Introduction to the National Instruments SoftMotion Drive Interface for IndraDrive

Application Note

Edition 01
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1.0 Overview

National Instruments (NI) allows users to integrate third-party EtherCAT servo drives into their real-time controller platform using the SoftMotion Drive Interface (SDI). This interface consists conceptually of a framework and a plugin as shown in Figure 1.

SDI effectively acts as a bridge between the LabVIEW SoftMotion trajectory planner and the IndraDrive servo drive. From the user’s point of view, it allows native LabVIEW motion commands to be used directly with the Bosch Rexroth drive hardware. Note that this configuration takes full advantage of the real-time capabilities of the EtherCAT bus.

Figure 1 The SoftMotion Drive Interface consists of a framework and a plugin. The framework is supplied by National Instruments and is common to all SDI implementations, while the plugin is supplied by the drive manufacture and is unique to each drive type. The Bosch Rexroth SDI plugin may be downloaded from the LabVIEW Tools Network.
1.1 Hardware requirements

National Instruments real-time controller: NI models cRIO 9064, cRIO 9022, cRIO 9033 and cRIO 9039 have been tested internally, but additional options from NI may be available. Contact National Instruments for more information. At a minimum, the controller must have a network adapter that can be configured as an EtherCAT master and the controller must support the LabVIEW SoftMotion and real-time modules.

Servo drive: Bosch Rexroth IndraDrive C or IndraDrive Cs drives that support EtherCAT CoE may be used. Additional options include IndraDrive ML and IndraDrive Mi\(^1\). In all cases, firmware version MPx-20V10 or higher is required. For commissioning purposes, it is recommended to purchase the additional engineering port (X26) option. This is identified in the type code as the EP option. For clarity this document will focus on IndraDrive Cs. Configuration of the other drive options is similar.

Servo motor: Bosch Rexroth offers MSK, MS2N and MSM series servo motors as standard options, as well as a wide variety of linear and kit motors. In most cases, third-party motors may also be used provided a suitable position feedback device is available. Contact your Bosch Rexroth representative or see our website\(^2\) for more information.

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1 IndraDrive ML supports power output up to 4 MW. IndraDrive Mi integrates drive and motor in a single package. Note that IndraDrive Mi does not support the EP option.
2 [www.boschrexroth.com/indradrive](http://www.boschrexroth.com/indradrive)
Figure 3 Bosch Rexroth offers a wide selection of synchronous, asynchronous, linear and kit motors. The range of the IndraDrive servo family extends from 50 W up to 4 MW.
1.2 Software requirements

- IndraWorks Ds 14v14 or higher
- NI LabVIEW 2015 f2 or higher
- NI Real-Time Module
- NI FPGA Module
- NI SoftMotion Module
- NI Industrial Communications for EtherCAT
- NI-RIO Drivers
- NI Application Builder (recommended)

Figure 4 shows a typical installation of LabVIEW, with the required additional software packages highlighted.

*Figure 4* National Instruments Measurement and Automation Explorer (MAX) provides a listing of the currently installed NI software.
1.3 **SDI Plugin installation**

Preferred method via VI Package Manager:

It is recommended to install the SDI plugin using the JKI VI Package Manager (VIPM). This free software is available on National Instruments’ website, but may also be downloaded directly from JKI: https://vipm.jki.net/

To install the plugin, launch VIPM, select the LabVIEW version, then, in the list of available add-ons, right-click on “SDI Plugin – Bosch Rexroth IndraDrive” and select Install. Note that installation will be finalized only after the user accepts the end-user license agreement (EULA).

![VIPM screenshot](image1.png)

*Figure 5 VIPM is the preferred method of installing the Bosch Rexroth SDI plugin.*
After successful installation, *SDI Plugin-Bosch Rexroth IndraDrive* will be listed under the installed add-ons:

![Image of VI Package Manager]

*Figure 6 The JKI VI Package Manager may be used to verify that the SDI plugin has been installed.*

Note that if online access to the NI LabVIEW Tools Network Repository is not possible, VIPM still may be used to install the plugin provided the required VI package file is available locally. In this case, launch VIPM and select File>Open Package File(s). Navigate to the required VI package and click OK. Follow the wizard to complete the installation process.

