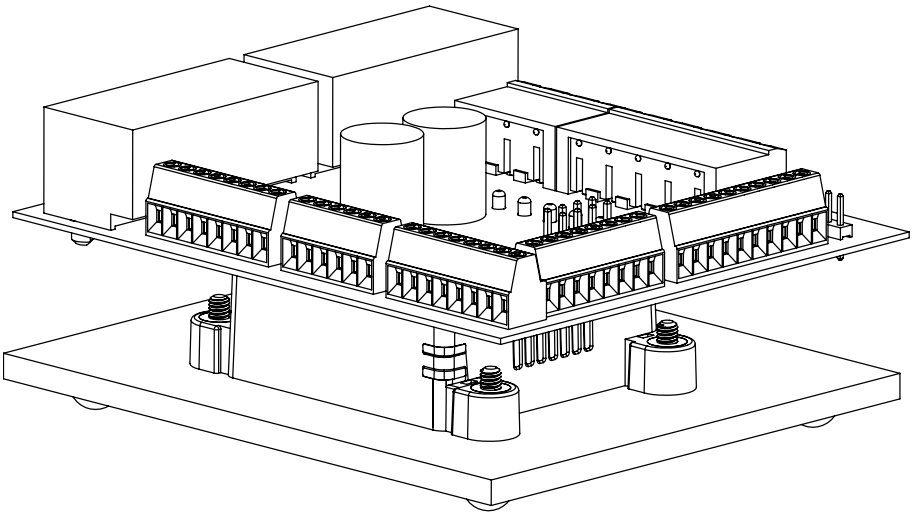
PERFORMANCE MOTION DEVICES
MOTION CONTROL AT ITS CORE



ION®/CME N-Series Digital Drive Developer Kit

User Manual

Revision 1.0 / January 2024

Performance Motion Devices, Inc.

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Related Documents

ION/CME N-Series Digital Drive User Manual

Complete description of the N-Series ION family of digital drives including complete mechanical, electrical, and software specifications.

Magellan Motion Control IC User Guide

Complete description of the Magellan Motion Control IC features and functions with detailed theory of its operation.

C-Motion Magellan Programming Reference

Descriptions of all Magellan Motion Control IC commands, with coding syntax and examples, listed alphabetically for quick reference.

C-Motion Engine Development Tools Manual

Describes the C-Motion Engine Development Tools that allow user application code to be created and compiled on a host PC, then downloaded, executed and monitored on a C-Motion Engine module.

C-Motion/PRP II Programming Reference

Describes C-Motion language function calls and associated PRP-formatted packets along with data types for the ION/CME N-Series ION Digital Drives.

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1. Introduction

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1.1 ION/CME N-Series Digital Drive Overview

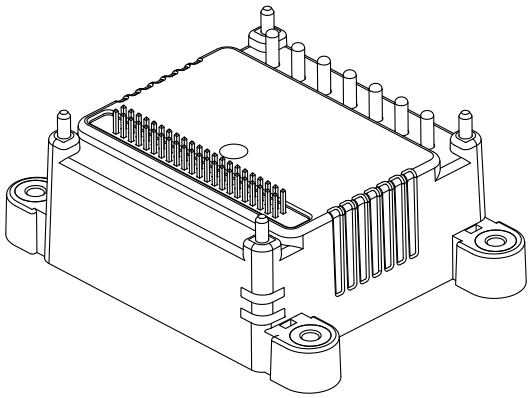


Figure 1-1: N-Series ION Digital Drive

This manual provides a complete user guide for the ION/CME N-Series Digital Drive Developer Kits. For documentation on ION/CME N-Series Digital Drive units, or other members of PMD's ION Digital Drive family please consult the appropriate documentation.

ION/CME N-Series Digital Drives are single-axis motion controllers with integrated power electronics and network communications. Various models are available to drive DC Brush, Brushless DC, and step motors. Their very compact

size, range of power output levels, and high level of connectivity make them an ideal solution for embedded or distributed motion control applications that require high performance in a small envelope.

ION N-Series Drives are based on PMD's Magellan Motion Control IC and perform profile generation, encoder position feedback, position servo compensation, step motor stall detection, brushless DC motor commutation, microstep generation, digital current/torque control, and more. All members of the ION family have integrated, high-power drive stages which protect from overcurrent, undervoltage, overvoltage, overtemperature, and short-circuit faults.

N-Series ION host communication options include Ethernet, CAN, RS232/RS485, and SPI (Serial Peripheral Interface). Each drive also supports an additional CAN and SPI expansion network for connecting to other N-Series ION or to other peripherals. All ION/CME N-Series Drives include a C-Motion Engine, allowing user application code to be downloaded and executed directly in the drive, along with NVRAM memory and trace memory for permanent and temporary storage of control parameters and performance trace results.

The N-Series IONs are PCB (printed circuit board) mounted and are packaged in a plastic and metal solderable module measuring 1.48" x 1.48" x 0.66" (37.6 mm x 37.6 mm x 16.8 mm). They come in three power levels; 75 watts, 350 watts, and 1,000 watts and utilize a 44 pin (2 x 22) 50-mil header for signal connections and a 7-pin high current connector for the DC bus and motor connections.

There are 36 different ION/CME N-Series Digital Drives in all, consisting of the combinations of four motor types (step motor, Brushless DC, DC Brush, Multi-Motor), three host interfaces (Serial, CAN/SPI, Ethernet), and three power levels (low, medium, high). Note that multi-motor units allow the motor type, either Brushless DC, DC Brush, or step motor, to be user programmed.

For a complete list of N-Series ION part numbers refer to Section 3.1, "N-Series ION Unit Part Numbers and Configurations."

1.2 Developer Kit Overview

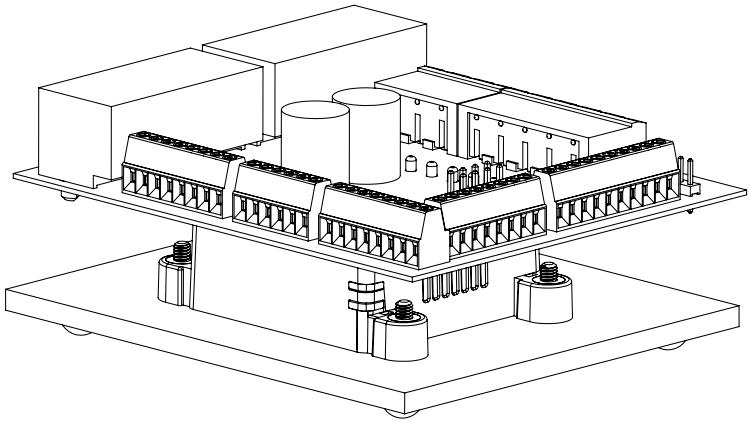


Figure 1-2: N-Series ION Development Kit

The ION/CME N-Series Digital Drive Developer Kits are integrated board/software packages that serve as a mechanical, electrical, and software design tool for prototyping and building systems with N-Series ION Drives.

The core of each developer kit is an interconnect board that provides convenient connections to your PC, the motor hardware, and other peripherals that will be used in your application.

As shown in Figure 1-2 the N-Series ION is mounted in between a metallic heat sink base (which also serves the purpose of providing a footing for bench-top use) and the DK interconnect board which provides the connectors. Alternatively you can remove the metallic heat sink base and mount the N-Series ION with attached DK interconnect

board directly on your machine hardware. For exact dimensions of the N-Series ION refer to Section 3.6, "Physical Dimensions."

1.3 Developer Kit Part Numbers

1.3.1 Pre-Assembled Developer Kits

The following N-Series Drive Developer Kits are fully assembled and installed with a multi-motor ION unit type. These various P/Ns represent three different host interface types (serial, CAN/SPI, Ethernet) and three different power levels (low, medum, high):

DK P/N	ION P/N Installed	Host Interface	Power Level
DK481S0056/02	DD481S0056/02	Serial	Low
DK481S0056/06	DD481S0056/06	Serial	Medium
DK481S0056/18	DD481S0056/18	Serial	High
DK481C0056/02	DD481C0056/02	CAN/SPI	Low
DK481C0056/06	DD481C0056/06	CAN/SPI	Medium
DK481C0056/18	DD481C0056/18	CAN/SPI	High
DK481D0056/02	DD481D0056/02	Ethernet	Low
DK481D0056/06	DD481D0056/06	Ethernet	Medium
DK481D0056/18	DD481D0056/18	Ethernet	High

1.3.2 Component Developer Kits

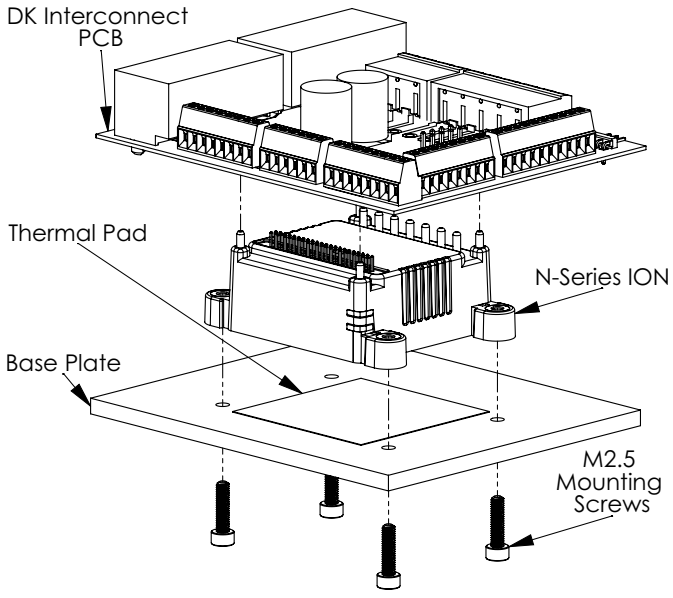


Figure 1-3: N-Series ION DK Showing Component Stack Elements

There may be occasions where it is preferable for the user to assemble an N-Series ION developer kit themselves. The main advantage of this is that it allows developer kit setups to be created with N-Series IONs other than the multi-motor type.

To facilitate this three non pre-assembled component developer kits are available as shown in the table below:

P/N	Host Interface	Comments
DK4X1S	Serial	Supports all serial host interface N-Series ION units
DK4X1C	CAN/SPI	Supports all CAN/SPI host interface N-Series ION units
DK4X1D	Ethernet	Supports all Ethernet host interface N-Series ION units

Each of these component-only DKs contain a DK interconnect PCB, a metallic base plate, and various mounting hardware such as screws and a thermal pad to allow the user to assemble a complete DK setup. Note that these DKs P/Ns do not include the N-Series ION unit itself. The N-Series ION must be ordered separately.

For instructions on how to assemble a developer kit setup from a component-only DK refer to Section 3.5, "Component Developer Kit Assembly."

1.4 Developer Kit Components List

The ION/CME N-Series Digital Drive Developer Kits contain the following components:

- Developer Kit interconnect board with N-Series Drive soldered in place
- Metal heat sink base with rubber feet
- USB to 3-pin serial programming cable
- Additional cables or accessories, depending on the host interface type of the ION unit

The following software and design materials are also included with each N-Series ION Developer Kit:

- Pro-Motion Windows-based exercisor
- C-Motion Engine Software Developer Kit:
  - A complete toolset for the creation of user-specific applications running on ION/CME or host
  - An open-source compiler
- C-Motion libraries
- PDFs of all N-Series ION documentation
- Gerber files for the DK Interconnect boards

For a detailed list of components for each N-Series ION DK type refer to Section 3.2, "Developer Kit Hardware Contents."

1.5 Getting Started & Installation Overview

1. Before using the N-Series ION Drive the software must be installed. See Section 1.7, "Software Installation," for instructions on installing the software.
2. Next, connect your system's motor, power, encoder, and sensors to operate the motion hardware. See Section 1.10.1, "Connection Summary," for a description of the available connections and options for the N-Series ION DK interconnect boards.

3 Connect the N-Series Drive to the host PC via the 3-pin programming cable. See Section 1.10.5, "Programming Connector (J9)," for a description of this procedure.

4 Once this hardware configuration is complete, the final step to finish the installation is to perform a functional test of the finished system. See Section 1.13, "First-Time System Verification," for a description of this procedure.

Once these steps have been accomplished, the installation is complete, and the DK setup is ready for operation.

1.6 Recommended Hardware

To install an N-Series ION developer kit the following hardware is recommended.

- PC with Intel (or compatible) processor, 1 Gbyte of available disk space and 256 MB of available RAM. The supported PC operating systems are Windows XP, Vista, Windows 7, Windows 8, Windows 10.
- One step, DC Brush, or Brushless DC motor.

  This motor may or may not provide encoder position feedback signals, depending on the type of motor being used. Encoder feedback is normally used with DC Brush motors and with Brushless DC motors (although not required because Hall sensors can be used for the position feedback). For step motors, encoders are an option.
- Cables as required to connect to the motor and associated motion hardware such as feedback signals.
- Power supply. The N-Series ION Drive requires only a single voltage supply. Its internal logic and other circuitry is powered from this input voltage using an internal DC to DC converter. The input voltage range is 12-56V.

1.7 Software Installation

The software distribution for the developer kit is downloaded from the PMD website at the URL: https://www.pmdcorp.com/resources/software.

All software applications are designed to work with Microsoft Windows.

To install the software:

1 Go to the Software Downloads section of PMD's website located at https://www.pmdcorp.com/resources/software and select download for "N-Series ION Developer Kit Software"

2 After selecting download you will be prompted to register your DK, providing the serial # for the DK and other information about you and your motion application.

3 After selecting submit the next screen will provide a link to the software download. The software download is a zip file containing various installation programs. Select this link and downloading will begin.

4 Once the download is complete extract the zip file and execute the Pro-Motion install and extract the SDK. Here is more information on Pro-Motion and the SDK used with N-Series ION.

- **Pro-Motion** – an application for communicating to, and exercising PMD ICs, modules, or boards.
- **C-Motion/PRP II SDK** – an SDK (Software Developer's Kit) for creating PC and downloadable user code for ION/CME N-Series Digital Drive products. Also supports creating motion

applications using the .NET (C#, VB) programming languages for all products. Contains PDF versions* of all PMD documentation.

*Adobe Acrobat Reader is required for viewing these files. If the Adobe Acrobat Reader is not installed on your computer, it may be freely downloaded from http://www.adobe.com.

Here is more information on the available software resources.

