.

A rising edge on digital input **4** triggers motion (that is, enables and starts motion) according to the combined binary state of inputs 1, 2 and 3.

Up to eight motion segments (0, 1, 2, 3, 4, 5, 6 or 7) can be controlled this way.

Object	Description	Input 3	Input 2	Input 1	
Object 2F90h	Motion Segment 0	0	0	0	all inputs off
Object 2F91h	Motion Segment 1	0	0	1	input 1 on
Object 2F92h	Motion Segment 2	0	1	0	input 2 on
Object 2F93h	Motion Segment 3	0	1	1	inputs 1, 2 on
Object 2F94h	Motion Segment 4	1	0	0	input 3 on
Object 2F95h	Motion Segment 5	1	0	1	inputs 1, 3 on
Object 2F96h	Motion Segment 6	1	1	0	inputs 2, 3 on
Object 2F97h	Motion Segment 7	1	1	1	inputs 1, 2, 3 on

Note

This table shows input 1 set to Motion Segment 0, input 2 set to Motion Segment 1, and input 3 set to Motion Segment 2. The number of the motion segment that will be triggered is determined by:

Segment number to execute = (*input 3*)x4 + (*input 2*)x2 + (*input 1*)

10.4 Virtual Inputs

Virtual inputs are activated in same way as actual inputs.

Virtual inputs can be useful in situations caused by saturated current, for example, if the motor is blocked by an obstacle or hard stop.

Object	Name	Description
Object 2FC5	Virtual Inputs	Read only. This object indicates the status of the virtual inputs. This object is organized bit-wise. The bits have the following meaning: bit 0: Negative limit switch bit 1: Positive limit switch bit 2: Home switch bit 3: Reserved bit 16-31: Manufacturer-specific The bit values have the following meaning: 0 = Switch is off 1 = Switch is on
Object 2FC6h	Virtual Input Mode	This object defines the function of each virtual input. 0 = Disabled 1 = General 2 = Home switch 3 = Limit switch positive direction 4 = Limit switch negative direction 5 = Remote enable 6 = Start motion command for profiled position operation mode 7 = Touch probe 1 8 = Touch probe 2
Object 2FC7	Virtual Input Setting	This object defines the condition that will activate a virtual input. 0 = Disabled 1 = Current saturated 2 = Current saturated low 3 = Current saturated high

10.5 Digital Output Modes

Object 209Ch is used to set the functionality of the stepIM digital output.

The following modes can be selected.

Mode	Functionality	Description
0	Disabled	
1	Motor Speed Set	Output is ON when: Velocity Actual Value (object 606Ch) > Velocity Level 2 for Digital Output Definition (object 20A0h)
2	Current	Output is ON when: Current Actual Value (object 6078h) > Current Level 2 for Digital Output Definition (object 209Ah)
3	Reserved	
4	Motor Speed Set Clear	Output is ON when: Velocity Actual Value (object 606Ch) < Velocity Level 1 for Digital Output Definition (object 209Fh) **AND** Velocity Actual Value (object 606Ch) > Velocity Level 2 for Digital Output Definition (object 20A0h)
5	Over-Voltage (for regeneration resistor)	Output is ON when: DC Link Circuit Voltage (object 6079h) > Voltage Level for Digital Output Definition (object 2F85h) This condition has hysteresis of ±500 millivolt
6	Motion Completed	Position In Window (20B5)
7	In Position	Output is ON when: Position Actual Value (6063h) < Position Window (object 6067h) **AND** Position Actual Value (6063h) > The negative value of Position Window (object 6067h)
8	Zero Speed	Output is ON when: Velocity Actual Value (object 606Ch) < Velocity Level 2 for Digital Output Definition (object 20A0h) **AND** Velocity Actual Value (object 606Ch) > -Velocity Level 2 for Digital Output Definition (object 20A0h)

Mode	Functionality	Description
9	Software Position Limit Switch	Output is ON when: Position Actual Value (object 6063h) > Position Level 1 for Digital Output Definition (object 209Dh) **OR** Position Actual Value (object 6063h) < Position Level 2 for Digital Output Definition (object 209Eh)
10	Active	Output is ON when: Operation Enabled bit of Statusword is ON.
11	Reserved	
12	Brake	When output is ON: Brake is released.
13	Set by object 60FE	Set by user in object 60FEh

10.6 Motion Controlled by Analog Output

Refer to the section *Analog Torque Operation Mode*.

Refer to the section *Analog Velocity Operation Mode*.

11 Recorder

11.1 General

The stepIM has an integral recorder that enables recording of up to four different objects at run time.

The recorder can start the recording on command, by fault or by evaluation of a condition.

11.2 Programming the Recorder

1. The recorder can record up to four different channels.
2. Write the values of the CANopen indices to record in sub-indices 2 to 5 of object 2F10h (Recorder Channels).
3. A list of all objects that can be recorded is held in object 2F14h (recordable parameters).
4. Set the number of points that will be recorded per channel in object 2F15h. This value must not exceed the maximum number of available points divided by the number of channels.
5. Set the sample time of the recorder in object 2F11h (recorder sample cycle). This value determines the frequency of the recording in multiples of 62.5 µs.

11.3 Triggering the Recorder

The recorder has three trigger types (object 2F12h, sub-index 1: recorder trigger):

- **Immediate**. The recording will start as soon as the recorder has started (object 2F16h: recorder start).
- **By condition object.** The recording will start as soon as the recorder has started (object 2F16h: recorder start) and the condition has been met. The condition consists of three elements:
    - Condition object (object 2F12h, sub-index 2: recorder condition channel index): the object index of the inspected condition.
    - Condition value (object 2F12h, sub-index 3: recorder condition value): the value that must be passed by the condition object in order to trigger the recorder.
    - Condition comparator (object 2F12h, sub-index 4: recorder condition comparator): the passing direction of the value (rising edge or falling edge).
- **By fault.** The recording will start as soon as the recorder has started (object 2F16h: recorder start) and a fault has occurred. The trigger consists of 1 element:

- Buffer location (object 2F12h, sub-index 5): the position of the trigger in the recorder results buffer (i.e., all points preceding this value were recorded before the condition occurred).

11.4 Starting the Recorder

To start the recorder, write 1 to object 2F16h (Recorder Start).

Writing 0 cancels recording if it is in progress.

11.5 Retrieving the Results

Once the recorder has finished successfully (object 20E6h: record done indicator), the recorder results buffer can be retrieved from object 2F18h (Recorder Results). To retrieve the results:

- Reset the buffer index by writing 1 to object 2F18h, sub-index 1 (reset results index).
- Read object 2F18h sub-index 2 to retrieve each point's value. On each read operation the buffer is automatically advanced to the next point and the next point is retrieved. Repeat reading this object according to the value of 2F13h (Recorder Total Number of Points).

If more than a single channel was recorded, the recorded points are arranged as follows:

<1st channel 1st point>

<2nd channel 1st point>

<3rd channel 1st point>

<1st channel 2nd point>

<2nd channel 2nd point>

<3rd channel 2nd point>

.

.

.

<1st channel last point>

<2nd channel last point>

<3rd channel last point>

12 Working with stepIM and Controllers

This chapter explains how to configure different controllers for communication and operation with the stepIM models.

12.1 Configuring Beckhoff Controller for stepIM – EtherCAT

This chapter/section explains how to configure the Beckhoff controller for communication and operation with the stepIM EtherCAT models.

The application system consists of the following elements:

- stepIM EtherCAT model and ServoStudio 2 software.
- Beckhoff controller with EtherCAT communication module, and TwinCAT software.
-

Notes

Beckhoff controller refers to TwinCAT NC PTP (point-to-point axis positioning software).

TwinCAT NC PTP includes axis positioning software (set value generation, position control), an integrated software PLC with NC interface, operating program for commissioning and an I/O connection to the axes through various fieldbuses. TwinCAT NC PTP replaces conventional positioning modules and NC controllers. The controllers that are simulated by the PC cyclically exchange data with drives and measuring systems via the fieldbus.

Beckhoff controllers are programmed in accordance with the IEC 61131-3 programming standard.

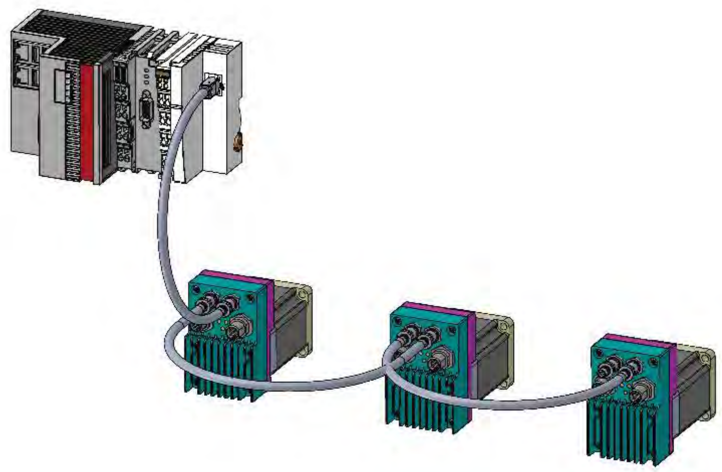


Figure 12-1. Connecting stepIM with Beckhoff Controller

12.1.1 Establishing Communication between Controller and PC

Note The ESI (EtherCAT slave information) XML file for stepIM must reside in the TwinCAT folder, located at: *dir_installation_folder*:\TwinCAT\3.1\Config\Io\EtherCAT

Using TwinCAT software, establish communication between the controller and the PC by performing the following steps.

1. Activate **TwinCAT** software.
2. Select **New TwinCAT Project**.

Figure 12-2.

3. In the **Name** field, enter the name of the project, and click **OK**.

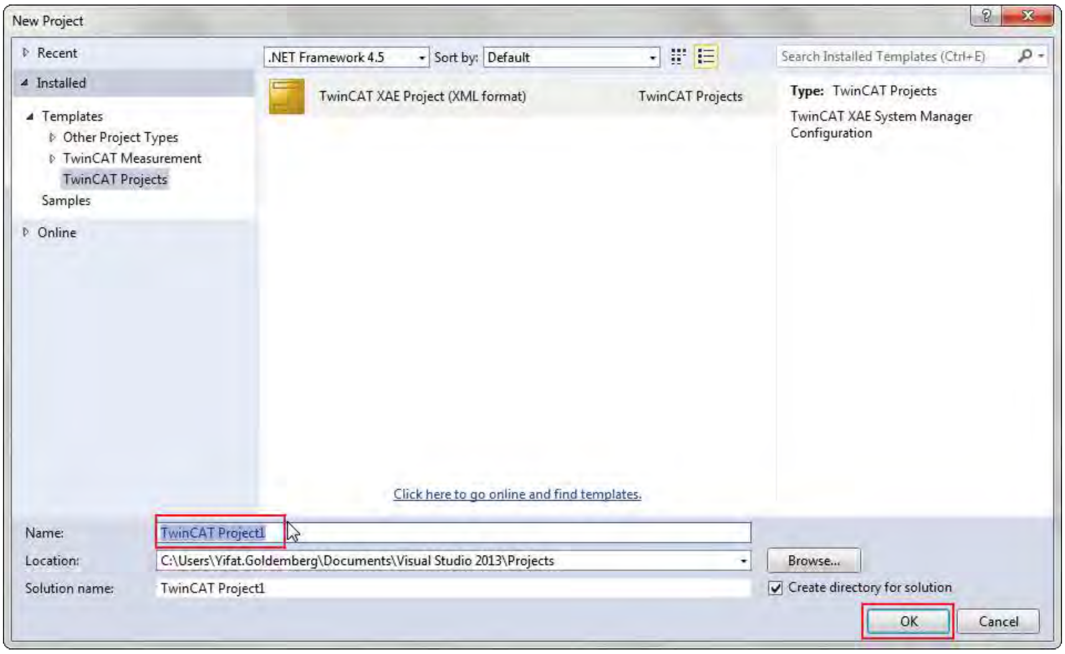


Figure 12-3.

4. In the navigation pane, select **SYSTEM**.

   In the General tab, click **Choose Target**.

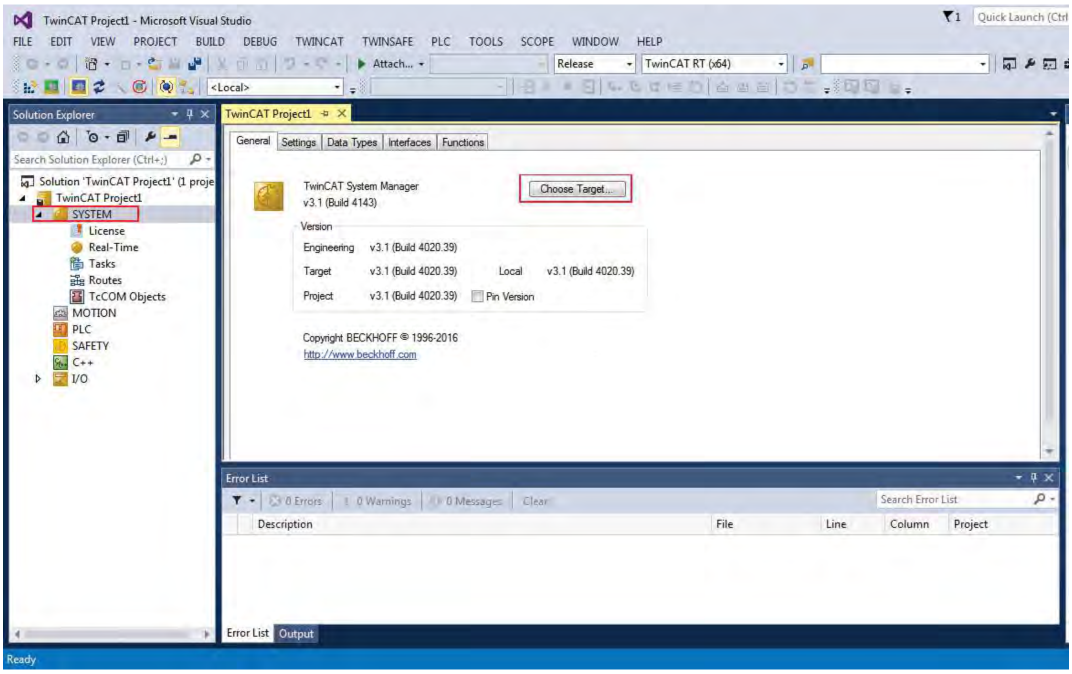


Figure 12-4.