Alternate manual method:

If JKI VI Package Manager itself is not available, it is still possible to install the SDI plugin manually. Contact your Bosch Rexroth representative for the required files.

The SDI plugin consists of a set of virtual instruments (VIs) and a device description file. Copy the files provided to the LabVIEW installation folder as follows:

1. Add the SDI plugin VI and class files to folder `<LabVIEW>\vi.lib\Motion\plugins\BoschRexroth IndraDrive Plugin`, where `<LabVIEW>` represents the particular installation of LabVIEW.

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3 Current SDI plugin version: *sdi_plug_in_bosch_rexroth_indradrive-1.0.1.3.vip.*
On a typical 32-bit LabVIEW installation, the resulting configuration would look like this:

![Image](image1)

Figure 7 Adding the SDI plugin VIs to the LabVIEW installation. Note that the user may have to manually create folder BoschRexroth IndraDrive Plugin.

2. Add the device description file named "BoschRexroth_IndraDrive_CoE_NI.xml" to folder <LabVIEW>\resource\Framework\Providers\indcomcat\DD

Correct configuration of the device description file on a typical 32-bit LabVIEW installation is shown below.

![Image](image2)

Figure 8 Adding the SDI plugin device description file to the LabVIEW installation.

Once the SDI plugin is installed correctly, the plugin specific VIs will be available in the block diagram palette under Addons>BoschRexroth_IndraDrive_PluginAxis.

![Image](image3)

Figure 9 The Bosch Rexroth SDI plugin consists of two public VIs: Open and nismSDIFramework. Their use is discussed in later sections.
2.0 Connecting to the cRIO control

When available, cRIO’s USB Type B interface provides the easiest method of carrying out the initial device configuration. First, make sure NI Device Monitor is running on the host PC:

![Image of NI Device Monitor](image)

*Figure 10 NI Device Monitor may be launched from the Windows Start menu.*

Next, after attaching a USB A/B cable from the host PC to the cRIO control, NI Device Monitor will indicate that a device has been recognized by showing the following dialog:

![Device Detected dialog](image)

Selecting “Configure and install software to this device>Go” will launch NI Measurement & Automation Explorer (“NI MAX”), with the device listed under remote systems:
Connected devices are shown in NI MAX under Remote Systems.

At this point the user is ready to install the necessary software to the device and to configure the network adapters. These points will be discussed in the next sections.

If the USB Type B interface is not available on the cRIO control, and the IP address of device is not known, then it may be required to reset the network adapters to their factory default settings. See the device or user manual provided by National Instruments for more information. By default, any network adapters will accept an address provided by a DHCP server. If this is not available, the device will connect to the network using a link-local IP address of the form 169.254.xxx.xxx. Once a network connection to the device is established, launch NI MAX and verify that the device is shown under Remote Systems as described before. See Figure 11.
2.1 Configuring the Ethernet adapters

Here we assume that a connection to the cRIO device has been made as described in the previous section. In particular, we assume that NI MAX is running and the device is listed under Remote Systems.

To configure the Ethernet adapters of the cRIO control, select the device under Remote Systems and click on the tab labeled “Network Settings.”

Configure the primary Ethernet adapter with the desired network settings. The primary adapter will be used for commissioning and programming activities. Set the secondary Ethernet adapter to adapter mode “EtherCAT”.

Figure 12 Ethernet adapters may be configured in NI MAX under Network Settings.
2.2 **Software updates**

NI MAX is also used to configure the system software running on the cRIO control. Under Remote Systems, click the triangle to the left of the device so that the subitems are visible. Right-click on Software and click Add/Remove Software.

![Add/Remove Software](image)

*Figure 13* Use NI MAX to install software to the connected device.

National Instruments will recommend a list of software modules to install (a "software set"). In addition to the standard software set, be sure to include the following addons:

- LabVIEW SoftMotion Module, NI-RIO IO Scan, NI Industrial Communications for EtherCAT.

These options are shown in Figure 14.