1.7.1 Pro-Motion

Pro-Motion is a sophisticated, easy-to-use exerciser program which allows all ION unit parameters to be set and/or viewed, and allows all features to be exercised. Pro-Motion features include:

- Motion oscilloscope graphically displays processor parameters in real-time
- AxisWizard to automate axis setup and configuration
- Position loop and current loop auto-tuning
- Project window for accessing motion resources and connections
- Ability to save and load settings
- Distance, time, and electrical units conversion
- Frequency sweep and bode plot analysis tools
- Motor-specific parameter setup
- Axis shuttle performs continuous back and forth motion between two positions
- C-Motion Engine monitor debug window
- C-Motion Engine user application code download

1.7.2 C-Motion

C-Motion provides a convenient set of callable routines comprising the C language code required for controlling N-Series IONs, whether running on a separate host computer such as a PC, an embedded microcontroller, or running inside the ION Board on the C-Motion Engine. C-Motion includes the following features:

- Magellan axis virtualization
- Ability to communicate to multiple PMD motion cards or modules
- Ability to communicate via PC/104 bus, serial, CAN, Ethernet, SPI (Serial Peripheral Interface), or 8/16 bit parallel bus
- Provided as source code, allowing easy compilation & porting onto various run-time environments including a PC, microprocessor, embedded card, or C-Motion Engine
- Can be easily linked to any C/C++ application

Three different version of C-Motion SDKs are available; the regular C-Motion SDK is used with PMD products such as Juno ICs, Magellan ICs, and non-CME version ION 500 & 3000 Digital Drives and non-CME version Prodigy Motion Boards. The C-Motion/PRP SDK is used with /CME version products such as ION/CME 500 and Prodigy/CME motion boards. Finally the C-Motion/PRP II SDK is used with ION/CME N-Series Digital Drives.

C-Motion SDK libraries used with Magellan IC products are documented in the *Magellan Motion Control IC Programming Reference*. C-Motion SDK libraries used with Juno IC products are documented in the *Juno Velocity & Torque Control IC*

Programming Reference. C-Motion/PRP SDK libraries are documented in the *C-Motion/PRP Programming Reference*. C-Motion/PRP II SDK libraries are documented in the *C-Motion/PRP II Programming Reference*.

1.7.3 .NET Language Support

A complete set of methods and properties is provided for developing applications in Visual Basic and C# using a dynamically loaded library (DLL) containing PMD library software. The DLL may also be used from any language capable of calling C language DLL procedures, such as Labview, but no special software support is provided.

Includes the following features:

- Magellan axis virtualization
- Ability to communicate to multiple PMD motion cards or modules
- Ability to communicate via PC/104 bus, serial, CAN, Ethernet, or SPI
- Provided as a single DLL and Visual Basic .NET source code for easy porting onto various PC environments

1.8 DK Interconnect Board Overview

Figure 1-4 shows the location of various components for the three different DK interconnect boards which differ in the host interface type; serial, CAN/SPI, or Ethernet.

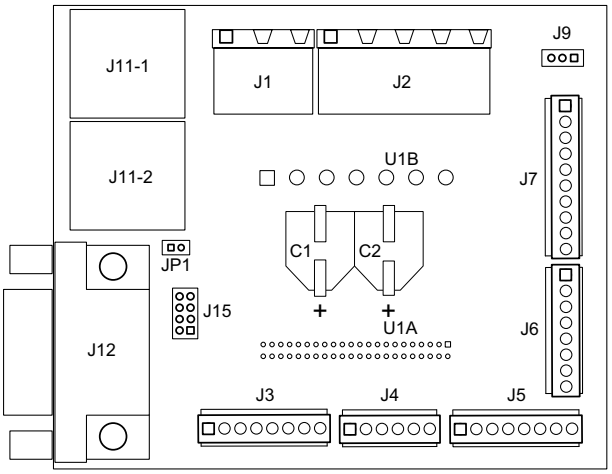


Figure 1-4: Serial Host Interface DK Interconnect Board

Figure 1-5: CAN/SPI Host Interface DK Interconnect Board

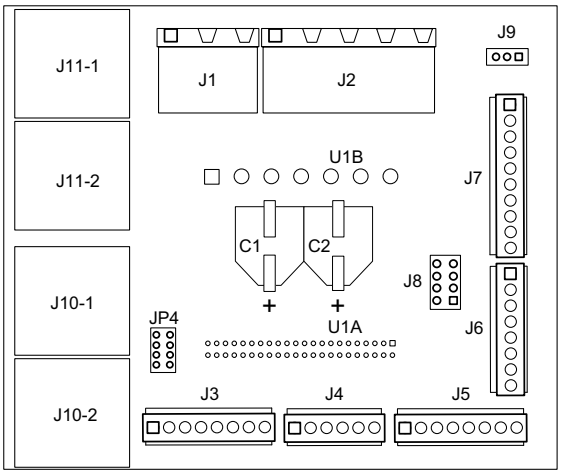
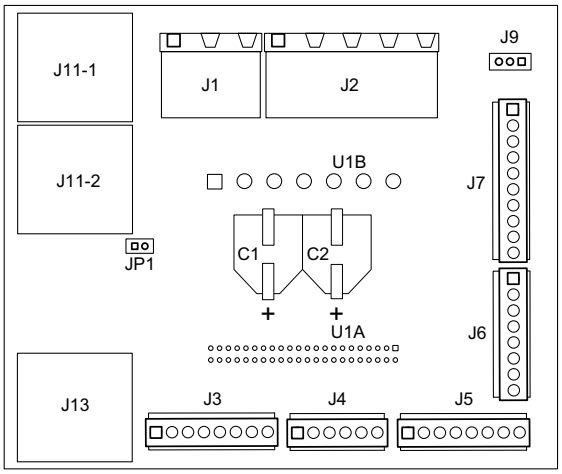


Figure 1-6: Ethernet Host Interface DK Interconnect Board



The following table identifies these components:

Label	Description
J1	HV Power Connector
J2	Motor Drive Connector
J3	Feedback Connector
J4	Hall Signals Connector
J5	Auxiliary Connector
J6	Motion Signals Connector
J7	Indexer Connector
J8	Host SPI Connector (CAN/SPI DK version only)
J9	Programming Connector
J10	Host CAN Connector (CAN/SPI DK version only)
J11	Expansion CAN Connector
J12	Host Serial Connector (Serial DK version only)
J13	Host Ethernet Connector (Ethernet DK version only)
J15	Host Serial Header Connector (Serial DK version only)
JP1	Serial & Ethernet board jumper
JP4	CAN/SPI board jumpers
U1A	N-Series ION Signal Connector pins
U1B	N-Series ION Power Connector pins

Label	Description
C1, C2	HV Capacitors

1.9 Configuring the Board

Each of the DK boards have user-settable jumper settings to configure their function. The factory default settings of these jumpers are designed to work with the 'getting started' instructions provided in this chapter. For more complex setups however you may find it useful to change these settings.

1.9.1 Ethernet & Serial Board Jumper Settings

Here are descriptions of the jumper settings for the Serial and Ethernet DK boards, which are shown in Figure 1-4 and Figure 1-6 respectively:

Jumper	Label	Factory Default	Description
JP1	N/A	Installed	When installed connects a 120 ohm termination resistor at the Expansion CAN bus. The terminating resistor should be used if the DK board is located at the end of the CAN network bus.

1.9.2 CAN/SPI Board Jumper Settings

Here are descriptions of the jumper settings for the SPI/CAN DK board, which is shown in Figure 1-5:

Jumper	Label	Factory Default	Description
JP4-1	E-Term	Installed	When installed connects a 120 ohm termination resistor at the Expansion CAN bus. The terminating resistor should be used if the DK board is located at the end of the CAN network bus.
JP4-2	H-Term	Installed	When installed connects a 120 ohm termination resistor at the Host CAN bus. This terminating resistor should be used if the DK board is located at the end of the CAN network bus.
JP4-3	SynchIn	Not installed	When installed connects pin 4 of the J10-2 Host CAN connector to the N-Series ION's SynchIn signal which is pin 34 of the Signal Connector. This connection allows daisy-chain ID assignment to be used described in the *ION/CME N-Series Digital Drive User Manual.*
JP4-4	SynchOut	Not installed	When installed connects pin 4 of the J10-1 Host CAN connector to the N-Series ION's SynchOut signal which is pin 37 of the Signal Connector. This connection allows daisy-chain ID assignment to be used described in the *ION/CME N-Series Digital Drive User Manual.*

1.10 Connecting the Board

Before operating the developer kit the interconnect board must be connected to your PC, the motor hardware, and any other motor/machine peripherals to be used with the N-Series ION in your application. For the first time installation a relatively minimal set of connections are needed which are summarized in Section 1.10.1, "Connection Summary." In subsequent sections detailed pinouts for all of the DK board connectors and associated signals are provided.

1.10.1 Connection Summary

Figures 1-7 through 1-9 provides general connection overviews for Brushless DC, DC Brush, and step motors. These diagrams do not show all possible connections or operational modes, but show a typical minimal set of connections that may be used with this first-time installation of the N-Series ION.

Figure 1-7: Brushless DC Motor Connection Overview

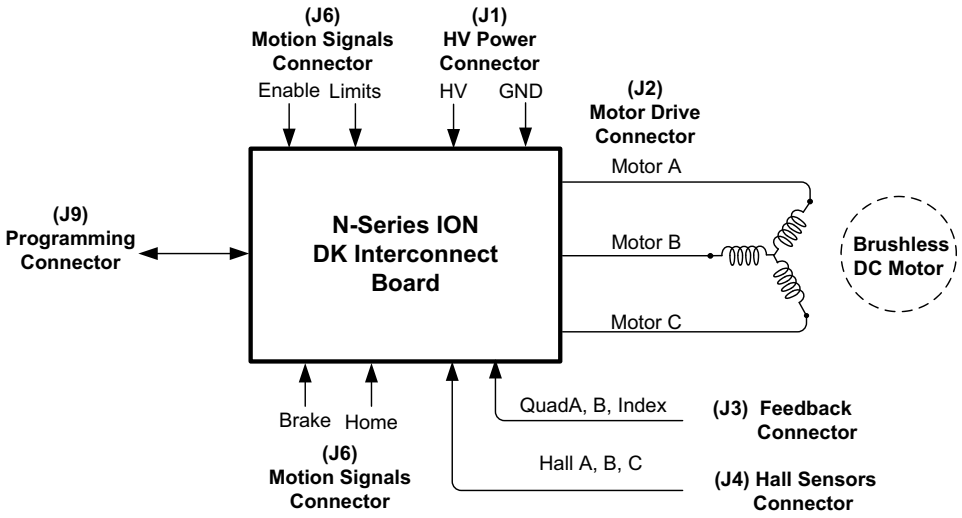
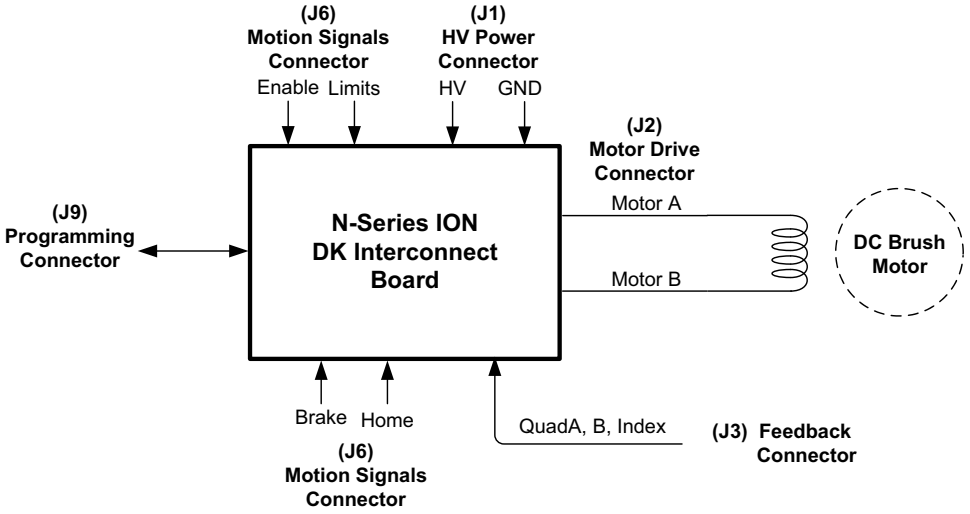


Figure 1-8: DC Brush Motor Connection Overview



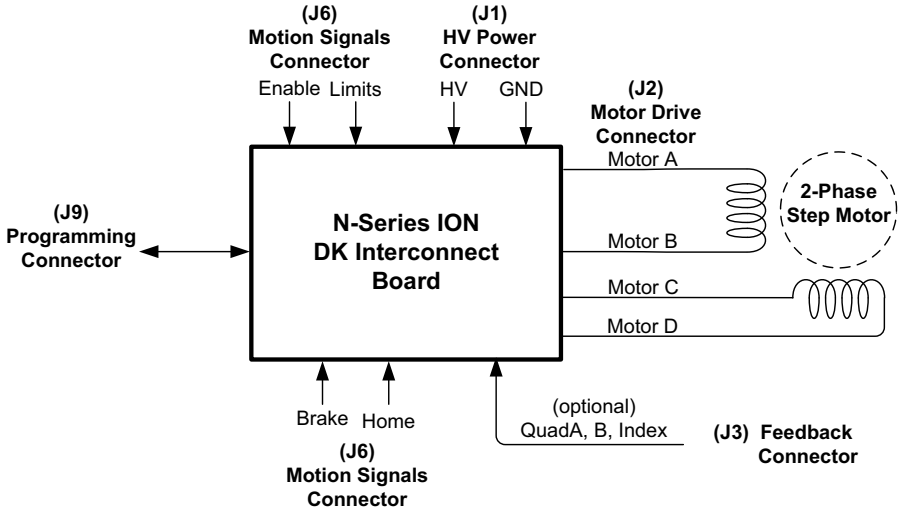


Figure 1-9: Step Motor Connection Overview

The connections highlighted in the figures above are provided below in table form.

Signal	Pin #	Comments
Feedback Connector (J3)		
+5V	1	+5V and GND may be used to power the encoder
GND	2	
QuadA1+, QuadA1-	3, 4	Encoder optional for step motors. If single-ended encoders used connect to + (positive) only
QuadB1+, QuadB1-	5, 6	
Index+, Index-	7, 8	Most encoders provide an Index pulse, which is useful for homing or for detecting lost encoder counts
Motion Signals Connector (J6)		
PosLim, NegLim	1, 2	Optional but frequently used signals to detect travelling beyond motion range of machine.
Home	3	Optional but frequently used signal to home the motor axis after startup
Enable	4	Enable signal must be driven low for N-Series ION to function. This is most easily accomplished by jumpering to pin 8 (GND) of this connector
Brake	7	Optional but frequently used safety signal to shut down motor operation
GND	8	Ground
Hall Signals Connector (J4)		
HallA, HallB, HallC	1, 2, 3	Used with Brushless DC motors only
GND	4	Ground return for Hall sensors
Programming Connector (J9)		
Srl3Xmt, Srl3Rcv	1, 2	These pins provide a serial connection that will be used for first time operation of the DK board. The USB to 3-pin programming cable included with the developer kit connects to this port.
GND	3	
HV Power Connector (J1)		
HV Aux, HV	1, 2	HV Aux and HV are usually tied together. They provide power for the internal unit logic after conversion by internal DC to DC and drive the motor coils. Must be in the range of 12 - 56V
GND	3	Power Ground Return

Signal	Pin #	Comments
Motor Drive Connector (J2)		
Motor A-D	1, 2, 3, 4	Drive connections to motor. Motor A & B are used with DC Brush motors Motor A, B, C are used with Brushless DC motors Motor A & B drive phase A of step motors Motor C & D drive phase B of step motors
Case/shield	5	A case/shield connection is strongly recommended for most motor setups.