5. The **Choose Target System** dialog box opens.

   Click **Search (Ethernet)** to search for the controller in the network.

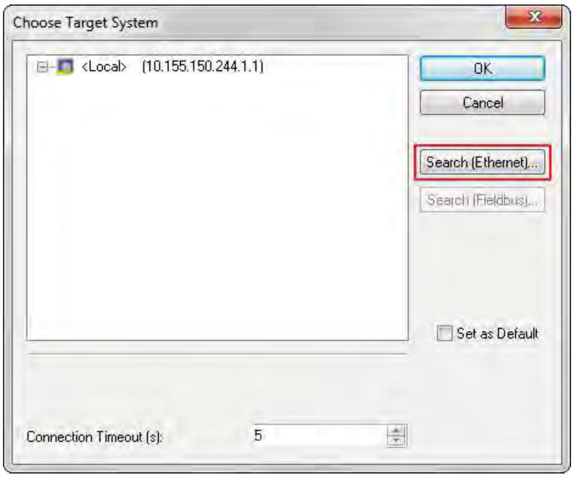


Figure 12-5.

6. The **Add Route** dialog box opens.

   Enable the option **IP Address**, and click **Broadcast Search**.

   Wait for the controller name (in the format CX-xxx) to appear.

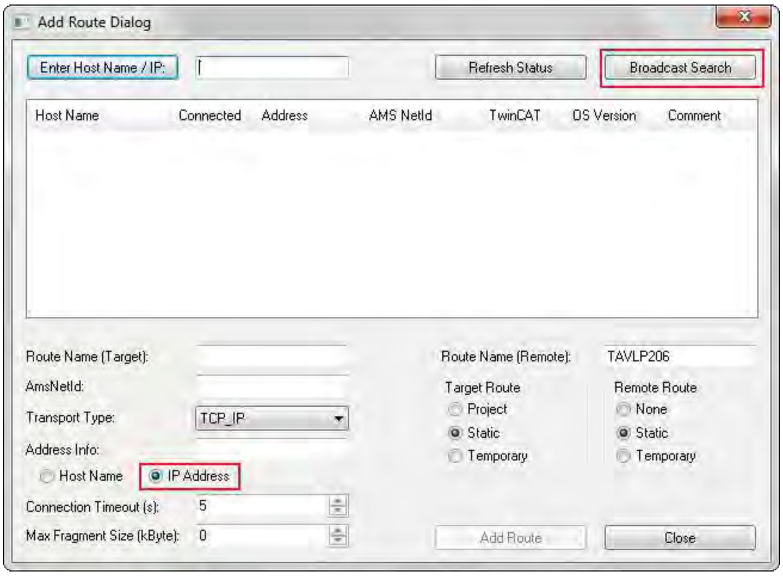


Figure 12-6.

7. When the controller appears, select it. The option **Add Route** becomes active.

   Click **Add Route**.

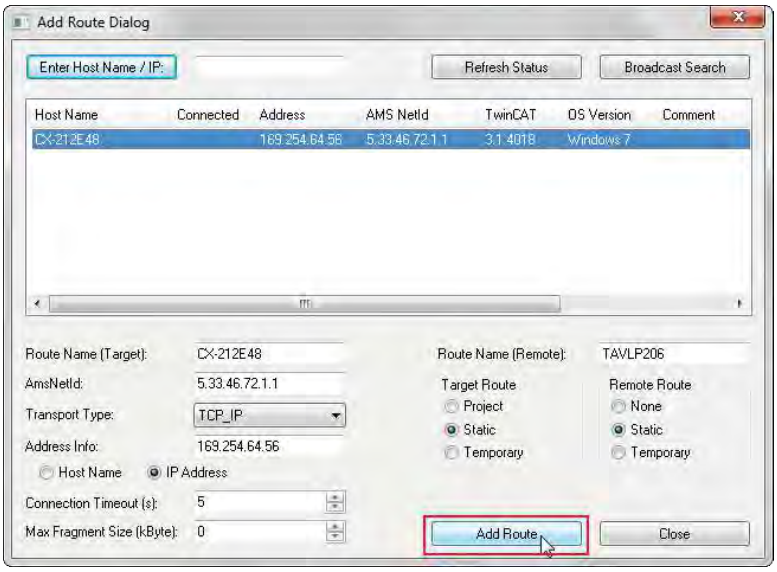


Figure 12-7.

8. The **Logon Information** dialog box opens.

   Enter the following:
   User Name: **Administrator**
   Password: **1**

   Click **OK**.

Figure 12-8.

9. In the **Add Route** dialog box, be sure an **X** appears next to the controller name. This means the controller is properly connected to the PC.

7. **Close** this dialog box.

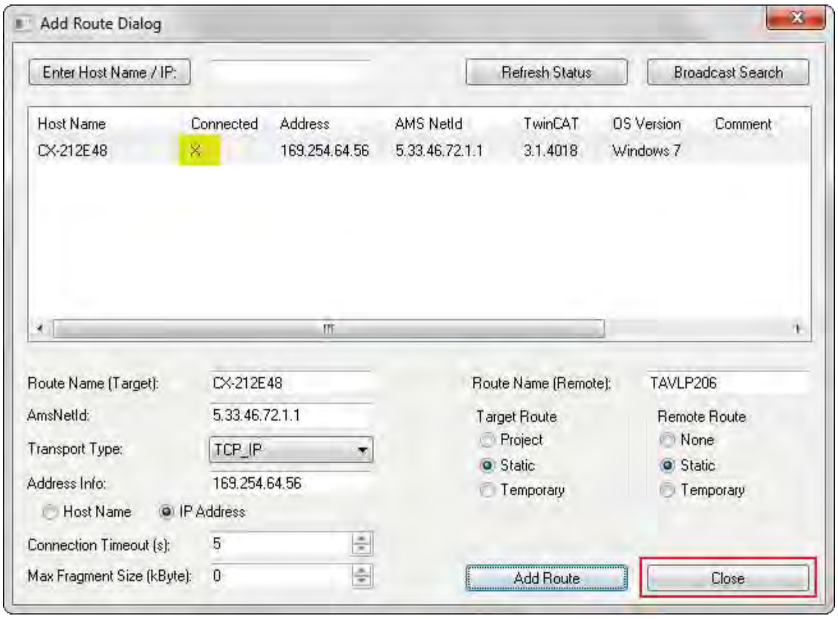


Figure 12-9.

10. In the **Choose Target System** dialog box, click to select the controller, and click **OK**.

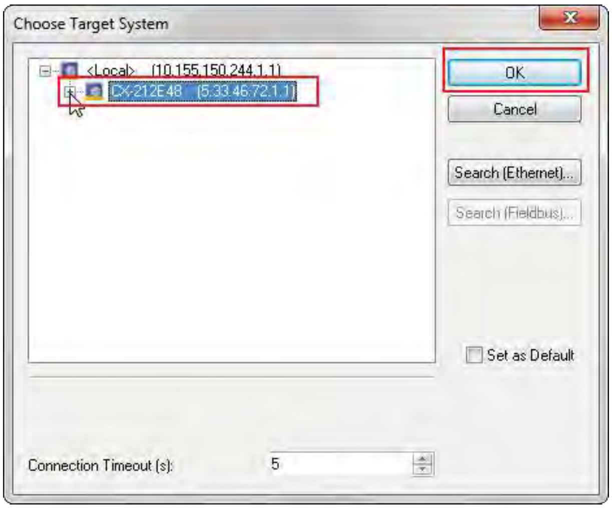


Figure 12-10.

11. At the prompt, click **Yes**.

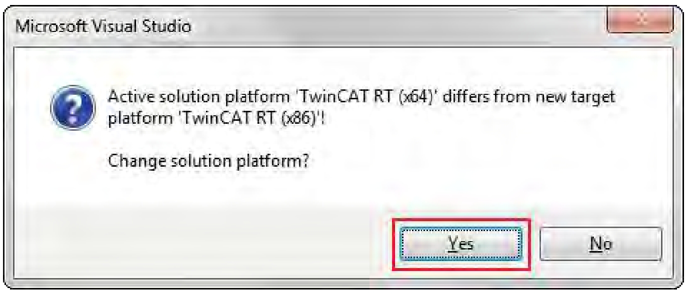


Figure 12-11.

Once the connection is established, the host controller name appears on the screen.

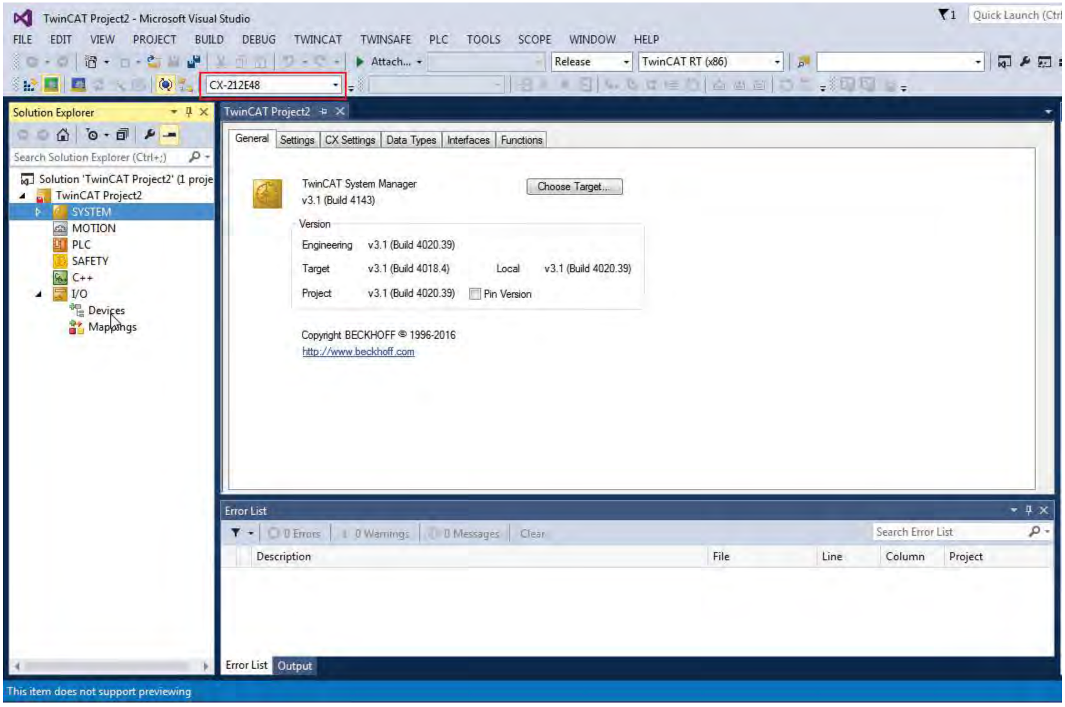


Figure 12-12.

12. Make sure the TwinCAT System Manager is in **Config Mode**.

    When Config Mode is active, the Config Mode button in the toolbar is highlighted.

    Click the **Config Mode** button to activate.

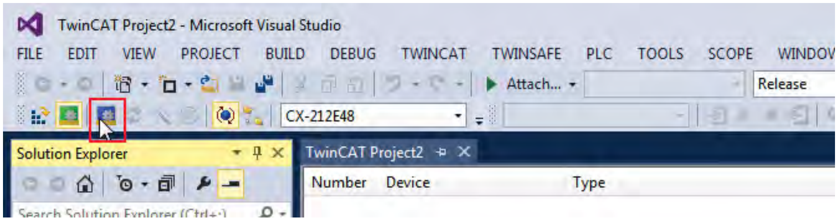


Figure 12-13.

13. At the prompt, click **OK**.

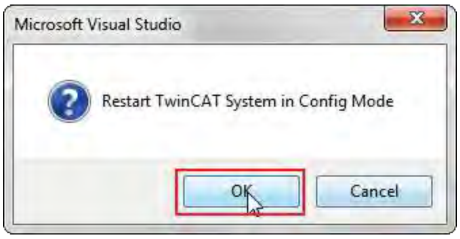


Figure 12-14.

12.1.2 Establishing Communication between Controller and Drive

Using **TwinCAT** software, establish communication between the controller and the drive by performing the following steps:

1. In the navigation pane, expand **I/O**, and then right-click on **I/O Devices**.
2. Select **Scan Devices**.

   At the prompt, click **OK**.