![Software Set Add-ons](image)

*Figure 14* The Bosch Rexroth SDI plugin requires that the connected device software include the add-ons shown.
After completing the installation wizard, the active device software will be shown in the device tree. The figure below shows a typical installation.

Figure 15 The software currently installed on a connected device may be viewed in the NI MAX project tree under Remote Systems.
3.0 **IndraDrive Cs commissioning**

IndraWorks Ds is free software that may be used to commission the IndraDrive Cs. It is available for download at [www.boschrexroth.com/indradrive](http://www.boschrexroth.com/indradrive). Note that IndraWorks Ds version 14V14 or later is required.

3.1 **Physical connections**

The connections points for the IndraDrive Cs (Economy and Basic versions) are shown in Figure 16. Optional interfaces are indicated with an asterisk (*).

![Image of IndraDrive Cs connections](image-url)

**Figure 16** Standard and optional interfaces for IndraDrive Cs.

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4 IndraDrive Cs (Advanced) is similar, but in that case the CANopen over EtherCAT ports are labelled X22, X23.
### 3.2 Connecting to the drive

Using an Ethernet cable, connect your host PC to the engineering port (X26) on the IndraDrive Cs. Launch IndraWorks Ds. The following dialog screen should appear:

![Connection selection dialog](image)

*Figure 17 “Network search” allows the user to search for any connected IndraDrive devices.*

Option 1. From the tab labeled “Network search,” select the appropriate network adapter from the dropdown and click Browse. Irrespective of the local LAN settings (provided that some TCP/IPv4 address has been assigned), the software will browse the network for drive instances. Any drives discovered on the network will be listed according to network address. Select the desired drive by checking the box in the Connect column. Connect to the drive by clicking OK.

If the chosen network adapter and the IndraDrive Cs are not on a common subnet, IndraWorks Ds will ask whether the IP settings of this adapter should be extended so that a connection can be made:
Figure 18  IndraWorks Ds will extend the network adapter settings so that a connection to a device not on the local subnet may be made.

Connect to the drive by clicking “Extend IP Address Settings Now.”

Option 2. The IP address of the X26 port is may be obtained (or edited) from the front panel of the drive. The required key sequence is shown below.

Figure 19  Depiction of IndraDrive Cs front panel. Use the Esc and Enter keys to navigate through the menus. Once an editable item in the menu is reached, press Enter to edit or Esc to cancel. Use the up and down arrow keys to change selected values. See the IndraDrive Cs documentation for more information.
Use the Enter and Escape keys to navigate through the various menus. Use the up and down arrow keys to edit the individual fields or select individual menu items. If the IP address is changed, the new address does not take effect until the drive is rebooted.

Once the IP address of the X26 port is known, adjust the settings of the local network adapter so that the two devices are on the same subnet.

From the tab labeled “IP address search,” enter the drive’s IP address or a range within which the IP address occurs, then click Browse. As in option 1, if the drive is recognized on the network, it will be listed in the main list box. Select the desired drive by checking the box in the Connect column and clicking OK.

Figure 20 "IP address search" allows users to browse for IndraDrive devices within a specified address range.
3.3 **Loading base parameters**

The drive may be reset to its default settings by selecting Commissioning>Load basic parameters from the main menu. In the resulting dialog, select the desired options and click “Close.” Resetting the parameters to their default settings is typically only required if the drive has been used previously.

*Figure 21 Use the “Load Basic Parameters” dialog in IndraWorks Ds to reset the drive to its default settings.*
3.4 Setting the master communication

For use with the cRIO control, the multi-protocol, real-time communication ports (typ. X24/X25) of the IndraDrive must be configured to use the **CANopen over EtherCAT** protocol.

From the explorer panel on the left, select Master Communication. In the associated dialog, set the Active protocol to “CAN Application Protocol over EtherCAT (CoE)”.

Confirm that the drive profile should be set to “CiA 402.” Changes to the master communication will take effect only after the drive is rebooted.

