stepIM

Integrated Closed Loop Stepper Motor

Technical Training Manual

Manual Revision: 1.0
Firmware Version: 0.0.2.89
Software Version: 1.41.6.0

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Revision History

Document Revision	Date	Remarks
1.0	Aug. 2016	Initial release

Firmware Revision	Software (GUI) Revision
0.0.2.89	1.41.6.0

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Technical Support

If you need assistance with the installation and configuration of the stepIM drive, contact Servotronix technical support: tech.support@servotronix.com

Contents

1 Introduction to stepIM Demo Kit

1.1 Training Resources

Only essential background information is included in this training manual. For more details and explanations about the stepIM hardware and software systems, use the following resources:

- **stepIM User Manual**. Hardware installation, configuration and operation.
- **stepIM CANopen Reference Manual**. Parameters and commands used to program the CDHD.
- **stepIM ServoStudio Reference Manual**. Software (graphic interface) for configuring, operating and tuning the drive.
- **Online Help**.

  The **Help** button in the ServoStudio toolbar or **F1** opens the online help.

  Alternately, right-click on any screen or screen element, and select the **Help** option to access relevant information.

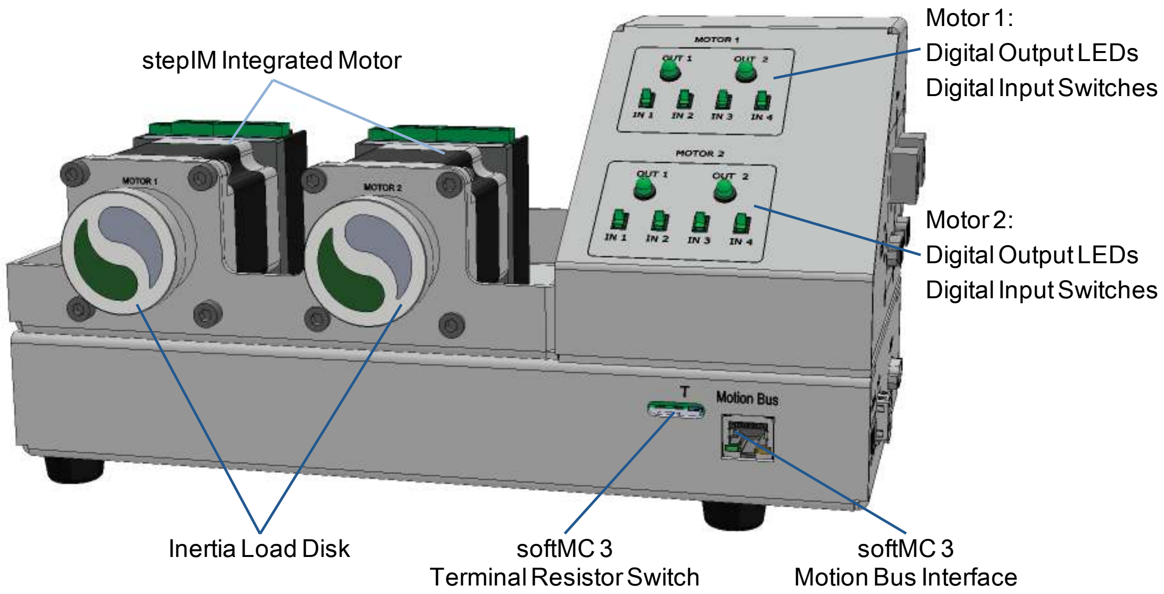
1.2 Demo Kit Components

The stepIM Demo Kit showcases the performance and functionality of the stepIM servo drive. The portable unit can be easily carried and used at demonstration and training sites.

The stepIM Demo Kit consists of two stepIM motors with integrated servo drive, a motion controller (optional), and a number of elements that emulate external inputs, outputs, and communication interfaces.

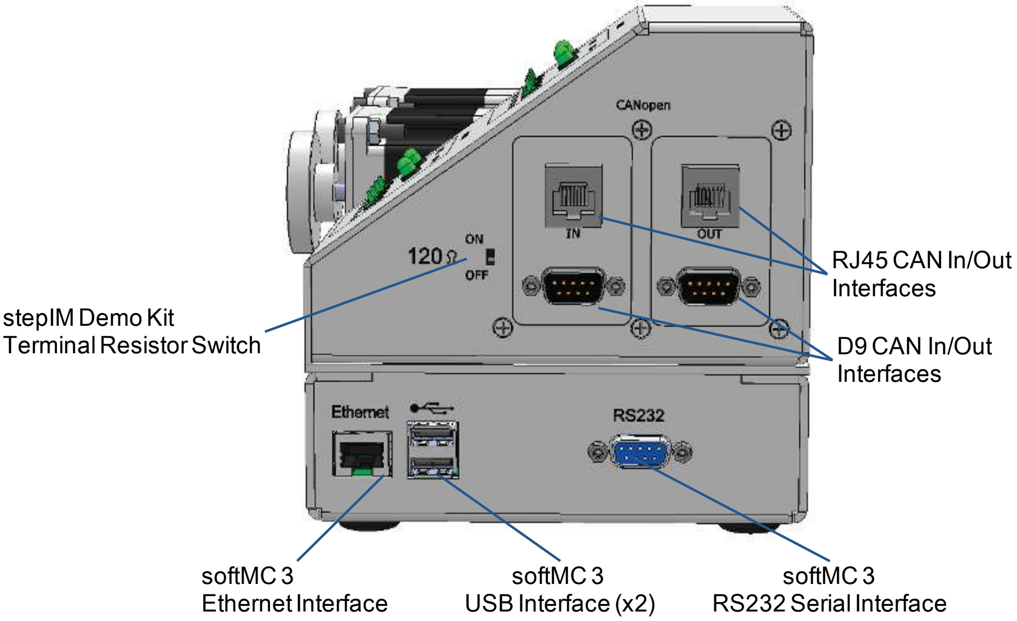
This training manual will guide you through a series of exercises in which you will use the Demo Kit, along with ServoStudio software, and learn how to properly configure, program and operate the stepIM drive.

Note: The tutorials in this manual do not use the softMC 3 motion controller.



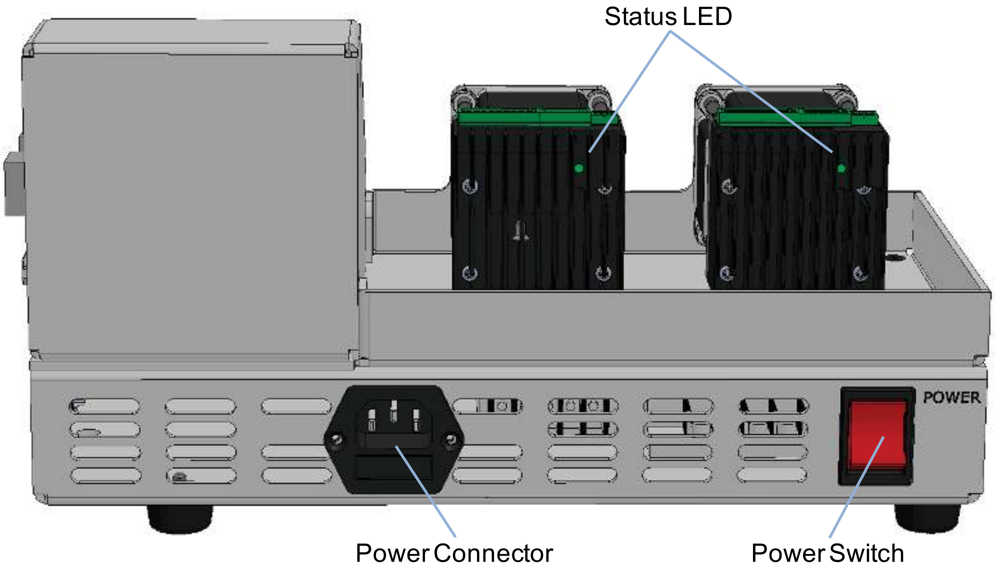
Demo Kit – Front

Component	Description
stepIM (x2)	Motor with integrated servo drive
Inertia Load Disk	Aluminum disk connected to the motor shaft
Digital Outputs	2 green LEDs per **stepIM**, labeled OUT1, OUT2
Digital Inputs	4 switches with green LED per **stepIM**, labeled IN1, IN2, IN3, IN4
softMC 3 Terminal Resistor Switch	*Not used in this training manual.*
softMC 3 Motion Bus Interface	*Not used in this training manual.*



Demo Kit – Side

Component	Description
stepIM Demo Kit Terminal Resistor Switch	
RJ45 CAN In/Out Interfaces	
D9 CAN In/Out Interfaces	
softMC 3 Ethernet Interface	*Not used in this training manual.*
softMC 3 USB Interface (x2)	*Not used in this training manual.*
softMC 3 RS232 Serial Interface	*Not used in this training manual.*



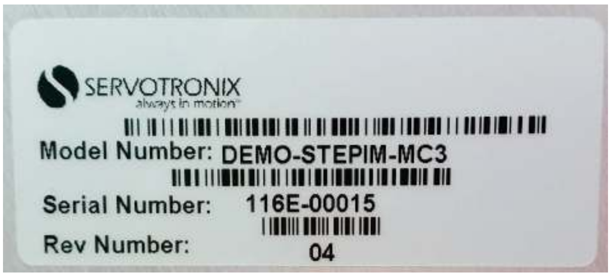
Demo Kit – Rear

Component	Description
Status LEDs	
Power Switch	Powers demo kit and all components in the unit.
Power Connector	Plug for connecting AC power to unit.

Demo Kit – Product Label

Note the location of the product label on the back of the stepIM Demo Kit.

If you require technical support, you must provide this information to the support team.



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Model Number: DEMO-STEPIM-MC3

