



Motion Control Products

Configuring Step and Direction operation on ABB Motion drives

Application Notes 260

Version E (English)

Step 
Direction 



Introduction

Step and direction configuration is a simple control format which allows motion to be controlled from two inputs on the drive, one used to represent a requirement for a step change in the axis position and one used to represent the direction of travel. In essence the step and direction outputs from the motion controller / PLC are connected to one of the available encoder input channels on the drive and the drive is configured to follow this encoder, but the drive decodes the encoder count in a "step and direction mode" rather than the usual A/B quadrature decoding method.

Both MicroFlex e190 and MotiFlex e180 support the following encoder channels that can be used for step and direction input:

- Encoder channel 1 (24Vdc single ended encoder formed from fast digital inputs 1 and 2)
- Encoder channel 2 (RS422/5V differential encoder input)

Because this form of control is usually associated with low-cost systems it is unusual for the drive's simulated encoder output to be used by the motion controller to close the position loop, instead the motion controller usually treats the axis as an "open loop" stepper axis (relying on the drive itself to ensure the motor position matches the demand set by the incoming step/direction signals). This is not always the case though, sometimes the controller may want to perform "closed loop control", in which case the drive's simulated encoder output will be used to feedback actual position (when using MicroFlex e190 this would mean that a digital encoder or resolver must be used on the motor to allow use of encoder channel 2 via the Universal Encoder Input for the step and direction inputs).

Configuration of step and direction mode just requires a few simple parameters to be configured via Mint Workbench. As a result, there is no need to run a Mint program.

NOTE: Neither drive supports 5V single ended step and direction inputs. Should your motion controller / PLC provide 5V TTL single ended step and direction signals it will be necessary to either include an intermediate signal conversion unit from a third party or you will need to use encoder channel 2 and bias the A- and B- encoder input lines to 2.5Vdc using a resistor network and the drive's 5V encoder supply output – please contact your local ABB support office for further information if required.

Pre-requisites

You will need to have the following to work through this application note:

- Mint Workbench build 5868 or later (see new.abb.com/motion for latest downloads and support information)
- An MicroFlex e190 or MotiFlex e180 drive with firmware build 5868.7.0 or later firmware, tuned and configured for position control as per the [AN00250 Drive Tuning](#) application note.
- Appropriate hardware connected to the drive to provide suitable step and direction signals. If using encoder channel 2 (5V DC) for example, then an ABB NextMove e100 or NextMove ESB-2 with differential stepper outputs or an ABB PLC with an FM562 PTO module would be suitable. If using encoder channel 1 (24V DC) then connection of two switches to digital inputs 1 and 2 will be sufficient for testing the basic operation

It is assumed the reader has a basic working knowledge of Mint Workbench and that the drive has already been tuned for the application. Throughout this document we will assume the use of a MicroFlex e190, but the process is identical for a MotiFlex e180 drive.

Installation requirements

Because this type of system is usually operated "open loop" the positional accuracy achieved is very dependent on the number of steps detected by the drive being accurate. As a result, it is critical that all recommended installation practices relating to EMC performance are followed exactly...

- Drives should be mounted onto non-painted metal backplates
- An earth connection from the main panel earth star point should be made on the drive
- Motor power cable shields must be p-clipped to earth close to the drive
- Control signals must be routed away from power cables
- Differential step and direction signals must be wired using twisted pair cable with an overall shield
- Single ended step and direction signals must be wired as a twisted pair with the return signal and with an overall shield
- Functional earth connections on the device providing the signals must be installed
- Typically, the 0Vdc of the control power supply should be linked to earth

Please refer to the relevant drive's installation manual for full details.

Wire connection

Connection for single ended 24V DC using Channel 1

When using encoder channel 1 (the 24Vdc encoder channel formed by digital inputs 1 and 2) the controller providing the step and direction signals may use current sourcing / open emitter outputs (providing 24Vdc to DIN1+ and DIN2+, with DIN1- and DIN2- connected to 0Vdc) or it may use current sinking / open collector outputs (pulling DIN1- and DIN2- down to 0Vdc with DIN1+ and DIN2+ connected to 24Vdc).

In both cases it is still vital to ensure twisted pairs are used for these signals (twist the signal for DIN1+ with the signal for DIN1- and twist the signal for DIN2+ with the signal for DIN2-).

In the case of a PLC/controller using open collector outputs it is also necessary to install pull-up resistors in the circuit as shown in the diagram below to achieve a bandwidth of 250 kHz:

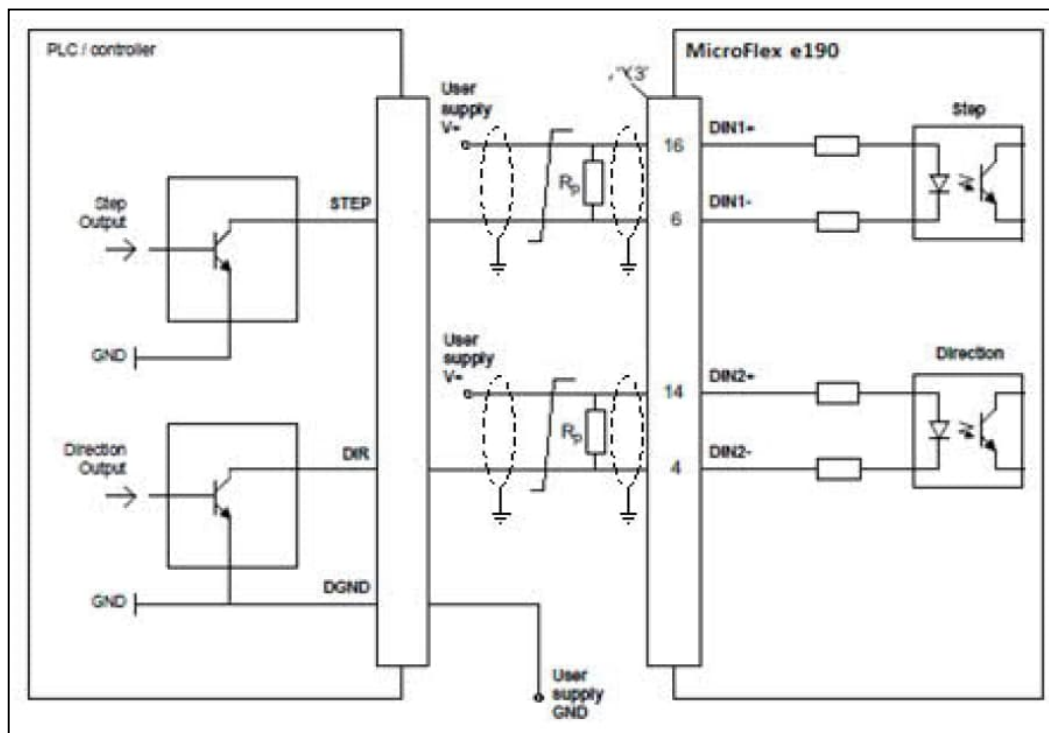


Figure 1

It is also important to ensure these resistors have the correct (minimum) power rating as shown below...