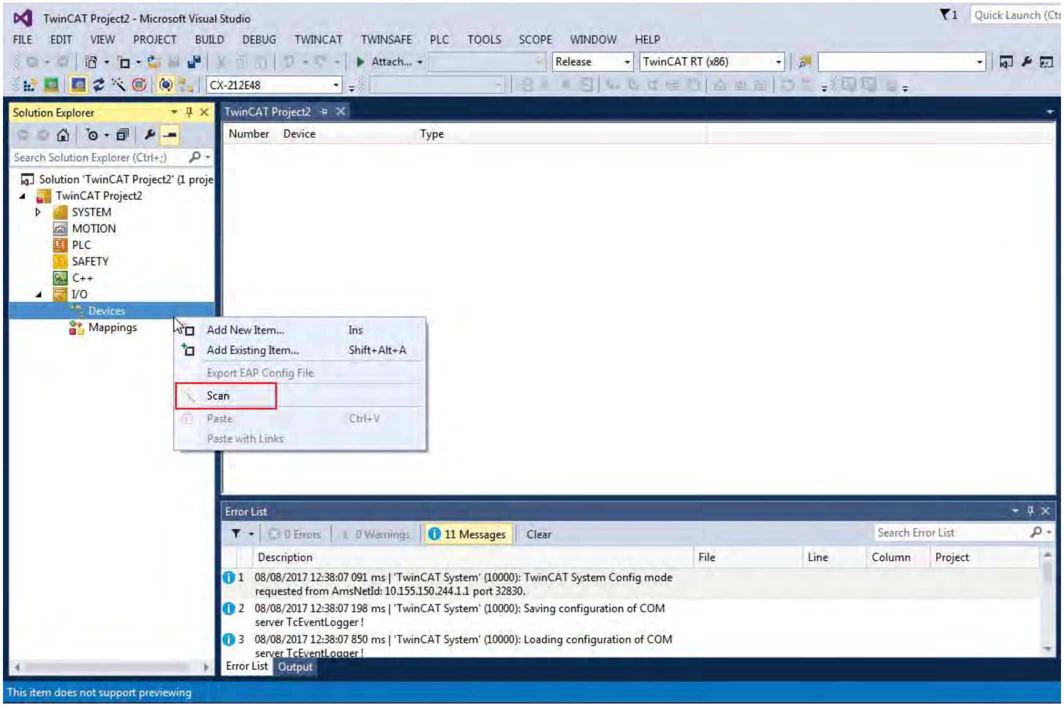


Figure 12-15.

3. After the scanning, detected devices are displayed.

   stepIM is identified as **Device 4 (EtherCAT)**.

   Enable the option **Device 4 (EtherCAT)**, and click **OK**.

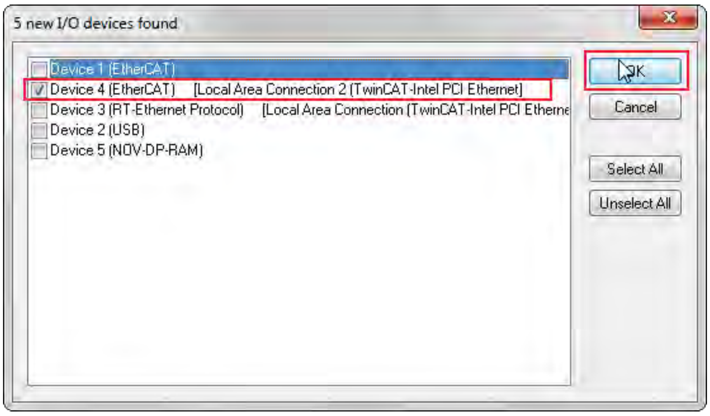


Figure 12-16.

4. At the prompt to scan for boxes (slaves), click **Yes**.

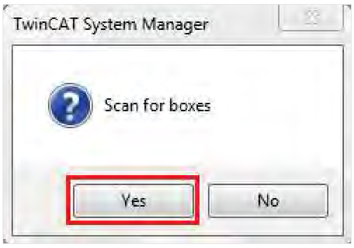


Figure 12-17.

5. At the prompt 'Append the linked axis to', select **NC configuration**. Click **OK**.

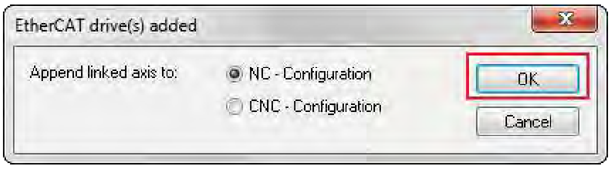


Figure 12-18.

6. At the prompt to activate FreeRun, click **Yes**.

Figure 12-19.

7. At the end of this procedure, **Device 4 (EtherCAT)** is displayed in the navigation pane.

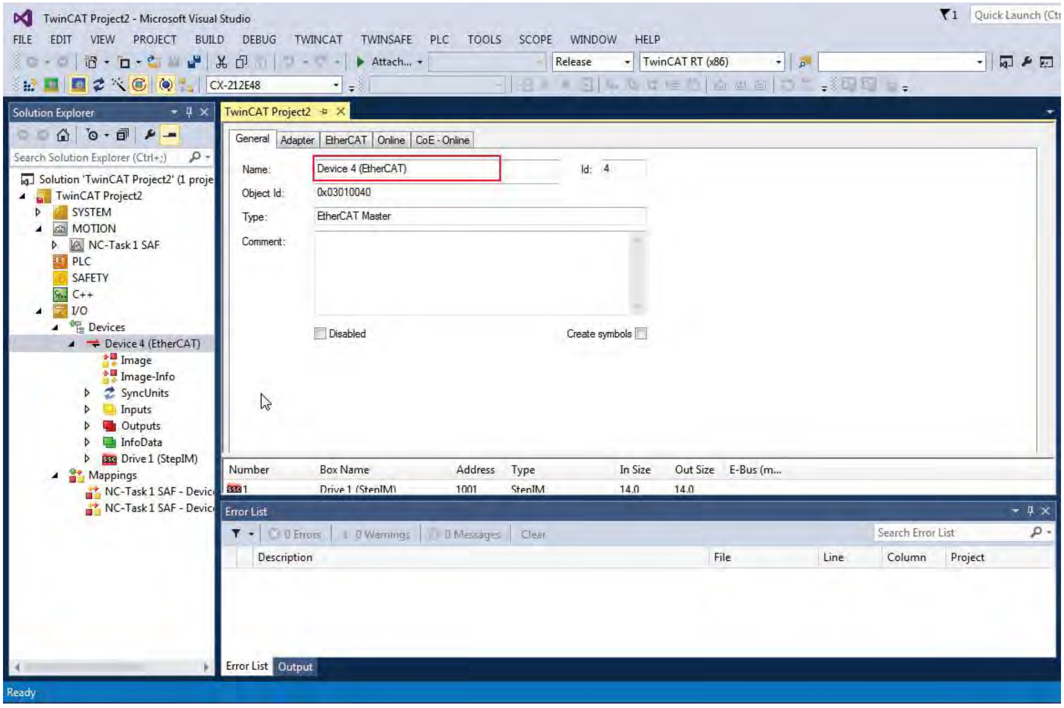


Figure 12-20.

12.1.3 Generating Motion

1. Make sure the TwinCAT System Manager is in **Config Mode**.

Figure 12-21.

2. In the navigation pane, expand **SYSTEM**, and select **Real Time**.

   In the Settings tab, select **Base Time = 1 ms**.

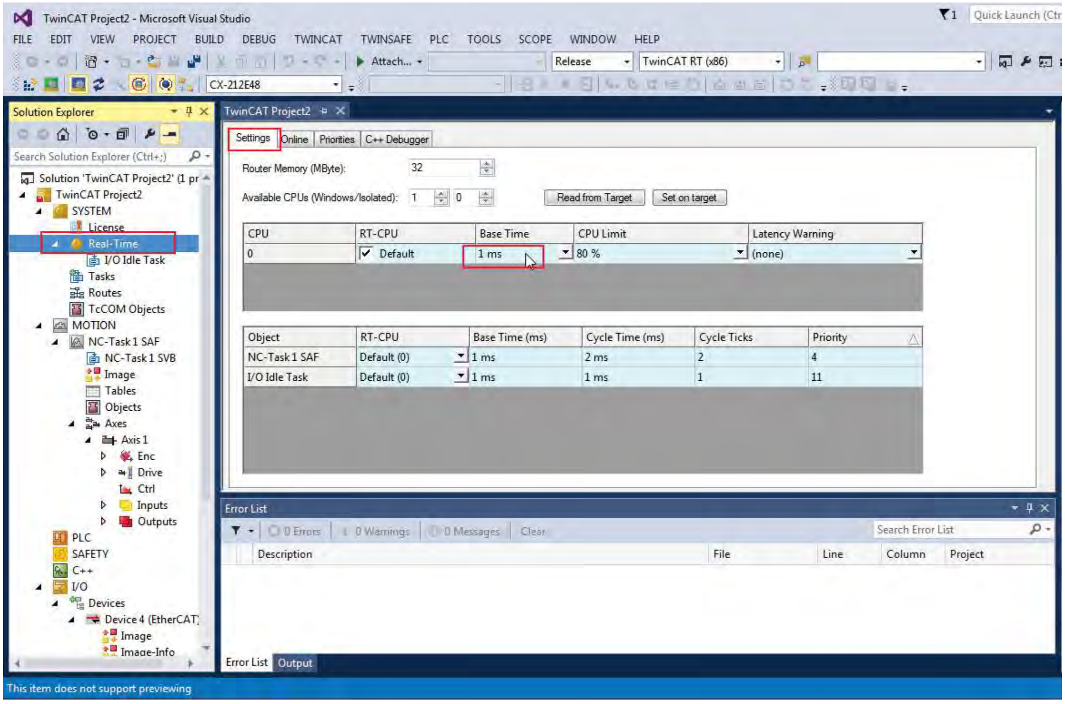


Figure 12-22.

3. In the Priorities tab, enable **Automatic Priority Management**.

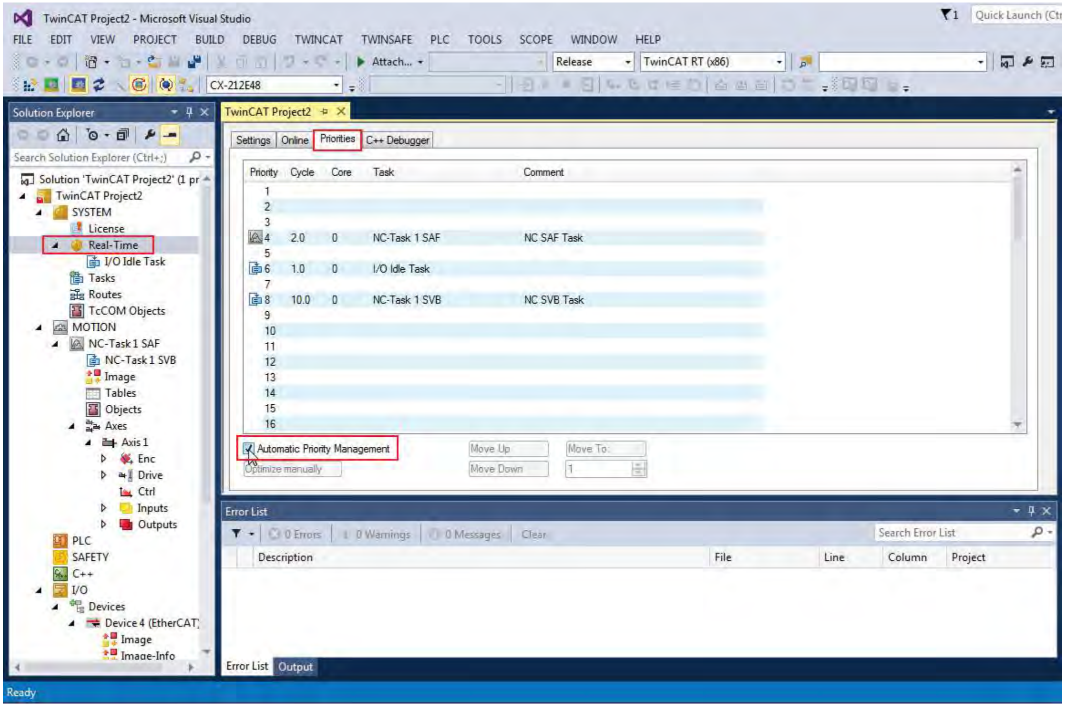


Figure 12-23.

4. In the navigation pane, expand **SYSTEM**, and select **I/O Idle Task**.

   In the **Task** tab, select **Cycle ticks = 1 ms**.

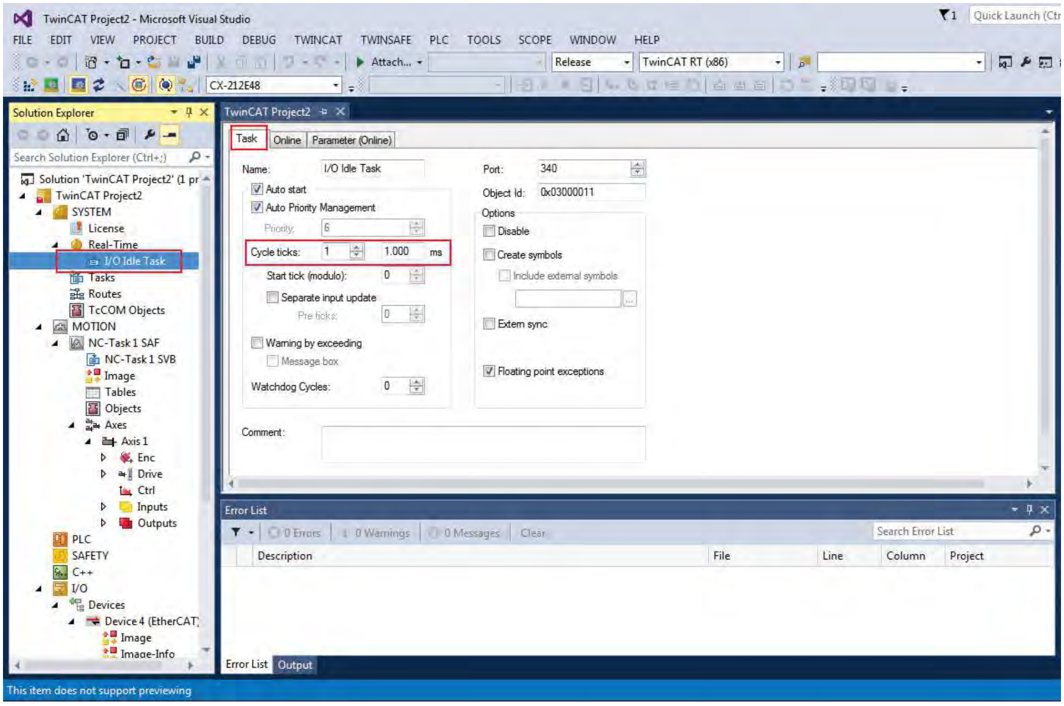


Figure 12-24.