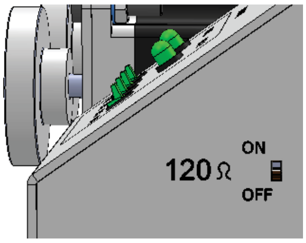
Serial Number: 116E-00015

Rev Number: 04

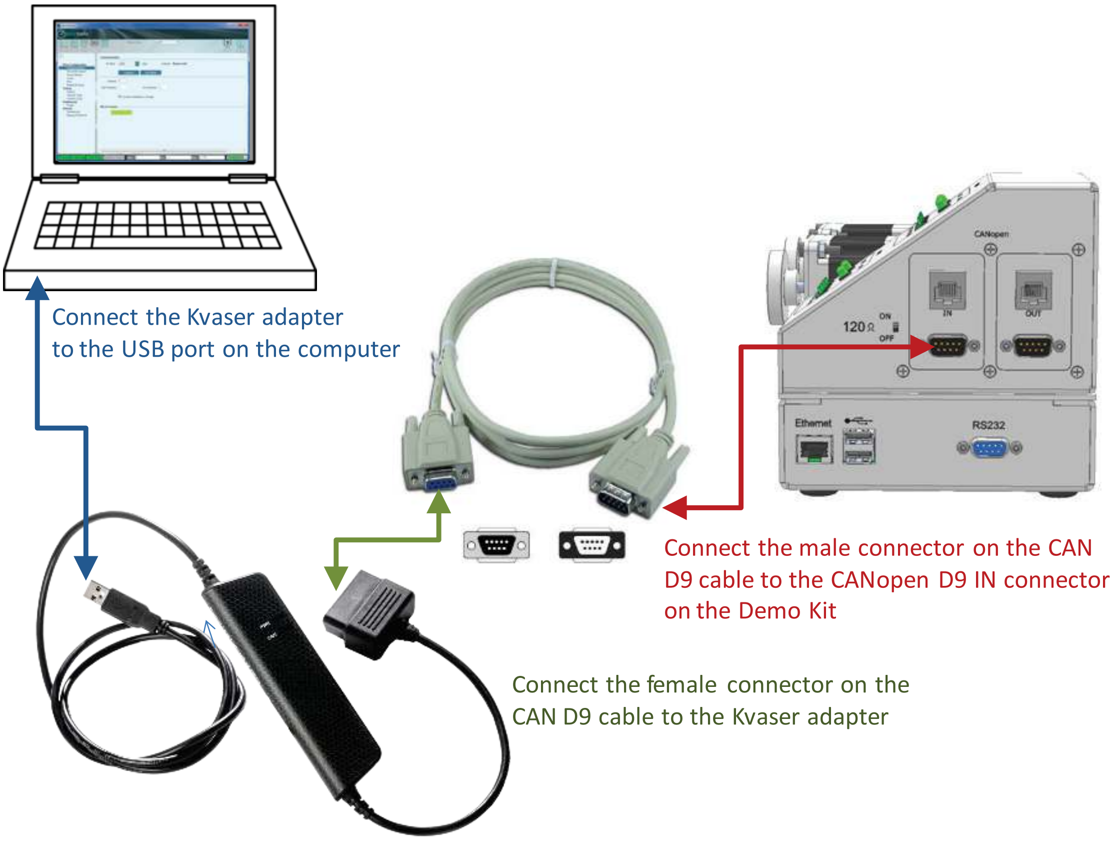
2 Cable Connections

Exercise

1. Note the location of the power connector and power switch on the rear side of the stepIM Demo Kit.
2. Before turning on power, make sure all input switches on the front panel of Demo Kit are set to the **Off** position.
3. Make sure the 120Ω terminal resistor switch on the side of the Demo Kit is set to the **On** position.



4. Using the power cable supplied with the unit, connect the Demo Kit to the power supply.
5. Refer to the the diagram below, and complete the cable connections, as described in the following steps.



Connect the Kvaser adapter to the USB port on the computer

Connect the male connector on the CAN D9 cable to the CANopen D9 IN connector on the Demo Kit

Connect the female connector on the CAN D9 cable to the Kvaser adapter

6. Kvaser Leaf Light (EAN:73-30130-00685-00) is a CAN-USB adapter used to connect the stepIM and the host computer to enable communication between the drive and ServoStudio software.

   If the Kvaser driver has not yet been installed on the host computer, download and install the software from the Kvaser website, and install the driver according to the on-screen instructions.

7. Connect the male connector on the CAN D9 cable to the CANopen bus IN connector on the Demo Kit.

8. Connect the female connector on the CAN D9 cable to the Kvaser adapter.

9. Connect the Kvaser adapter 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.
   - Make sure the Kvaser adapter **PWR** green LED is lit.

10. Turn on the Demo Kit power switch.

    You should now see a blinking green LED on the back of each stepIM.

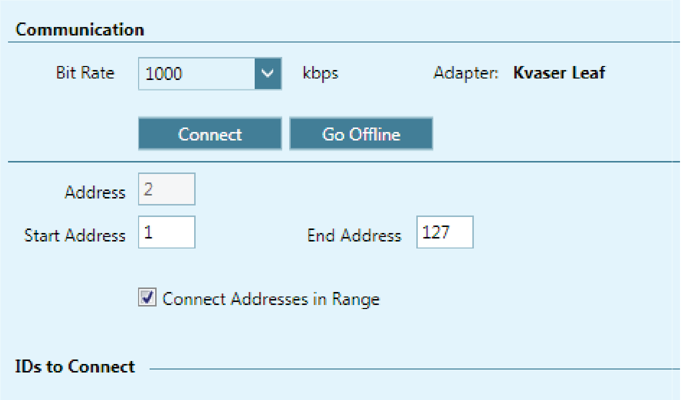
3 Communication

Exercise

1. Activate ServoStudio software.
2. If the ServoStudio has not yet been installed on the host computer, download and install the software from this link:
   http://www.servotronix.com/CDHD.html > Software | ServoStudio GUI
3. From the ServoStudio navigation sidebar, click **Preferences**. Then select the **Advanced** tab**.**

   Make sure **CANopen Device** is set to **Kvaser Leaf**.
4. From the ServoStudio navigation sidebar, select **Communication**.

   The **Communication** screen is displayed.



Communication

Bit Rate 1000 kbps Adapter: Kvaser Leaf

Connect Go Offline

Address 2

Start Address 1 End Address 127

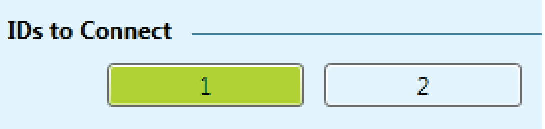
☑ Connect Addresses in Range

IDs to Connect

5. Select **Connect Addresses in Range**, and press **Connect.**

   At the prompt, click **OK**.

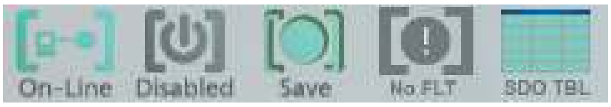
   Wait for the software to identify the connected drives:



IDs to Connect

1 2

6. You should now see the **On-Line** button in the menu bar.



Exercise

The stepIMs on the Demo Kit are preset to address nodes 1 and 2.

You can establish communication faster by limiting the address range.

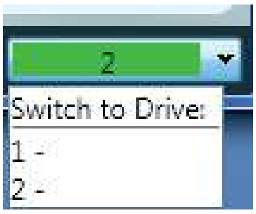
1. Disconnect and then reconnect the Kvaser cable from the computer.
2. Change the **End Address** value to **2**, and press **Connect**.

   Note how quickly the address nodes are detected.
3. You should now see that the Kvaser adapter **CAN** orange LED blinks, indicating communication between the computer and the stepIMs is established.

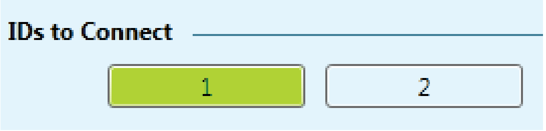
Exercise

Multiple stepIMs can be accessed through the same instance of ServoStudio provided they are all on the same CANopen network. However, ServoStudio can communicate with only one drive at a time.

1. To select a drive, use the **Switch to Drive** menu in the status bar at the bottom of the screen.



2. You can also select a drive by clicking on the drive's node ID in the Communication screen.

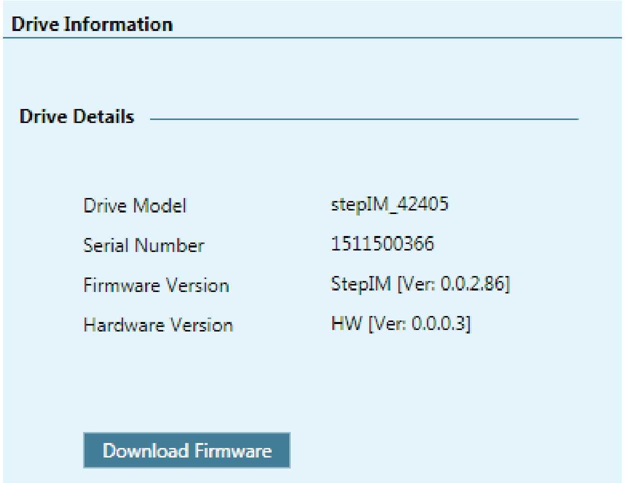


4 Drive Information

Exercise

1. From the ServoStudio navigation sidebar, select **Drive Information**.

   The **Drive Information** screen is displayed.



Drive Information

Drive Details

Drive Model	stepIM_42405
Serial Number	1511500366
Firmware Version	StepIM [Ver: 0.0.2.86]
Hardware Version	HW [Ver: 0.0.0.3]

2. Check the drive details for each stepIM in the Demo Kit.
3. For each stepIM, make a copy of the drive details.

   If you require technical support, you must provide this information to the support team.

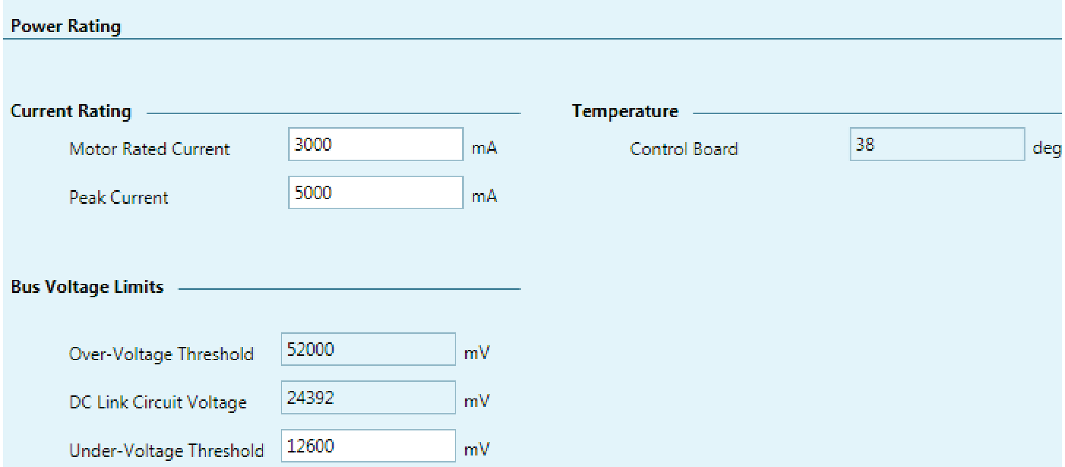
The **Download Firmware** button in the Drive Information screen allows you to update drive firmware in the stepIM. *It is not used in this training manual*.

5 Power Rating

Exercise

1. From the ServoStudio navigation sidebar, select **Power Rating**.

The **Power Rating** screen is displayed.



Power Rating

Current Rating

Motor Rated Current 3000 mA

Peak Current 5000 mA

Temperature

Control Board 38 deg

Bus Voltage Limits

Over-Voltage Threshold 52000 mV

DC Link Circuit Voltage 24392 mV

Under-Voltage Threshold 12600 mV

2. Check the power rating details for each stepIM in the Demo Kit.

Note: You should not change any of the values displayed in this screen, even though some of them can be manipulated.

Exercise

Answer the following questions:

- What is the DC voltage that is being applied to the motor?
- What is the temperature of the control board?
- Refer to the User Manual. What is the temperature value that will result in an over-temperature error.

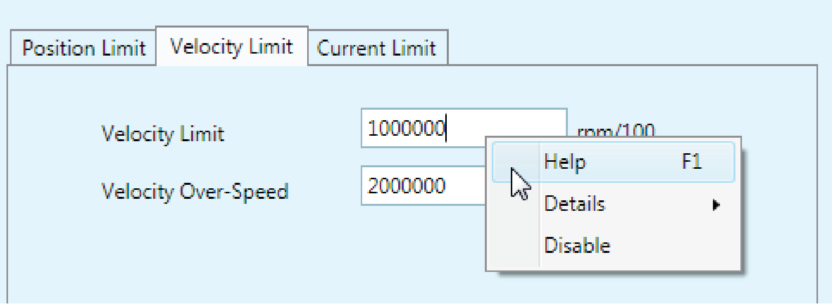
Refer to *Answers to Exercises* at the end of this manual.