Resistor Rp	Bandwidth
None	Low
470 ohms (1.5 Watts) or 1k ohms (1 Watt)	250 kHz

Connection for Differential 5V DC using Channel 2

When using encoder channel 2 (the 5Vdc encoder channel formed by external encoder input X7) the controller providing the step and direction are wired into the 9 pin D sub connector as shown below.

It is still vital to ensure twisted pairs are used for these signals.

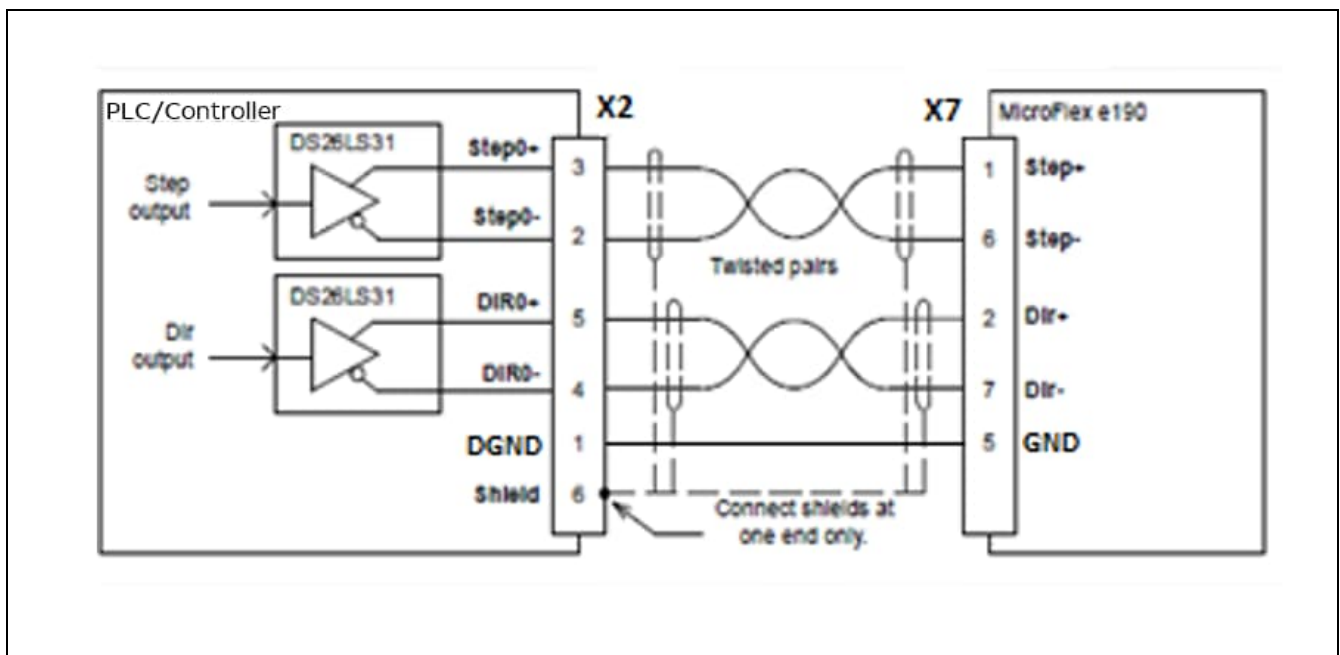


Figure 2

Configuring parameters

Setting servo drive parameters can be done by following the process below. Firstly, we should set the communication settings

1. Make sure the PC IP settings are set to the same subnet as the servo drive, and then open the Mint SiderBar.

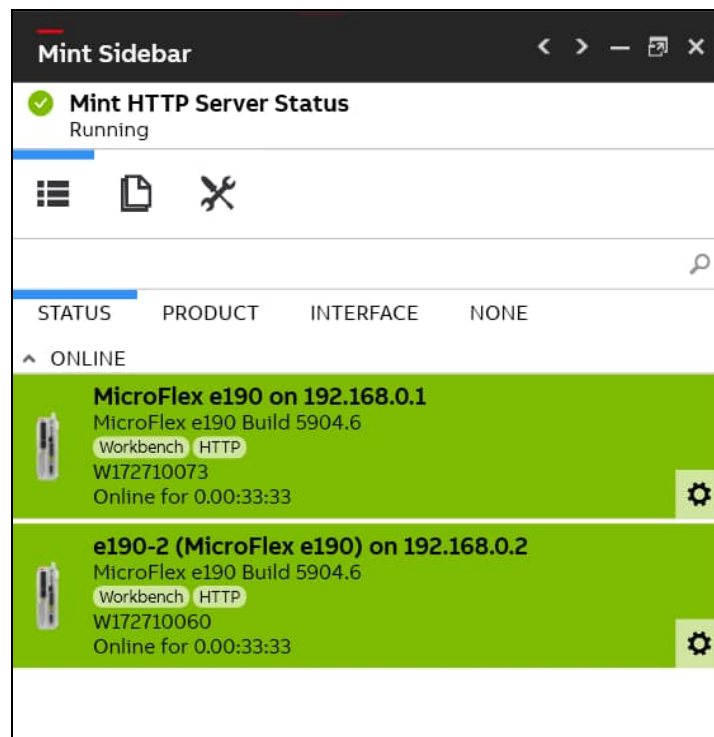



Figure 3

2. Based on the result of the scanning via Sidebar, select the drive to configure and click the icon  to launch a Mint Workbench session.
3. Once open from within the Mint workbench session you can configure the communication settings by clicking on "configuration" to set the name of the drive.