The following sections provide detailed information on all of the connectors on the N-Series DK Interconnect boards.

1.10.2 Feedback Connector (J3)

The following table details the Feedback Connector (J3), which is an 8-pin jackscrew style connector.

Pin #	Signal Name	Description
1	+5V	+5V power output which may be used to power the motor's encoder circuitry
2	GND	This is the preferred ground connection for the quadrature and Index signal inputs
3	QuadA1+/Cos+*	Differential A+ or Cos+ encoder input for primary axis. *Optional for step motors.*
4	QuadA1-/Cos-*	Differential A- or Cos- encoder input for primary axis. *Optional for step motors.*
5	QuadB1+/Sin+*	Differential B+ or Sin+ encoder input for primary axis. *Optional for step motors.*
6	QuadB1-/Sin-*	Differential B- or Sin- encoder input for primary axis. *Optional for step motors.*
7	Index1+/BiSSClock+	Differential Index+ or BiSSClock+ encoder connection for primary axis. *Optional for step motors.*
8	Index1-/BiSSClock-	Differential Index- or BiSSClock- encoder connection for primary axis. *Optional for step motors.*

** Quadrature encoder type is the default setting. For information on how to change encoder types refer to the ION/CME N-Series Digital Drive User Manual.*

1.10.2.1 Single-ended Encoder Connections

Encoder inputs may be connected differentially, with two wires per signal (as shown in the table above), or with just one wire per signal. If single-ended encoders are used, connect encoder signals to the positive encoder input only. The negative input may remain unconnected.

1.10.3 Motion Signals Connector (J6)

The following table details the Motion Signals Connector (J6). This connector is an 8-pin jackscrew style connector.

Pin #	Signal Name	Description
1	PosLim	Positive position limit input (optional)
2	Neglim	Negative position limit input (optional)
3	Home	Home signal input (optional)
4	Enable	Enable input signal
5	FaultOut	FaultOut signal output
6	Reset	Reset signal input (optional)
7	Brake	Brake signal input (optional)
8	GND	Digital ground

1.10.3.1 Enabling the Board

N-Series IONs require an active *Enable* signal to operate. To accomplish this the Motion Signals Connector (J6) is used. Connect terminal #4 of J6 (indicated on the board as En) to terminal #8 of the same jackscrew connector (indicated on the board as GND) using a short wire.

1.10.4 Hall Signals Connector (J4)

The following table details the Hall Signals Connector (J4). Hall signals are used with Brushless DC motors. This connector is a 6-pin jackscrew style connector.

Pin #	Signal Name	Description
1	HallA	Hall Sensor A Input
2	HallB	Hall Sensor B Input
3	HallC	Hall Sensor C Input
4	GND	Digital ground
5	AnalogIn+	Positive differential signal of the general purpose analog input
6	AnalogIn-	Negative differential signal of the general purpose analog input

1.10.5 Programming Connector (J9)

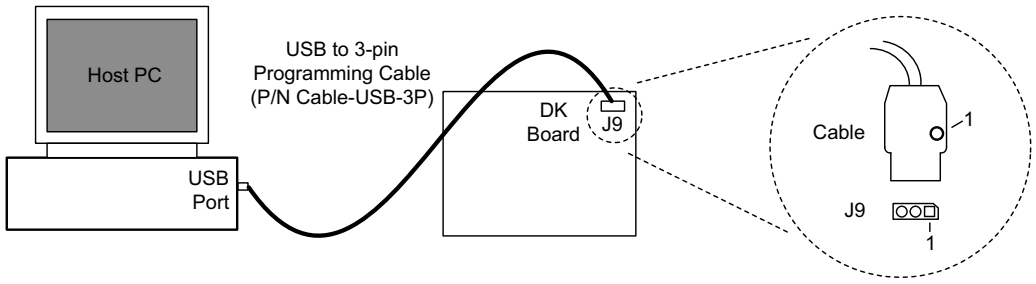


Figure 1-10: PC to N-Series ION DK Board Connection

In this first-time installation we will use the N-Series ION's 3-pin serial programming interface for communicating to the PC. For this purpose, a 3-pin programming cable is included with the developer kit. This serial cable (PMD p/n Cable-USB-3P) should be connected to the board's J9 Programming Connector, while the opposite end of the cable should be connected to one of your computer's USB ports. Take special care when connecting to the 3-pin connector on the board that pin #1 on the cable (marked with a dot on the cable) aligns with pin #1 on the connector (marked by a square pad shape).

The following table details the Programming Connector (J9). This connector is a 3-pin 2 mm header.

Pin #	Signal Name	Description
1	Srl3Xmt	Serial programming port transmit signal
2	Srl3Rcv	Serial programming port receive signal
3	GND	Ground

If operating the developer kit in high EMI environments or at high motor current levels, shielding on the 3-pin programming cable may be required to insure reliable communication between the PC and the ION unit. Contact your PMD representative for additional information and support.

1.10.6 Power Connector (J1)

The following table details the Power Connector (J1).

The Power Connector is a Würth Elektronik 3 Position Terminal Block Header P/N 691313710003.

Pin #	Signal Name	Description
1	HV Aux	Positive motor voltage power used to drive N-Series ION's internal logic
2	HV	Positive motor voltage power used to drive the motor
3	GND	Motor voltage power ground

The HV Aux and HV pins are normally tied together but may be kept separate.

1.10.7 Motor Drive Connector (J2)

The following table details the motor drive connector (J2). There are four motor drive connections and a shield connection. Not every motor type uses all four drive connections.

The J2 Motor Drive Connector is a Würth Elektronik 5 Position Terminal Block Header P/N 691313710005.

Pin #	Signal Name	Description
1	Motor A	A motor drive lead. Used with all motor types.
2	Motor B	B motor drive lead. Used with all motor types
3	Motor C	C motor drive lead. Used with all motor types except DC Brush
4	Motor D/Shunt	D motor drive lead used with step motors only, or shunt output used with DC Brush or Brushless DC motors.
5	Case/shield	Connection to motor case/shield. A shield connection is strongly recommended for most motor setups. This pin is connected to the N-Series ION's Power Connector GND signal.

1.10.7.1 Connection by Motor Type

You may refer to Figures 1-7 through 1-9 or use the table below to determine which leads should be connected for each supported motor type:

Motor Type	DK Board Pin # and Name	Motor Coil Connections
Brushless DC	1, Motor A	A winding connection
	2, Motor B	B winding connection
	3, Motor C	C winding connection
	5, Case/shield	(optional) motor shield connection
DC Brush	1, Motor A	+ winding connection
	2, Motor B	- winding connection
	5, Case/shield	(optional) motor shield connection
Step motor	1, Motor A	phase A+ winding connection
	2, Motor B	phase A- winding connection
	3, Motor C	phase B+ winding connection
	4, Motor D	phase B- winding connection
	5, Case/shield	(optional) shield connection

Shield connections to the motor are strongly recommended. Not connecting the shield signal may result in increased EMI (electromagnetic interference), reduced immunity to ESD (electrostatic discharge), or electrical noise resulting in motor operation failure.

1.10.8 Auxiliary Connector (J5)

The following table details the Auxiliary Connector (J5). This connector is an 8-pin jackscrew style connector.

Pin #	Signal Name	Description
1	+5V	+5V power output which may be used to power the encoder
2	GND	Ground
3	QuadA2+	Auxiliary encoder differential A+ quadrature input
4	QuadA2-	Auxiliary encoder differential A- quadrature input
5	QuadB2+	Auxiliary encoder differential B+ quadrature input
6	QuadB2-	Auxiliary encoder differential B- quadrature input
7	Index2+/BiSSData+*	Differential Index+ or BiSSData+ encoder connection.
8	Index2-/BiSSData-*	Differential Index- or BiSSData- encoder connection.

** Quadrature encoder type is the default setting for both the primary and auxiliary axis. For information on how to change encoder types refer to the ION/CME N-Series Digital Drive User Manual.*

1.10.9 Indexer Connector (J7)

The following table details the Indexer Connector (J7). This connector is an 10-pin jackscrew style connector.

Pin #	Signal Name	Description
1	GND	Ground
2	DigitalIO1	Digital I/O bit 1
3	DigitalIO2	Digital I/O bit 2
4	DigitalIO3/AxisIn*	Digital I/O bit 3 or AxisIn signal depending on pin MUX setting. AxisIn is the default functionality.
5	DigitalIO4/SynchIn*	Digital I/O bit 4 or SynchIn signal depending on pin MUX setting. SynchIn is the default functionality.
6	DigitalIO5/AxisOut*	Digital I/O bit 5 or AxisOut signal depending on pin MUX setting. AxisOut is the default functionality.
7	DigitalIO6/HostInterrupt*	Digital I/O bit 6 or HostInterrupt signal depending on pin MUX setting. HostInterrupt is the default functionality.
8	DigitalIO7/SynchOut*	Digital I/O bit 7 or SynchOut signal depending on pin MUX setting. SynchOut is the default functionality.
9	DigitalIO8	Digital I/O bit 1
10	GND	Ground

** To access the desired function the pin MUX setting may need to be changed. Refer to the ION/CME N-Series Digital Drive User Manual for more information.*

1.10.10 Host SPI Connector (J8)

The following table details the Host SPI Connector (J8), which is provided with CAN/SPI host interface N-Series ION DKs. This connector is an 8-pin 4x2 100 mil header.

Pin #	Signal Name	Sense Interpretation	Description
1	HostSPIXmt	N/A	Host SPI transmit output
2	HostSPIRcv	N/A	Host SPI receive input
3	HostSPIClock	N/A	Host SPI clock input
4	HostSPISelect	Active Low	Host SPI Enable input
5	HostInterrupt	Active Low	Magellan HostInterrupt signal output
6	HostSPIStatus	Active Low	Magellan Host SPI Status signal output
7	GND	N/A	Ground
8	Reset	Active Low	Master N-Series ION unit reset

1.10.11 Host CAN Connector (J10-1, J10-2)

The following table details the Host CAN Connectors (J10-1 and J10-2), which are provided with CAN host interface N-Series ION DKs. These connectors consist of two 8-pin RJ45s wired such that each J10-1 connector pin connects to the matching J10-2 connector pin (daisy chain configuration).

J10-1 Pin #	J10-2 Pin #	Signal Name	Description
1	1	HostCAN+	Host CAN+
2	2	HostCAN-	Host CAN-
3	3	GND	Ground
4	4	SynchIn/SynchOut	Depending on DK board jumper setting this pin may carry a synch signal. See Section 1.9.2, "CAN/SPI Board Jumper Settings." for details.
5	5	N.C.	
6	6	N.C.	
7	7	GND	Ground
8	8	N.C.	

1.10.12 Expansion CAN Connector (J11-1, J11-2)

The following table details the Expansion CAN Connectors (J11-1 and J11-2), which consist of two 8-pin RJ45 connectors wired such that each J11-1 pin connects to the matching J11-2 connector pin (daisy chain configuration).

J11-1 Pin #	J11-2 Pin #	Signal Name	Description
1	1	ExpCAN+	Expansion CAN+
2	2	ExpCAN-	Expansion CAN-
3	3	GND	Ground
4	4	N.C.	
5	5	N.C.	
6	6	N.C.	
7	7	GND	Ground
8	8	N.C.	

1.10.13 Host Serial Connector (J12)

The following table details the Host Serial Connector (J12), which is provided with serial host interface N-Series ION DKs. This connector supports two RS232 ports or a single RS485 port operating in either RS485 full duplex, or RS485 half duplex mode. This connector is a female DB-9.

Pin #	Signal Name	RS232	RS485 Full Duplex	RS485 Half Duplex
			J12	
1	No connect	no connect	no connect	no connect
2	Srl1Xmt	Serial 1 transmit output	no connect	no connect
3	Srl1Rcv	Serial 1 receive input	no connect	no connect
4	No connect	no connect	no connect	no connect
5	GND	Ground	Ground	Ground
6	$RS485Rcv^{+}$	no connect	Positive (non-inverting) receive input	no connect
7	$Srl2Rcv/RS485Rcv^{-}$	Serial 2 receive input	Negative (inverting) receive input	no connect
8	$Srl2Xmt/RS485Xmt^{-}$	Serial 2 transmit output	Negative (inverting) transmit output	Negative transmit/receive
9	$RS485Xmt^{+}$	no connect	Positive (non-inverting) transmit output	Positive transmit/receive

1.10.14 Host Serial Header Connector (J15)

The following table details the Host Serial Header Connector (J15), which is provided with serial host interface N-Series ION DKs. This connector provides a subset of the signals provided with the Host Serial Connector (J12). This connector is an 8-pin 100 mil header.

Pin #	Signal Name	Description
1	Srl2Xmt	Serial2 Transmit
2	Srl2Rcv	Serial2 Receive
3	Srl1Xmt	Serial1 Transmit
4	Srl1Rcv	Serial1 Receive
5	DigitalIO6	DigitalIO6 signal
6	RS485Sel	RS232/RS485 select pin
7	GND	Ground
8	GND	Ground

1.10.15 Host Ethernet Connector (J13)

The following table details the Host Ethernet Connector (J13), which is provided with Ethernet host interface N-Series ION DKs. This connector is a female RJ-45.

Pin #	Signal Name	Description
		J13
1	EthernetTx+	Ethernet differential transmit positive
2	EthernetTx-	Ethernet differential transmit negative
3	EthernetRx+	Ethernet differential receive positive
4	No connect	No connect
5	No connect	No connect
6	EthernetRx-	Ethernet differential receive negative
7	No connect	No connect
8	No connect	No connect

1.11 Enabling the N-Series ION

The N-Series ION must receive an active ***Enable*** signal to drive the motor. This is usually accomplished via a short jumper wire connecting the ***Enable*** signal on the Motion Signals Connector (J6) to ground. See Section 1.10.3.1, "Enabling the Board," for details.

1.12 Applying Power

Once you have made your motion hardware, communication, and power connections, hardware installation is complete and the N-Series ION is ready for operation. When power is applied, the N-Series ION's green power LED should light. This LED is labeled D24 in Figure 1-4. If the LED does not light, recheck connections.

After power up no motor output will be applied. Therefore the motors should remain stationary. If the motors move or jump, power down and check the motor and encoder connections. If anomalous behavior is still observed, call PMD or your PMD representative for assistance.

1.13 First-Time System Verification

The first time system verification procedure summarized below has two overall goals. The first is to connect the N-Series ION with your PC so that they are communicating properly, and the second is to initialize the axis and bring it under stable control capable of making controlled moves. While there are many additional capabilities that Pro-Motion and N-Series IONs provide, the first time verification will create a foundation for further successful exploration and development.

Here is a summary of the steps that will be used during first time system verification. Each of these steps will be described below in a separate section.