6 Limits

1. From the ServoStudio navigation sidebar, click **Limits**.

   The **Limits** screen is displayed.

2. View the various tabs in this screen. Right-click in parameter fields, and use the information from Help and/or Details to answer the questions in the following exercises.



Velocity Limit 1000000 rpm/100

Velocity Over-Speed 2000000

Exercise – Velocity Limits

- What is the index of the CANopen object for Velocity Limit?
- What is the default value of the velocity limit, in hexadecimal format?
- What is the default value in decimal format?

Exercise – Position Limits

- What are the three methods that can be used to define position limits?

Exercise – Current Limits

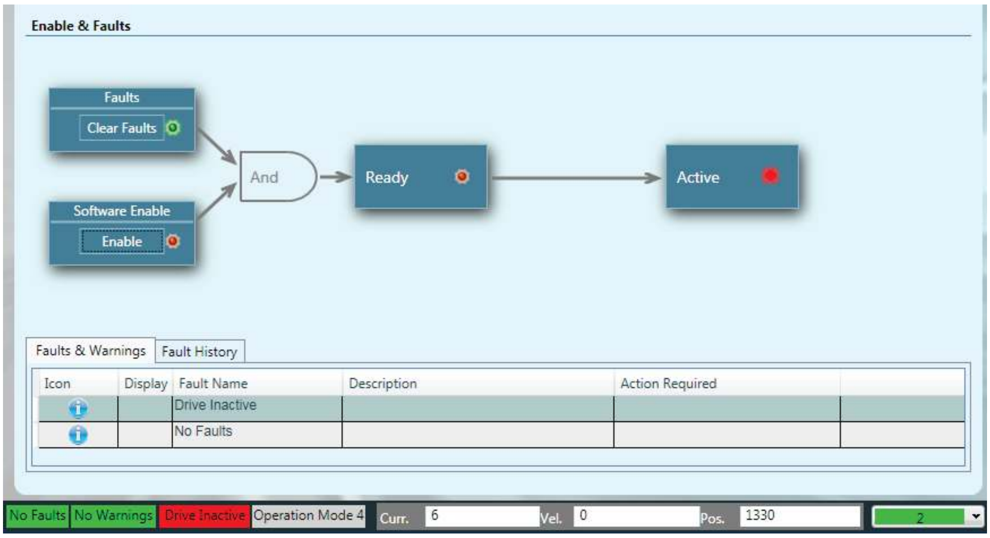
- What is the index of the CANopen object for Motor Peak Current?
- What is the index of the CANopen object for Motor Rated Current?

Refer to *Answers to Exercises* at the end of this manual.

7 Enable & Faults

The **Enable & Faults** screen graphically shows the conditions required for the drive to be enabled. As long as any light in the diagram is red, the drive remains disabled. When all lights are green, the drive is enabled.

The **Faults|No Faults** segment of the status bar at the bottom of every ServoStudio screen is **green** as long as no faults exist; it is **red** whenever a fault exists.

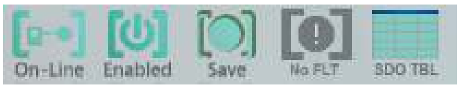


Icon	Display	Fault Name	Description	Action Required
ⓘ		Drive Inactive		
ⓘ		No Faults		

No Faults | No Warnings | Drive Inactive | Operation Mode 4 | Curr. 6 | Vel. 0 | Pos. 1330 | 2

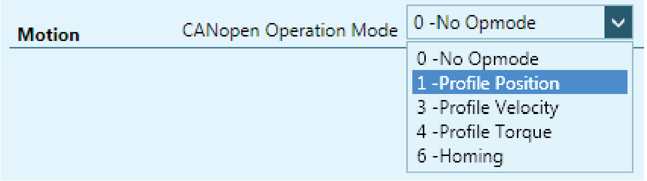
After a fault condition is removed, the fault remains latched until cleared by any of the following methods:

- Click the **Faults|Clear Faults** button
- Click the **Software Enable|Enable** button
- Right-click the **Faults|No Faults** segment of the status bar
- Click the **Enable|Disable** button in the menu bar to toggle to the enabled stated.



Exercise

1. Make sure drive is **online** and **disabled**.
2. From the ServoStudio navigation sidebar, select **Motion**.
3. Set the CAN Operation mode to **1-Profile Position**.



Motion

CANopen Operation Mode: 0 -No Opmode

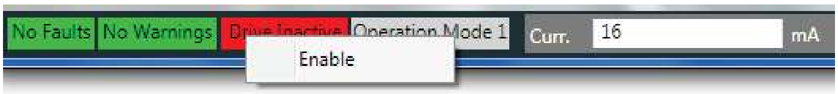
4. Gently take hold of the load disk of the motor that is currently communicating with the software, and attempt to turn it back and forth.

The disk moves easily when the drive is disabled.

5. Click the **Enable|Disable** button in the menu bar to enable, and then disable the drive.

Take hold of the load disk and make sure the drive is disabled.

6. Right-click on the red **Drive Inactive** segment in the status bar, and then click **Enable**.



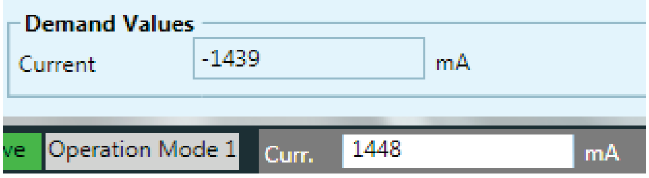
Curr. 16 mA

All indicators in the screen should now be green.

7. Again, take hold of the inertia load disk of the motor that is communicating with the software, and attempt to turn it back and forth.

You should feel the disk resisting manual movement when the drive is enabled.

Observe the values of the **Current Demand** and the **Actual Current**.



Current -1439 mA

Curr. 1448 mA

8. Let go of the disk. Disable and enable the drive, and observe the change in the current values.

8 Basic Operation – Profile Position

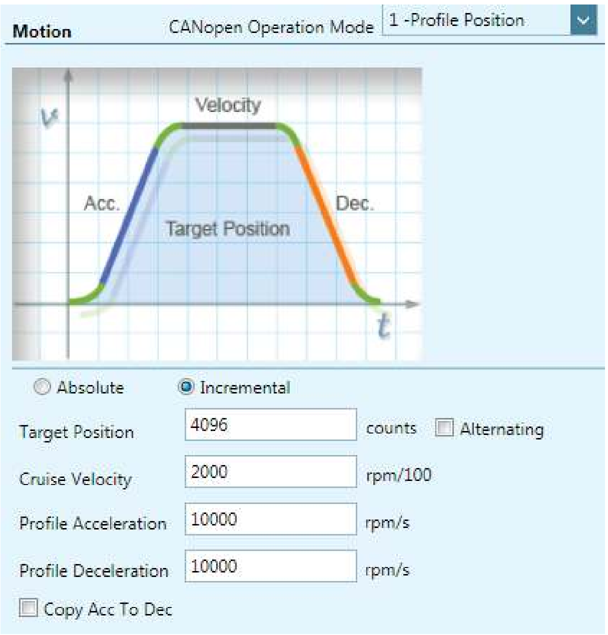
An incremental command moves the motor the specified number of counts from its current location.

An absolute command moves the motor the specified number of counts from the encoder 0 position.

The stepIM encoder has a resolution of 4096 counts (pulses) per revolution.

Exercise – Incremental Position Command

1. Make sure drive is online and disabled.
2. From the ServoStudio navigation sidebar, select **Motion**.
3. Set the Operation mode to **1-ProfilePosition**.
4. Enable the **Incremental** option.



CANopen Operation Mode: 1 -Profile Position

○ Absolute ● Incremental

Target Position: 4096 counts □ Alternating

Cruise Velocity: 2000 rpm/100

Profile Acceleration: 10000 rpm/s

Profile Deceleration: 10000 rpm/s

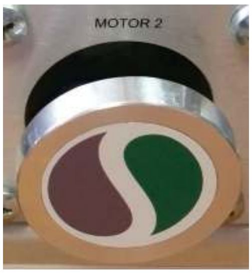
□ Copy Acc To Dec

5. Define an incremental motion command that will move the motor one revolution (4096 counts) at a speed of 20 rpm (2000 rpm/100).

   Enter the parameter values as shown in the screen above.

   - Target Position: **4096**
   - Cruise Velocity: **2000**
   - Profile Acceleration: **10000**
   - Profile Deceleration: **10000**

6. Manually move the motor load disk so that the graphic element is at a clearly defined position, as shown in the image below. This will make it easy to visually detect and count each revolution of the motor.



7. Enable the drive.
8. Click the **Start** button to start motion, and observe the motor load disk.
9. After motion stops, enable the **Alternating** option.
10. Click **Start** to execute the command. At the end of the movement, press Start again. Repeat several times, and observe the result.

    This option is useful for applications requiring back and forth motions.
11. Clear the **Alternating** option.
12. Increase Cruise Velocity to 200 rpm (20000 rpm/100), and click **Start**. Note the increase in speed.
13. Reduce Cruise Velocity to 50 rpm (5000 rpm/100).
    Change Target Position to 40960 counts (ten revolution).
    Click **Start**, and observe the result. Count the revolutions.

Exercise – Absolute Position Command

1. Enable the **Absolute** option.
2. Define an absolute motion command that will move the motor to the position **102400** encoder counts. Cruise velocity can remain as defined previously.
3. Click **Start** to execute the command. Observe the encoder count value at the bottom of the screen. Motion stops when the count reaches 102400.
4. Now, move the motor to position 0 (counts) in exactly one minute.

   Enter the parameter values as follows.

   - Target Position: **0**
   - Cruise Velocity: **2500** (102400/4096 = 25 revolutions/minute)
   - Profile Acceleration: **10000**
   - Profile Deceleration: **10000**
5. Keep on eye on a watch or timer, and press **Start**.
6. Motion will stop when the count reaches 0, and one minute has elapsed.

9 Basic Operation – Velocity

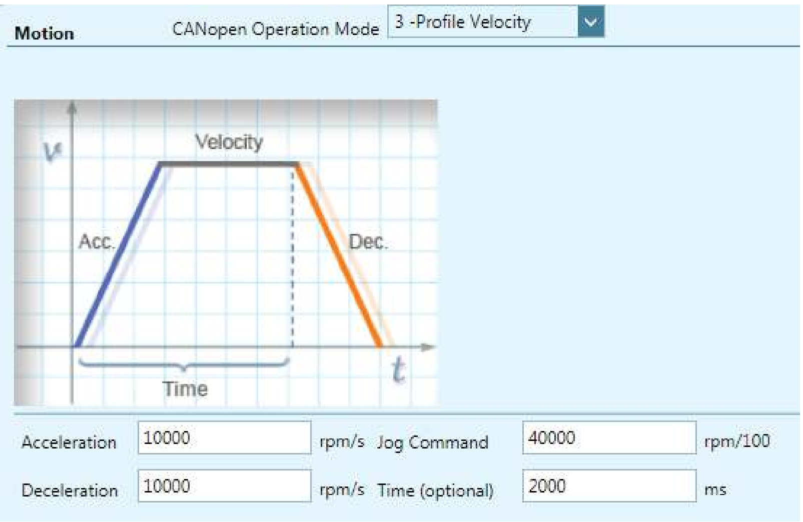
Note: The drive must be disabled whenever the operation mode is changed.