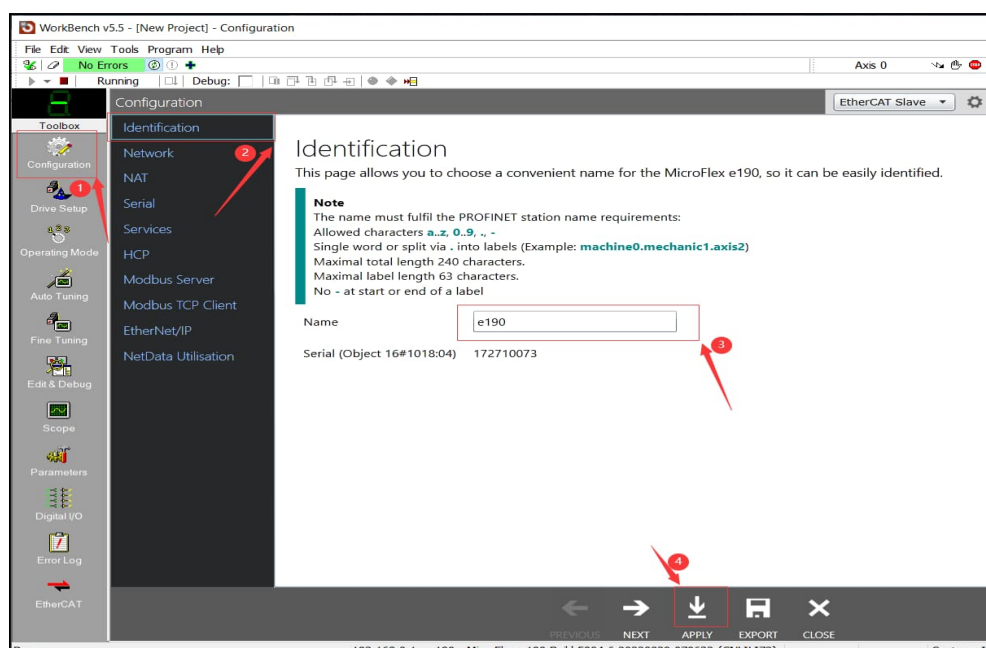


Figure 4

4. Open the network interface in the configuration bar and set the IP address of the server driver, in case of conflict with the local PC. After finishing the settings, click the button of “apply”, downloading the parameters.

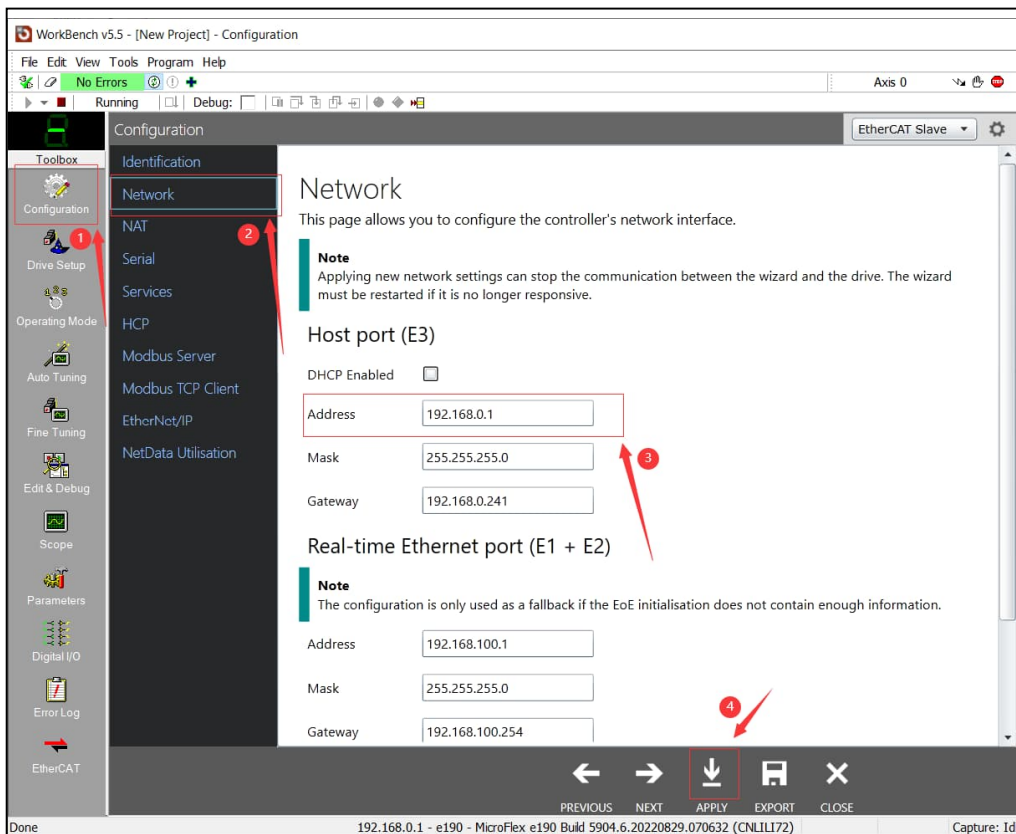


Figure 5

Next, we can start the drive parameter configuration

1. Select “Drive Setup”, and then configure the motor parameters. After finishing the settings, please click the button of “finish”.