1. Initiate Pro-Motion and establish communication between the PC and the N-Series ION using the serial 3-pin programming cable.
2. Run Pro-Motion's Axis wizard to initialize parameters such as encoder direction and safe servo parameters (if using a servo motor).
3. Execute a simple point to point move profile demonstrating that the axis is operating correctly and under stable control.

During this first time system setup you may find it useful to refer to other manuals including the *Magellan Motion Control IC User Guide*.

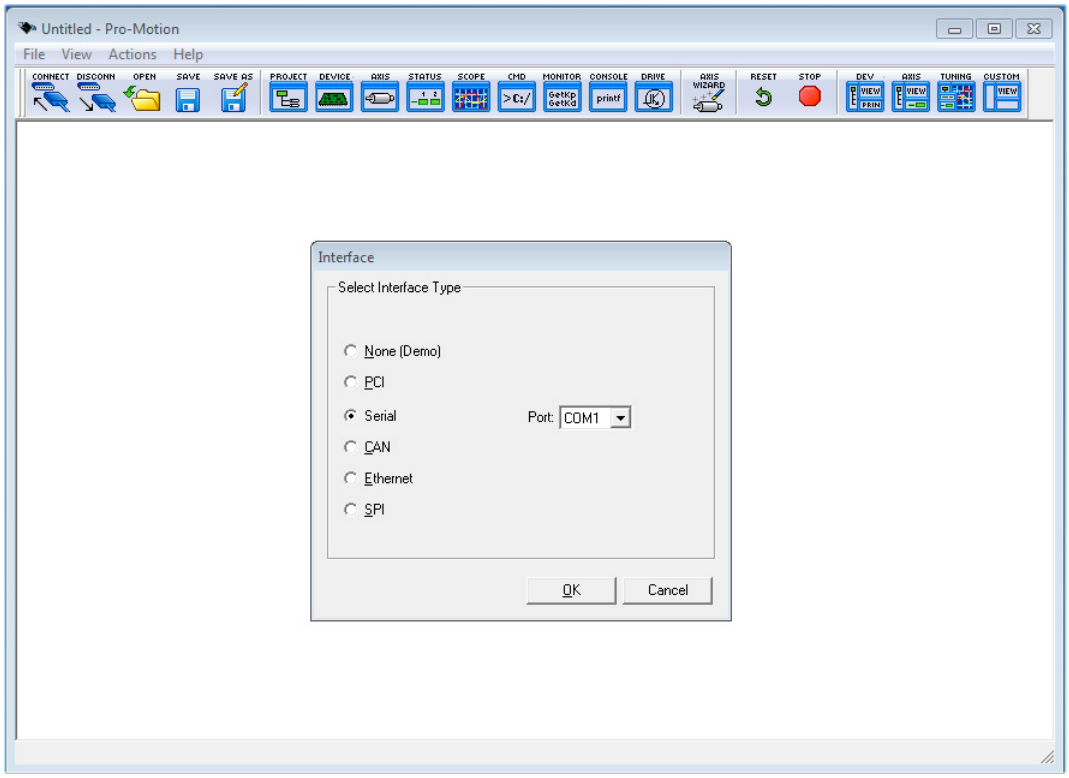
1.13.1 Establishing Communications

To establish serial communications:

1. Make sure the N-Series ION DK interconnect board is powered and connected to the PC via the 3-pin programming cable as shown in Figure 1-10.
2. Launch the Pro-Motion application.

   When Pro-Motion is launched you will be prompted with an Interface selection window. A typical screen view when first launching Pro-Motion appears below.

The purpose of the Interface dialog box is to indicate to Pro-Motion how your N-Series ION is connected to the PC. It provides various selectable communication options such as serial, CAN, Ethernet.

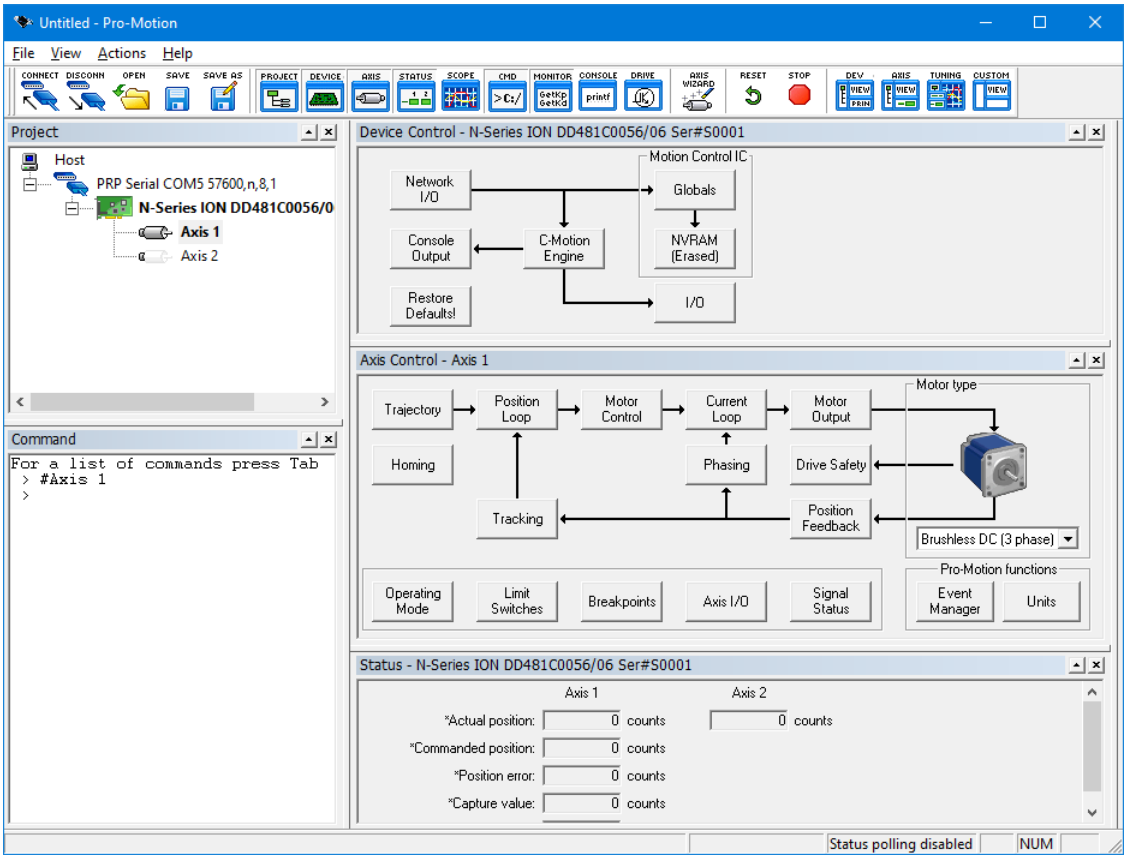


3 Click Serial, select the com port that the DK is connected to, and then click OK.

The Serial Port dialog box displays with default communication values of 57,600 baud, no parity, 1 stop bit, and point to point protocol.

4 Click OK without changing any of these settings.

If serial communication is correctly established, a set of object graphics loads into the Project window to the left, as shown in the following figure.



For example, you will see the N-Series ION name next to an icon of the drive, and below that you see an axis icon. Highlighting (single clicking) either the ION icon or the axis icons with the mouse is used to select specific drives, and is useful later on in the first time system verification.

If serial communications are not correctly established, a message appears indicating that an error has occurred. If this is the case, recheck your connections and repeat from step 1.

1.13.2 Running the Axis Wizard

The next step to verify the correct operation of the system is to initialize the axis, thereby verifying correct amplifier operation, encoder feedback connections (if an encoder is used), and other motion functions. All of this can be conveniently accomplished using Pro-Motion's Axis Wizard function. This versatile and easy to use tool initializes all supported motor types including step, DC brush, and brushless DC.

To operate the Axis Wizard:

1. Select axis 1 to initialize in the Project window to the left of the screen.
2. With this icon highlighted, click the Axis Wizard toolbar button.

The Axis Wizard initialization window appears.

3 Click Next and follow the Axis Wizard instructions for each page of the axis initialization process. A typical Axis Wizard sequence takes 5-10 minutes.

The most common reasons for the Axis Wizard to not complete normally are an inability to auto-tune the motor, or problems determining the correct commutation sequence for brushless DC motors. Should this happen, it is possible to perform a manual tuning or commutation setup if desired.

1.13.3 Performing a Simple Trajectory Move

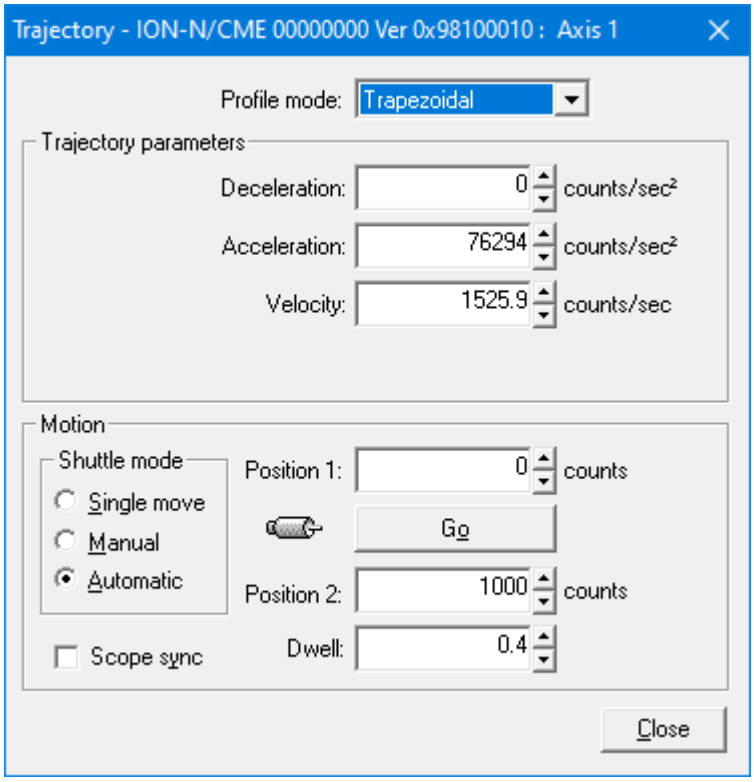
The last step in first time system verification is to perform a simple move for each axis.

To perform a simple move:

1 In the Project Window, select the motion axis that you would like to move by clicking the corresponding icon.

2 Click the Axis view button on the far right of the toolbar. Alternatively, click Axis View on the Axis menu. Your screen organization changes to give easy access to windows that are used while exercising the motion axes.

3 Click the Trajectory button in the Axis Control window. The Trajectory dialog box appears.



4 In the Profile mode list, select Trapezoidal.

5 Enter motion profiles for deceleration, acceleration, velocity, and destination position (Position 1) that are safe for your system and will demonstrate proper motion.

Pro-Motion provides various selectable units for distance and time, but defaults to units of encoder counts (or pulses for step motors) for distance and seconds for time. This means the default units for velocity are counts/sec, and the default units for acceleration and deceleration are counts/sec^2. So for a motor that has 2,000 counts per rotation, to perform a symmetric trapezoidal move of 25 rotations with a top speed of 5 rotations per second and with an acceleration time of two seconds, the parameters in the Trajectory dialog box would be set as follows:

Deceleration: 5,000 counts/sec^2

Acceleration: 5,000 counts/sec^2

Velocity: 10,000 counts/sec

Position 1: 0 counts

Position 2: 50,000 counts.

6 Click Go and confirm that the motion occurred in a stable and controlled fashion.

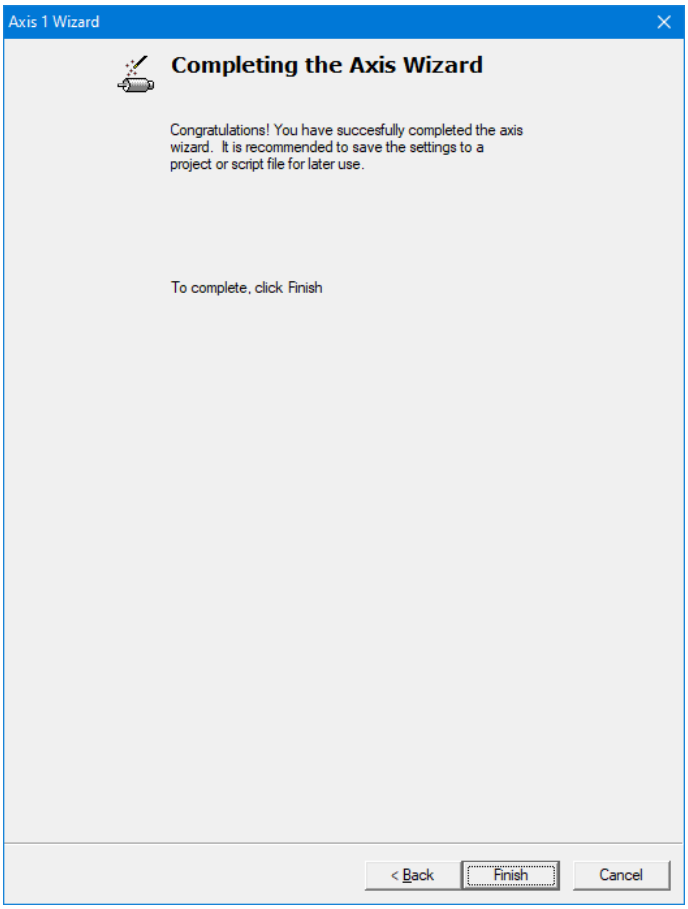
Congratulations! First-time system verification for this axis is now complete.

1.14 Saving Your Settings

The very last screen in the axis wizard sequence is called "Completing the Axis Wizard" and serves the purpose of reminding you to save the control parameter settings that you established with the Axis Wizard to a project file. Projects are a useful way to manage multiple Pro-Motion sessions, particularly when experimenting with different hardware setups or different control parameter groupings.

Each project can be assigned a name and recalled at a later time using that name. The application information that is stored via the project mechanism includes gain settings, safety limits, and other parameters set up with the Axis Wizard or set while using the main parameter setting windows provided by Pro-Motion. The list of parameters that are saved and recalled with the project mechanism can be set by the user if desired.

To store parameters to a project select File/New Project from the main menu at the top of the screen.



1.15 Exploring Further

Once you are finished setting up the motor using the Axis Wizard and saving your project settings, Pro-Motion has extensive performance trace facilities that can be accessed from its main control windows along with other motor control functions. You can use these facilities to further checkout and optimize your system's performance.

When restarting Pro-Motion it is generally useful to restore the configuration that you have saved from your past Pro-Motion sessions. Do this by selecting File/Open Project, selecting the correct file previously stored.

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2. Connecting via Host Interfaces

In This Chapter

- Activating CAN Communications
- Activating Serial Communications
- Activating Ethernet Communications
- Activating SPI Communications
- C-Motion Engine User Code Development

In the previous chapter's 'getting started' description the PC was communicating to the N-Series ION via its programming port using the 3-pin programming cable. However there will likely be times when you want to connect Pro-Motion to the N-Series ION via its native host interface, either CAN FD, serial, Ethernet, or SPI. Accomplishing this is described in the following sections.