Exercise – Velocity Jog Command

1. Make sure drive is online and disabled.
2. From the ServoStudio navigation sidebar, select **Motion**.
3. Set the Operation mode to **3-Profile Velocity**.
4. Define a velocity Jog command that will move the motor at a speed of 400 rpm for 2 seconds.

   Enter the parameter values as shown in the screen below.

   - Profile Acceleration: **10000**
   - Profile Deceleration: **10000**
   - Jog Command: **40000**
   - Time: **2000**



Motion

CANopen Operation Mode: 3 -Profile Velocity

Acceleration: 10000 rpm/s

Jog Command: 40000 rpm/100

Deceleration: 10000 rpm/s

Time (optional): 2000 ms

5. Enable the drive.
6. Click the **Start** button to start motion, and observe the motor load disk.

7. Modify the parameter values as shown in the screen below.
   - Profile Acceleration: **1000**
   - Profile Deceleration: **1000**
   - Jog Command: **5000**
   - Time: **10000**

8. Click the **Start** button to start motion, and immediately take hold of the inertia load disk, and attempt to hold it in place.

Observe the **Demand** and the **Actual** current values.
Note how the current increases in an attempt to overcome the obstacle and complete the motion.

9. Changing the Jog command to a negative value: **-60000**

Leave the Time field blank.

10. Click the **Start** button to start motion.

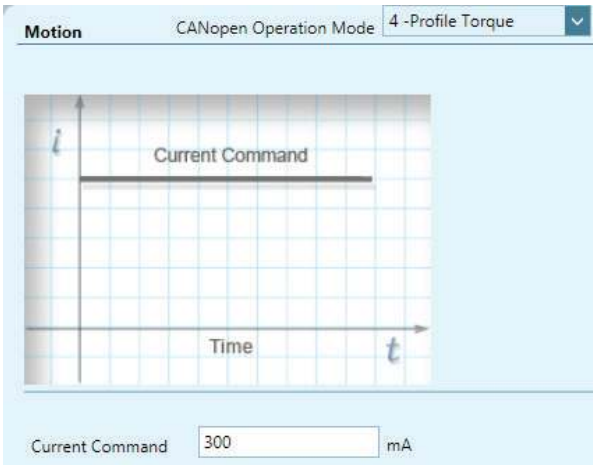
11. After several moments, press **Stop**.

10 Basic Operation – Torque

Note: The drive must be disabled whenever the operation mode is changed.

Exercise – Velocity Jog Command

1. Make sure drive is online and disabled.
2. From the ServoStudio navigation sidebar, select **Motion**.
3. Set the Operation mode to **4-Profile Torque**.



Motion

CANopen Operation Mode: 4 -Profile Torque

Current Command: 300 mA

4. Define a Current command of 300 mA, as shown in the screen above.
5. Enable the drive.
6. Click the **Start** button to start motion.
7. While the motor is turning, take hold of the load disk, and observe the effect.

Your grasp should be sufficient to halt the movement of the disk. You will feel little or no resistance of the disk since torque operation does not utilize a servo control loop.

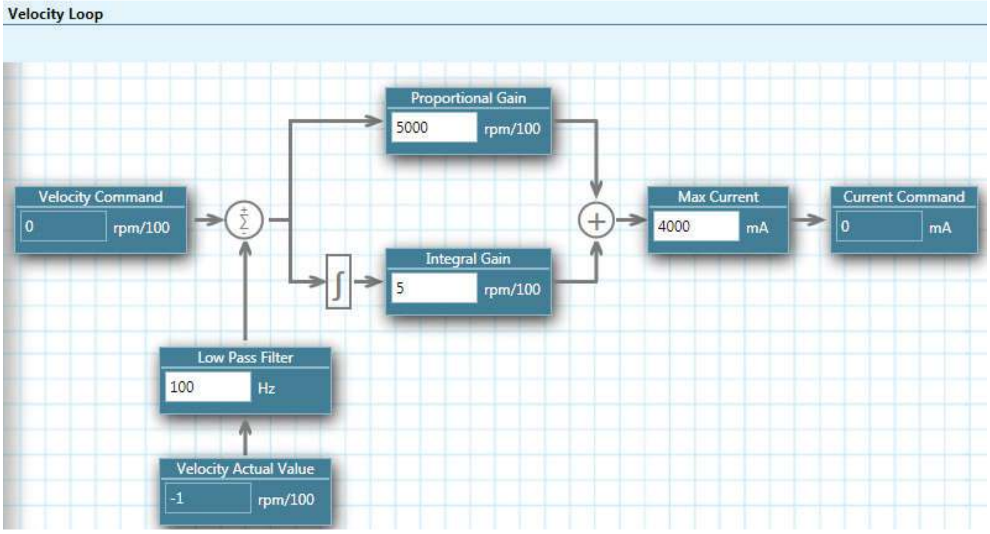
Observe the **Demand** and the **Actual** current values. The values do not change.

8. After several moments, press **Stop**.

11 Velocity Control Loop

Exercise

From the ServoStudio navigation sidebar, select **Velocity Loop**.



Velocity Command 0 rpm/100

Proportional Gain 5000 rpm/100

Integral Gain 5 rpm/100

Low Pass Filter 100 Hz

Velocity Actual Value -1 rpm/100

Max Current 4000 mA

Current Command 0 mA

This screen shows the settings for the PID velocity control loop.

These values are predefined by the manufacturer for the Demo Kit.

Do not change any of the values in this field, even if they can be manipulated.

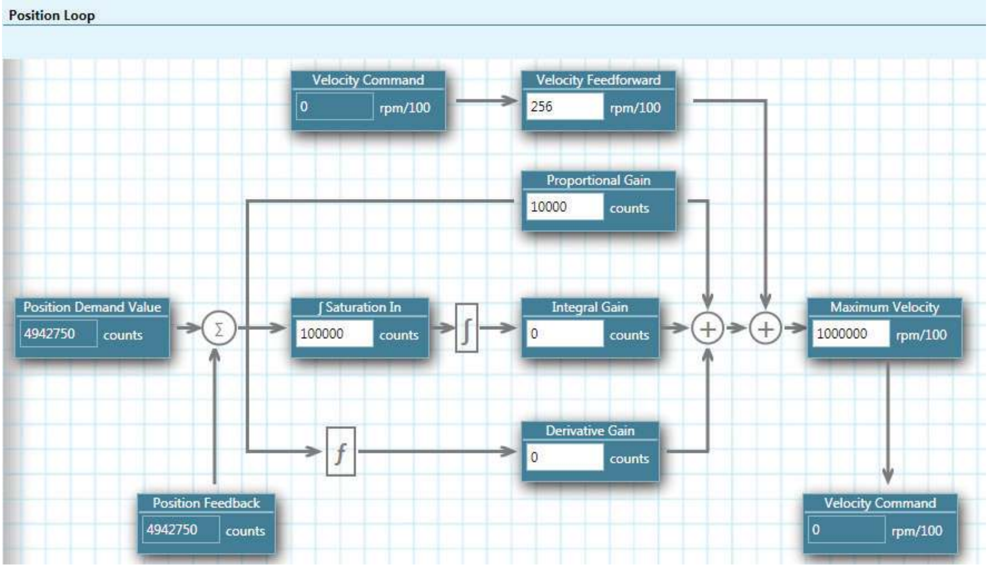
If you have any issues or problems, make sure the values on your screen are the same as the ones shown here.

If you type in a parameter value, the field turns blue, and you must press Enter to send the value to the drive RAM. To save parameters in the drive's non-volatile memory, you must also press the **Save** button in the menu bar.

12 Position Control Loop

Exercise

From the ServoStudio navigation sidebar, select **Position Loop**.



Position Loop

Velocity Command: 0 rpm/100

Velocity Feedforward: 256 rpm/100

Proportional Gain: 10000 counts

Position Demand Value: 4942750 counts

∫ Saturation In: 100000 counts

Integral Gain: 0 counts

Maximum Velocity: 1000000 rpm/100

Derivative Gain: 0 counts

Position Feedback: 4942750 counts

Velocity Command: 0 rpm/100

This screen shows the settings for the PID position control loop.

These values are predefined by the manufacturer for the Demo Kit.

Do not change any of the values in this field, even if they can be manipulated.

If you have any issues or problems, make sure the values on your screen are the same as the ones shown here.

If you type in a parameter value, the field turns blue, and you must press Enter to send the value to the drive RAM. To save parameters in the drive's non-volatile memory, you must also press the **Save** button in the menu bar.

13 Digital Inputs

The **I/Os** screen enables you to configure functionality and polarity of the digital inputs in your application, and to monitor the state of digital inputs

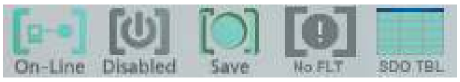
- **Mode** defines the functionality of the digital input or output.
- **Inversion** inverts the polarity of a digital input or output; simply click the option to invert the polarity.

  When **Inversion** option is set:

  - Input and Output LEDs in the software change color.
  - Output LEDs on the Demo Kit change color.
  - Input LEDs on the Demo Kit **do not change** except when the switch is actually toggled between on and off positions.

Exercise - Input as Remote Enable Switch

1. Make sure the drive is disabled.

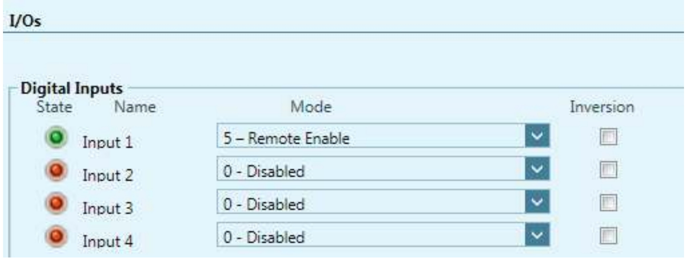


2. From the ServoStudio navigation sidebar, select **I/Os**.

   The **I/Os** screen is displayed.

   You will see that that all four digital inputs are set to **1-Disabled.**

3. Set Input 1 to **5-Remote Enable**.
4. On the Demo Kit, turn **on** switch **IN 1** and observe the effect:
   - The LED on the Demo Kit input turns green.
   - The LED graphic on the screen turns green.
   - The drive becomes enabled.



I/Os

Digital Inputs

State	Name	Mode	Inversion
●	Input 1	5 – Remote Enable	□
●	Input 2	0 - Disabled	□
●	Input 3	0 - Disabled	□
●	Input 4	0 - Disabled	□

5. On the Demo Kit, turn **off** switch **IN 1** and observe the effect:
   - The LED on the Demo Kit input turns red.
   - The LED graphic on the screen turns red.
   - The drive becomes disabled.

6. Leave the switch off, and select the **Inversion** option to invert the polarity of the input:

   - The LED graphic turns green.
   - The drive becomes enabled.

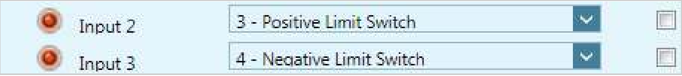
   Note that the LED on the Demo Kit input switch does not change states when Inversion is selected.