![Master Communication dialog in IndraWorks Ds to activate the CANopen over EtherCAT protocol. The CiA 402 drive profile must be used.](image-url)
After rebooting the drive, the active drive profile may be verified under Axis>Master Communication>Settings:

Figure 23  The active CoE configuration may be viewed in IndraWorks Ds under Master Communications>Settings. The SDI plugin requires that the CIA 402 drive profile be used.
3.5 Configuring the drive scaling

IndraDrive Cs allows the user to scale the drive freely per the requirements of the application. Typically this means that the drive position refers to the actual position of the driven load in appropriate units. If the load is rotating, the drive is scaled in degrees. If the load is moving linearly, the drive is scaled in millimeters. Any gearing between the motor and the load must be accounted for. In the linear case, the feed constant (i.e. the amount of linear travel per revolution input) must also be defined.

In IndraWorks Ds, use dialog Mechanical Axis System/ Scaling to configure the drive as required.

Note that when using IndraDrive with the SDI plugin, the position data format type Absolute is preferred, as data rollover is handled by SoftMotion. Also, the maximum travel range (S-0-0278.0.0 / 0x2116 01) is determined by SoftMotion; user configuration of this parameter is lost whenever SoftMotion activates the Scan Engine.
3.6 Configuring the I/O

With reference to Figure 16, the X31 interface of IndraDrive Cs supports 7 digital input pins plus 1 additional pin that may be configured as an input or output. The SDI plugin provides minimal support for this interface. The supported input types are shown in IndraWorks DS> I/O X31/X32.

![Figure 24](image)

Figure 24 The SDI plugin supports hard travel limit switches, a home switch, as well as a single high-speed probe capture input.

The travel limit inputs, as well as the home switch input, may be landed on any of the 8 pins. If used, probe input 1 must be landed on pin 1 or pin 2. All inputs are optional.
3.7 Configuring the touch probe

IndraDrive Cs supports high-speed capture of the motor position on the rising edge of the probe 1 input. See Figure 24 of the previous section for the required digital input configuration. High-speed capture of the internal system clock or a secondary encoder is also possible. To configure the capture settings, in IndraWorks Ds, see the dialog labeled Probe. A typical configuration is shown in Figure 25.

![Probe configuration dialog in IndraWorks Ds](image)

Figure 25 Use the Probe dialog in IndraWorks Ds to configure the high-speed capture of the selected signal. Data capture is triggered by the rising or falling edge of the digital input configured as “Probe 1”.
4.0 Creating a blank LabVIEW project

To create a blank LabVIEW project, launch LabVIEW and double-click Blank Project from the list of Recent Project Templates⁵.

![LabVIEW Launch Page](image)

*Figure 26* Use LabVIEW’s launch page to create a Blank Project or open previously created projects.

4.1 Inserting a controller into a LabVIEW project

Once the blank project is created, the controller may be added to the project by selecting *New > Targets and Devices* from the context menu of the main node in the project tree. In the resulting dialog box, select your device from the list of available devices, then click OK. Note that the devices are listed according to type, and the discovery process is only launched once the type is expanded. Know your device type! When prompted by the wizard, define the programming mode as *Scan Interface*.

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⁵ Note that clicking the button labeled Create Project will open a template wizard. Here the user may leverage non-trivial (i.e. not blank) templates, including templates for state machines and SoftMotion. Where applicable, use of these templates is strongly encouraged.
4.2 Adding the EtherCAT master to the project, and scanning for any slaves

Next we add the EtherCAT master to the system together with any connected IndraDrive Cs devices. First, ensure that each drive is powered and configured to use CAN over EtherCAT as the method of master communication. Next, use Ethernet CAT 5e (or better) cabling to create a daisy chain from the EtherCAT master port (eth1) to each slave. Note that on IndraDrive Cs, the bottom port (typ. X25) is the input and the top port (typ. X24) is the output. Figure 2 gives a typical configuration.

From the controller's context menu, select New>Targets and Devices… In the dialog that appears, expand folder EtherCAT Master Device and select the adapter shown. Click OK.
As a result, the EtherCAT Master will be added to the project along with any discovered slave devices. Notice that the device addresses are automatically assigned according to the topological order and do not correspond to any SercoS addresses that may have been preassigned by the user.

If desired, the user may rename the devices. To do this, right-click on the device in question and select Rename.