5. In the navigation pane, expand **MOTION** and select **NC-Task1 SAF**.

   In the **Task** tab, select **Cycle ticks = 1 ms**.

   Note that the Priority value = 4. There is no need to change it.

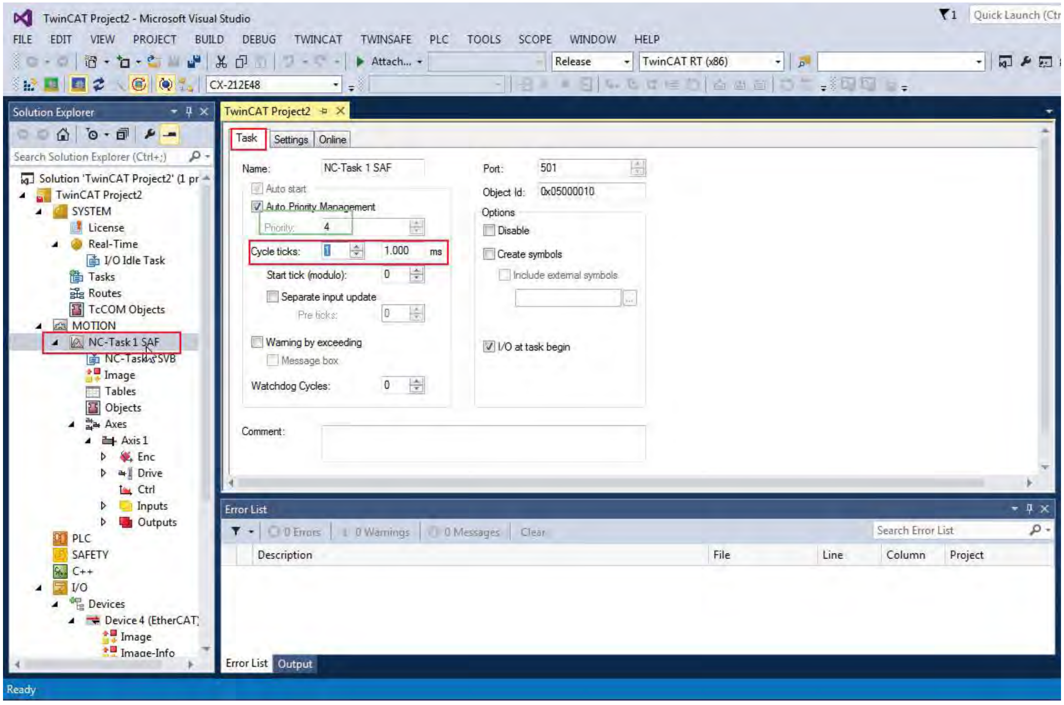


Figure 12-25.

6. In the navigation pane, expand **MOTION** > **NC-Task1 SAF** and select **NCT-Task1 SVB**.

   In the Task tab, select **Cycle ticks = 1 ms**.

   Be sure the priority of NC-Task1 SVB has a higher value than the priority of NC-Task1 SAF.

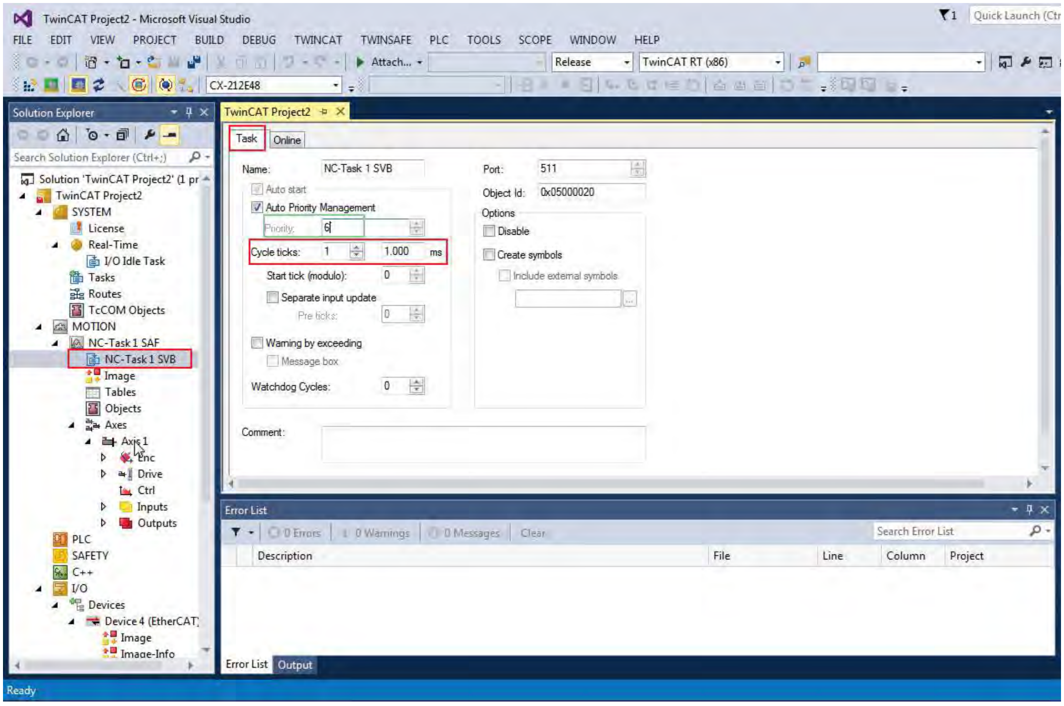


Figure 12-26.

7. In the navigation pane, expand **MOTION** > **NC-Task1 SAF** > **Axes** > **Axis 1** and select **Enc**.

   In the **Parameter** tab, do the following:

   - **Encoder Evaluation** > **Scaling Factor Numerator** = **1.**
   - **Encoder Evaluation** > **Scaling Factor Denominator** = **4096.**

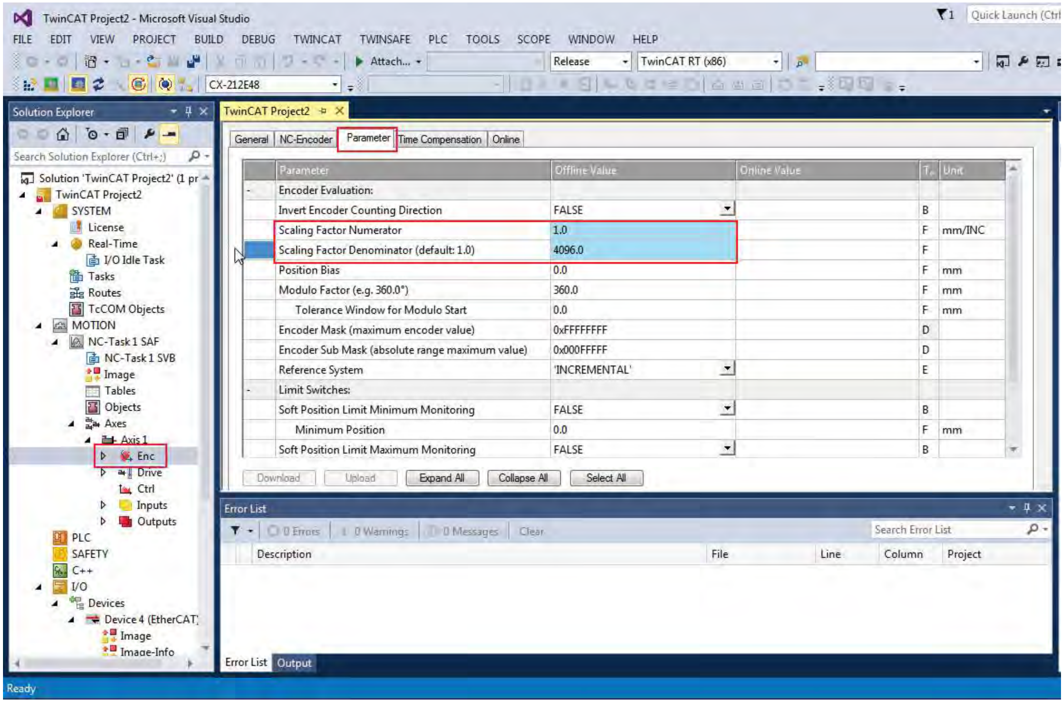


Figure 12-27.

8. In the navigation pane, expand **MOTION** > **NC-Task1 SAF** > **Axes** > **Axis 1** and select **Ctrl**.

   In the Parameter tab, select **Monitoring** > **Position Lag Monitoring** = **FALSE.**

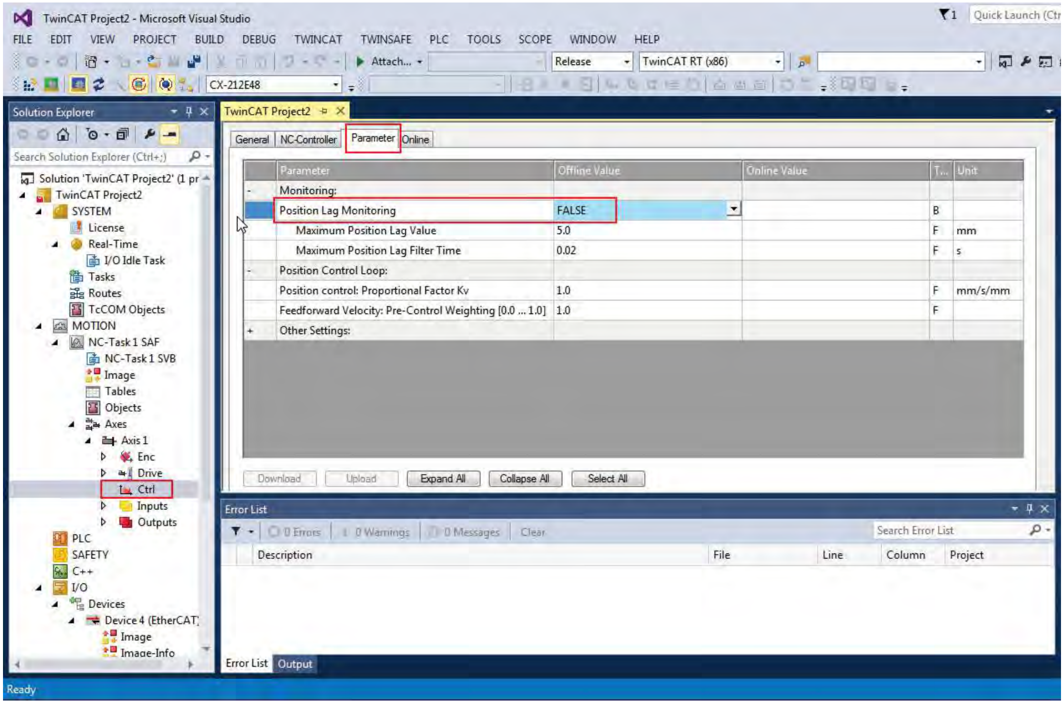


Figure 12-28.

9. In the navigation pane, expand **I/O** > **Devices** > **Device 4 (EtherCAT)**, and select **Drive 1 (**stepIM**).**

   In the DC tab, select **Operation Mode** = **DC-Synchronous**.

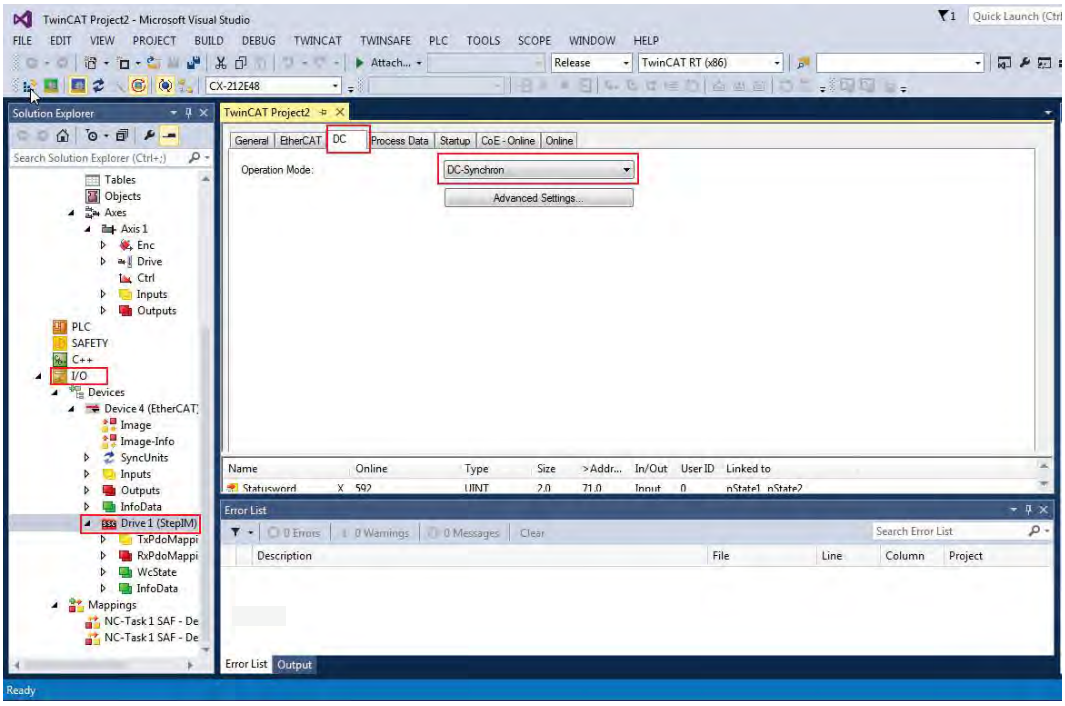


Figure 12-29.