7. Clear the **Inversion** option.

Exercise - Input as Position Limit Switch

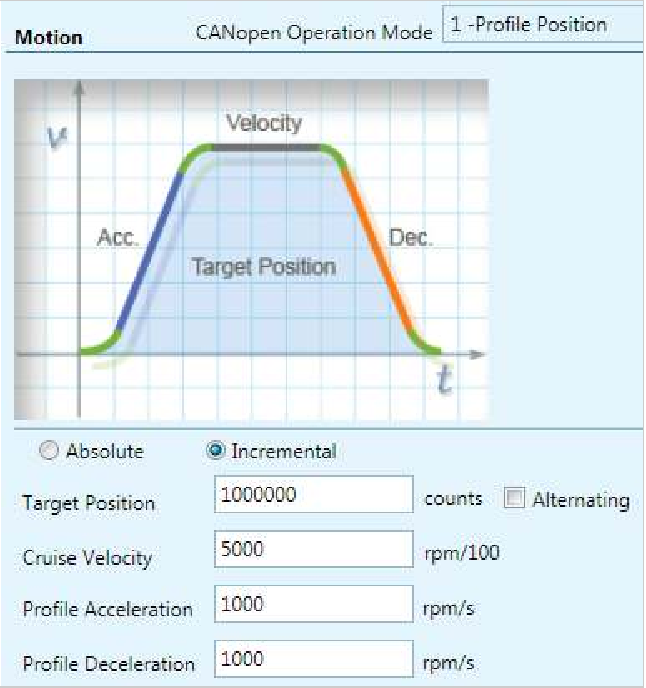
An input can be defined as a limit switch.

1. Make sure switch **IN 2** and switch **IN 3** are **off**, and the drive is enabled.
2. In the Digital I/Os screen, set Input 2 Mode to **Positive Limit Switch**. Set Input 3 to **Negative Limit Switch.**



● Input 2	3 - Positive Limit Switch	□
● Input 3	4 - Negative Limit Switch	□

3. Go to the **Motion** screen, select operation mode **Profile Position**, and reenable the drive.
4. Define a movement using the settings shown in the screen below.



Motion CANopen Operation Mode 1 -Profile Position

○ Absolute ● Incremental

Target Position	1000000	counts	□ Alternating
Cruise Velocity	5000	rpm/100	
Profile Acceleration	1000	rpm/s	
Profile Deceleration	1000	rpm/s	

5. Enable the drive and press **Start** to start the movement.

   - While the motor is in motion, turn **on** switch **IN 2**.
   - Observe the stopping of the motor. It stops immediately.
   - Turn off switch IN 2. Motion does not resume automatically. You must press **Start** again.

6. In the Motion screen, change the Target Position to a **negative** value, and press **Start**.

- While the motor is in motion, turn **on** switch **IN 3**.
- Observe the stopping of the motor. It stops immediately.
- Turn off switch IN 3. Motion does not resume automatically. You must press **Start** again.

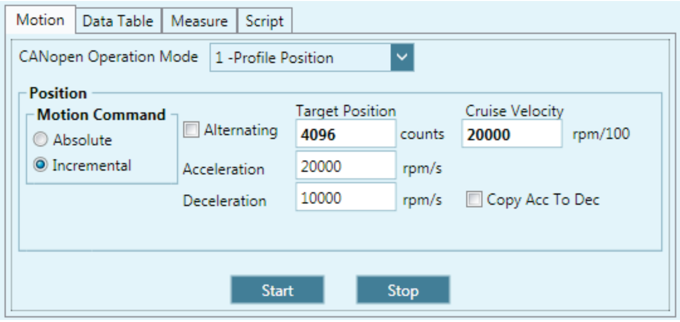
14 Recording

ServoStudio provides extensive recording and data graphing capabilities.

Recording can be set up to be triggered when a specified event or condition occurs. In addition, ServoStudio enables continuous data recording or a one-time recording. ServoStudio also allows execution of a motion command during recording. This is useful, and even necessary, as a tuning tool.

Exercise

1. Make sure drive is online and disabled.
2. From the ServoStudio navigation sidebar, select **Scope**.
3. In the Motion tab, enter the following settings:
   - CANopen Operation Mode: 1-Profile Position
   - Motion Command: Incremental
   - Target Position: 4096 counts
   - Cruise Velocity: 20000 rpm/100
   - Acceleration/Deceleration: 10000 rpm/s



CANopen Operation Mode: 1 -Profile Position

Position

Motion Command
○ Absolute
● Incremental

□ Alternating

Target Position: 4096 counts

Cruise Velocity: 20000 rpm/100

Acceleration: 20000 rpm/s

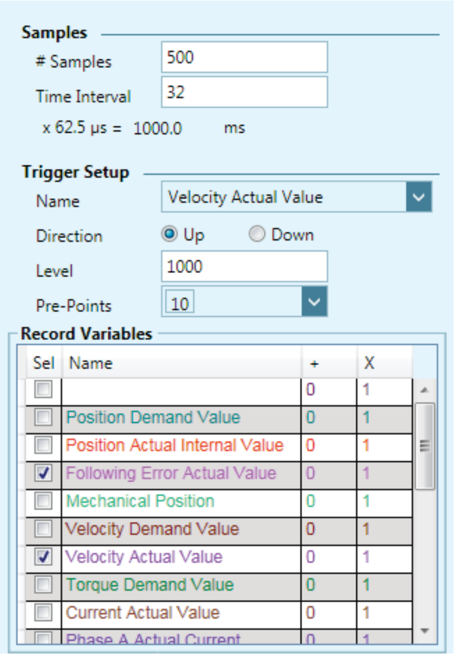
Deceleration: 10000 rpm/s

□ Copy Acc To Dec

4. Enable the drive, and click **Start** to verify the motion.
   You should see that the motor load disk makes one revolution.
5. In the Recording Setup pane, on the right of the screen, enter the following settings:
   - Samples
     - # Samples: **500**
     - Time Interval: **32** (= *1 second of recording*)
   - Trigger Setup
     - Name: Velocity Actual Value

       Direction: Up
     - Level: 1000
       Recording will begin as soon as the velocity exceeds 10 rpm (1000 rpm/s)

  - Pre-Points: **10**
- Record variables. Select the following two variables:
  - Following Error Actual Value
  - Velocity Actual Value



Samples

Samples: 500

Time Interval: 32

x 62.5 µs = 1000.0 ms

Trigger Setup

Name: Velocity Actual Value

Direction: ● Up ○ Down

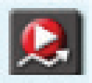
Level: 1000

Pre-Points: 10

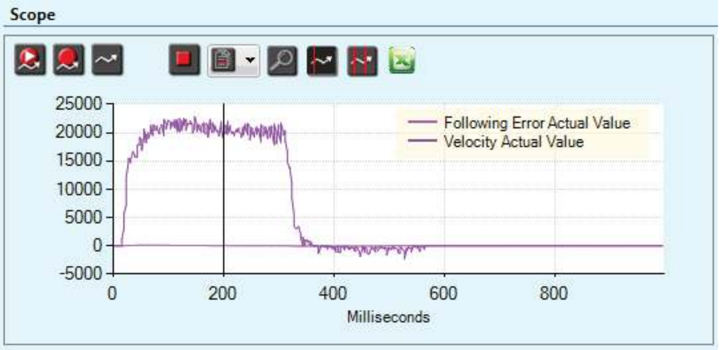
Record Variables

Sel	Name	+	X
□		0	1
□	Position Demand Value	0	1
□	Position Actual Internal Value	0	1
☑	Following Error Actual Value	0	1
□	Mechanical Position	0	1
□	Velocity Demand Value	0	1
☑	Velocity Actual Value	0	1
□	Torque Demand Value	0	1
□	Current Actual Value	0	1
□	Phase A Actual Current	0	1

6. Make sure drive is enabled, then click the **Move Record and Plot** button in the toolbar.

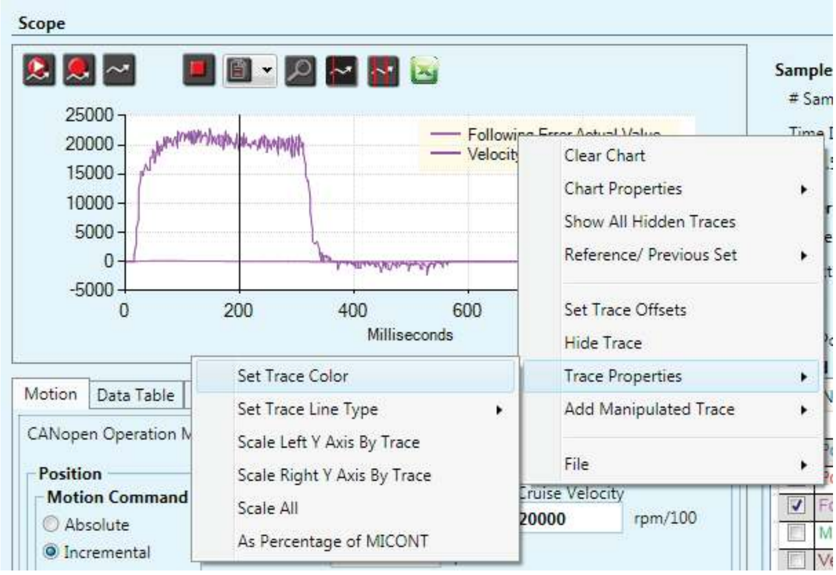


The plot soon appears:



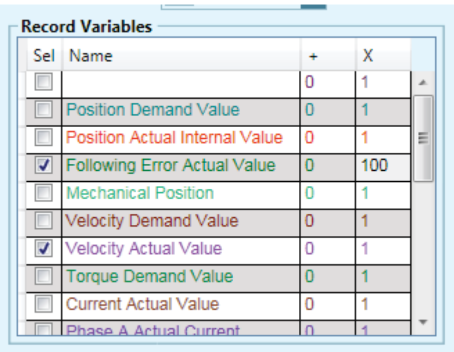
Scope

7. Improve the clarity of the plot by changing the color of one of the traces: Right-click on the trace of Following Error Actual Value, and define a different color for the trace. **Trace Properties** > **Set Trace Color**.



8. Sometimes, you may need to change the scaling of a recorded variable because its trace may be too small to view properly (because the graph is scaled to the largest value of another variable).

For example, improve the clarity of the plot by entering a scaling factor of **100** for the **Following Actual Error** variable.



Record Variables

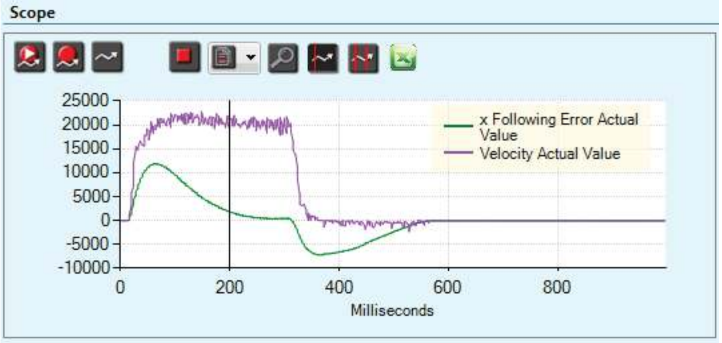
Sel	Name	+	X
☐		0	1
☐	Position Demand Value	0	1
☐	Position Actual Internal Value	0	1
☑	Following Error Actual Value	0	100
☐	Mechanical Position	0	1
☐	Velocity Demand Value	0	1
☑	Velocity Actual Value	0	1
☐	Torque Demand Value	0	1
☐	Current Actual Value	0	1
☐	Phase A Actual Current	0	1

Notes: Be sure to press **Enter** upon entering a scaling factor.