2.1 Activating CAN Communications

N-Series IONs of CAN/SPI host interface type support CAN FD communications through their host CAN port, and all N-series IONs support CAN FD communication through their expansion CAN port. CAN FD supports CANbus 2.0 functionality as a subset, and therefore if you plan to use CANbus 2.0 this is supported. For detailed information on N-Series ION's CAN interfaces refer to the *ION/CME N-Series Digital Drive User Manual*

2.1.1 CAN Hardware Setup

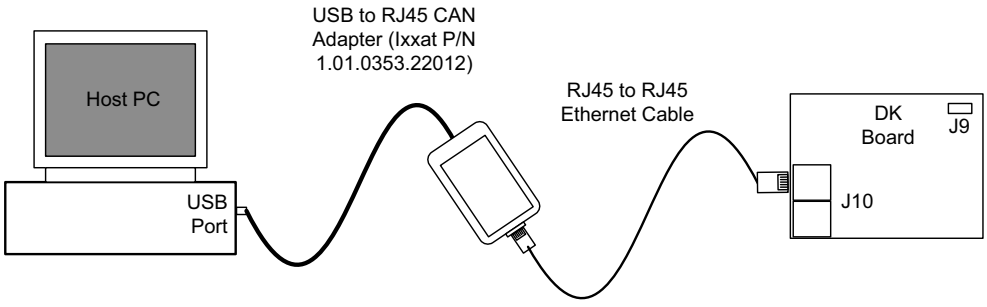


Figure 2-1: Hardware Setup for Communicating via CAN

For your PC to communicate via CAN you will typically use a USB to CAN converter which provides an RJ45 interface.

The CAN/SPI N-Series ION DK board directly accepts this cable at either J10-1 or J10-2. Either socket can be used because each signal is daisy chained from one connector to the other. This is convenient for creating a CAN based network with multiple ION units installed.

For your convenience the following table provides a list of accessories that you may find useful for CAN communications:

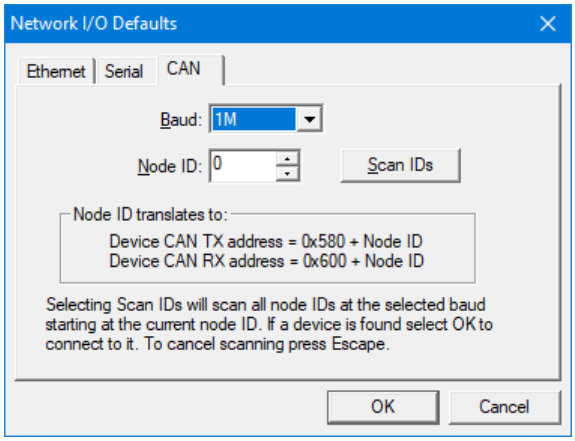
Vendor	P/N	Description	Included with CAN DK
Ixxat	1.01.0353.22012	USB to CAN FD connector, RJ45 interface	No
CableWholesale	10x8-56101	6' Cat 6 Ethernet connector cable	No

For detailed wiring information on the PMD-manufactured accessories listed above, refer to Section 3.3, "Selected Cable & Accessory Specifications."

2.1.2 Setting Up the ION For CAN Communications

Here is the Pro-Motion sequence used to set up the N-Series ION to connect via its CAN host interface. Note that if you are able to operate the N-Series ION at its default CAN settings of 1M baud and node ID 0 you can skip to Section 2.1.3, "Setting Up Pro-Motion For CAN Communications."

1. With serial communications via the 3-pin programming cable functioning properly, click the Device toolbar button. The Device window appears.
2. Click Network I/O. The Network I/O Defaults dialog box appears.
3. Click the CAN tab. This window appears with data entry fields for the bit rate and the node ID. This is shown below with default values visible.



4. Enter the desired bit rate and node ID in the corresponding data fields.
5. Click OK to store as the power on default.
6. Click the Reset toolbar button. After the ION is reset, it uses the default parameters that you specified.

The N-Series ION has now been programmed to be ready for CAN communications.

2.1.3 Setting Up Pro-Motion For CAN Communications

To setup Pro-Motion to communicate by CAN:

1. Click the Connect toolbar button.
2. Select CAN, and then click OK.
3. Enter the same bit rate and node ID as was programmed into the ION previously.

4 When complete, click OK.

If CAN communication is successful, an additional set of graphical icons representing your N-Series ION and axis will be loaded into the Project window.

If communication is not successful, after about 30 seconds, a Communications Timeout Error dialog box appears. If this happens, recheck your connections, and retry to establish CAN communications.

When CAN communications are functioning properly, the final step is to disable serial communications.

2.1.4 Disconnecting Serial Communications

The last step is to disconnect the programming port serial connection. To accomplish this:

1 Select the serial link version of the ION in the Project window.

2 Click the Disconnect toolbar button. A dialog box appears asking if you are sure you want to disconnect.

3 Click OK. You will notice that the serial ION icon and axes graphical icons in the Project box disappear, leaving only the CAN link icons for the ION and axis.

CAN communication setup is now complete. You are ready to execute all Pro-Motion functions via CAN.

2.2 Activating Serial Communications

N-Series IONs of serial host interface type support RS232, RS422, and RS485 communications. For detailed information on N-Series ION's serial interfaces refer to the *ION/CME N-Series Digital Drive User Manual.*

In the following sections we will detail how to connect from a PC to the N-Series ION's serial connections using two different connection schemes; RS232 and RS485.

2.2.1 RS232 Hardware Setup

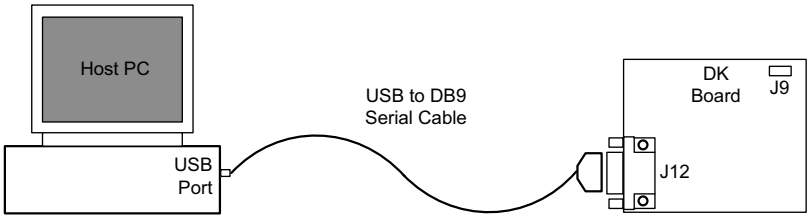


Figure 2-2: Hardware Setup for Communications via RS232

For your PC to communicate via RS232 you will use the USB to DB9 serial converter cable (PMD P/N Cable-USB-DB9) which is included with serial host N-Series ION DKs. As shown in Figure 2-2 the DK interconnect board directly accepts this cable at its J12 connector. Note that you should plug this cable into a USB port on your PC different than the one already being used for the USB to 3-pin programming port cable that you used for setup and first time verification.

In addition, the N-Series ION should be set to RS232 rather than RS485 communication. With a factory default N-Series ION unit connected as shown in the figure above RS232 is automatically selected. If desired however, this setting can be set and stored in the N-Series ION's NVRAM. See Section 2.2.6, "Setting Up the ION for RS485 Communications" for more information.

Although in this RS232 setup description we will only use Serial1, serial host N-Series IONs provide two RS232 interfaces, Serial1 and Serial2. PMD has available in its accessories library a cable that allows access to both of the serial

ports. To order this cable contact your local PMD representative. For convenience the two cables mentioned above are listed in the table below:

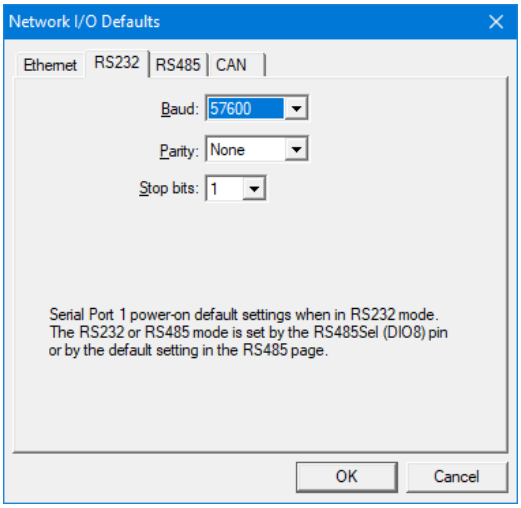
Vendor	P/N	Description	Included with Serial DK
PMD	Cable-USB-DB9	Male DB9 to USB serial converted cable.	Yes
PMD	Cable-4355-01.R	Male DB9 dual serial to two single-channel female DB9 cable.	No

For detailed wiring information on both of these cables refer to Section 3.3, "Selected Cable & Accessory Specifications."

2.2.2 Setting Up the ION for RS232 Communications

Here is the Pro-Motion sequence used to set up the N-Series ION to connect via its Serial1 RS232 host interface.

1. With serial communications via the 3-pin programming cable functioning properly, click the Device toolbar button. The Device window appears.
2. Click Network I/O. The Network I/O Defaults dialog box appears.
3. Click the Serial tab. This window appears with data entry fields for the default serial port setting such as the baud rate. This is shown below with default values visible.



4. Enter the desired baud in the corresponding data fields.
5. Click OK to store as the power on default.
6. Click the Reset toolbar button. After the ION is reset, it uses the default parameters that you specified.

The N-Series ION has now been programmed to be ready for RS232 communications.

2.2.3 Setting Up Pro-Motion for RS232 Communications

To setup Pro-Motion to communicate by RS232:

1. Click the Connect toolbar button.
2. Select RS232 and then click OK.
3. Enter the same serial port settings as were programmed into the ION previously.
4. When complete, click OK.

If RS232 communication is successful, an additional set of graphical icons representing your N-Series ION and axis will be loaded into the Project window. If communication is not successful, after about 2 seconds, a Communications Timeout Error dialog box appears. If this happens, recheck your connections, and retry to establish RS232 communications.

When RS232 communications are functioning properly, the final step is to disable serial communications to the ION's Serial3 programming port connection

2.2.4 Disconnecting Serial3 Programming Port Communications

The last step is to disconnect the programming port serial connection. To accomplish this:

1. Select the serial link version of the ION in the Project window.
2. Click the Disconnect toolbar button. A dialog box appears asking if you are sure you want to disconnect.
3. Click OK. You will notice that the serial ION icon and axes graphical icons in the Project box disappear, leaving only the Serial1 RS232 link icons for the ION and axis.

RS232 communication setup is now complete. You are ready to execute all Pro-Motion functions via RS232.

2.2.5 RS485 Hardware Setup

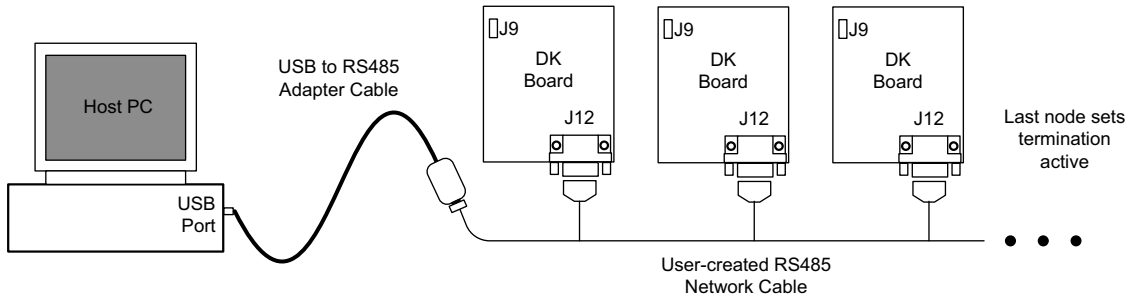
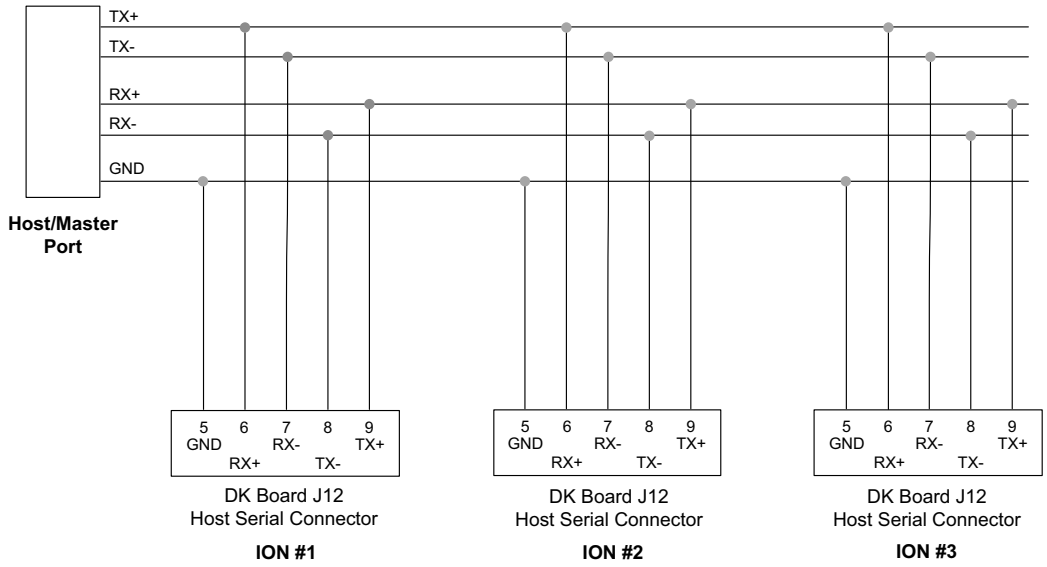


Figure 2-3: Hardware Setup for Communications via RS485

In addition to RS232 communications at Serial1 and Serial2, N-Series IONs support RS422 and RS485 communications via the Serial1 interface. Communicating by RS485 is typically less of a 'plug and play' process than communicating by RS232 however, and requires the user to create their own cables.

RS422 is essentially a subset of RS485 which uses a similar differential electrical interface but has only a single node connection. We will therefore focus on RS485 and show how to wire a network of RS485-connected N-Series IONs.

Figure 2-4: RS485 Signal Connection Diagram



RS485 is a master slave system. When connecting to a PC running Pro-Motion the PC functions as the master, and each N-Series ION in the network functions as a slave. Figure 2-4 shows the basic wiring scheme that is used for a full duplex (four-wire) connection. Four wire is recommended over two-wire because it has higher reliability. Additional details such as what wire type to use, wire shielding, twisting differential wire pairs, length of wire etc. will not be detailed here but are important so a reference text on RS485 networks should be consulted.

For reliable communications the last unit on both sides of the network cable should provide termination. For most systems 120 ohms of termination resistance is recommended. N-Series IONs provide user programmable internal termination of 120 ohm.

For additional information on serial communication functions with N-Series IONs refer to the *ION/CME N-Series Digital Drive User Manual.*

To prepare the PC to function as the RS485 master an RS422/485 USB adapter or RS485 card should be purchased and installed. Follow the product directions to install the software drivers. If properly installed and visible to Windows, Pro-Motion should recognize the RS485 port and be able to communicate with it automatically. For convenience the following table lists a vendor and P/N for such an adaptor product:

Vendor	P/N	Description
Advantech	BB-USOPTL4	Isolated high retention USB to RS422/485 converter (USB cable included)

2.2.6 Setting Up the ION for RS485 Communications

Each ION unit to be installed in the RS485 network needs to be programmed with network settings. If the IONs are mounted on the DK interconnect board, these settings can be programmed using Pro-Motion communicating to the ION via the 3-pin programming port.