10. Click the **Activate Configuration** button in the toolbar.

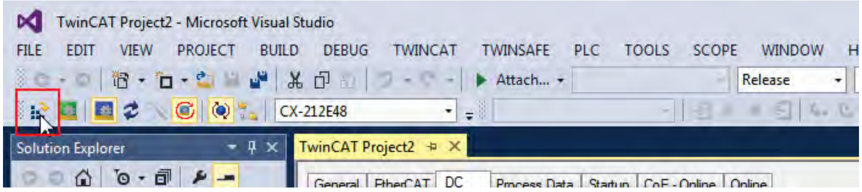


Figure 12-30.

11. At the prompt to Activate Configuration, click **OK**.

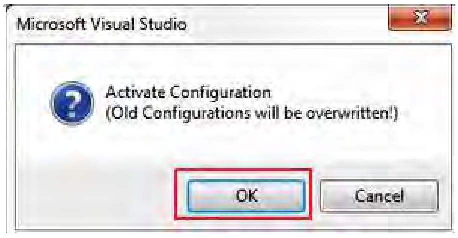


Figure 12-31.

12. At the prompt to restart TwinCAT in Run Mode, click **OK**.

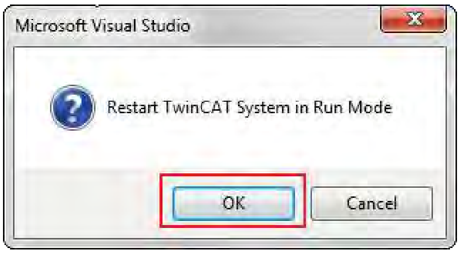


Figure 12-32.

13. Open the **Online** tab.

    The **Online** tab shows the PDO objects that the drive manages.

    Make sure the value of Mode of Operation (object 6060h) = **8**

    The drive is set to Cyclic Synchronous Position mode (opmode 8) through object 6060h.

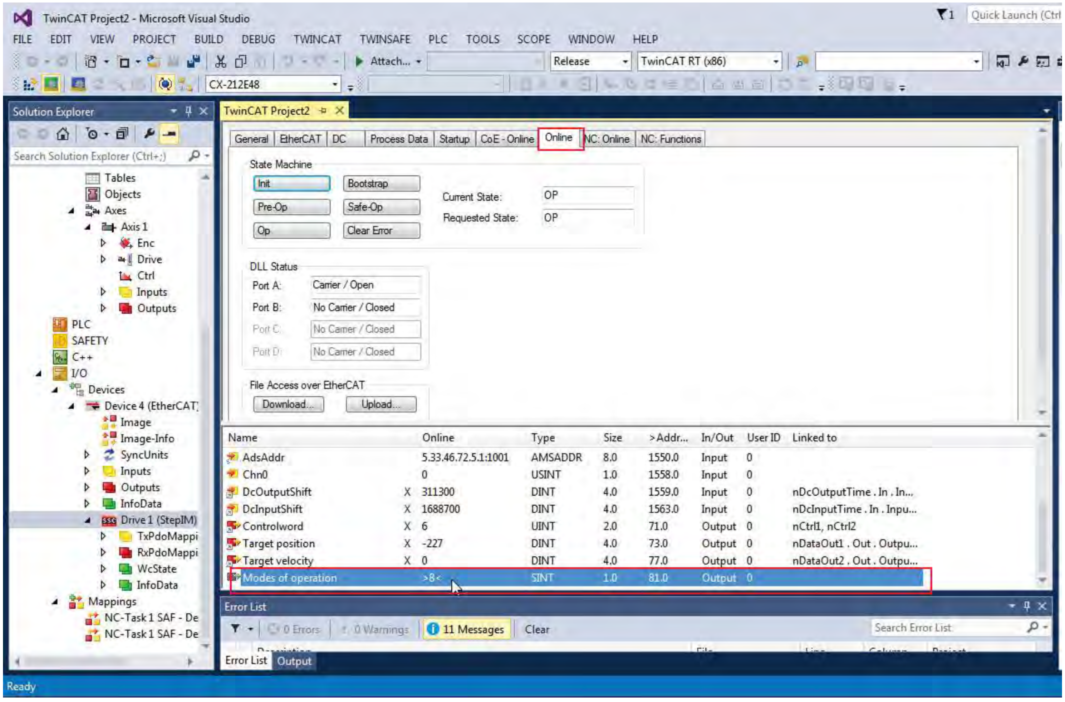


Figure 12-33.

14. Open the **CoE-Online** tab.

    The **CoE Online** tab shows the SDO objects that the drive manages.

    Make sure the value of **Interpolation Time Period** (object **60C2h**) is as follows:

    Sub-index 01 **(60C2:01) = 1**

    Sub-index 02 **(60C2:02) = -3**

    The interpolation time for the Cyclic Synchronous operation modes is set through object 60C2h (sub-index 01 and sub-index 02).

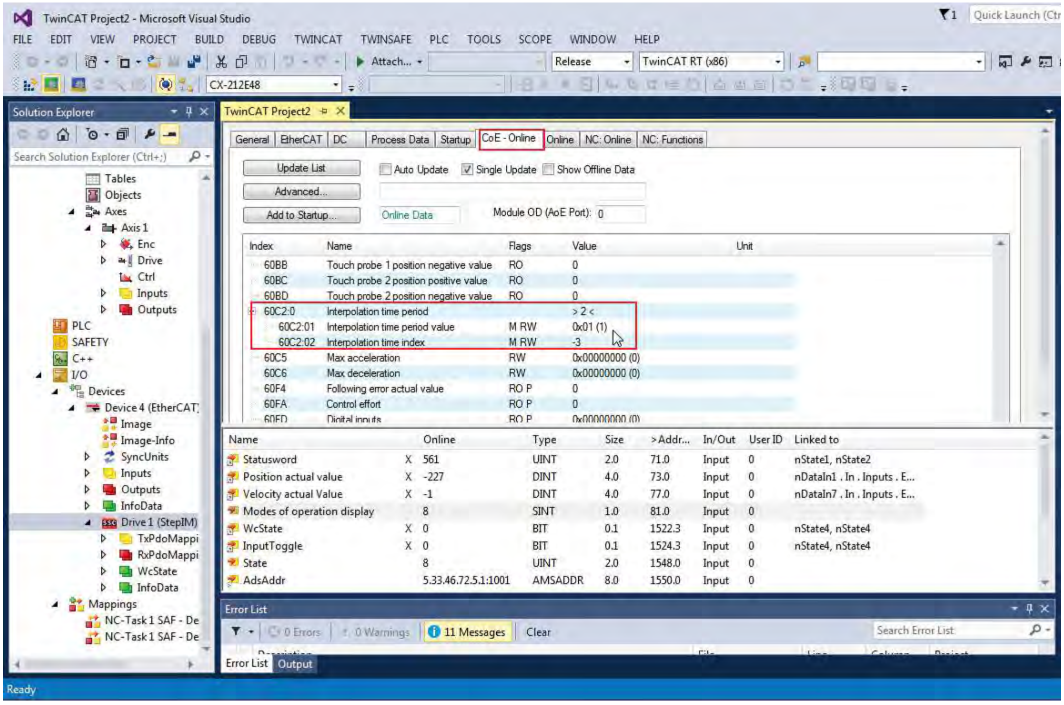


Figure 12-34.

Note The interpolation time must be configured with the same value of cycle ticks as configured in I/O Idle Task, in NC-Task 1 SAF, and in NC-Task 1 SVB.

15. Click the **Activate Configuration** button in the toolbar to activate **Run Mode.**

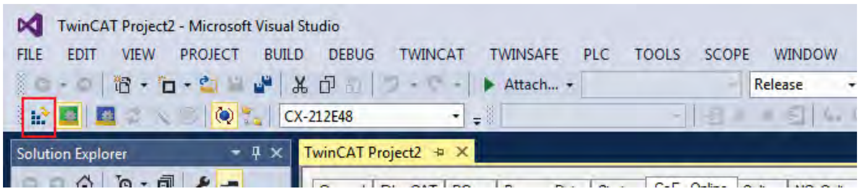


Figure 12-35.

While in Run mode, motion can be generated. The NC PTP communicates with the drive and receives all the values of the variables contained in each of the PDO objects (which were automatically mapped by the controller).

16. In the **NC-Online** tab, test communication with the drive:

Take hold of the motor shaft, and turn it manually; check whether the position feedback value changes.

Refer to the following figure, which shows the various functions.

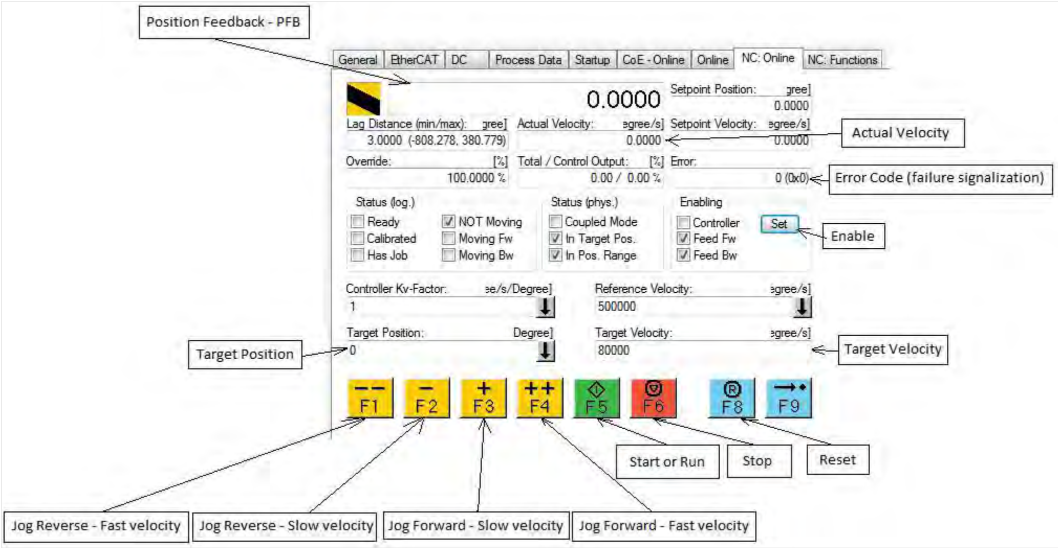


Figure 12-36.

Generating Motion in Cyclic Synchronous Position Mode

The following steps demonstrate how to generate a motion in Cyclic Synchronous Position mode.

In the **NC: Online** tab you will send a target position with a velocity to the drive. The controller will execute a motion profile.

1. Enable the drive:

   a. In the **NC: Online** tab, click **Set**.

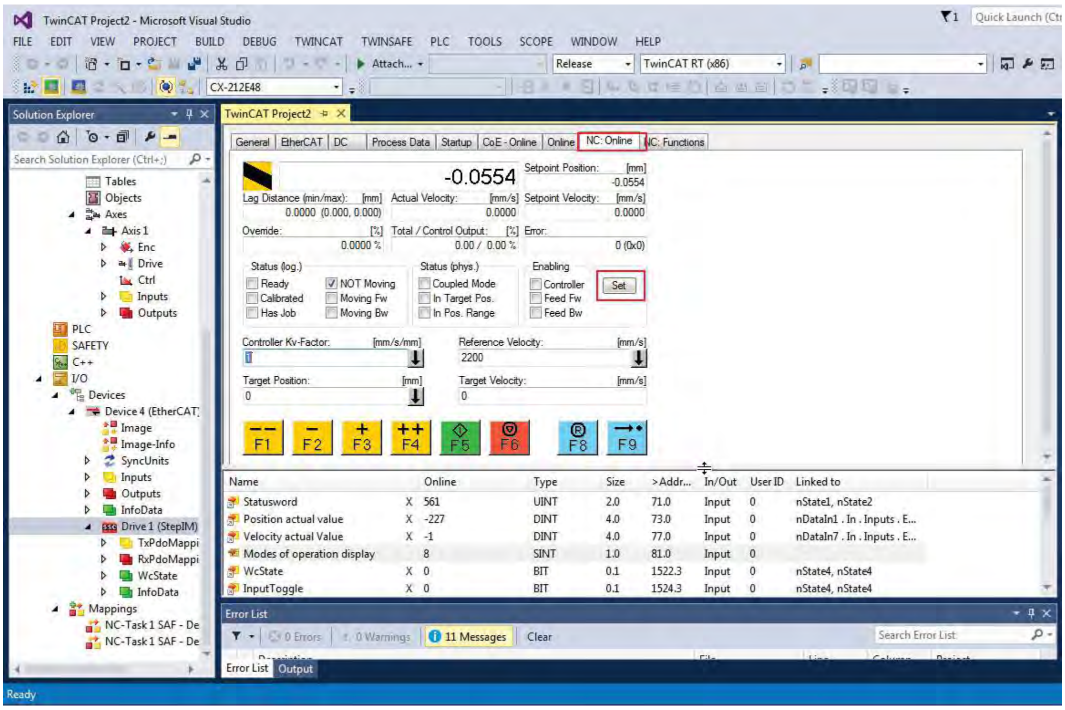


Figure 12-37.

   b. Enable the options: **Controller**, **Feed Fw** and **Feed Bw**, or select **All**

c. Click **OK**

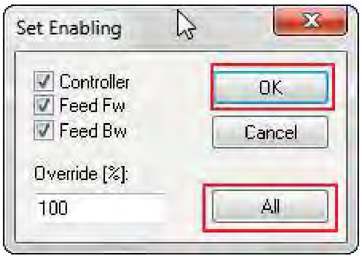


Figure 12-38.

Note	To disable the drive: NC-Online Screen > **Enabling** > Clear the option **Controller**; then click **OK.**

2. In **the NC: Online** tab, use the motion buttons – F1, F2, F3 and F4 – to generate the motion profiles:

   F1: Sends a jog command in the negative direction (CCW) with a fast velocity.

   F2: Sends a jog command in the negative direction (CCW) with slow velocity.

   F3: Sends a jog command in the positive direction (CW) with slow velocity.

   F4: Sends a jog command in the positive direction (CW) with fast velocity.

3. Configure the velocity in the controller.

   In the navigation pane, select **Motion** > **NC-Task1 SAF** > **Axes** > **Axis1**

   Then select **Parameters** > **Manual Velocity** (Slow and Fast).