Whenever an scaled trace is in effect, the character **x** is displayed next to the variable name in the legend.

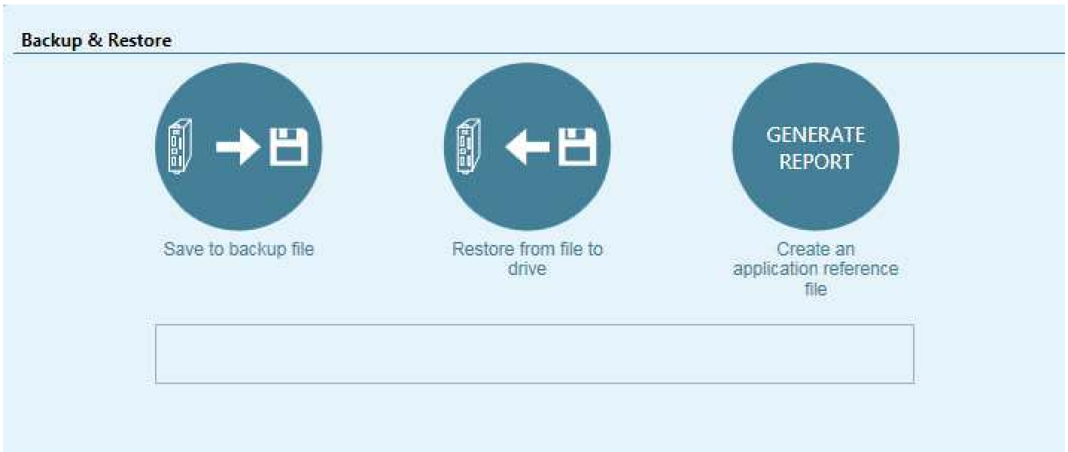
Note the changes in the plot.

Note that the recording lasted 1 second (1000 ms).



15 Save / Generate Report

The **Backup & Restore** screen allows you to save and load parameters to and from files on the host computer.


Backup & Restore
Save to backup file
Restore from file to drive
GENERATE REPORT
Create an application reference file

Exercise – Generate a Report

The **Report Generator** is a ServoStudio utility that allows you to save a copy of all system settings. It creates a set of files which can be sent to technical support and/or kept for reference.

It is strongly recommended that you create a report whenever you complete configuration of your application, even when the system is functioning properly.

1. In the Backup & Restore screen, click **Generate Report**.
2. Enter application and user information in the Reporter dialog box, and click Create Report.

   The Report Generator creates a set of CSV and TXT files within a zip file and saves it in the default path: c:\users\owner\Documents\ServoStudio\Reports\History

16 CANopen Operation

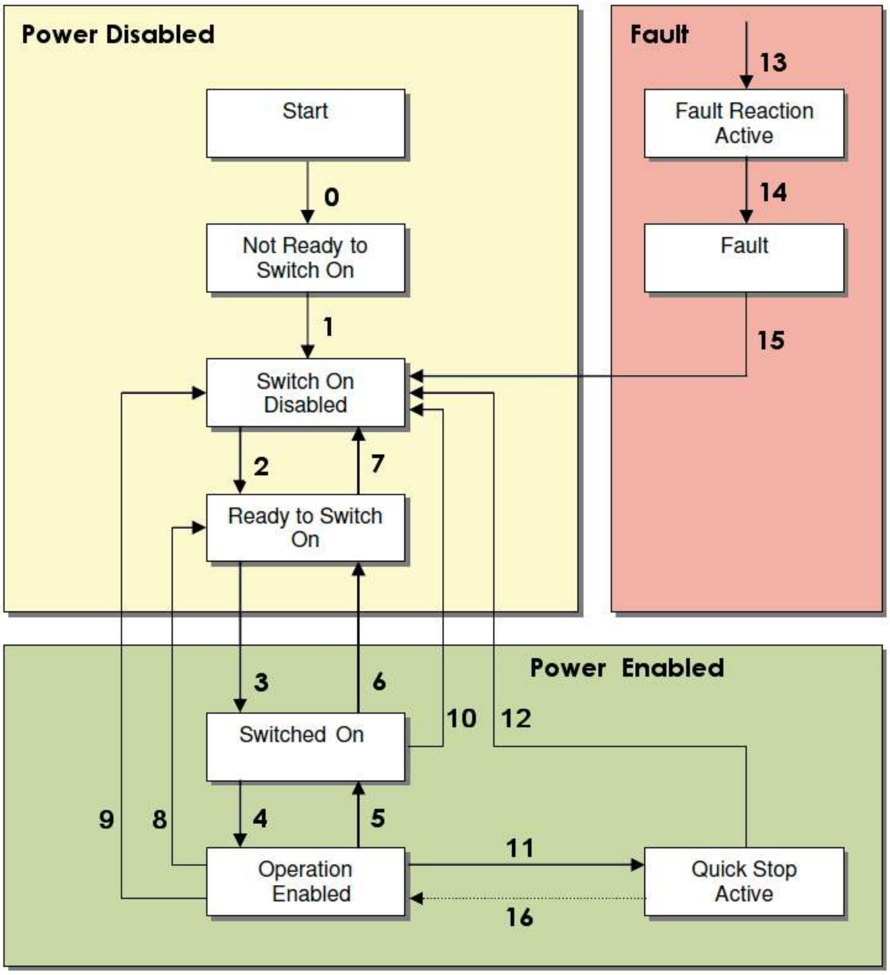
A stepIM integrated motor typically functions as a slave of an external controller or PLC on a CAN (Controller Area Network) bus. This chapter serves to demonstrate the commands and status messages that are exchanged between the controller and stepIM using CANopen protocol.

The sequencing of stepIM power-up and motion are controlled by the stepIM state machine. It determines which commands are accepted; for example, motor movement cannot start unless the state machine is in the Operation Enable state. The state machine also provides the ability to respond to faults and to disable the drive.

Object **6040h** (controlword) is used to request state transitions while object **6041h** (statusword) reflects the current state of the state machine. In the diagram below, the names represent the **states** while the numbered arrows represent **transitions**.

The state indicated by object **6041h** is updated when the transition has been completed.

State Machine Transition Diagram



6040h – Controlword – State Transition Command Bits

Controlword Bit	**7** **Fault Reset**	**3** **Enable Operate**	**2** **Quick Stop**	**1** **Enable Voltage**	**0** **Switch On**		
Command						**Transition**	**to State**
Shut Down	0	X	**1**	**1**	0	**2**, 6, 8	**Ready to Switch On**
Switch On	0	0	**1**	**1**	**1**	**3**	**Switched On**
Disable Voltage	0	X	X	0	X	7, 9, 10, 12	
Quick Stop	0	X	0	1	X	7, 10, 11	
Disable Operation	0	0	1	1	1	5	
Enable Operation	0	**1**	**1**	**1**	**1**	**4**, 16	**Operation Enabled**
Reset Fault	**>> 1**	X	X	X	X	**15**	**Switch On Disabled**

To enable the drive for operation, the state machine must complete the following sequence of transitions:

15 > Disabled

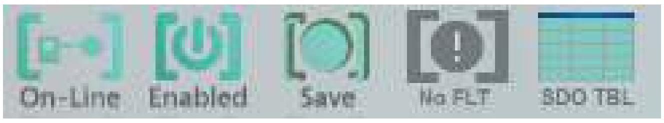
2 > Ready to Switch On

3 > Switched On

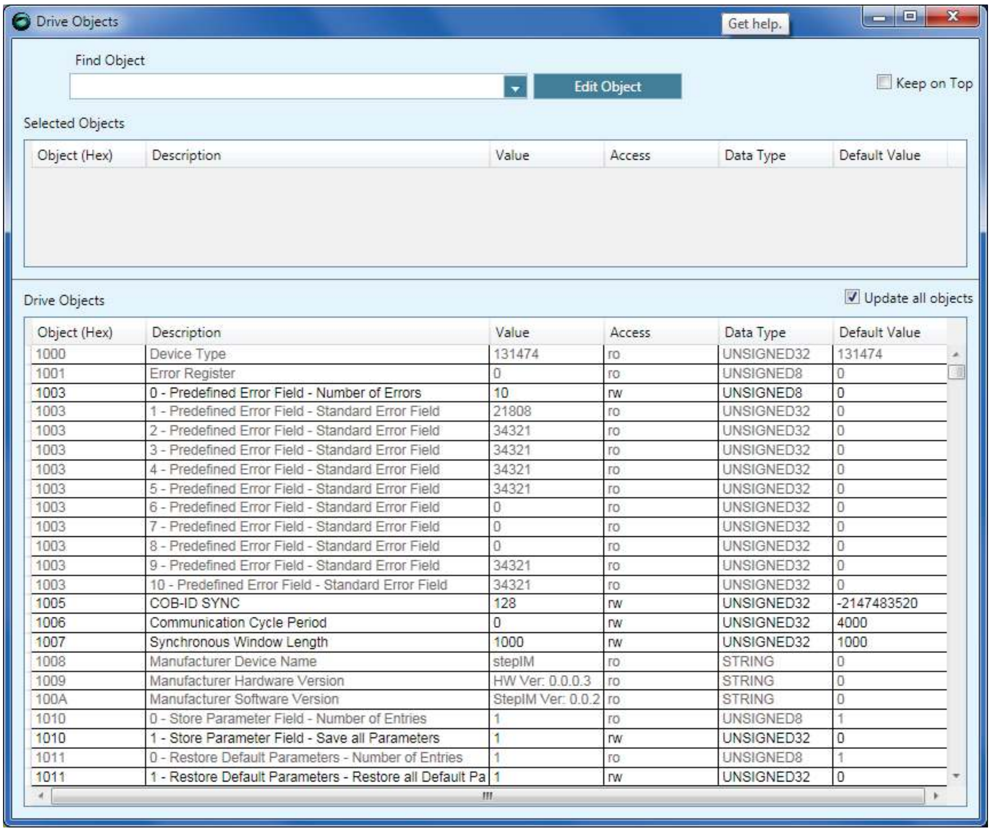
4 > Operation Enabled

Exercise – Enable the Drive

1. Make sure drive is online and disabled.
2. From the ServoStudio toolbar, select **SDO TBL**.



The Drive Objects dialog box opens.