*Figure 29 EtherCAT slave devices may be renamed using the associated context menu.*
4.3 Distributed Clock

Each EtherCAT slave device corresponding to an IndraDrive C or IndraDrive Cs should have its distributed clock enabled as shown in Figure 30. Users will find this setting on the Properties page for each device listed under the EtherCAT master. In addition, SYNC 1 must be enabled. The default values for cycle time=1 and shift time=0 may be used.

All other default values for the EtherCAT slave properties are acceptable and need not be altered. For reference, these default values are listed below.

- EtherCAT Advanced Mailbox
  Mailbox Poll Period (scan periods) = 1

- EtherCAT Advanced Watchdog
  Sync Manager Watchdog = Enabled
  Timeout = 1000 x 100 us

- EtherCAT Advanced Initial Commands
  No initial commands required

Figure 30 IndraDrive Cs must be configured with the distributed clock and SYNC1 options enabled as shown.
4.4 Adding SoftMotion axes

NI SoftMotion does not issue instructions to an EtherCAT servo device directly, but rather to an intermediary software object known as a SoftMotion axis. This means that to each of the EtherCAT slaves listed under the EtherCAT master, we must assign a SoftMotion axis.

To do this, right-click the controller in the project tree and select New>SoftMotion Axis…

In resulting Axis Manager dialog, use the Add New Axis button to add a SoftMotion axis to the project. The system will choose a slave device to be associated or “bound” to the new axis. If the default binding is incorrect or unintended, click the Change Binding button and reassign the hardware using the Resource Binding dialog.

SoftMotion axes will be listed in the project tree as shown in Figure 31. Note that additional simulated (i.e. “unbound” or not associated to hardware) axes may also be added. Such axes may be useful in particular as virtual masters in gearing or camming applications.
4.5 **SoftMotion axis configuration**

Refer to NI documentation or the LabVIEW online help for a complete description of the SoftMotion axis functionality. Here we only note one critical aspect of the configuration. Selecting Properties from the context menu of a SoftMotion axis opens the Axis Configuration dialog. Referring to Figure 33, click on **Encoder** to scale the position or “feedback” of the SoftMotion axis. The user may scale the axis as required, but if the IndraDrive Cs is scaled in rotary degree units with the default position resolution, then it would be customary to define **Units** as ‘deg’ or ‘degree’ and to set the number of **Counts per deg** to 1000.

![Figure 31](image1.png)

**Figure 31** SoftMotion axes are listed in the LabVIEW project tree together with their associated EtherCAT devices.

![Figure 32](image2.png)

**Figure 32** In IndraWorks Ds, the extended scaling parameterization of the IndraDrive Cs is shown. Here, Exponent = -3 indicates that the rotary position will be resolved to the nearest 1/1000 degree. (N.B. 1/1000 = 10⁻³)
These axis configuration settings are for SoftMotion parameters only. To configure drive specific parameters, either use your drive’s configuration software or use your drive’s programmatic configuration API, if supported. See **Axis Help** for more information.

**Figure 33** Properties page of the SoftMotion object. Preferred scaling of the default drive configuration is shown.
4.6 Deploying the project configuration

Once the EtherCAT master and slave devices have been added to the project, as well as the associated SoftMotion axes, the project configuration may be deployed to the control. To do this, right-click on the cRIO controller in the project tree and select Deploy All.

![Project Tree with Deploy All option highlighted]

Note that if EtherCAT slave devices are physically added or removed, the project configuration must be altered accordingly and re-deployed.

4.7 Scan Engine

The NI documentation describes the Scan Engine as follows:

> The NI Scan Engine enables efficient single-point access to sets of data channels, such as I/O channels, using a scan that stores data in a global memory map and updates all values at a single rate, known as the scan period.\(^6\)

All real-time EtherCAT processing done by the controller happens within the context of the Scan Engine. Real-time processing does not occur until the Scan Engine has been switched to its Active state. Users may set the states of the Scan Engine (Active, Configuration) using the tool provided in the Utilities menu. However, switching of the Scan Engine is typically handled programmatically using the nismSDIFramework VI within the Bosch Rexroth SDI add-on. See Section X.X.