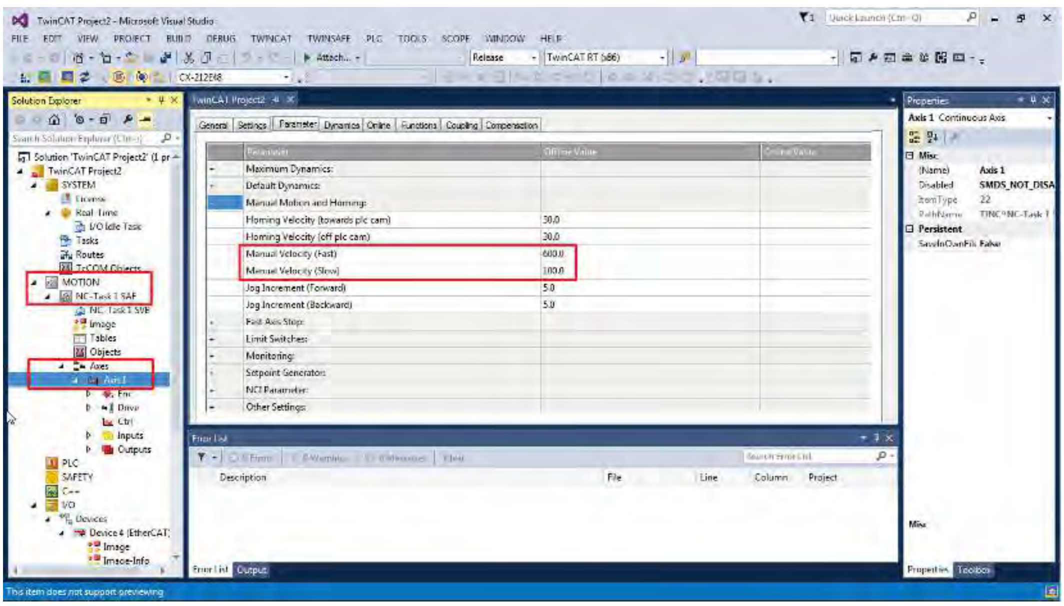


Figure 12-39.

4. Set values for **Target Position** and **Target Velocity**.

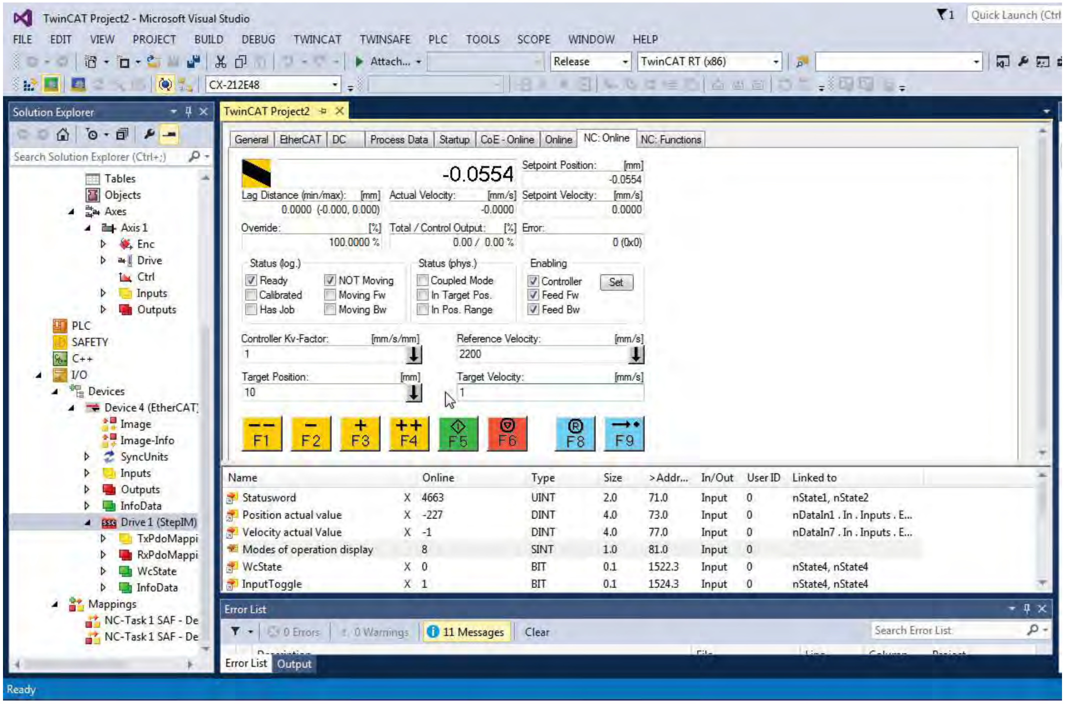


Figure 12-40.

Note	Target Position units in revolutions. Target Velocity units in rps.

5. Press the **F5** (green button) to start the motion profile in Synchronous Position mode.

   Press **F6** (red button) to stop the motion.

   Press **F8** (blue button) to clear any faults.

Generating Absolute and Relative Motion

To generate absolute or relative motion in Position Profile mode, do the following:

1. Open the **NC: Functions** tab.
2. Configure the target position, the target velocity, the acceleration and deceleration, and the jerk of the motion.

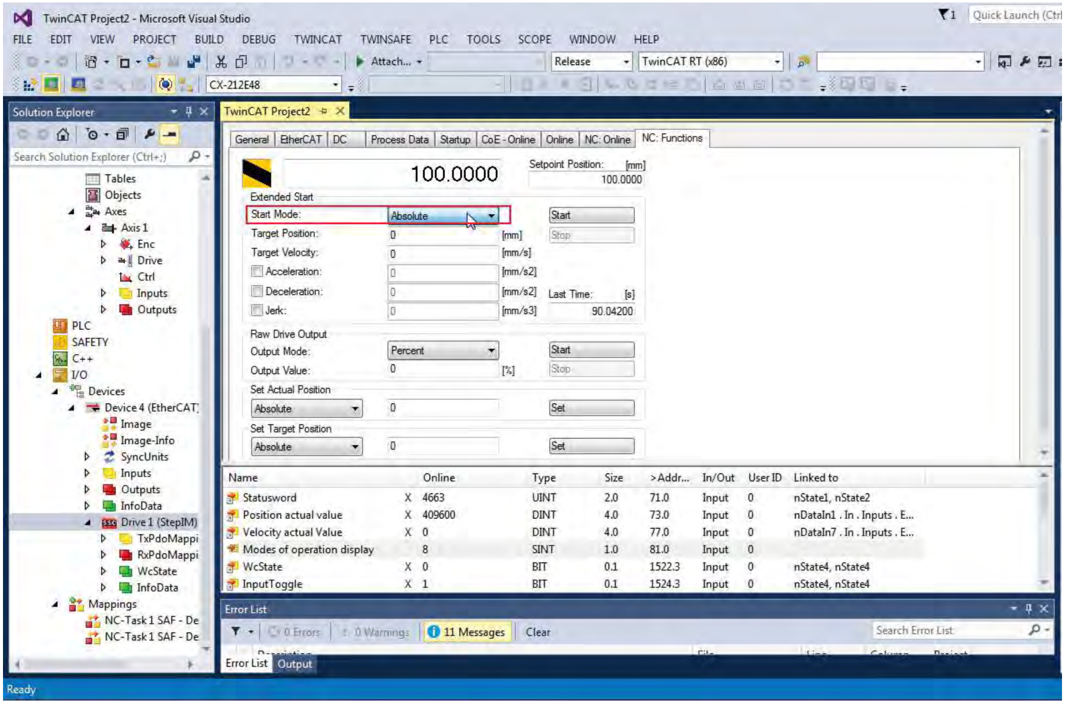

TwinCAT Project2 - Microsoft Visual Studio
Quick Launch (Ctrl
FILE EDIT VIEW PROJECT BUILD DEBUG TWINCAT TWINSAFE PLC TOOLS SCOPE WINDOW HELP
Attach...
Release
TwinCAT RT (x86)
CX-212E48
Solution Explorer
Search Solution Explorer (Ctrl+;)
Tables
Objects
Axes
Axis 1
Enc
Drive
Ctrl
Inputs
Outputs
PLC
SAFETY
C++
I/O
Devices
Device 4 (EtherCAT)
Image
Image-Info
SyncUnits
Inputs
Outputs
InfoData
Drive 1 (StepIM)
TxPdoMappi
RxPdoMappi
WcState
InfoData
Mappings
NC-Task 1 SAF - De
NC-Task 1 SAF - De
TwinCAT Project2
General EtherCAT DC Process Data Startup CoE - Online Online NC: Online NC: Functions
100.0000
Setpoint Position: [mm]
100.0000
Extended Start
Start Mode: Absolute
Start
Target Position: 0 [mm]
Stop
Target Velocity: 0 [mm/s]
Acceleration: 0 [mm/s2]
Deceleration: 0 [mm/s2]
Last Time: [s]
Jerk: 0 [mm/s3]
90.04200
Raw Drive Output
Output Mode: Percent
Start
Output Value: 0 [%]
Stop
Set Actual Position
Absolute 0 Set
Set Target Position
Absolute 0 Set
Name Online Type Size >Addr... In/Out User ID Linked to
Statusword X 4663 UINT 2.0 71.0 Input 0 nState1, nState2
Position actual value X 409600 DINT 4.0 73.0 Input 0 nDataIn1 . In . Inputs . E...
Velocity actual Value X 0 DINT 4.0 77.0 Input 0 nDataIn7 . In . Inputs . E...
Modes of operation display 8 SINT 1.0 81.0 Input 0
WcState X 0 BIT 0.1 1522.3 Input 0 nState4, nState4
InputToggle X 1 BIT 0.1 1524.3 Input 0 nState4, nState4
Error List
0 Errors 0 Warnings 11 Messages Clear
Search Error List
Error List Output
Ready

Figure 12-41.

13 Firmware Upgrade

13.1 Firmware Upgrade – CANopen Models

13.1.1 Firmware Upgrade via ServoStudio 2 – CANopen

Preparation

Download the required firmware file from the STXI Motion website or contact Technical Support..

Important: Before upgrading the firmware, do the following:

1. Backup the drive parameters since parameter settings may be lost during the upgrade. After the upgrade is completed, the parameters can be reloaded/restored.

   To backup parameters from ServoStudio 2, go the **Backup & Restore** screen, and click the **Save to Backup** button.

2. Read the release note or other documentation supplied with the new firmware.

Note The Backup & Restore option does not restore the drive address after firmware upgrade. To set the drive address, use object 2F1Bh.

Procedure

1. From the ServoStudio 2 **Drive Information** screen, click **Download Firmware**.

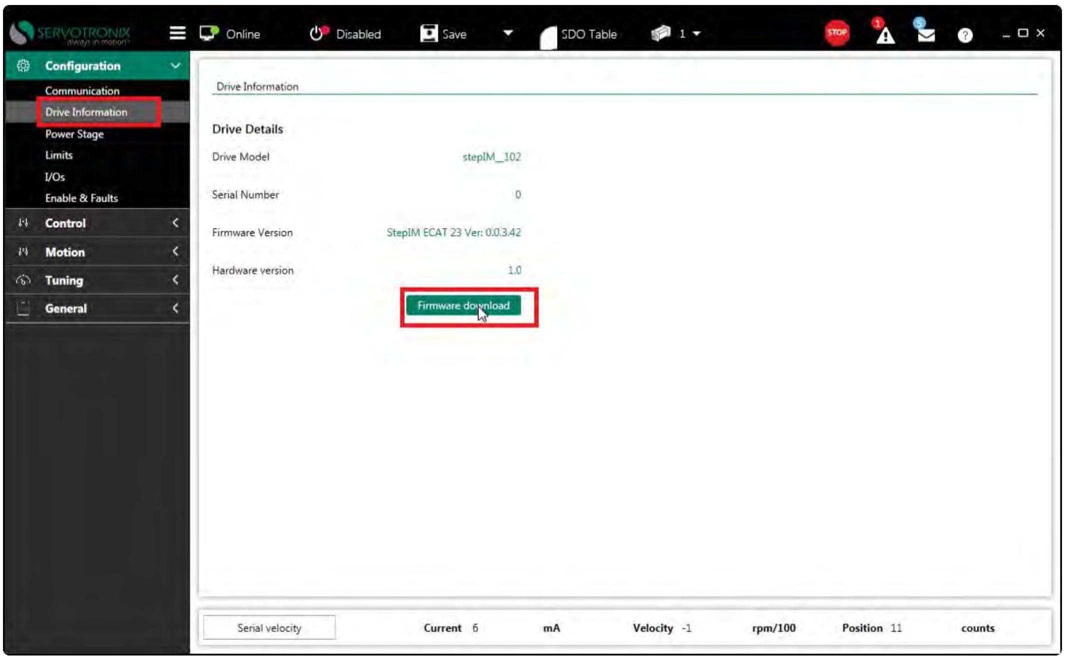


Figure 13-1. Firmware Upgrade Interface

2. The **Firmware Upgrade** dialog box opens.

   Set the address of the stepIM unit to be upgraded.

   Browse to and select the stepIM firmware file, and click **Download**.