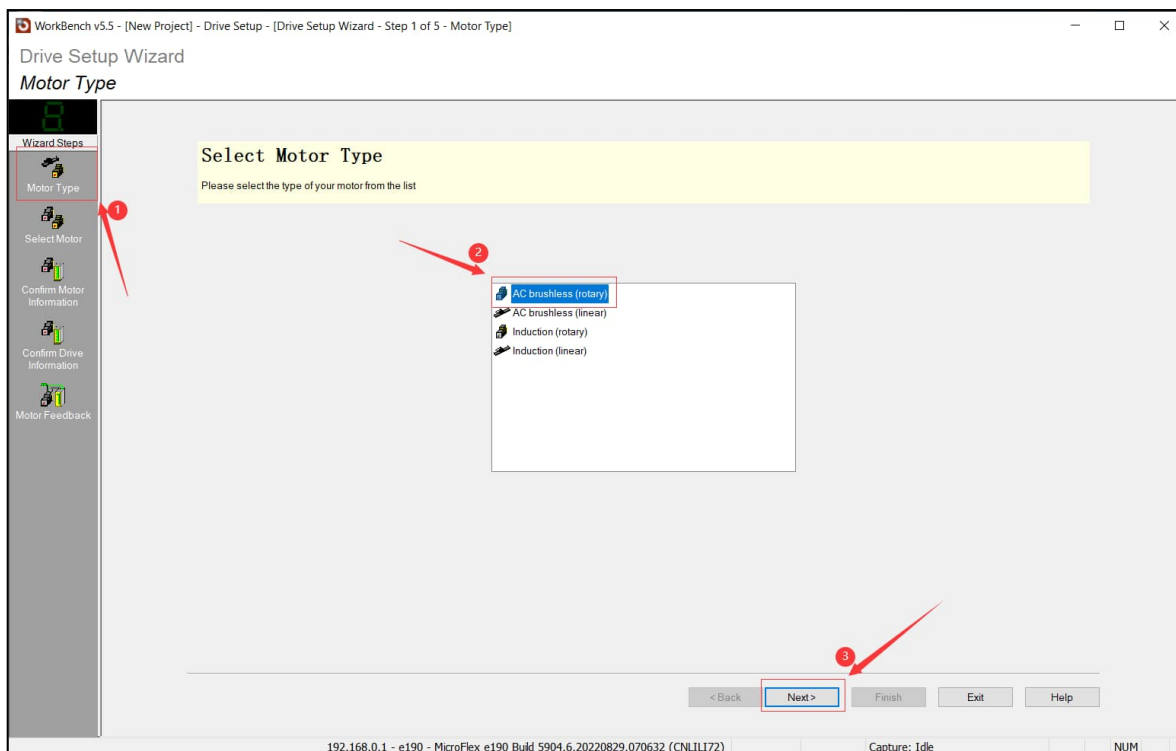


Figure 6

2. Select the "Operating Mode", then following the steps shown below, to configure the options.
 - a. Control Mode Should be position
 - b. If you want to use an enable Input select; Drive Enable Input mode = Crash stop, disable, no error, select Hardware Enable, select which drive enable input you want to use
 - c. To use PTO mode, you must select Control Ref Source = Direct

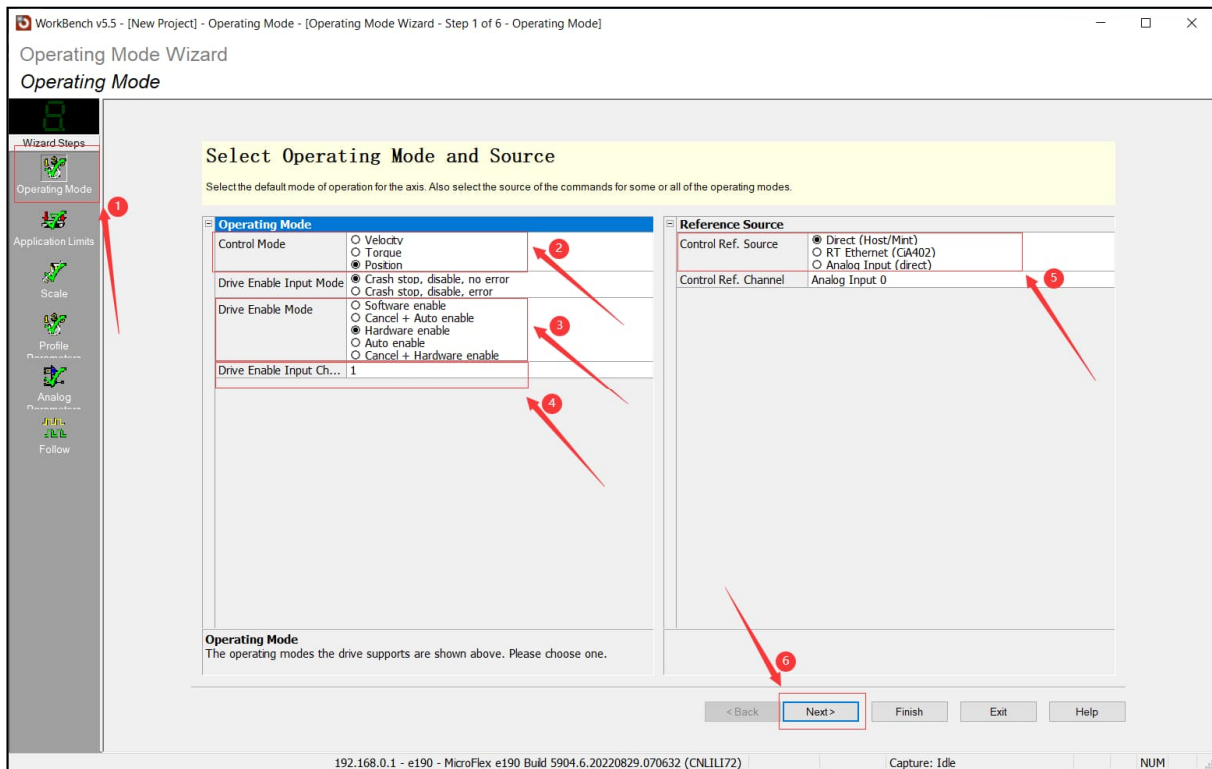


Figure 7

3. At the last step of the operating mode, we can see the page "Select PTO", here PTO mode can be configured easily. Several settings are made automatically but some must be set by the user. These settings can be understood below:

Parameter setting	Meaning
Step & Direction	Defines which channel will be used in the application
Encoder Mode	Default is 4 (step and direction) is okay for most applications but can be changed as needed.
Encoder (pre) Scale	The ENCODERPRESCALE keyword is used to divide the number of encoder counts from the encoder input. This effectively modifies the number of encoder counts received by the drive.
Encoder Numerator / Denominator	Used to set the ratio at which the drive will follow the output pulses from the master encoder
Motor Direction	This modifies the sign of the relationship between the physical forward direction of the motor and that which the drive considers to be forwards