Object (Hex)	Description	Value	Access	Data Type	Default Value

Object (Hex)	Description	Value	Access	Data Type	Default Value
1000	Device Type	131474	ro	UNSIGNED32	131474
1001	Error Register	0	ro	UNSIGNED8	0
1003	0 - Predefined Error Field - Number of Errors	10	rw	UNSIGNED8	0
1003	1 - Predefined Error Field - Standard Error Field	21808	ro	UNSIGNED32	0
1003	2 - Predefined Error Field - Standard Error Field	34321	ro	UNSIGNED32	0
1003	3 - Predefined Error Field - Standard Error Field	34321	ro	UNSIGNED32	0
1003	4 - Predefined Error Field - Standard Error Field	34321	ro	UNSIGNED32	0
1003	5 - Predefined Error Field - Standard Error Field	34321	ro	UNSIGNED32	0
1003	6 - Predefined Error Field - Standard Error Field	0	ro	UNSIGNED32	0
1003	7 - Predefined Error Field - Standard Error Field	0	ro	UNSIGNED32	0
1003	8 - Predefined Error Field - Standard Error Field	0	ro	UNSIGNED32	0
1003	9 - Predefined Error Field - Standard Error Field	34321	ro	UNSIGNED32	0
1003	10 - Predefined Error Field - Standard Error Field	34321	ro	UNSIGNED32	0
1005	COB-ID SYNC	128	rw	UNSIGNED32	-2147483520
1006	Communication Cycle Period	0	rw	UNSIGNED32	4000
1007	Synchronous Window Length	1000	rw	UNSIGNED32	1000
1008	Manufacturer Device Name	stepIM	ro	STRING	0
1009	Manufacturer Hardware Version	HW Ver: 0.0.0.3	ro	STRING	0
100A	Manufacturer Software Version	StepIM Ver: 0.0.2	ro	STRING	0
1010	0 - Store Parameter Field - Number of Entries	1	ro	UNSIGNED8	1
1010	1 - Store Parameter Field - Save all Parameters	1	rw	UNSIGNED32	0
1011	0 - Restore Default Parameters - Number of Entries	1	ro	UNSIGNED8	1
1011	1 - Restore Default Parameters - Restore all Default Pa	1	rw	UNSIGNED32	0

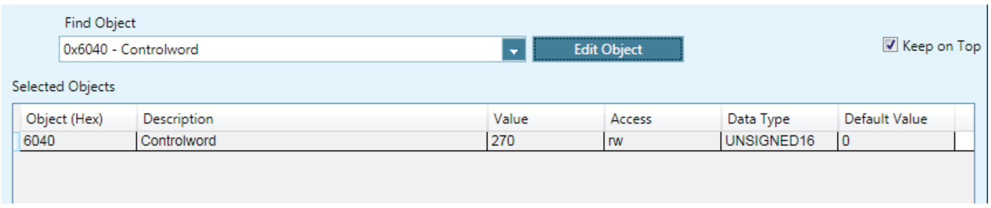
3. Place the cursor in the Find Object field, and enter **6040**.

Select object **0x6040-Controlword**, and press **Enter**.

Then click **Edit Object**.

You can now manipulate the value of the Controlword.

Note that values are entered in decimal format.



Object (Hex)	Description	Value	Access	Data Type	Default Value
6040	Controlword	270	rw	UNSIGNED16	0

4. Refer to the table below, and do the following, in sequence:

a. Place the cursor in the **Value** field, type **128**, and press **Enter**.

b. Place the cursor in the **Value** field, type **6**, and press **Enter**.

c. Place the cursor in the **Value** field, type **7**, and press **Enter**.

d. Place the cursor in the **Value** field, type **15**, and press **Enter**.

Transition > To State	**Bits in object 6040h**		**Hexadecimal Value**	**Decimal Value**
15 > Disabled	bit 7	2^7	0x80	**128**
2 > Ready to Switch On	bit 2 + bit 1	$2^2 + 2^1$	0x06	**6**
3 > Switched On	bit 2 + bit 1 + bit 0	$2^2 + 2^1 + 2^0$	0x07	**7**
4 > Operation Enabled	bit 3 + bit 2 + bit 1 + bit 0	$2^3 + 2^2 + 2^1 + 2^0$	0xF	**15**

5. Gently take hold of the motor load disk of the motor, and check for the resistance indicating that the drive is enabled.

Exercise – Generate Motion

Perform the following steps to generate a motion of one revolution at 20 rpm, and then generate a motion of ten revolutions at 200 rpm.

	Command	**Object**	**Hexadecimal Value**	**Decimal Value**
1	Disable drive	**6040**h	0x06	**6**
2	Switch to Profile Position operation mode (opmode 1)	**6060**h	0x1	**1**
3	Enable the drive	**6040**h	0x07	**7**
4	Set target position to one revolution (= 4096 counts)	**607A**h	0x1000	**4096**
5	Set speed to 2000 (20 rpm)	**6081**h	0x7D0	**2000**
6	Enable operation	**6040**h	0xF	**15**
7	Start motion (execute one revolution)	**6040**h	0x7F	**127**
8	Enable operation	**6040**h	0xF	**15**
9	Start motion (execute one revolution)	**6040h**	0x7F	**127**
10	Set target position to ten revolutions (= 40960 counts)	**607A**h	0xA000	**40960**
11	Set speed to 20000 (200 rpm)	**6081**h	0x4E20	**20000**
12	Enable operation	**6040**h	0xF	**15**
13	Start motion (execute ten revolutions)	**6040**h	0x7F	**127**

17 Motion Triggered by Digital Inputs

Digital inputs can be used to start, execute and stop pre-defined motions.

Object 20E0h is used to configure the digital input motion triggers.

Objects 2F90h—2F99h are used to configure motion segments. Object 2F90h is motion segment 0, object 2F91h is motion segment 1, and so forth.

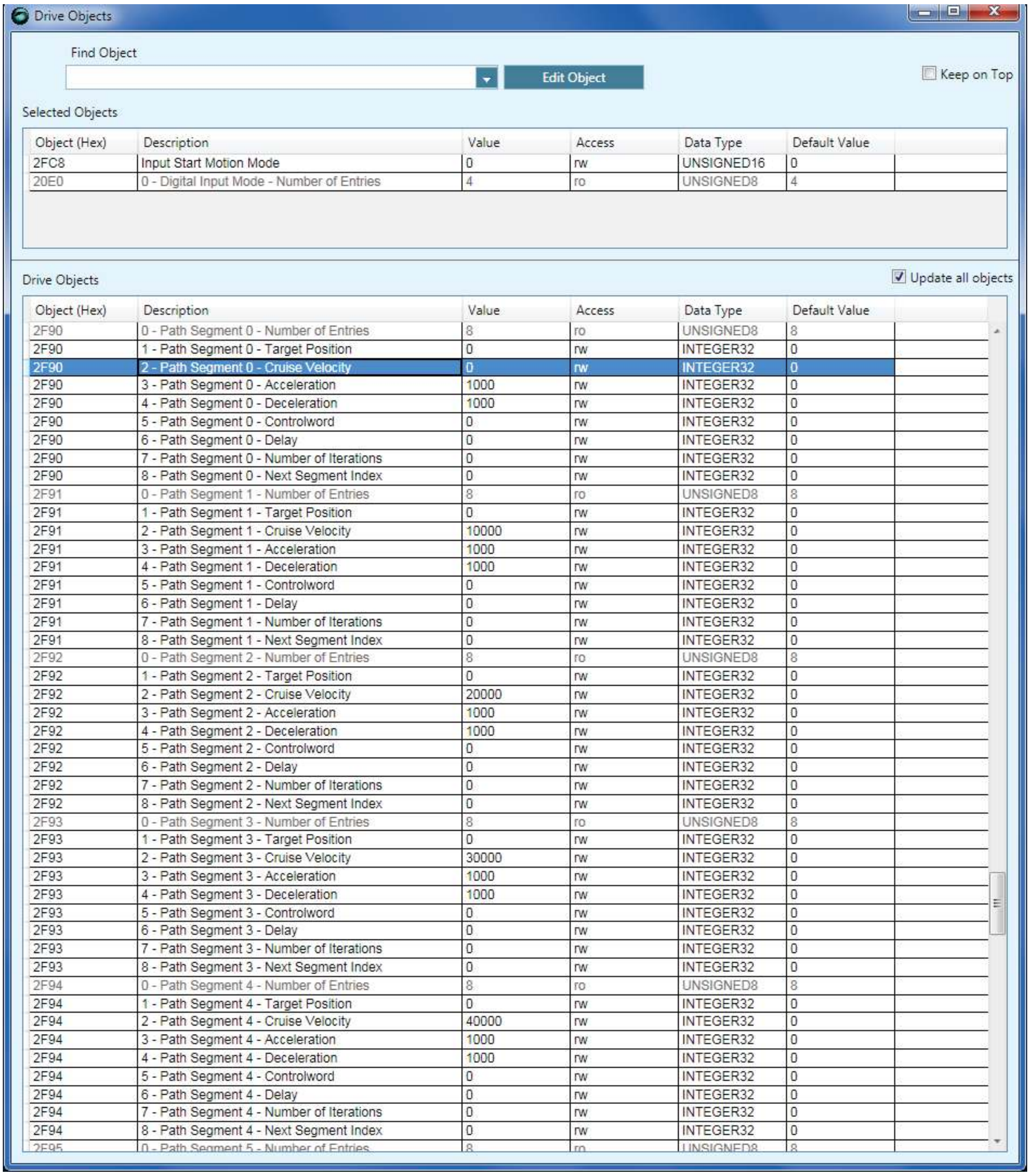
Object 2FC8h toggles the functionality of digital inputs as motion triggers.

Preliminary Task

1. Disable the drive.
2. In the ServoStudio Drive Objects table, define the properties of 8 motion segments using objects 2F90h through 2F97h.

   Since the segments will be movement **speed** (and not a position path), you need to define only sub-index 2 (cruise velocity), sub-index 3 (acceleration) and sub-index 4 (deceleration) for each object, as follows:

Object	Sub-index	Description	Value
2F90h	Sub-index 2	cruise velocity	**0 (no velocity)**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000
2F91h	Sub-index 2	cruise velocity	**10000**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000
2F92h	Sub-index 2	cruise velocity	**20000**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000
2F93h	Sub-index 2	cruise velocity	**30000**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000
2F94h	Sub-index 2	cruise velocity	**40000**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000
2F95h	Sub-index 2	cruise velocity	**50000**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000
2F96h	Sub-index 2	cruise velocity	**60000**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000
2F97h	Sub-index 2	cruise velocity	**70000**
	Sub-index 3	acceleration	1000
	Sub-index 4	deceleration	1000



Selected Objects

Object (Hex)	Description	Value	Access	Data Type	Default Value
2FC8	Input Start Motion Mode	0	rw	UNSIGNED16	0
20E0	0 - Digital Input Mode - Number of Entries	4	ro	UNSIGNED8	4