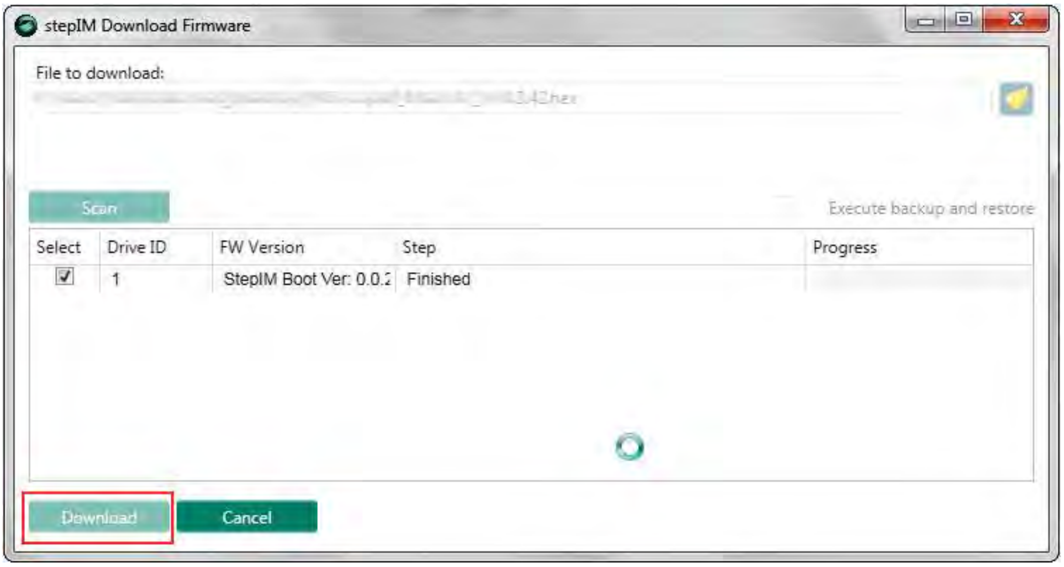


Figure 13-2. Firmware Upgrade Interface

During the firmware upgrade process, the stepIM red LED is steadily-lit.

Resuming Operation

1. Go to the ServoStudio 2 **Drive Information** screen, and check the drive firmware version to verify that the new firmware has been loaded.
2. To restore values to the drive parameters, go the ServoStudio 2 **Backup & Restore** screen, and click the **Restore** button.

Note The Backup & Restore option does not restore the drive address after firmware upgrade. To set the drive address, use object 2F1Bh.

3. Check the version release notes, and set any parameters that may have been added to the new version.
4. Save the parameters to the non-volatile parameter memory: either via object 1010h (store parameter field), or click the **Save** button on the ServoStudio 2 toolbar.

Boot Mode

If the firmware loading process has been interrupted, or the firmware is corrupted, the stepIM red LED will continue flashing after power-up.

13.1.2 Firmware Upgrade over CANopen

Firmware Upgrade – Protocol

Firmware upgrade over CANopen communication is done by the bootloader. During the boot of the stepIM, the controller can access the bootloader and start the firmware upgrade procedure. The stepIM bootloader supports a minimal set of CANopen objects to enable the firmware upgrade procedure. The bootloader is stored in a protected section of the product's flash memory, and saves the new firmware to its allocated flash sectors.

After power-up, the drive is in boot mode for about 5 seconds. During this brief interval, a CANopen access to the drive prevents it from starting the firmware, and the drive can accept a firmware upgrade.

The following CANopen objects are used in the firmware upgrade procedure:

- 1000h – device type
- 2000h – main program
- 2001h sub-index 1 – flash ready
- 2001h sub-index 2 – erase flash
- 2002h – unlock Bootloader (only in bootloader versions 2.3 and newer)
- 2800h – domain transfer

Note Except for object 1000h, these objects are unique to the stepIM bootloader, and do not exist in the product firmware.

Firmware Upgrade – Procedure

CAN ID during firmware upgrade:

- Bootloader versions prior to 0.0.2.3: During the boot, the CAN ID of the stepIM is 127.
- Bootloader versions 0.0.2.3 and newer: During the boot, the CAN ID of the stepIM is the last drive address that was set for the drive, or CAN ID 101 if the address has not been changed.

Perform the following steps to upgrade the firmware:

1. Power up the drive.
   - Bootloader versions prior to 2.3: within the first 5 seconds after power-up, access the drive at CAN ID 127 by reading the value of object 1000h.
   - Firmware versions 2.3 and newer: within the first 5 seconds after power-up, write 0x6E65706F ("open") to object 2002h.
2. Erase the flash memory by writing value 1 to object 2001h sub-index 2.
   - Wait 10 to 20 seconds; the drive hangs during the flash erase.

3. Read the value from object 2001h sub-index 1
   - If the value of 2001h sub-index 1 is not 0, this indicates a problem with the flash erase. Repeat the procedure from step 2. If the problem persists, contact technical support.
   - When the value of 2001h sub-index 1 is 0, continue to the next step.
4. Send the firmware file via object 2800h.
5. When the file send is done, read the value of object 2000h.
   - If the value of object 2000h is not 0, this indicates that firmware send failed. Repeat the procedure from step 2. If the problem persists, contact technical support.
   - If the value of object 2000h is 0, the firmware upgrade is successful. Restart the drive.

The following table shows the return values from erase and programming:

Description	Name	Value
Success	SUCCESS	0
Erase and programming errors	CSM_LOCKED	10
	REVID_INVALID	11
	ADDR_INVALID	12
Erase specific errors	NO_SECTOR_SPECIFIED	20
	FAIL_PRECONDITION	21
	FAIL_ERASE	22
	FAIL_COMPACT	23
	FAIL_PRECOMPACT	24
Programming specific errors	FAIL_PROGRAM	30
	FAIL_ZERO_BIT_ERROR	31
	FAIL_VERIFY	40

13.2 Firmware Upgrade – EtherCAT Models

Note

After FoE is completed and while still in bootstrap state, a communication disconnection lasting 30 to 60 seconds may occur. This may be due to a master command to transition from Bootstrap to Init state, or a power cycle of the drive. During this 30–60 second disconnection, the new firmware version becomes active.

After FoE is completed (or interrupted), if the master starts another FoE operation while the drive is still in Bootstrap state, the drive will disconnect for about 10 seconds.

13.2.1 Firmware Upgrade via ServoStudio 2 – EtherCAT

Preparation

Download the required firmware file from the STXI Motion website or contact Technical Support.

Important: Before upgrading the firmware, do the following:

1. Backup the drive parameters, since parameter settings may be lost during the upgrade. After the upgrade is completed, the parameters can be reloaded/restored.

   To backup parameters from ServoStudio 2, go the **Backup & Restore** screen, and click the **Backup** button.

2. Read the release note or other documentation supplied with the new firmware.

Note

The Backup & Restore option does not restore the drive address after firmware upgrade. To set the drive address, use object 2F1Bh.

Upgrade Procedure

1. From the ServoStudio 2 **Drive Information** screen, click **Download Firmware**.

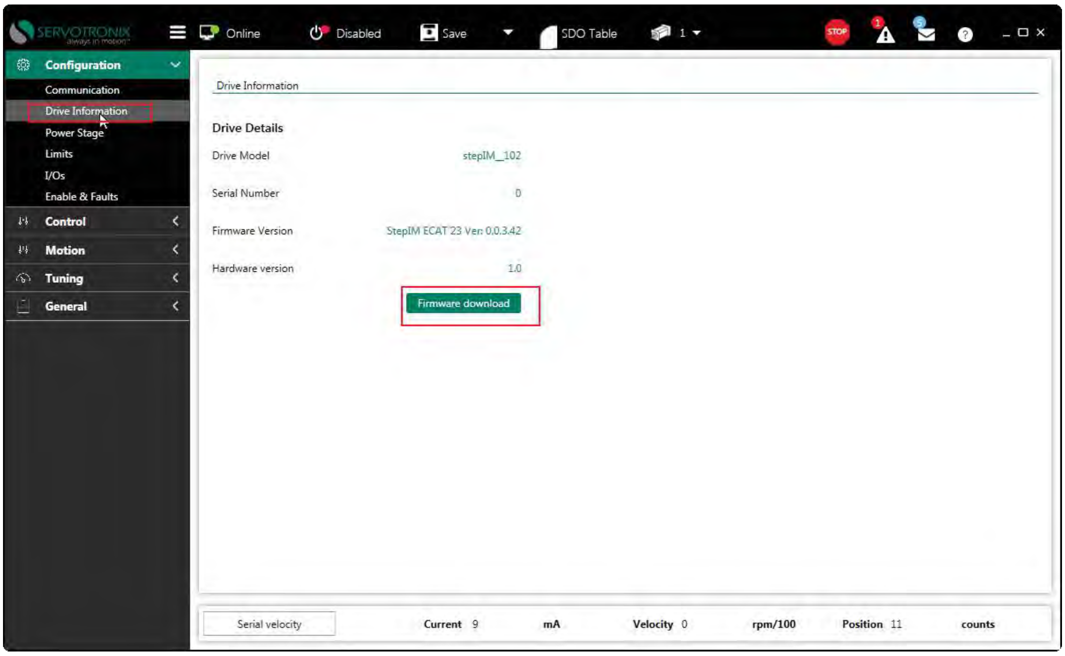


Figure 13-3.

2. The **Firmware Upgrade** dialog box opens.

Browse to and select the stepIM firmware (ECAT) file and click **Download**.

8.

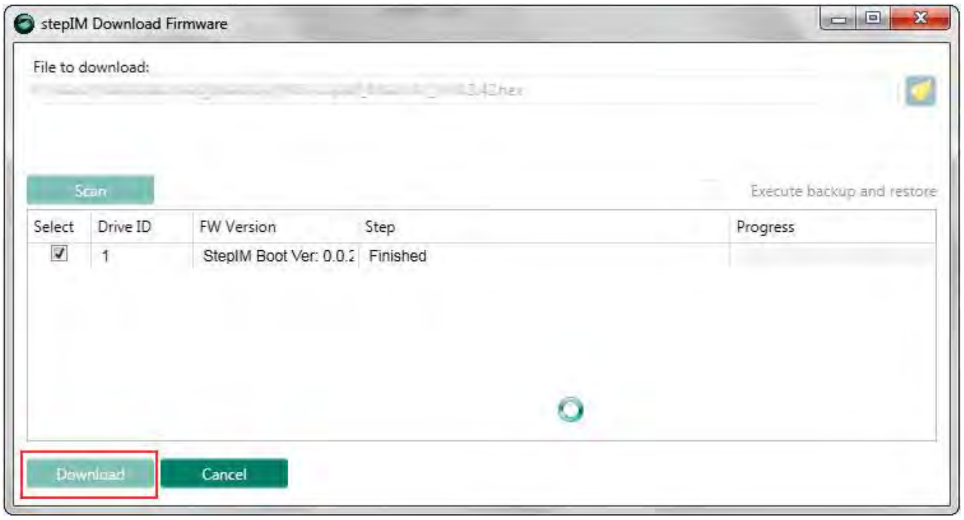


Figure 13-4.

During the firmware upgrade process, the stepIM red LED is lit steadily.

Resuming Operation

1. Go to the ServoStudio 2 **Drive Information** screen, and check the drive firmware version to verify that the new firmware has been loaded.

2. To restore values to the drive parameters, go the ServoStudio 2 **Backup & Restore** screen, and click the **Restore** button.

Note The Backup & Restore option does not restore the drive address after firmware upgrade. To set the drive address, use object 2F1Bh.

3. Check the version release notes, and set any parameters that may have been added to the new version.

4. Save the parameters to the non-volatile parameter memory: either via object 1010h (store parameter field), or click the **Save** button on the ServoStudio 2 toolbar.

Boot Mode

If the firmware loading process has been interrupted, or the firmware is corrupted, the stepIM red LED will continue flashing after power-up.

13.2.2 Firmware Upgrade via TwinCAT – EtherCAT

1. In the navigation pane, expand **I/O** > **Devices** > **Device 4 (EtherCAT)**, and select **Drive 1 (stepIM)**.

2. Make sure the stepIM is in the **Bootstrap** state, as described in the section *EtherCAT Network Management*.

3. In the **Online** tab, click **Download**.

   Browse to and select the stepIM firmware file.

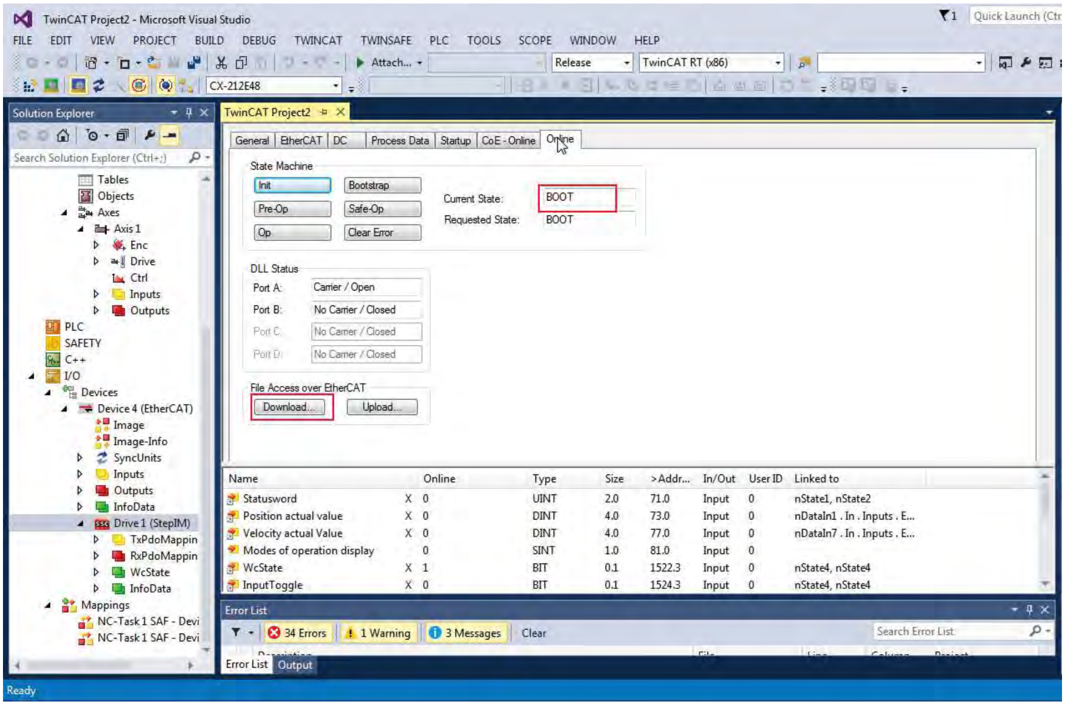


Figure 13-5.