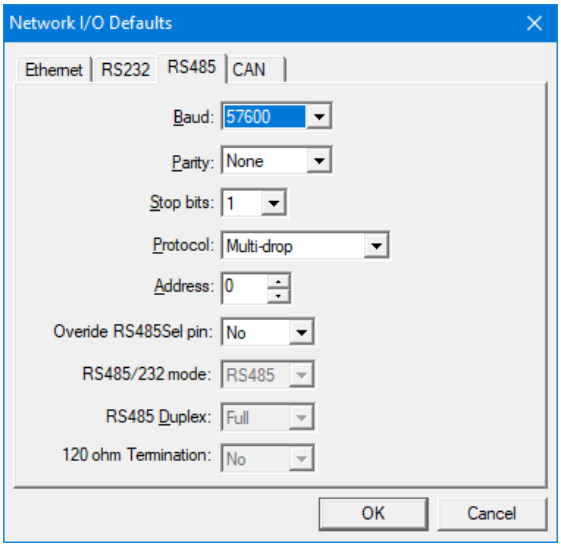
Each successive ION will be programmed, powered down, and then the 3-pin cable is detached and attached to the next unit to be programmed. After the final unit is programmed the 3-pin programming cable should be detached.

The table below provides a summary of the available serial network settings as well as recommended values for creating the RS485 network:

Parameter	Default Setting	Setting Options	Comment
Override RS485Sel pin	no	no yes	If this field is set to "no" the value of pin 9 of the serial N-Series ION's Signal Connector (which can be accessed on the DK board via Pin 9 of J7, the Indexer Connector), will be read to select RS232 or RS485 (high = RS232, low = RS485). If this field is set to "yes" the pin value will be ignored and the RS232/ RS485 setting will be read from the setting of the next field.
RS232 or RS485	RS232	RS232 RS485	See above. This setting is only used if the 'Override RS485Sel pin' is programmed to "yes".
Node ID	0	0-31	Each ION unit should be programmed with a different node address.
Duplex (full/half)	full duplex	half duplex full duplex	If using a four wire connection scheme full duplex should be selected. Two wire schemes should select half duplex.
Termination active	no	application specific	The last ION in the network should have termination active. All other units should have termination inactive.

Once each N-Series ION unit has been programmed and wired into the network the system is ready to operate.

2.2.7 Setting Up Pro-Motion for RS485 Communications



With a RS422/RS485 USB Adapter or other RS485 network card installed in the PC and drivers loaded, the instructions provided in Section 2.2.3, "Setting Up Pro-Motion for RS232 Communications" can be followed to configure the PC to talk to the RS485 network IONs, except that the RS485 tab rather than the RS232 tab should be selected. The programmed baud rate should match the baud rate entered into the N-Series IONs, the protocol should be programmed to multi-drop, and the correct address/node ID should be entered.

With the full network powered on, If RS485 communication is successful, an additional set of graphical icons representing each of the N-Series IONs on the network will be loaded into the Project window. If communication is not successful, after about 2 seconds a Communications Timeout Error dialog box appears. If this happens, recheck your connections, and retry to establish communications with the ION units.

If RS485 communications are functioning properly, the last step is to disconnect the Serial3 programming port. Instructions to do this can be found at Section 2.2.4, "Disconnecting Serial3 Programming Port Communications."

RS485 communication setup is now complete and you are ready to execute all Pro-Motion and N-Series ION functions via RS485 network.

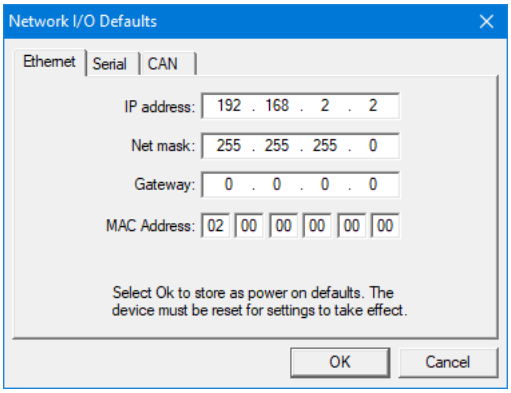
2.3 Activating Ethernet Communications

N-Series IONs of Ethernet host interface type support 100 Base-T Ethernet Communications. For detailed information on N-Series ION's Ethernet interface, refer to *ION/CME N-Series Digital Drive User Manual.*

2.3.1 Setting Up the ION For Ethernet Communications

Here is the Pro-Motion sequence used to set up the N-Series ION to connect via its Ethernet host interface.

1. With serial communications via the 3-pin programming cable functioning properly, click the Device toolbar button. The Device window appears.
2. Click Network I/O. The Network I/O Defaults dialog box appears.
3. Click the Ethernet tab. This window appears with data entry fields for the IP Address, the Net Mask, and the gateway. This is shown below with default values visible.



4. Enter the IP Address in the corresponding data field as well as the net mask and gateway if this is required for your network.

For a typical installation you will not change the netmask and gateway default values, but you must specify a valid, unique IP Address. If you are not sure what IP addresses are free and available for your Ethernet network contact your system administrator.

5. Click OK to store as the power on default.

6 Click the Reset toolbar button. After the ION is reset, it uses the default parameters that you specified.

The N-Series ION has now been programmed to be ready for Ethernet communications.

2.3.2 Setting Up Pro-Motion For Ethernet Communications

To setup Pro-Motion to communicate by Ethernet:

1 Click the Connect toolbar button.

2 Select Ethernet, and then click OK.

3 Enter the same IP Address as was programmed into the ION previously.

4 When complete, click OK.

If Ethernet communication is successful, an additional set of graphical icons representing your N-Series ION and axis will be loaded into the Project window.

If communication is not successful, after about 30 seconds, a Communications Timeout Error dialog box appears. If this happens, recheck your connections, and retry to establish Ethernet communications.

When Ethernet communications are functioning properly, the final step is to disable serial communications.

2.3.3 Disconnecting Serial Communications

The last step is to disconnect the programming port serial connection. To accomplish this:

1 Select the serial link version of the ION in the Project window.

2 Click the Disconnect toolbar button. A dialog box appears asking if you are sure you want to disconnect.

3 Click OK. You will notice that the serial ION icon and axes graphical icons in the Project box disappear, leaving only the Ethernet link icons for the ION and axis.

SPI communication setup is now complete. You are ready to execute all Pro-Motion functions via SPI.

2.4 Activating SPI Communications

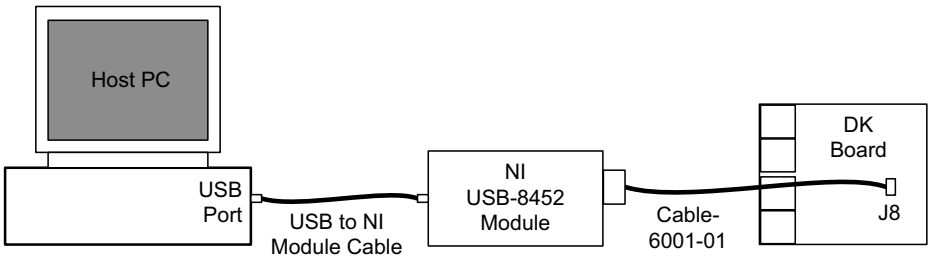
N-Series IONs of CAN/SPI host interface type support host-connected SPI (Serial Peripheral Interface) Communications. For detailed information on N-Series ION's SPI interface, refer to *ION/CME N-Series Digital Drive User Manual.*

2.4.1 SPI Hardware Setup

The N-Series ION CAN/SPI DK supports an SPI (Serial Peripheral Interface) connection for host communications via its J8 connector. This connector may be used to directly communicate with the CAN/SPI DK from a user-created custom hardware design, or alternatively, communicate to the SPI port via a Windows-based PC. Figure 2-5 shows this.

Note that while inter-card SPI connections are generally not recommended, they may be useful in various circumstances such as to debug SPI-specific problems with a particular application.

Figure 2-5: PC to N-Series ION DK SPI Connection Diagram



The major components required for PC to N-Series ION CAN/SPI DK communications are listed below:

Item	Part number	Manufacturer	Description
J8 to SPI interface module cable	Cable-6001-01	PMD	This cable interconnects the National Instruments USB-8452 module to the DK's J8 connector
SPI interface module	NI USB-8452	National Instruments	This module generates SPI signals compatible with the N-Series IONs 's host SPI interface.
SPI interface module USB cable	NI USB-8452	National Instruments	This cable connects a USB port with the NI USB-8452 module. It is included with purchase of the USB-8452 module

For detailed wiring information on the PMD-manufactured accessories listed above, refer to Section 3.3, "Selected Cable & Accessory Specifications."

The special hardware items listed above, which are required for SPI communications between Pro-Motion and the CAN/SPI ION DK are not included with the standard N-Series ION CAN/SPI DK. These items must be purchased separately from the indicated manufacturer.

Only the above-listed SPI interface module is supported by Pro-Motion. User-designed or other third-party SPI interface modules will not function correctly with Pro-Motion unless they are 100% compatible with the above listed SPI interface module.

2.4.2 Setting Up Pro-Motion For SPI Communications

Once the hardware is in place setting up a Pro-Motion to SPI connection is actually easier than for the other ION host connections types (Serial, CAN, Ethernet) because there are no communication parameters to set in the N-Series ION unit.

Therefore it is not necessary to initially connect via the 3-pin programming cable, and correspondingly it is not necessary to disable this connection after SPI communications have been established. So the entirety of the setup sequence consists of specifying to Pro-Motion that it should communicate by SPI.

To setup Pro-Motion to communicate by SPI:

1. Click the Connect toolbar button.
2. Select SPI, and then click OK.

If SPI communication is successful, an additional set of graphical icons representing your N-Series ION and axis will be loaded into the Project window.

If communication is not successful, after a few seconds, a Communications Timeout Error dialog box appears. If this happens, recheck your connections, and retry to establish SPI communications.

2.5 C-Motion Engine User Code Development

The next few sections will provide information and suggestions to get you started if your application calls for user-written code to be executed on the N-Series ION's C-Motion Engine (CME).

Creating, compiling, downloading, and verifying a user-written C-Motion application on a N-Series ION is accomplished with PMD's C-Motion Engine development system, described in the *C-Motion Engine Development Tools Manual*. The outcome of such a development sequence is a downloadable .bin file that contains the user application code and that can be executed by the C-Motion Engine.

2.5.1 Connections Overview

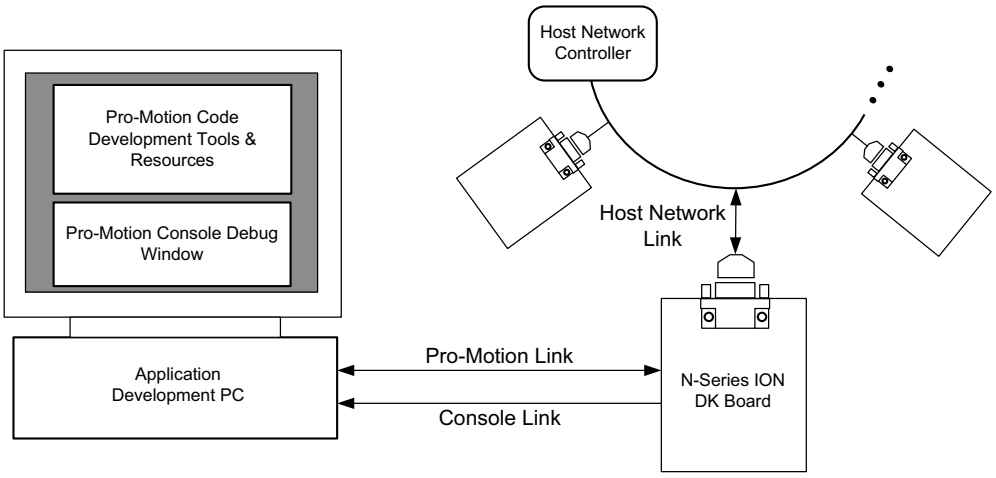


Figure 2-6: Typical Connection Links During C-Motion Engine Code Development

Figure 2-6 shows a typical connection architecture for C-Motion Engine user code development with a N-Series ION. There are three separate communication links:

Pro-Motion Link

The Pro-Motion link connects the PC that holds Pro-Motion, the user source code, and the source code editing and compiling tools to the N-Series ION that will receive the user code. This link allows the user code, once compiled and converted into a .bin file format, to be downloaded and eventually executed on the ION's C-Motion Engine. In addition this link can be used to monitor the status of the motion system even while the CME-based user application code is executing. This may be useful, for example, to track the location and status of the controlled axis.

The Pro-Motion link uses PRP (PMD Resource Access Protocol) to communicate with the N-Series ION. For more information on PRP refer to the *C-Motion/PRP II Programming Reference*.

The Pro-Motion link is generally always present during CME code development and execution.

Host Network Link

Many N-Series ION units in the actual application will be linked to a host/supervisory network to receive commands and report results and status. An example of a host network link is a factory floor network.

The host network link often uses an application-specific custom protocol or end-industry specific standard protocol to command the N-Series ION. Examples of commands that might be sent on such a host network are "Arm Extend" or "Move indexer to slot #15". The protocol and interpretation of such commands are specific to the end application and so the user code downloaded into the N-Series ION, among other things, will have the job of interpreting and responding to such commands. It is also possible that the host network utilizes PRP for communication, particularly if all of the devices on the network are PMD based products such as ION/CME or Prodigy/CME boards.

Not all systems executing user code on the CME will have a host network. For example some applications are fully standalone and do not have a host network.

For examples of different network topologies and applications supported by N-series IONs refer to the "Typical Applications" section of the *ION/CME N-Series Digital Drive User Manual.*

Console Link

The final link in a typical CME code development setup is the console channel. This function is discussed in more detail in the *ION/CME N-Series Digital Drive User Manual* but provides a convenient pathway for sending printf type statements from the user code running on the N-Series ION to a separate monitor or to the Pro-Motion debug console window.

The console link does not have a protocol as such and transmits in ASCII whatever messages are sent using printf commands executed in the CME user code.

While a console port connection may be useful, particularly in the earlier stages of user code development, not all systems will need or use a console channel link.

2.5.2 Development Connections by ION Unit Type

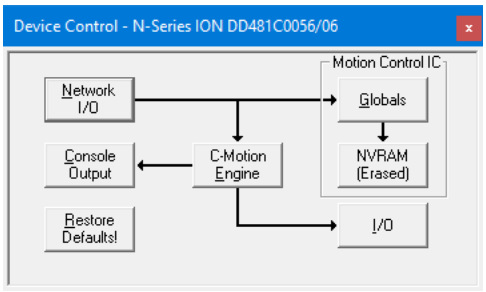
The table below provides information on typical connections, for each N-Series ION host interface type, for the above three link types. As noted earlier not every application will require all three connection links.