As the Scan Engine switches from Configuration to Active, the EtherCAT master will attempt to complete its phase run-up (Pre-operational -> Bootstrap -> Safe Operational -> Operational). In addition, as directed by the EtherCAT master, each IndraDrive Cs device will attempt to switch from Parameter Mode to Operation Mode.

4.8 Setting the Scan Period

The Properties page of the cRIO controller allows the user to set the period of the Scan Engine. This value corresponds directly to the update rate of the EtherCAT bus. Scan Periods of 1 ms, 2 ms and 10 ms have been tested. Generally, a lower Scan Period will improve servo motor performance. However, systems with high axis counts - because of the corresponding higher network traffic - may require a larger Scan Period.
5.0 General approach to modifying NI sample code for use with SDI plugin

The NI sample code provided in their NI Example Finder tool may be easily modified for use with the SDI plugin. To launch NI Example Finder, in LabVIEW select Help>Find Examples from the main menu.

In particular, see the sample code found in NI Example Finder>Toolkits and Modules>SoftMotion>Express VIs.

An example of how to modify the sample code is shown in the next two figures. Figure 34 shows the original code, in this case Power.vi. Figure 35 shows modified version.

![Figure 34 Original sample code: Power.vi. National Instruments provides many samples such as this in their NI Example Finder library.](image)

![Figure 35 Power.vi edited to include the SDI plugin. Modified code is boxed in orange.](image)

With regard to the required modifications, we note the following:

- The SoftMotion axis resource must be tied to the SDI plugin using the Open VI found on the Block Diagram palette under Addons>BoschRexroth_IndraDrive_PluginAxis.
  
  ![Motion Resource](image)

  A separate instance of Open.vi is required for each SoftMotion axis.

- Next, transition the Scan Engine to Active Mode using the nismSDIFramework.SetFrame method. This is standard NI code, but for convenience may be found on the

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7 In all figures that follow, a purple flowline refers to a SoftMotion resource, while a yellow flowline refers to the standard error path. To simplify the figures these flowlines will not be labelled.
Bosch Rexroth IndraDrive PluginAxis palette. (Its standard location is on the Block Diagram pallet under Vision and Motion>NI SoftMotion>Advanced>Set Mode.)

- Finally, upon exiting the application, return the Scan Engine to Configuration Mode using a second call to nismSDIFramework.SetFrame, this time with the transition target defined as Configuration Mode.

5.1 SoftMotion palette

Subsequent sections introduce some of the basic functionality provided by the SoftMotion palette. This functionality is not specific to the Bosch Rexroth SDI plugin and is included here for convenience only. See the relevant NI documentation for more information.

Figure 36 The Bosch Rexroth SDI plugin supports VIs found on the SoftMotion palette. On the Block Diagram workspace, see Vision and Motion>NI SoftMotion>Express.
5.2 Reading and clearing faults

The error status of the IndraDrive Cs may be monitored using the Read.vi from the SoftMotion palette.

Make sure the selected method is set as Status and the Input/Output type is selected as fault occurred.

Similarly, the Read VI may be configured to read the fault code of the IndraDrive Cs by selecting method Faults.

Figure 37 IndraWorks Ds and LabVIEW state after triggering positive travel range limit fault.

If a drive fault has occurred, the user may clear it by calling the Clear Faults VI:
Hint: If a drive error does occur, further information may be found in the IndraWorks Ds help files. See *IndraWorks Ds>Help>Drive Help>INDR*-MPx-20VRS*. Note that all drives faults are referenced internally using format FXXXX.

![Clear Faults](image)

*Figure 38* The IndraWorks Ds help files include fault-specific information, troubleshooting tips, as well as general information.
5.3 Power

Use the Power VI from the SoftMotion palette to energize the motor.

Note that there are separate inputs for enabling the axis (i.e. the SoftMotion object) and for enabling the physical servo drive. The SoftMotion axis may be enabled without enabling the drive (the converse is not true), but in practice these are usually enabled (or disabled) together simultaneously.

To disable the drive (i.e. de-energize the motor), call Power with `enable drive = false`.