4. In the **CoE-Online** tab, read the version number of the firmware in object **2E00h**:

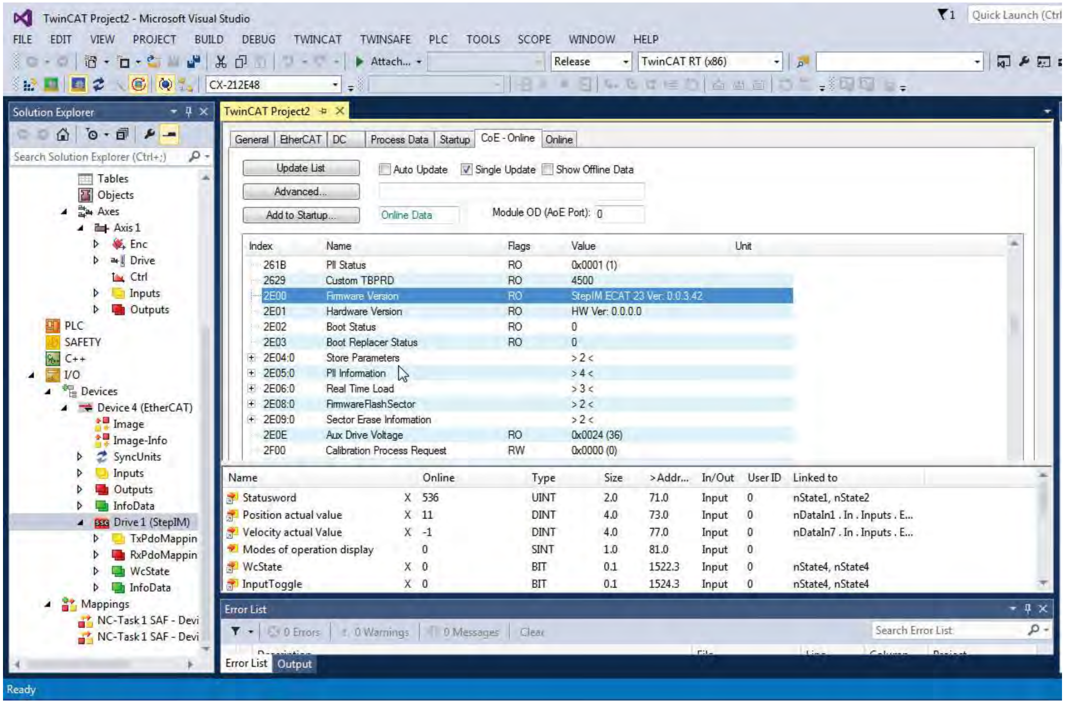

TwinCAT Project2 - Microsoft Visual Studio
Solution Explorer
TwinCAT Project2
CoE - Online
Update List
Advanced...
Add to Startup...
Online Data
Module OD (AoE Port): 0
2E00 Firmware Version RO StepIM ECAT 23 Ver: 0.0.3.42
2E01 Hardware Version RO HW Ver: 0.0.0.0
Error List

Figure 13-6.

14 Troubleshooting

14.1 LEDs – CANopen Models

stepIM CANopen models have a bi-color LED that serves as a **status** indicator. The LED is located on the heat sink panel.

Figure 14-1. Status LED – CANopen

Table 14-1. Status LED Indicators – CANopen

Color	Boot	Operational
Orange	**Flashing**: Within the first 5 seconds after power-up, and before stepIM transitions to Operational state.	
Green		**Lit steadily**: The stepIM is enabled. No faults. **Flashing**: The stepIM is disabled. No faults.
Red		**Lit steadily**: A fault has been detected and needs attention. The LED remains lit until the error is resolved. **Flashing**: A fault that was detected no longer exists, but has not yet been cleared via Controlword.

14.2 LEDs – EtherCAT Models

stepIM EtherCAT models have a bi-color LED that serves as a status indicator, and four LEDs that serve as fieldbus indicators.

The LEDs are located on the heat sink panel.

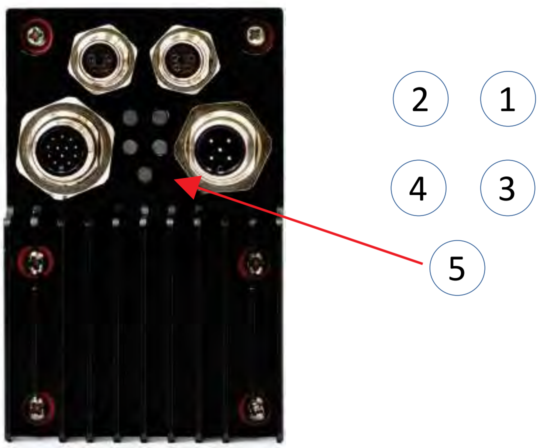


Figure 14-2. Communication and Status Indicator LEDs – EtherCAT
1-L/A IN, 2-L/A OUT, 3-RUN, 4-ERR, 5-Status

Table 14-2. Fieldbus LED Indicators – EtherCAT

LED	Color	Behavior	Meaning
L/A IN	**Green**	Off	No connection to the preceding EtherCAT module.
		Lit steadily	Connected to the preceding EtherCAT module.
		Flashing	Communicating with the preceding EtherCAT module.
L/A OUT	**Green**	Off	• No connection to the next EtherCAT module.
		Lit steadily	• Connected to the next EtherCAT module.
		Flashing	Communicating with the next EtherCAT module.
RUN	**Green**	Off	EtherCAT module is in Initialization state.
		Flashing quickly	EtherCAT module is in Pre-Operational state.
		Flashing slowly	EtherCAT module is in Safe Operational state.
		Lit steadily	EtherCAT module is in Operational state.
ERR	**Red**	Off	No error.
		Flashing	Invalid configuration.
		Single flash	Unsolicited state change.
		Double flash	Application watchdog timeout.
		Flickering	Booting error.
		On	PDI watchdog timeout.

Table 14-3. Status LED Indicator – EtherCAT

LED	Color	Boot	Operational
Status	Red	**Flashing quickly**: When power is turned on. After 10 seconds, switches to Operation state.	**Lit steadily**: A fault has been detected and needs attention. The LED remains lit until the error is resolved. **Flashing slowly**: A fault that was detected no longer exists, but has not yet been cleared via Controlword.
	Orange	**Flashing quickly**: Transition from Initial to Boot state has occurred. **Note**: Operational state requires a transition from Boot to Initial state.	**Lit steadily**: The stepIM is disabled. No faults. Object 2F70h = 1.
	Green		**Lit steadily**: The stepIM is enabled. No faults. **Flashing slowly**: The stepIM is disabled. No faults. Object 2F70h = 0 (default).

14.3 Built-in Protection

When a drive fault occurs, the fault is automatically latched and the drive is disabled.

Faults must be explicitly cleared before the drive can be enabled.

14.4 Faults

The following table lists the fault (emergency error) codes. When an illegal state occurs in the drive, the stepIM sends the code to the master device as object 603Fh (Error Code).

Whenever object 603Fh has a value other than 0, there is a fault in the drive. The CANopen state machine enters Fault mode, and the stepIM cannot be enabled.

Table 14-4. Faults

Error code	Name	Description	Action Required
2214h	Over-current	Hardware or software over-current was detected. The maximum current value is set at object 2036h.	Check the current loop parameters (current proportional gain 2007h, current integral gain 2006h). Increase maximum current value (object 2036h) or reduce the current saturation value (object 6073h).
2310h	I2T limit	Energy usage is higher than the I2T limit value (object 2034h). The value of I2T value (object 2033h) is greater than the value of I2T limit value (object 2034h).	Check the parameter values in the control loops. Check the demanded velocity (object 6081h), acceleration (object 6083h) and deceleration (object 6084h) and motor load. Increase I2T limit value (object 2034h) if needed, or set it to 0 to disable this functionality.
3110h	Over-voltage	Bus voltage exceeds the value that is set at the over-voltage fault level (object 20A1h).	Check the bus power voltage (object 0790h). Increase the value of object 20A1h.
3120h	Under-voltage	Bus voltage is lower than the value that is set at the under-voltage fault level (object 20CFh).	Check the bus power voltage (object 0790h). Reduce the value of the under-voltage fault level (object 20CFh).

Error code	Name	Description	Action Required
4310h	Over-temperature	The temperature of the drive is higher than 90°C (194°F) or lower than -30°C (-22°F), or the temperature sensor has a malfunction.	Check the drive measured temperature, at object 2044h. Reduce the load on the drive.
5530h	EEPROM fault	One of the following faults occurred: Checksum error while loading parameters. EEPROM read fault: The drive firmware could not access the EEPROM during LOAD (object 1011h). EEPROM write fault: The drive firmware could not access the EEPROM during SAVE (object 1010h).	If the fault occurs when powering-up the stepIM after firmware upgrade, run the SAVE command (object 1010h). Use the command object 1011h to reload the parameters from the EEPROM. Reset the drive, and try again. The EEPROM might be damaged and the drive requires service.
7122h	Reserved	-	-
7310h	Over-speed	Actual speed exceeds the velocity over speed value (object 606Ch).	Check the velocity-loop parameters (VGI 2026h and VGP 2027h). Increase velocity over speed (object 2F0Ah), or reduce the velocity limit (object 20EEh).
8130h	Heartbeat loss	Heartbeat event when heartbeat is not received within the heartbeat consumer time.	Check that the heartbeat consumer and producer times match. Consumer heartbeat setting: object 1016h. Producer heartbeat setting (in master, not in stepIM) setting: object 1017h. To disable heartbeat monitoring, set object 1016h to 0. To disable fault in case of a heartbeat event, set object 6007h to 0.

Error code	Name	Description	Action Required
8400h	Velocity error	The difference between the velocity command and the actual velocity is greater than the value that is set in maximum velocity error (object 2F08h).	Check the parameter values in the control loops. Check the demanded velocity (object 6081h), acceleration (object 6083h) and deceleration (object 6084h). Increase the value of the maximum velocity error (object 2F08h). If needed, or set it to 0 to disable this functionality.
8611h	Position error	The difference between the position command and the actual position is greater than the value that is set in maximum position error (object 6065h)	Check the parameter values in the control loops. Check the demanded velocity (object 6081h), acceleration (object 6083h) and deceleration (object 6084h). Increase the value of the position error maximum (object 6065h) if needed.
F001h	Acceleration / deceleration violation	The motor acceleration or deceleration is greater than the value of the maximum acceleration (object 60C5h).	Check control loops parameters. Check the demanded velocity, acceleration and deceleration. Or, increase the value of the maximum acceleration object 60C5h, or set it to 0 to disable this functionality.
FF00h	Position command error	The difference between two sequential position commands is greater than the value of the maximum position derivative (object 2F0Bh). Position derivative = difference between two sequential position commands. **Note**: Interpolated mode only.	Check motion controller configuration. Check the demanded velocity (object 6081h), acceleration (object 6083h) and deceleration (object 6084h). Or, increase the value of the maximum position derivative (object 2F0Bh), or set it to 0 to disable this functionality.
FF01h	Active Disable process failure	The Active Disable process did not finish within the defined time.	Make sure the timeout value for the Active Disable process is long enough to allow the drive to decelerate to a standstill and become disabled (object 2FF2 sub-index 2) according to the disable method.

Error code	Name	Description	Action Required
FF03h	PLL lock lost	In synchronous motion, the drive phase locked loop (PLL) on sync signal has failed.	Check CAN sync cycle parameter (object 60C2h) and increase it if needed.
FF04h	Power stage fault	Power stage generated a fault due to over- or under-voltage, over-current or over-temperature.	Check that drive operating condition are within the specification of the product.
FF05h	Encoder failure	Magnetic encoder has failed.	Try to reboot the product. If the fault persists, drive will need to be serviced.
FF06h	Gate drive voltage failure	Power chip low voltage	Check bus power supply. If power supply is OK, contact Technical Support.
FF07h	PDO message lost	Generated after 10 consecutive lost PDO messages in synchronous position (SP) mode. Occurs when PLL is not locked, and system attempts to enable the drive. Drive will be enabled and fault will be generated.	Check PDO mapping.
FF0Ah	Power stage Over-temperature	The temperature of the drive is higher than 150°C (302°F), or the temperature sensor has a malfunction.	

14.5 Network Communication Issues

The following table lists the objects that can be used to troubleshoot network communication issues.

Object	Name	Description
Object 2625h	Sync Lost Counter Limit	Read only. This object indicates the total number of lost sync messages in synchronous operation that will cause a PLL lost fault. **Note**: Factory set to 0, meaning it is disabled and therefore not in use.
Object 262Bh	Sync Consecutive Lost	Read/Write. This object indicates the number of consecutive lost sync messages in synchronous operation that will cause a PLL lost fault.
Object 262Ch	Sync Window Lost	Read/Write. This object defines the maximum deviation between expected and actual arrival time of a sync message before a PLL lost fault is generated.
Object 2626h	Sync Lost Counter	Read only. This object indicates the number of lost sync messages in synchronous operation.
Object 262Ah	Sync RT Counter	Read only. This object indicates the number of real-time interrupts between two sync messages.
Object 2627h	RPDO Lost Counter	Read only. This object indicates the number of lost PDO messages in synchronous operation.
Object 2628h	Position Derivative for Missing RPDO	Read only. This object indicates the change in position at the last received synced PDO, which can be used in the event of a lost PDO.
Object 2629h	Time-Base Period Register	Read only. This object indicates the time base of the drive real-time interrupt.
Object 262Dh	High Resolution Timer Difference	Read only. This object indicates the difference between the internal timer and the received value.
Object 2F30h	CAN Buffer Overflow Counter	Read only. This object keeps count of the CAN buffer overflow.
Object 2FC4h	CAN Error Counter	Read only. This object keeps count of communication errors. The value of the counter can be reset by writing 0 to the appropriate sub-index.

stepIM

User Manual