ION Host Interface Type	Pro-Motion Link	Host Network Link	Console Link
CAN/SPI	CAN - PRP node ID*	CAN - Host node ID	CAN - PRP node ID*
CAN/SPI	Serial3	SPI	Serial3
Serial	Serial3	RS232 - Serial1	Serial3**
Serial	Serial3	RS422 - Serial1	Serial3
Serial	Serial3	RS485 - Serial1	Serial3
Ethernet	TCP port 40100	TCP port 0-65,535 except 40100	UDP

* Pro-Motio*n and console traffic are carried via PRP on the PRP node ID. The Host node ID is user selected but must be different than the PRP node ID to avoid a conflict. If it is preferred that no additional CAN traffic is introduced to the Host CAN Network, Serial3 may instead be used for Pro-Motion and Console traffic.*

*** Serial3 carries Pro-Motion communications along with console traffic (using PRP's virtual console connection peripheral type). An alternative is to use the RS232 Serial2 connection for raw console traffic.*

2.5.3 Setting Up the Development Connections



Assuming that a functional Pro-Motion connection exists to the N-Series ION via Serial3, the programming port, the first step is to set up the host network connection if this has not been done already. Depending on the host interface you plan to use, refer to Section 2.1, "Activating CAN Communications" Section 2.2, "Activating Serial Communications" or Section 2.3, "Activating Ethernet Communications" for detailed instructions on specifying the host interface connection.

For CAN/SPI interface units, if using the CAN network to carry Pro-Motion and console traffic make sure that the host network node ID is different than the CAN PRP node ID, which is 0. PMD CAN products transmit on CAN address 0x600 and receive on 0x580 by default which equates to node ID 0. A node ID of 1 equates to addresses 0x601 and 0x581. There are 127 possible node IDs. The power-on node ID default can be changed via Pro-Motion or the SetDefault PRP command. If desired, the PRP CAN node ID can be changed via Pro-Motion using the CAN tab of the Network I/O Defaults window.

For the Ethernet interface typically all connections are made through Ethernet. The host network and Pro-Motion connections use TCP, and they must specify IP addresses different from each other to avoid conflicts. The console connection is also carried over Ethernet but uses the UDP protocol.

Finally, to set the console connection type use the Console Output Button located in the Device Control window.

2.5.4 Typical Code Development Session

With the CME code development connections in place, you are ready to start building your application using the tools provided in the C-Motion engine development system. These C-Motion engine development tools are used to create/edit, compile, and download user application code into the N-Series ION's CME (C-Motion Engine).

The development system can download the file image for the current code project being worked on, or a specific named file can be downloaded. Downloaded files images end with a ".bin" extension. Only one code image file may be downloaded into the C-Motion Engine at a time. Downloading a new image automatically erases the previous code image.

There are times when it may be useful to read specific characteristics of a code file that has been downloaded into the C-Motion Engine. For example a host controller in a production environment may want to confirm that the host application code version actually loaded on the C-Motion Engine matches the expected production code version. To confirm this information Pro-Motion displays, in the C-Motion Engine Window, the file name of the downloaded user application code, the checksum of the downloaded file, the date & time of file creation, and the version number of the C-Motion Engine itself is displayed.

To retrieve this information Pro-Motion sends PRP commands to the N-Series ION requesting this data. For complete information on the format and function of these, and other C-Motion calls refer to the *C-Motion/PRP II Programming Reference*.

2.5.4.1 Code Compilation, Downloading & Execution

The C-Motion Engine Development Tools Manual provides detailed step by step information on how to the edit, compile, and link source application code. The C-Motion Engine development environment uses the 'Programmer's Notepad' text editor and the GNU Compiler Collection (GCC) compiler and linker.

Once a .bin file has been generated it can be transferred and stored in the N-Series ION's CME using Pro-Motion. After the user code has been loaded into the N-Series ION unit it is ready to be executed. If the auto-execution flag has been set then the simplest way to begin executing the code is to re-power the N-Series ION. After initialization the user code will execute automatically.

If code execution is set to manual, with the N-Series ION powered on the code can be started using Pro-Motion via the C-Motion Engine Window. Once the code executes you should begin to see any printf statements that you have embedded in the code displayed in the console channel. During initial code development this is a convenient method to confirm that the code loaded correctly and is executing.

2.5.4.2 Sample "Hello World" Code Development Sequence

To exercise and become familiar with the C-Motion Development tools you may find it helpful to compile, link, and download a sample "hello world" application included in the SDK, using the steps detailed in the *C-Motion Engine Development Tools Manual*.

When executed, this simple "hello world" code sends a "hello world" message to the console. As a next step you can edit the source code file, for example changing the output message slightly, and then re-compile, download, and execute this modified .bin code image.

If you have trouble during any of the steps above contact your PMD representative for assistance.

Congratulations! You are now ready to begin developing your C-Motion Engine-based application code. For a general introduction to the N-Series ION's C-Motion Engine refer to *ION/CME N-Series Digital Drive User Manual*. For detailed information on C-Motion commands refer to the *C-Motion/PRP II Programming Reference*. For more information on the tools provided for code development refer to the *C-Motion Engine Development Tools Manual*.

3. Reference

In This Chapter

3.1 N-Series ION Unit Part Numbers and Configurations

There are 36 different ION/CME N-Series Digital Drives in all, consisting of the combinations of four motor types (step motor, Brushless DC, DC Brush, Multi-Motor), three host interfaces (Serial, CAN/SPI, Ethernet), and three power levels (low, medium, high). Note that multi-motor units allow the motor type, either Brushless DC, DC Brush, or step motor, to be user programmed.

The following table shows the available N-Series ION part numbers:

P/N	Host Interface	Power Level	Voltage	Motor Type
Step Motor				
DD441S0056/02	Serial	Low (75W)	12-56V	Step Motor
DD441S0056/06	Serial	Medium (350W)	12-56V	Step Motor
DD441S0056/18	Serial	High (1,000W)	12-56V	Step Motor
DD441C0056/02	CAN/SPI	Low (75W)	12-56V	Step Motor
DD441C0056/06	CAN/SPI	Medium (350W)	12-56V	Step Motor
DD441C0056/18	CAN/SPI	High (1,000W)	12-56V	Step Motor
DD441D0056/02	Ethernet	Low (75W)	12-56V	Step Motor
DD441D0056/06	Ethernet	Medium (350W)	12-56V	Step Motor
DD441D0056/18	Ethernet	High (1,000W)	12-56V	Step Motor
Brushless DC				
DD431S0056/02	Serial	Low (75W)	12-56V	Brushless DC
DD431S0056/06	Serial	Medium (350W)	12-56V	Brushless DC
DD431S0056/18	Serial	High (1,000W)	12-56V	Brushless DC
DD431C0056/02	CAN/SPI	Low (75W)	12-56V	Brushless DC
DD431C0056/06	CAN/SPI	Medium (350W)	12-56V	Brushless DC
DD431C0056/18	CAN/SPI	High (1,000W)	12-56V	Brushless DC
DD431D0056/02	Ethernet	Low (75W)	12-56V	Brushless DC
DD431D0056/06	Ethernet	Medium (350W)	12-56V	Brushless DC
DD431D0056/18	Ethernet	High (1,000W)	12-56V	Brushless DC

P/N	Host Interface	Power Level	Voltage	Motor Type
DC Brush				
DD411S0056/02	Serial	Low (75W)	12-56V	DC Brush
DD411S0056/06	Serial	Medium (350W)	12-56V	DC Brush
DD411S0056/18	Serial	High (1,000W)	12-56V	DC Brush
DD411C0056/02	CAN/SPI	Low (75W)	12-56V	DC Brush
DD411C0056/06	CAN/SPI	Medium (350W)	12-56V	DC Brush
DD411C0056/18	CAN/SPI	High (1,000W)	12-56V	DC Brush
DD411D0056/02	Ethernet	Low (75W)	12-56V	DC Brush
DD411D0056/06	Ethernet	Medium (350W)	12-56V	DC Brush
DD411D0056/18	Ethernet	High (1,000W)	12-56V	DC Brush
Multi Motor				
DD481S0056/02	Serial	Low (75W)	12-56V	Multi Motor
DD481S0056/06	Serial	Medium (350W)	12-56V	Multi Motor
DD481S0056/18	Serial	High (1,000W)	12-56V	Multi Motor
DD481C0056/02	CAN/SPI	Low (75W)	12-56V	Multi Motor
DD481C0056/06	CAN/SPI	Medium (350W)	12-56V	Multi Motor
DD481C0056/18	CAN/SPI	High (1,000W)	12-56V	Multi Motor
DD481D0056/02	Ethernet	Low (75W)	12-56V	Multi Motor
DD481D0056/06	Ethernet	Medium (350W)	12-56V	Multi Motor
DD481D0056/18	Ethernet	High (1,000W)	12-56V	Multi Motor

3.2 Developer Kit Hardware Contents

3.2.1 Serial Host Interface DKs

The table below lists the hardware components and accessories provided with serial host interface N-Series ION DKs, P/Ns DK481S0056/02, DK481S0056/06, DK481S0056/18, and DK4X1S:

Name	PMD P/N	Description
N-Series ION Stack*		
N-Series ION unit**	DD481S0056/02 (low power) DD481S0056/06 (medium power) DD481S0056/18 (high power)	Either low, medium, or high power multi-motor serial interface N-Series ION unit
Serial DK PCB	PCB-1047-41	Populated four-layer interconnect PCB for serial host interface N-Series ION DKs
Base plate	NION-DKH-01	Black anodized aluminum N-Series ION DK base plate
Mounting screws	N/A	Four M2.5 x 0.45 mm thread, 8 mm long, button head screws
Thermal pad	NION-DKH-02	10 mil (.25 mm) thick thermal pad cut to dimensions 33.5 mm by 33.5 mm

Name	PMD P/N	Description
Other Cables & Components		
3-pin programming cable	Cable-USB-3P	USB to 3-pin programming cable for communicating with N-Series ION
DB9 serial cable	Cable-USB-DB9	Male DB9 to USB serial converter cable
Allen key***	N/A	1.5 mm Allen key

** With the pre-assembled DKs the ION unit, interconnect DK PCB, base plate, thermal pad, and mounting screws are all pre-assembled together and the ION unit is soldered into the PCB. With the non pre-assembled DKs the N-Series ION unit is not included and the components are provided without being assembled together. For instructions on assembling a complete N-Series ION DK stack refer to Section 3.5, "Component Developer Kit Assembly."*

*** ION unit not included with non pre-assembled DKs*

**** Allen key not included with pre-assembled DKs*

3.2.2 CAN/SPI Host Interface DKs

The table below lists the hardware components and accessories provided with CAN/SPI host interface N-Series ION DKs, P/Ns DK481C0056/02, DK481C0056/06, DK481C0056/18, and DK4X1C:

Name	PMD P/N	Description
N-Series ION Stack*		
N-Series ION unit**	DD481C0056/02 (low power) DD481C0056/06 (medium power) DD481C0056/18 (high power)	Either low, medium, or high power multi-motor CAN/SPI interface N-Series ION unit
CAN/SPI DK PCB	PCB-1047-21	Populated four-layer interconnect PCB for CAN/SPI host interface N-Series ION DKs
Base plate	NION-DKH-01	Black anodized aluminum N-Series ION DK base plate
Mounting screws	N/A	Four M2.5 x 0.45 mm thread, 8 mm long, button head screws
Thermal pad	NION-DKH-02	10 mil (.25 mm) thick thermal pad cut to dimensions 33.5 mm by 33.5 mm
Other Cables & Components		
3-Pin programming cable	Cable-USB-3P	USB to 3-pin programming cable for communicating with N-Series ION
CAN terminator	TRM-RJ45-02	RJ45 CAN terminator
Allen key***	N/A	1.5 mm Allen key

** With the pre-assembled DKs the ION unit, interconnect DK PCB, base plate, thermal pad, and mounting screws are all pre-assembled together and the ION unit is soldered into the PCB. With the non pre-assembled DKs the N-Series ION unit is not included and the components are provided without being assembled together. For instructions on assembling a complete N-Series ION DK stack refer to Section 3.5, "Component Developer Kit Assembly."*

*** ION unit not included with non pre-assembled DKs*

**** Allen key not included with pre-assembled DKs*

3.2.3 Ethernet Host Interface DKs

The table below lists the hardware components and accessories provided with Ethernet host interface N-Series ION DKs, P/Ns: DK481E0056/02, DK481E0056/06, DK481E0056/18, DK4X1E:

Name	PMD P/N	Description
N-Series ION Stack*		
N-Series ION Unit**	DD481D0056/02 (low power) DD481D0056/06 (medium power) DD481D0056/18 (high power)	Either low, medium, or high power multi-motor Ethernet interface N-Series ION unit
Ethernet DK PCB	PCB-1047-01	Populated four-layer interconnect PCB for Ethernet host interface N-Series ION DKs
Base plate	NION-DKH-01	Black anodized aluminum N-Series ION DK base plate
Mounting screws	N/A	Four M2.5 x 0.45 mm thread, 8 mm long, button head screws
Thermal pad	NION-DKH-02	10 mil (.25 mm) thick thermal pad cut to dimensions 33.5 mm by 33.5 mm
Other Cables & Components		
3-Pin Programming Cable	Cable-USB-3P	USB to 3-pin programming cable for communicating with N-Series ION
Ethernet cable	N/A	Standard 6' Cat 6 Ethernet connector cable
Allen key***	N/A	1.5 mm Allen key

** With the pre-assembled DKs the ION unit, interconnect DK PCB, base plate, thermal pad, and mounting screws are all pre-assembled together and the ION unit is soldered into the PCB. With the non pre-assembled DKs the N-Series ION unit is not included and the components are provided without being assembled together. For instructions on assembling a complete N-Series ION DK stack refer to Section 3.5, "Component Developer Kit Assembly."*

*** ION unit not included with non pre-assembled DKs*

**** Allen key not included with pre-assembled DKs*

3.2.4 Additional DK Accessories

The table below lists additional components that may be useful when working with N-Series ION DKs.

Name	Vendor & P/N	Description
USB to CAN FD connector	Ixxat, P/N: 1.01.0353.22012	USB to CAN FD connector, RJ45 interface. See Section 2.1, "Activating CAN Communications," for more information on the use of this cable.
Dual serial channel cable	PMD, P/N: Cable-4355-01.R	Male DB9 dual serial to two single-channel female DB9 cable. See Section 2.2, "Activating Serial Communications," for more information on the use of this cable.
Host SPI connector interface cable	PMD, P/N: Cable-6001-01	Adapter cable for NI USB-8452 to J8 DK connector. See Section 2.4, "Activating SPI Communications," for more information on the use of this cable.
SPI interface converter module & cable	National Instruments, P/N: NI USB-8452	USB to SPI converter module and associated cable. See Section 2.4, "Activating SPI Communications," for more information on the use of this converter module & cable.