Drive Objects

☑ Update all objects

Object (Hex)	Description	Value	Access	Data Type	Default Value
2F90	0 - Path Segment 0 - Number of Entries	8	ro	UNSIGNED8	8
2F90	1 - Path Segment 0 - Target Position	0	rw	INTEGER32	0
2F90	2 - Path Segment 0 - Cruise Velocity	0	rw	INTEGER32	0
2F90	3 - Path Segment 0 - Acceleration	1000	rw	INTEGER32	0
2F90	4 - Path Segment 0 - Deceleration	1000	rw	INTEGER32	0
2F90	5 - Path Segment 0 - Controlword	0	rw	INTEGER32	0
2F90	6 - Path Segment 0 - Delay	0	rw	INTEGER32	0
2F90	7 - Path Segment 0 - Number of Iterations	0	rw	INTEGER32	0
2F90	8 - Path Segment 0 - Next Segment Index	0	rw	INTEGER32	0
2F91	0 - Path Segment 1 - Number of Entries	8	ro	UNSIGNED8	8
2F91	1 - Path Segment 1 - Target Position	0	rw	INTEGER32	0
2F91	2 - Path Segment 1 - Cruise Velocity	10000	rw	INTEGER32	0
2F91	3 - Path Segment 1 - Acceleration	1000	rw	INTEGER32	0
2F91	4 - Path Segment 1 - Deceleration	1000	rw	INTEGER32	0
2F91	5 - Path Segment 1 - Controlword	0	rw	INTEGER32	0
2F91	6 - Path Segment 1 - Delay	0	rw	INTEGER32	0
2F91	7 - Path Segment 1 - Number of Iterations	0	rw	INTEGER32	0
2F91	8 - Path Segment 1 - Next Segment Index	0	rw	INTEGER32	0
2F92	0 - Path Segment 2 - Number of Entries	8	ro	UNSIGNED8	8
2F92	1 - Path Segment 2 - Target Position	0	rw	INTEGER32	0
2F92	2 - Path Segment 2 - Cruise Velocity	20000	rw	INTEGER32	0
2F92	3 - Path Segment 2 - Acceleration	1000	rw	INTEGER32	0
2F92	4 - Path Segment 2 - Deceleration	1000	rw	INTEGER32	0
2F92	5 - Path Segment 2 - Controlword	0	rw	INTEGER32	0
2F92	6 - Path Segment 2 - Delay	0	rw	INTEGER32	0
2F92	7 - Path Segment 2 - Number of Iterations	0	rw	INTEGER32	0
2F92	8 - Path Segment 2 - Next Segment Index	0	rw	INTEGER32	0
2F93	0 - Path Segment 3 - Number of Entries	8	ro	UNSIGNED8	8
2F93	1 - Path Segment 3 - Target Position	0	rw	INTEGER32	0
2F93	2 - Path Segment 3 - Cruise Velocity	30000	rw	INTEGER32	0
2F93	3 - Path Segment 3 - Acceleration	1000	rw	INTEGER32	0
2F93	4 - Path Segment 3 - Deceleration	1000	rw	INTEGER32	0
2F93	5 - Path Segment 3 - Controlword	0	rw	INTEGER32	0
2F93	6 - Path Segment 3 - Delay	0	rw	INTEGER32	0
2F93	7 - Path Segment 3 - Number of Iterations	0	rw	INTEGER32	0
2F93	8 - Path Segment 3 - Next Segment Index	0	rw	INTEGER32	0
2F94	0 - Path Segment 4 - Number of Entries	8	ro	UNSIGNED8	8
2F94	1 - Path Segment 4 - Target Position	0	rw	INTEGER32	0
2F94	2 - Path Segment 4 - Cruise Velocity	40000	rw	INTEGER32	0
2F94	3 - Path Segment 4 - Acceleration	1000	rw	INTEGER32	0
2F94	4 - Path Segment 4 - Deceleration	1000	rw	INTEGER32	0
2F94	5 - Path Segment 4 - Controlword	0	rw	INTEGER32	0
2F94	6 - Path Segment 4 - Delay	0	rw	INTEGER32	0
2F94	7 - Path Segment 4 - Number of Iterations	0	rw	INTEGER32	0
2F94	8 - Path Segment 4 - Next Segment Index	0	rw	INTEGER32	0
2F95	0 - Path Segment 5 - Number of Entries	8	ro	UNSIGNED8	8

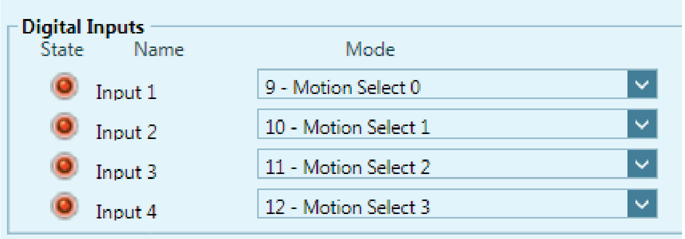
Exercise – Object 2FC8h = 1: Input Triggers a Predefined Motion

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

In this exercise, each of the 4 digital inputs will trigger a different motion segment, meaning 4 different speeds.

Object	Description	Input	Description	Value
2F90h	Motion Segment 0	1	cruise velocity	0 (=stop)
2F91h	Motion Segment 1	2	cruise velocity	10000
2F92h	Motion Segment 2	3	cruise velocity	20000
2F93h	Motion Segment 3	4	cruise velocity	30000

1. Make sure the drive is disabled, and the drive is communicating (online) with ServoStudio.
2. Make sure all input switches on the Demo kit are in the Off position.
3. In the ServoStudio Drive Objects table, set the value of object **2FC8h** to **1**.
4. Select the **Motion** screen, and then set the CAN Operation mode to **3-Profile Velocity**.
5. Select the **I/Os** screen, and then assign the four digital inputs to the four motion segments, as shown below.

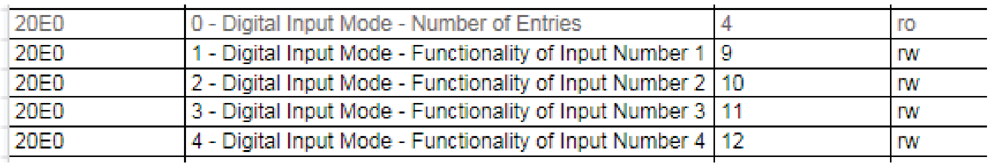


Digital Inputs

State	Name	Mode
●	Input 1	9 - Motion Select 0
●	Input 2	10 - Motion Select 1
●	Input 3	11 - Motion Select 2
●	Input 4	12 - Motion Select 3

6. In the Drive Objects table, make sure the option **Update all objects** is enabled.
7. Check the values of Object **20E0** sub-indices.

   Make sure the values are updated now appear as follows.



20E0	0 - Digital Input Mode - Number of Entries	4	ro
20E0	1 - Digital Input Mode - Functionality of Input Number 1	9	rw
20E0	2 - Digital Input Mode - Functionality of Input Number 2	10	rw
20E0	3 - Digital Input Mode - Functionality of Input Number 3	11	rw
20E0	4 - Digital Input Mode - Functionality of Input Number 4	12	rw

Using the Demo kit, switch the inputs on, off, and on again. Observe the response.

8. Switch on input 4. Motion is fast.
   Move input switch to off position (note: motion does not stop).
   Move switch back to on position.
9. Switch on input 3. Motion is slower.
10. Switch on input 2. Motion is even slower.
11. Switch on input 1. Motion stops (velocity=0)
12. All inputs are on. Turn them all off.
13. Again switch on inputs one at a time.
14. Switch off all inputs on the Demo Kit.
15. Switch on input 1. Then switch it off.

- 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**.

Exercise – Object 2FC8h = 0: Binary Value of Selected Inputs Triggers a Predefined Motion

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

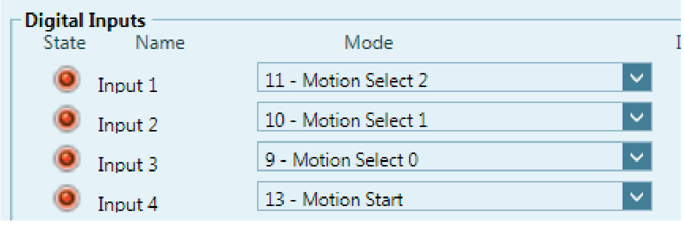
A rising edge on a fourth digital input triggers the motion according to the binary value of three inputs.

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

In this exercise, the combined binary value of inputs 1, 2 and 3 will trigger different motion segments of varying speed.

1. Make sure the drive is disabled, and the drive is communicating (online) with ServoStudio.
2. Make sure all input switches on the Demo kit are in the Off position.
3. In the ServoStudio Drive Objects table, set the value of object **2FC8h** to **0**.
4. Select the **Motion** screen, and then set the CAN Operation mode to **3-Profile Velocity**.
5. Select the **I/Os** screen, and then assign the four digital inputs to the four motion segments, as shown below.



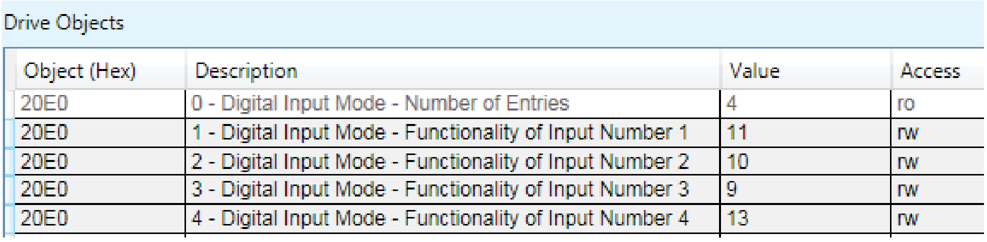
Digital Inputs

State	Name	Mode
●	Input 1	11 - Motion Select 2
●	Input 2	10 - Motion Select 1
●	Input 3	9 - Motion Select 0
●	Input 4	13 - Motion Start

6. In the Drive Objects table, disable and re-enable the option **Update all objects**.

7. Check the values of Object **20E0** sub-indices.

Make sure values are updated and now appear as follows.



Drive Objects

Object (Hex)	Description	Value	Access
20E0	0 - Digital Input Mode - Number of Entries	4	ro
20E0	1 - Digital Input Mode - Functionality of Input Number 1	11	rw
20E0	2 - Digital Input Mode - Functionality of Input Number 2	10	rw
20E0	3 - Digital Input Mode - Functionality of Input Number 3	9	rw
20E0	4 - Digital Input Mode - Functionality of Input Number 4	13	rw

8. Switch on inputs 1, 2 and 3. Then switch on input 4.
The motor rotates at the highest speed setting.

9. Switch off inputs 1, 2 and 3. Then switch input 4 off and on again.
The motor stops.

10. Switch off input 4. (All input switches are now off)

11. Switch on input 3. Then switch on input 4.
Switch off input 3. Then switch input 4 off and on again.4.

12. Refer to the summary table below, and cause the motor to rotate at various speeds by on different input switches.

Summary

The binary value of three inputs defines the motion.
A fourth input triggers the motion.

Object	Description	Input 3	Input 2	Input 1	Velocity (Example)
2F90h	Motion Segment 0	off	off	off	0 (=stop)
2F91h	Motion Segment 1	**ON**	off	off	10000
2F92h	Motion Segment 2	off	**ON**	off	20000
2F93h	Motion Segment 3	**ON**	**ON**	off	30000
2F94h	Motion Segment 4	off	off	**ON**	40000
2F95h	Motion Segment 5	**ON**	off	**ON**	50000
2F96h	Motion Segment 6	off	**ON**	**ON**	60000
2F97h	Motion Segment 7	**ON**	**ON**	**ON**	70000

Individual input defines and triggers a motion.

Object	Description	Input	Velocity (Example)
2F90h	Motion Segment 0	**1**	0 (=stop)
2F91h	Motion Segment 1	**2**	10000
2F92h	Motion Segment 2	**3**	20000
2F93h	Motion Segment 3	**4**	30000

18 Answers to Exercise Questions

18.1 Power Rating

- What is the DC voltage that is being applied to the motor?

  (24.4 V)

- What is the temperature of the control board?

  Can vary: 38°C – 42°C

- Refer to the User Manual. What is the temperature value that will result in an over-temperature error.

  38°C

18.2 Limits

Velocity Limits

- What is the index of the CANopen object for Velocity Limit?

  20EEh

- What is the default value of the velocity limit, in hexadecimal format?

  0xF4240

- What is the default value in decimal format?

  100,000

Position Limits

- What are the three methods that can be used to define position limits?

  Position (Following) Error

  Inputs (as limit switches)

  Software

Current Limits

- What is the index of the CANopen object for Motor Peak Current?

  2036h

- What is the index of the CANopen object for Motor Rated Current?

  6075h

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