Table 1

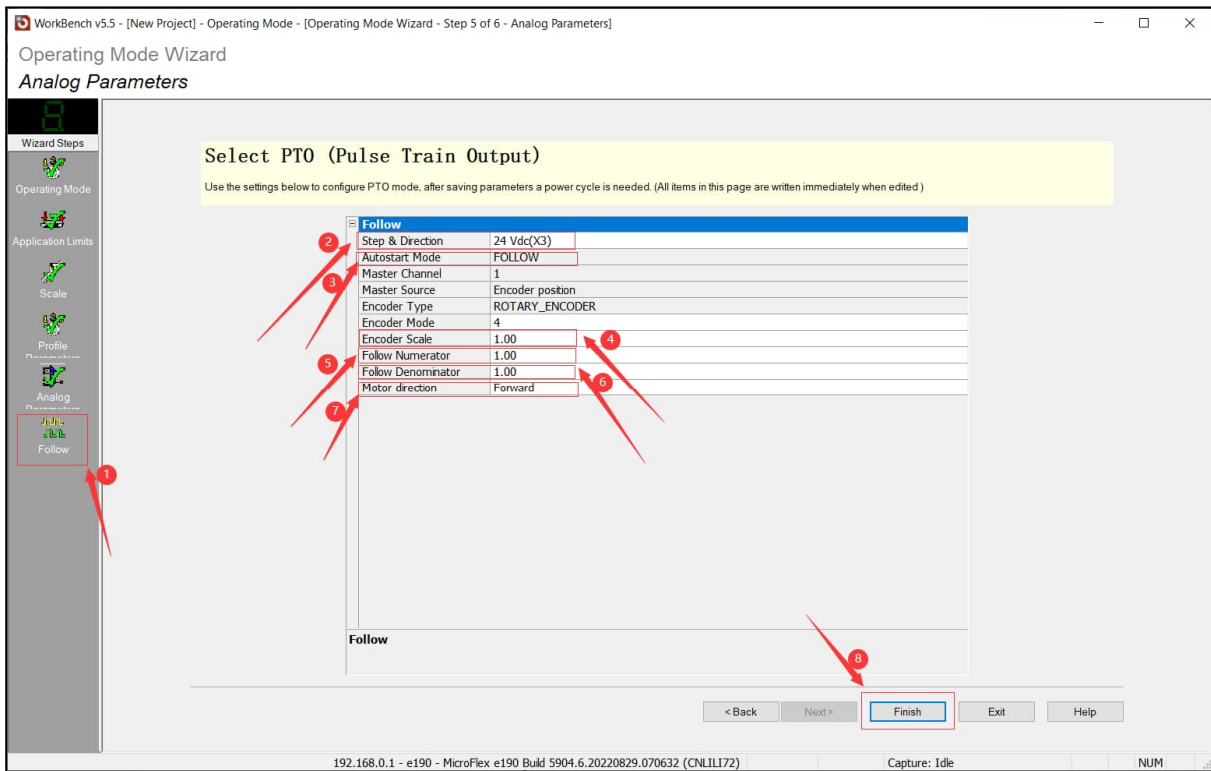


Figure 8

- After finishing the settings, click the button of “finish”.
- If any other application settings are required not covered above, these can be done by the parameter interface. To do this click the parameter setting button on the left of the interface to enter the servo parameters configuration interface and click “P#” button to show the parameter numbers for convenience. When the settings are completed, click the button to save.

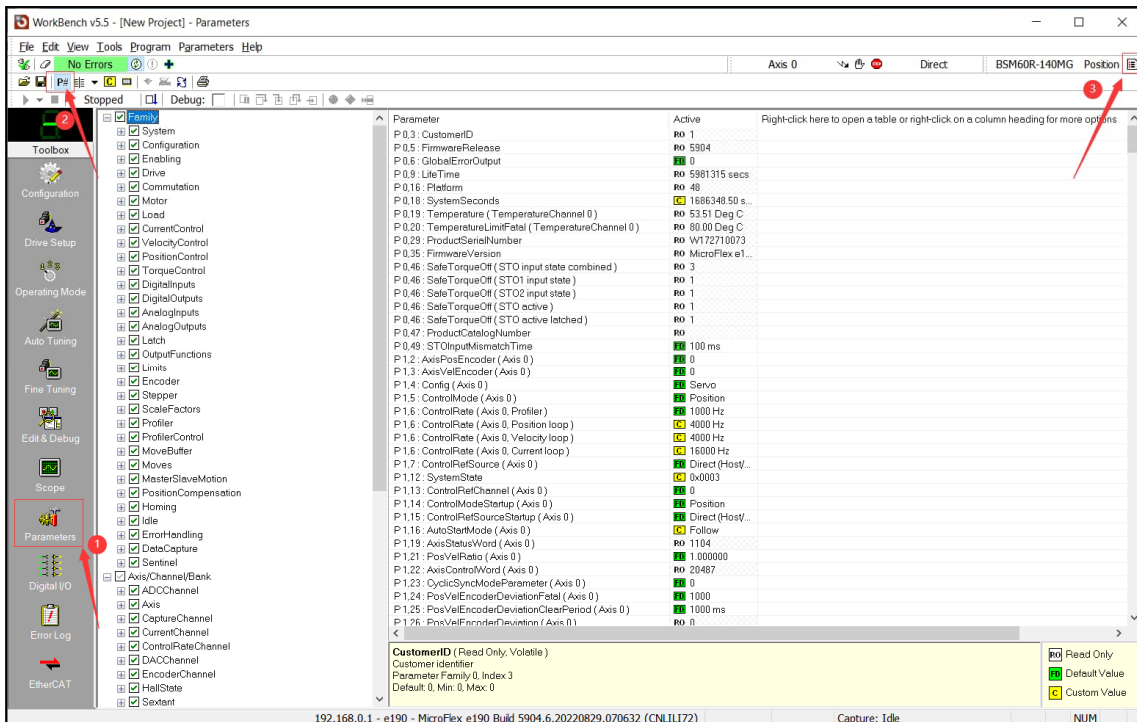


Figure 9

6. Considering that the PTO control mode is an open loop, the driver's status is unknown to the PLC/controller without additional wiring.
7. As a result, if you want to link the PLC to the drive, some digital output channels could be configured to achieve this. In the below example.