To monitor whether the drive is enabled, use the Read VI with the Method selected as `Status` and the Input/Output type set to `drive enabled`. Note that the status of the SoftMotion axis may also be monitored using the Input/Output type set to `axis enabled`.

The drive may only be enabled if it is in an error-free state. Users may want to proceed all calls to `Power(enable axis = true, enable drive = true)` with a call to `Clear Faults` as a matter of course.
5.4 **Position moves**

SoftMotion supports absolute or relative position moves using the Straight-Line Move VI. Select method “Absolute” or “Relative” as appropriate. In addition to the position target, the motion trajectory may be adjusted using inputs velocity, acceleration, deceleration, accel. jerk, decel. jerk and smoothing.

![Straight-Line Move VI](image)

Energize the servo motor using the Power VI prior to initiating a straight-line move.

![IndraWorks Ds oscilloscope](image)

*Figure 39 IndraWorks Ds oscilloscope showing axis trajectory when commanded to move to an absolute position of 1000 deg. Note that axis position is automatically set to position 0 after transitioning to Ab and that an absolute move does not require that the drive’s reference position has been established.*
The current motor position may be read using the Read VI with the Method select as *Data* and the Input/Output type set to *position*.

![Read VI diagram for position](image)

### 5.5 Velocity moves

To move the motor at a constant speed, use the Straight-Line Move as before, but with the method selected as *Velocity*. Inputs for acceleration, deceleration, accel. jerk, decel. jerk and smoothing are also available.

![Straight-Line Move diagram](image)

The current motor velocity may be read using the Read VI with the Method select as *Data* and the Input/Output type set to *velocity*.

![Read VI diagram for velocity](image)

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8 Note that Read VI supports multiple input/outputs. Users may read, for example, motor position and velocity in a single call. Here we show a single block output for clarity only.
### 5.6 Write setpoint

The commanded position, velocity or torque setpoints may be written to directly using the Write VI. The three variants are shown below.

When using any of these variants, be sure to provide setpoint updates within a timed loop synchronized to the Scan Engine. Within the timed-loop, memory allocation should be kept to a minimum. This will reduce jitter and improve performance.

The timed-loop structure is found on the Block Diagram under Structures>Times Structures. Once the loop is added to the VI, open the Configure Timed Loop dialog and set the internal timing source type to Synchronize to Scan Engine.

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9 In a sense these are mutually exclusive: If you are writing to one of the setpoints, don’t write to either of the other two.
Figure 40 Write velocity setpoint may be used to pipe real-time velocity commands to the IndraDrive Cs. Above is the calculated velocity trajectory. Below is the actual velocity output, shown in the IndraWorks Ds oscilloscope tool as well as LabVIEW.

5.7 Position error

The motor position error, in other words the deviation between the commanded and actual motor positions, may be read using the Read VI. As described previously, from the block’s context menu, define the Select Method as Data and from the list of available inputs or outputs, select position error.

Note that the position error exceeded output that is included in the Read.Status method is not currently supported.
5.8 **Home switch and the travel limit switches**

The Motion I/O method of the Read block allows the user to monitor the status of the home switch and the positive and negative travel limit switches.

Note that these input types must be explicitly configured in the drive’s digital I/O (X31). See the IndraDrive Cs Project Planning Manual for more information. The default configuration is shown below.
Further, the home switch is only read correctly provided the Enable Home Switch property for the SoftMotion axis is set explicitly. Note that it is also recommended to set the Home Switch Stop Mode to “Don’t Stop.”
5.9 Establishing the position reference ("referencing") of the axis

The Find Reference Move VI, found on the standard SoftMotion Express palette, provides the user with various methods of establishing the drive’s position reference. Either of the travel limit switches, the home switch, as well as the encoder’s internal reference mark, may be used to establish the position reference. The drive’s current position may also be used ("absolute"). We treat each of these variants in turn.

Reference Move – Forward Limit

To use the positive travel limit switch as the reference move target, add the Find Reference Move VI to your block diagram. Right-click on the block and, from the available methods, select Forward Limit. Set the Search Velocity as desired. When executed, the drive will move forward at the given search velocity until the positive travel limit is reached, at which point the drive will stop and set the position reference.  