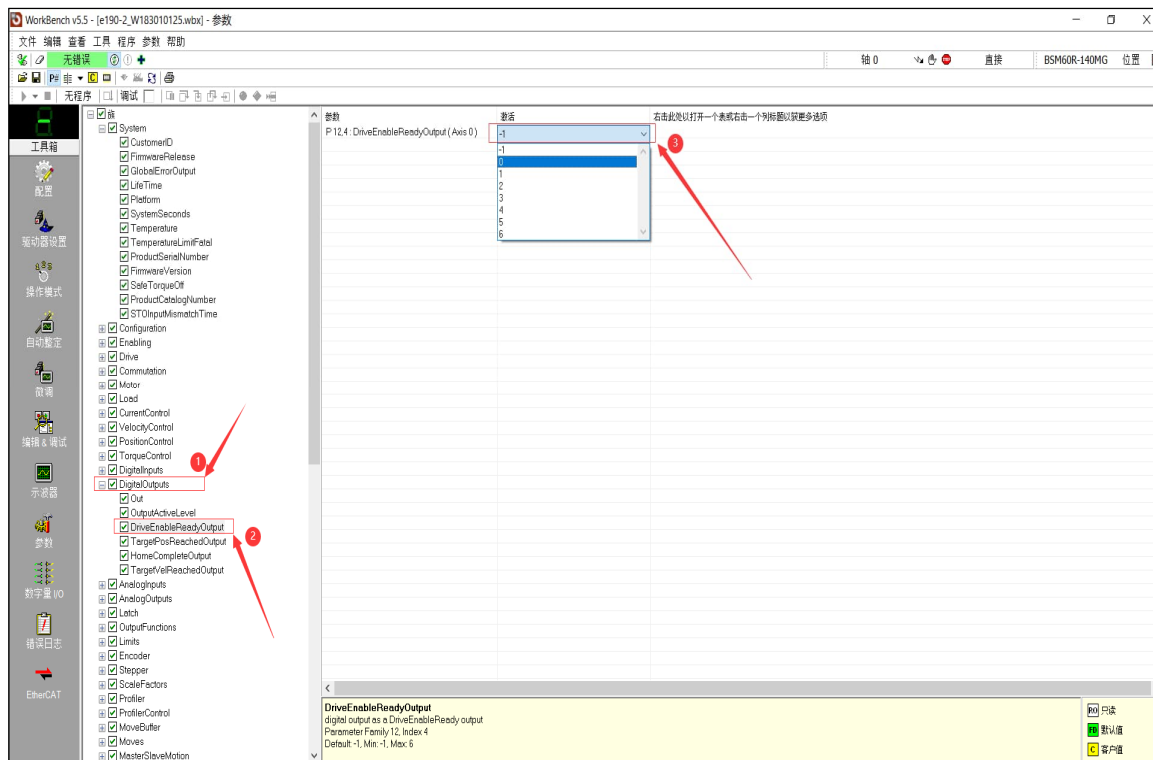


Figure 10

Table of useful parameters :

NO.	Parameter	Description	Outputs that can be selected
P0.6	GlobalErrOutput	Here we can define which Digital output is used as a global error output. This will allow the drive to show that it is in a state of error.	0-6*
P12.4	DriveEnableReadyOutput	Digital output used as signal of servo enable ready. The channel output is alternatively.	0-6*
P12.5	TargetPosReachedOutput	Digital output used as a TargetPosition Reached output. The channel output is alternatively.	0-6*
P12.6	HomeCompleteOutput	Digital output used as a Home completed signal output. The channel output is alternatively.	0-6*
P12.7	TargetVelReachedOutput	Digital output used as a Target Velocity Reach signal output. The channel output is alternatively.	0-6*

Table 2

*For e180 or e190 with OPT-SIO-01 fitted outputs 0-6 can be used. For standard e190 only 0-2.

Note: For more details on this the user can refer to the Mint Workbench help file.

8. open the Mint Workbench, and then select the relevant parameters settings. After the main parameters are all set, the application can be tested.

Understanding the follow modes

Firmware versions 5900 and above has two new options into the parameter of P26.12, "Follow Mode" which are useful for step and direction type applications. These are:

- 5 - "position with smooth filter"
- 6 - "position with average filter"

Note: The default setting for Step and Direction mode is "1 - no Ramp".

Both are useful for command position filtering. Use of these position command filters should be considered in following situations:

- The motion position command without the processing of acceleration and deceleration.
- The frequency of pulse command is low.
- The electronic Gear ratio is high.

To make these setting you can see the parameter selection below:

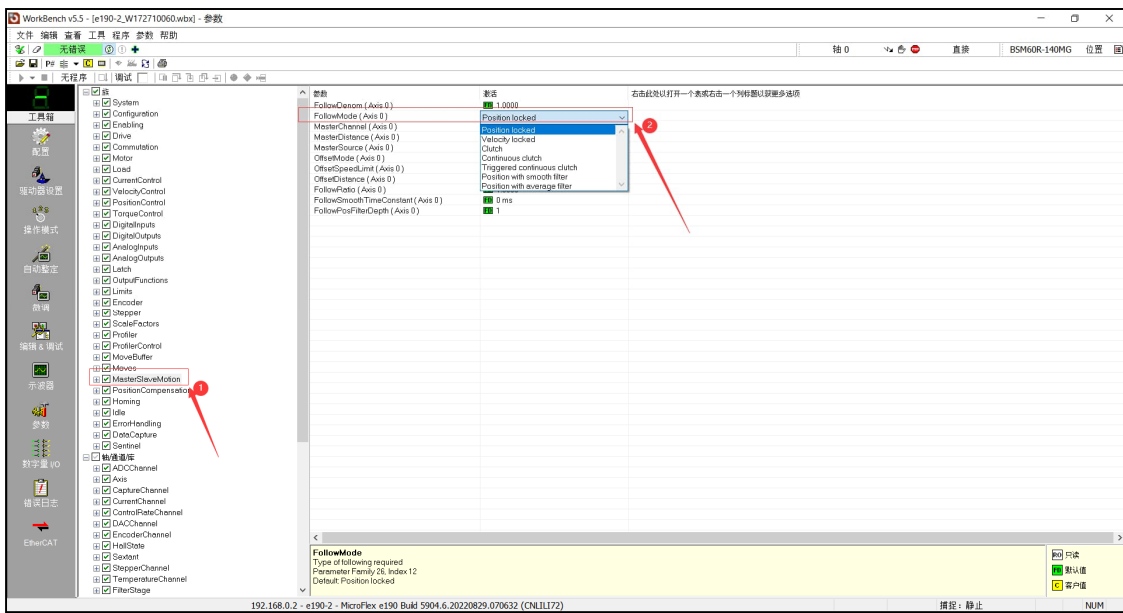


Figure 10

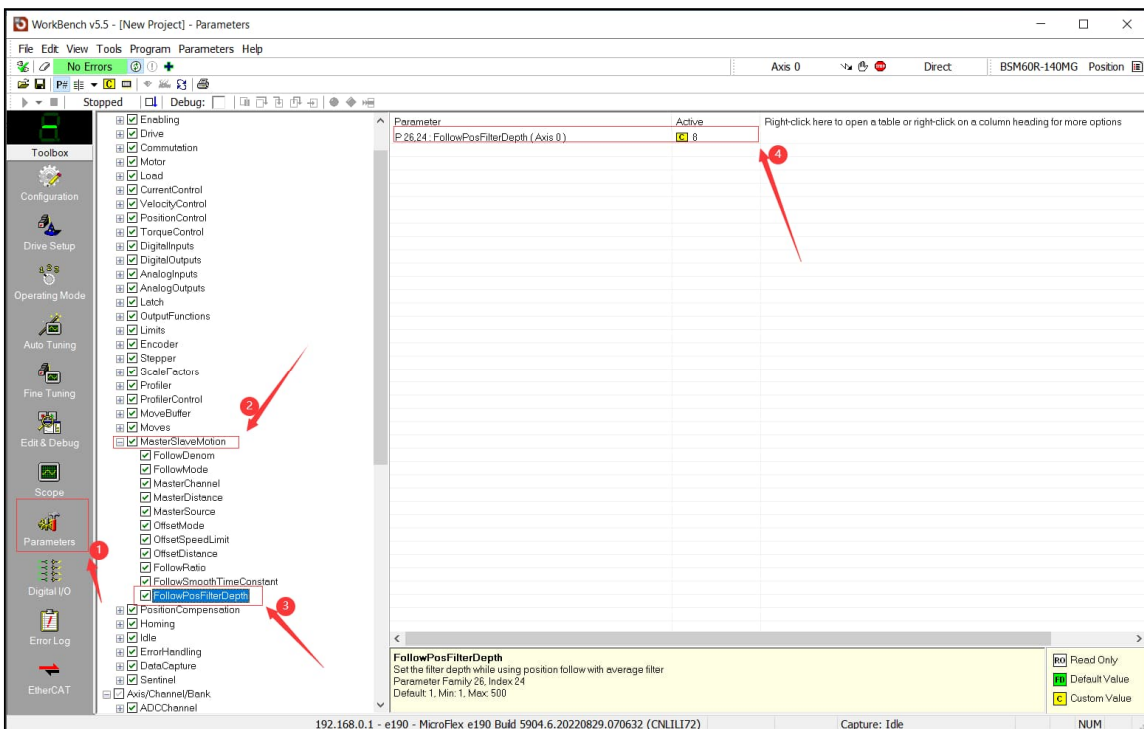


Figure 11

Position with smooth filter

This mode applies a time-based position command filter on pulse frequency to rise from 0 to 63.2% while position follow with smooth filter. To select this mode parameter P26.12 must be set to 5 - "position with smooth filter". The time in milliseconds can be set in Parameter P26.23. A diagram detailing this can be seen below.. For more details can refer to the helpfiles.

For example if FollowSmoothTimeConstant(0) = 600 ms then this will set the response time that the slave axis ramp to 62.3% of master velocity to 600 ms.

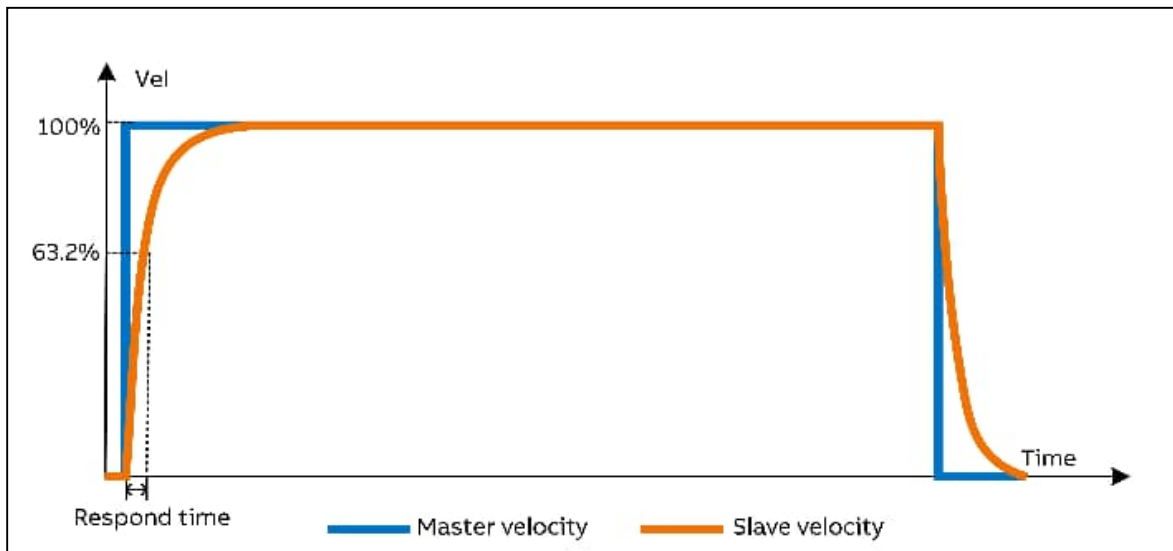


Figure12

Position with with average filter

This mode applies a sample-based position command filter based on number of samples used by an average filter. To select this mode parameter P26.12 must be set to 6 - "position with average filter".

For example, if parameter #P1.6 ControlRate(profiler) is 1kHz then the ramping time is 40/1000=0.04 seconds.

The number of samples can be set in Parameter P26.24. A diagram detailing this can be seen below. For more details can refer to the helpfiles.

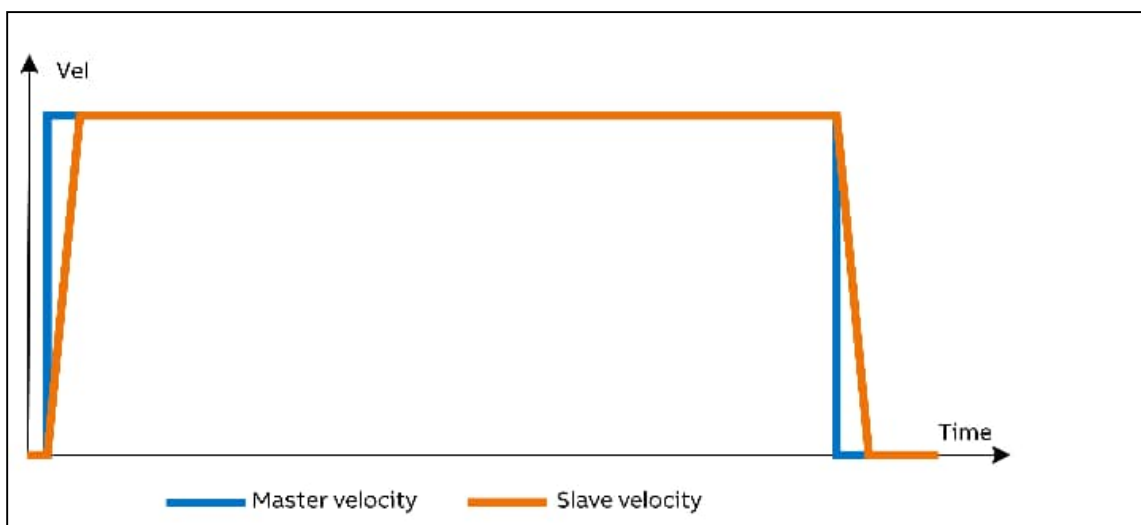


Figure13

Table of useful parameters

NO.	Parameter setting	Description
P1.16	AutoStartMode	Determines the mode of axis control after a power cycle. For PTO mode this is set as "4 -FollowMode".
P26.12	Follow Mode	Determines the methods of axis moving with PTI signals given. See earlier section "Understanding the follow modes"
P2.4	DriveEnableInputMode	Action in the event of the drive being disabled using the hardware enable. "Crash stop, disable, no error" is recommended.
P2.5	DriveEnableMode	Determines how the drive is enabled. "Hardware enable" should be selected here.
P2.7	DriveEnableInput	Digital input which is used as the Hardware drive enable input.
P19.8*	EncoderMode	Defines how the encoder channels will be used but "2 - step/direction" should be selected in here.
P19.13	EncoderType	Category of encoder device. "Rotary encoder" should be selected in here.
P19.25	EncoderOutChannel	Connects the emulated encoder output to a given encoder channel. The option depends on the wire diagram.
P21.4	ScaleFactor	Relationship between user position units and PTI encoder counts. Set according to the application requirements. *
P26.14	MasterChannel	Channel of a PTI source used for following. Master source is "encoder", and the channel should be set according to application requirements.
P26.22	FollowRatio	Following gear ratio used when automatically starting up in follow mode. Set according to the application requirements.

Table 3

*User can select which channel based on the used PTI interface (Channel 1 = 24v and Channel 2 = 5v)

Debugging

You need the following to complete the debugging of your application:

- Installing Mint Workbench build 5866 or later to configure the debug servo drive
- For example, Installing Automation Builder programming software to configure, program, and debug AC500 series PLC.
- A MicroFlex e190 or MotiFlex e180 drive with built-in firmware of 5868.7.0 or higher, according to AN00250, the manual driver tuning application describes tuning and configuring position control, and this manual uses the example of a BSM60R-140MG motor for the e190 series of drives.
- Correct hardware installation, wiring.
- The premise of debugging is that we assume that users already have a general grasp and understanding of our software Mint WorkBench and AutomationBuilder.

Verification

It is necessary to verify whether the parameter settings are correct, as a result, we can monitor the values of the application. If the number of the encoder increments is equal to the pulses sent by controller, the parameter settings generally are correct or else we should make sure parameter settings meet the requirement.

For example, below, in the interface of the Scope, we can select the “monitor” section. Then, add the “Encoder” and the channel relatively to the window. When the “trigger” icon is activated, the value can be read in real-time.

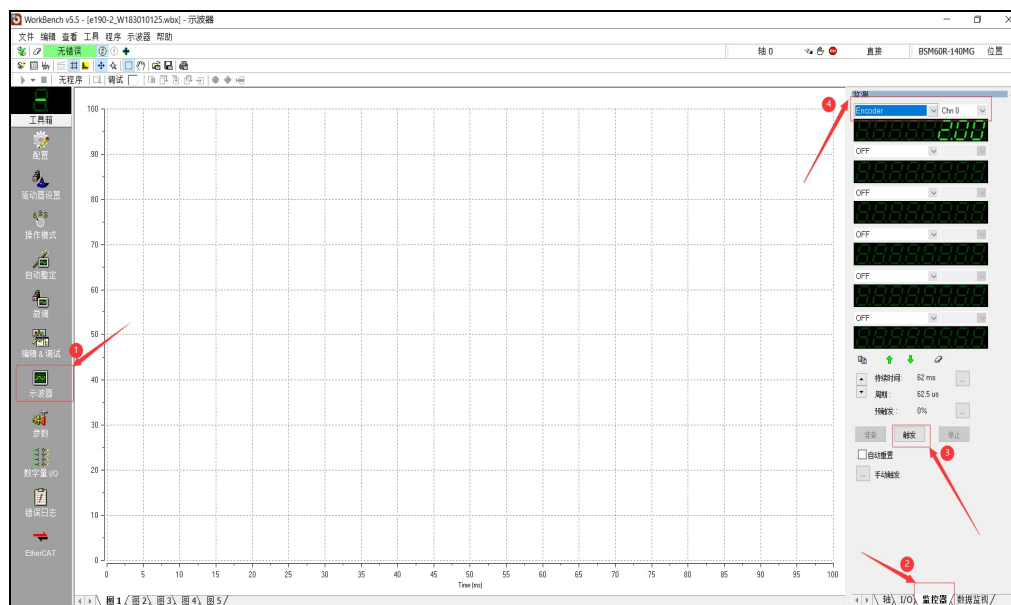


Figure 14

Contact us

For more information, please contact your local ABB representative or one of the following:

new.abb.com/drives/low-voltage-ac/servo-products
new.abb.com/drives
new.abb.com/drivespartners
new.abb.com/PLC

© Copyright 2022 ABB. All rights reserved.
 Specifications subject to change without notice.