Note that power must be supplied to the motor (see Power VI) prior to making the Find Forward Limit Reference Move.

Be sure to properly configure the positive travel limit switch in the settings of the IndraDrive Cs. See section Home switch and the travel limit switches.

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10 The Bosch Rexroth SDI plugin, regardless of the reference method selected, does not support inputs Approach Forward or Approach Velocity.
Reference Move – Index

To establish the position reference at the index pulse or reference mark of the encoder, add the Find Reference Move VI to your block diagram, selecting method Index. Configure the search direction and search velocity as desired. Upon execution, drive will move in the given direction and at the given search velocity until the encoder’s index pulse is detected, at which point the drive will stop and set the position reference.

![Find Index block diagram](image)

Note that power must be supplied to the motor (see Power VI) prior to making the Find Index Reference Move. No additional hardware configuration is required.

Reference Move – Reverse Limit

To use the negative travel limit switch as the reference move target, add the Find Reference Move VI to your block diagram. Right-click on the block and, from the available methods, select Reverse Limit. Set the Search Velocity as desired. When executed, the drive will move backward at the given search velocity until the negative travel limit is reached, at which point the drive will stop and set the position reference.

![Find Reverse Limit block diagram](image)

Note that power must be supplied to the motor (see Power VI) prior to making the Reference Move. Be sure to properly configure the negative travel limit switch in the settings of the IndraDrive Cs. See section Home switch and the travel limit switches.
Reference Move – Home switch

To use the home switch as the reference move target, add the **Find Reference Move** VI to your block diagram. Right-click on the block and, from the available methods, select Home. Configure the block inputs as required. Note that the block may be configure to look for either the rising or falling edge of the home switch. Upon execution, drive will move in the given direction and at the given search velocity until the home switch is detected, at which point the drive will stop and set the position reference.

Note that power must be supplied to the motor (see Power VI) prior to making the Reference Move.

Be sure to properly configure the home switch in the settings of the IndraDrive Cs. See section **Home switch and the travel limit switches**.

Reference Move – Absolute (Current position)

To reference the drive at its current position, use the Find Reference Move VI with method Absolute. This method does not initiate any motion.

The SDI plugin currently configures the drive in such a way that it must be re-referenced each time upon transitioning to operating mode (i.e. Scan Engine = active).
### 5.10 Position capture (touch probe)

The SoftMotion position capture functionality described here requires that Probe 1 be correctly configured in the settings of the IndraDrive Cs. See the IndraDrive Cs Project Planning Manual for more information. Additional information is given in Section X.X.

High-speed position capture may be enabled in LabVIEW by calling the Position Capture VI with method `Enable>Single` selected as active.

Once enabled, any values captured by the drive’s probe may be read using Read VI with method `Capture Data`.

In addition, indication that a capture has in fact occurred is given by the Status method of Read VI using output `capture occurred`.

Note that the position capture may be triggered by either the rising or falling edge of the associated probe input. This is configured in the properties of the SoftMotion axis itself as shown below.
To disable the position capture and reset the indicated capture status, call Position Capture again, this time with Method Disable.
6.0 References

a) Bosch Rexroth, IndraDrive Cs Drive Systems with HCS01, Project Planning Manual, R911322210
b) Bosch Rexroth, IndraDrive MPx-20 Version Notes, Release Notes, R911345606
c) Bosch Rexroth, Intelligent Drive Technology from Rexroth for LabVIEW Applications, Brochure, R999001241
d) Bosch Rexroth, Drive System - Rexroth IndraDrive, Catalog, R999000019
e) Bosch Rexroth, Rexroth IndraDrive MPx-16 to MPx-20 and PSB Parameters, Reference Book, R911328651

6.1 Other Resources

a) All Bosch Rexroth documentation is available for free download at our media directory: www.boschrexroth.com/mediadirectory
b) For Bosch Rexroth service or support issues, please contact our 24-hour support hotline (USA): 1-800-REXROTH
c) Additional contact information, including information about our sales partners, is available at www.boschrexroth.com/contact