3.3 Selected Cable & Accessory Specifications

PMD Part #: Cable-4355-01.R

Description: Male DB9 dual serial to two single-channel female DB9 cable

Length: 5 ft (1.5 m)

Notes: Bifurcated shielded cable with male DB9 (P1 in wiring table) splitting to female DB9 carrying Serial1 channel (Srl1 in table) and female DB9 carrying Serial2 channel (Srl2 in table).

P1 DB9 Pin#	P1 DB9 Signal Name	Srl1 DB9 Pin#	Srl2 DB9 Pin#
1	N.C.*	N.C.	N.C.
2	Srl1Xmt	2	N.C.
3	Srl1Rcv	3	N.C.
4	N.C.	N.C.	N.C.
5	GND	5	5
6	N.C.	N.C.	N.C.
7	Srl2Rcv	N.C.	3
8	Srl2Xmt	N.C.	2
9	N.C.	N.C.	N.C.
Shield	Shield	Shield	Shield

**N.C. = No Connection*

PMD Part #: Cable-6001-01

Description: Female 40-pin dual 100 mil header to female 8-pin dual 100 mil header cable

Length: 10 ft (3.0 m)

Cable: UL 1569 22 AWG

Notes: Connects National Instruments NI-8452 converter module to PMD 8-pin SPI connector interface.

40-Pin Header Pin #*	40-Pin Header Signal Name	8-pin SPI Header Pin #	Cable Color
2	GND	7	Blue
4	SPI_SCLK	3	Red
8	SPI_MISO	1	Black
12	SPI_MOSI	2	Brown
13	DIO(0)	6	Green
16	CS(0)	4	Orange
17	DIO(1)	5	Yellow

**all pins not detailed are No Connect*

PMD Part #: TRM-RJ45-02

Description: Male 120 ohm RJ45 CAN terminator (at pins 1 & 2)

Notes: UL94V-0 compliant polycarbonate RJ45 housing with phosphor bronze contacts and thermoplastic white cap. Meets requirements of TIA-1096 and CE2011/65/EU.

8-Pin RJ45*	Wiring
1	Pin 1 connected to pin 2 by 120 ohm resistor
2	

** all pins not detailed are No Connect*

3.4 Conversion Factors, Defaults and Limits

To correctly control various N-Series ION features it may be helpful to know certain drive-specific scale factors. The following tables summarize these values.

3.4.1 Conversion Factors, Low Power Units

The following table provides electrical conversion factors for low power level N-Series ION units (P/Ns: DD4X1X0056/02).

These factors convert various integer Magellan IC command arguments (referred to as having units of counts) to physical quantities such as amperage, volts, etc... For more information on the Magellan Motion Control IC refer to the *Magellan Motion Control IC User Guide*. For more information on C-Motion commands refer to the *C-Motion/PRP II Programming Reference.*

Unit	Example C-Motion Commands	Scaling	Example usage
Amps	GetCurrentLoopValue	.231 mA/count*	A command request to read the ActualCurrent parameter returns a value 12,345. This corresponds to a current of 12,345 counts * 0.231 mA/count = 2.851A
Volts	SetDriveFaultParameter GetBusVoltage	10.0 mV/count	To set an overvoltage threshold of 50V, the command value should be 50 V *1,000 mV/ V / 10.0 mV/count = 5,000
Temperature	SetDriveFaultParameter GetTemperature	.00391 °C/count	To set an overtemperature threshold of 65 °C, the command value should be 65 °C / .0039 °C/count = 16,624
I^2t continuous current	SetCurrent	.231 mA/count	To set an I^2t continuous current of 1.0A, the command value should be 1.0A * 1,000 mA/ A / 0.231 mA/count = 4,329
I^2t energy	SetCurrent	.00588 A^2Sec/count	To set an I^2t energy of 5.0 A^2Sec, the command value should be 5.0 A^2Sec / 0.00588 A^2Sec/count = 850

** Some C-Motion commands specifying a current may have a scaling of two times this value. Refer to the Magellan Motion Control IC User Guide for more information.*

3.4.2 Defaults & Limits, Low Power Units

The following table provides default values, low limits and high limits for various specifiable drive-related parameters for low power level N-Series ION units (P/Ns: DD4X1X0056/02).

Setting	Default Setting	Low Limit	High Limit
Overtemperature limit	75.0 °C	0 °C	75.0 °C
Overtemperature hysteresis	5.0 °C	0 °C	25.0 °C
Overvoltage limit	60.0 V	10.0 V	60.0 V
Undervoltage limit	10.0 V	10.0 V	56.0 V
I^2t continuous current limit, Brushless DC motor	1.5 A	0.0 A	1.5 A
I^2t continuous current limit, DC Brush motor	1.5 A	0.0 A	1.5 A

Setting	Default Setting	Low Limit	High Limit
I^2t continuous current limit, step motor	1.5 A	0.0 A	1.5 A
I^2t energy limit, Brushless DC Motor	2.95 A^2sec	0.0 A^2sec	2.95 A^2sec
I^2t energy limit, DC Brush Motor	3.63 A^2sec	0.0 A^2sec	3.63 A^2sec
I^2t energy limit, step motor	2.95 A^2sec	0.0 A^2sec	2.95 A^2sec

3.4.3 Conversion Factors, Medium Power Units

The following table provides electrical conversion factors for medium power level N-Series ION units (P/Ns: DD4X1X0056/06).

These factors convert various integer Magellan IC command arguments (referred to as having units of counts) to physical quantities such as amperage, volts, etc... For more information on the Magellan motion control IC refer to the *Magellan Motion Control IC User Guide*. For more information on C-Motion commands refer to the *C-Motion/PRP II Programming Reference*.

Unit	Example C-Motion Commands	Scaling	Example usage
Amps	GetCurrentLoopValue	.733 mA/count*	A command request to read the ActualCurrent parameter returns a value 12,345. This corresponds to a current of of 12,345 counts * 0.733 mA/count = 9.049
Volts	SetDriveFaultParameter GetBusVoltage	10.0 mV/count	To set an overvoltage threshold of 50V, the command value should be 50 V *1,000 mV/ V / 10.0 mV/count = 5,000
Temperature	SetDriveFaultParameter GetTemperature	.0039 °C/count	To set an overtemperature threshold of 65 °C, the command value should be 65 °C / .0039 °C/count = 16,667
I^2t continuous current	SetCurrent	.733 mA/count	To set an I^2t continuous current of 4.0A, the command value should be 4.0A * 1,000 mA/ A / 0.733 mA/count = 5,457
I^2t energy	SetCurrent	.0590 A^2Sec/count	To set an I^2t energy of 20.0 A^2Sec, the command value should be 20.0 A^2Sec / 0.0590 A^2Sec/count = 339

3.4.4 Defaults & Limits, Medium Power Units

The following table provides default values, medium limits and high limits for various specifiable drive-related parameters for low power level N-Series ION units (P/Ns: DD4X1X0056/06).

Setting	Default Setting	Low Limit	High Limit
Overtemperature limit	75.0 °C	0 °C	75.0 °C
Overtemperature hysteresis	5.0 °C	0 °C	25.0 °C
Overvoltage limit	60.0 V	10.0 V	60.0 V
Undervoltage limit	10.0 V	10.0 V	56.0 V
I^2t continuous current limit, Brushless DC motor	5.5 A	0.0 A	5.5 A
I^2t continuous current limit, DC Brush motor	7.1 A	0.0 A	7.1 A

Setting	Default Setting	Low Limit	High Limit
I^2t continuous current limit, step motor	5.0 A	0.0 A	5.0 A
I^2t energy limit, Brushless DC Motor	25.1 A^2sec	0.0 A^2sec	25.1 A^2sec
I^2t energy limit, DC Brush Motor	28.1 A^2sec	0.0 A^2sec	28.1 A^2sec
I^2t energy limit, step motor	28.2 A^2sec	0.0 A^2sec	28.2 A^2sec

3.4.5 Conversion Factors, High Power Units

The following table provides electrical conversion factors for high power level N-Series ION units (P/Ns: DD4X1X0056/18).

These factors convert various integer Magellan IC command arguments (referred to as having units of counts) to physical quantities such as amperage, volts, etc... For more information on the Magellan Motion Control IC refer to the *Magellan Motion Control IC User Guide*. For more information on C-Motion commands refer to the *C-Motion/PRP II Programming Reference*.

Unit	Example C-Motion Commands	Scaling	Example usage
Amps	GetCurrentLoopValue	2.198 mA/count	A command request to read the ActualCurrent parameter returns a value 12,345. This corresponds to a current of of 12,345 counts * 2.198 mA/count = 27.13A
Volts	SetDriveFaultParameter GetBusVoltage	10.0 mV/count	To set an overvoltage threshold of 50V, the command value should be 50 V *1,000 mV/ V / 10.0 mV/count = 5,000
Temperature	SetDriveFaultParameter GetTemperature	.0039 °C/count	To set an overtemperature threshold of 65 °C, the command value should be 65 °C / .0039 °C/count = 16,667
I^2t continuous current	SetCurrent	2.198 mA/count	To set an I^2t continuous current of 15.0A, the command value should be 15.0A * 1,000 mA/A / 2.198 mA/count = 6,824
I^2t energy	SetCurrent	.531 A^2Sec/count	To set an I^2t energy of 100.0 A^2Sec, the command value should be 100 A^2Sec / .531 A^2Sec/count = 188

3.4.6 Defaults & Limits, High Power Units

The following table provides default values, high limits and high limits for various specifiable drive-related parameters for low power level N-Series ION units (P/Ns: DD4X1X0056/18).

Setting	Default Setting	Low Limit	High Limit
Overtemperature limit	75.0 °C	0 °C	75.0 °C
Overtemperature hysteresis	5.0 °C	0 °C	25.0 °C
Overvoltage limit	60.0 V	10.0 V	60.0 V
Undervoltage limit	10.0 V	10.0 V	56.0 V
I^2t continuous current limit, Brushless DC motor	14.8 A	0.0 A	14.8 A
I^2t continuous current limit, DC Brush motor	19.0 A	0.0 A	19.0 A

Setting	Default Setting	Low Limit	High Limit
I^2t continuous current limit, step motor	13.4 A	0.0 A	13.4 A
I^2t energy limit, Brushless DC Motor	257.4 A^2sec	0.0 A^2sec	257.4 A^2sec
I^2t energy limit, DC Brush Motor	280.5 A^2sec	0.0 A^2sec	280.5 A^2sec
I^2t energy limit, step motor	281.0 A^2sec	0.0 A^2sec	281.0 A^2sec

For the N-Series ION, default values and limits for the I^2t continuous current limit and I^2t energy limit are designed to be safe for operation in the drive's highest output mounting option, namely, using a cold plate for heat sinking. See Section 3.7, "Mechanical Mounting," for information on N-Series ION mounting options.

If the N-Series ION drive is being operated at a lower voltage it may be possible to specify values for I^2t continuous current limit and I^2t energy limit that are higher than the default, but lower than or equal to the limit, since the continuous output current rating of the N-Series ION drive is higher for lower input voltages. See *ION/CME N-Series Digital Drive User Manual* for drive output specifications.

For other mounting configurations, or for use with motors that have lower current and energy limits, it may be useful to set these parameters to values lower than the default values.

It is the responsibility of the user to set the I^2t continuous current and I^2t energy limit parameters to values that are safe for the specific N-Series ION mounting configuration and motor setup being used.

3.5 Component Developer Kit Assembly

3.5.1 Overview

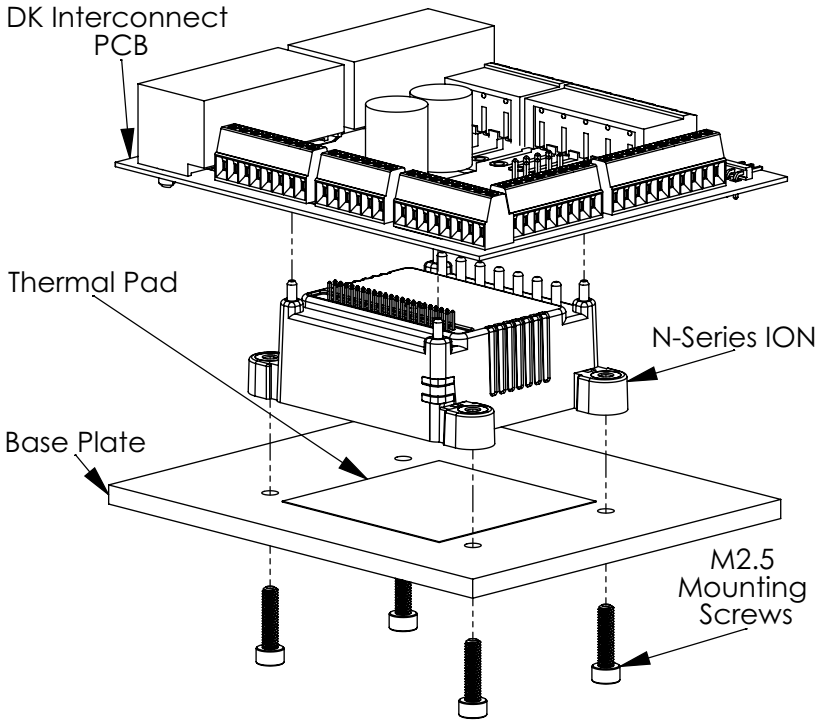


Figure 3-1: N-Series ION DK Showing Component Stack

When using non pre-assembled N-Series ION DKs assembly of the N-Series ION with the DK components is required. Along with the N-Series ION unit, which is not included with non pre-assembled DKs and must be ordered separately, the component stack elements are listed in the table below from top to bottom.

DK Stack Component Name	Description
DK Interconnect PCB	One of three possible PCBs that is soldered to the N-Series ION and provides convenient connectors to access the ION functions. The ION unit interface type (serial, CAN/SPI, or Ethernet) must be matched with the associated DK interconnect PCB type. For more information on this and exact P/Ns refer to Section 3.2, "Developer Kit Hardware Contents."
N-Series ION unit	One of 36 different N-Series ION units. As noted above the ION unit type must match the PCB interconnect PCB unit type
Thermal pad	33.5 mm x 33.5 mm x .25 mm thermal pad that insures correct thermal flow between the ION unit and the included base plate or application mounting surface
Mounting screws	Four M2.5 mounting screws
Base plate	Black anodized aluminum mounting plate which functions both as a heat sink and as a platform support for bench-top exercising of the DK. The bottom of the plate has four rubber feet for stability.

The next few sections will provide detailed instructions for assembling a complete DK stack from the components listed above. For additional information on mechanical mounting of the N-Series ION unit refer to Section 3.7, "Mechanical Mounting." For additional information on DK P/Ns and contents refer to Section 3.2, "Developer Kit Hardware Contents."

The N-Series ION contains electronic components and is therefore subject to damage from ESD (Electro Static Discharge). Therefore, during the assembly procedures described below and at all other times while handling the ION unit the operator should apply measures to reduce the potential for ESD damage which include use of grounding straps, anti-static mats, environmental controls, and other measures.

3.5.2 Assembly Sequence

Attaching the thermal pad to the N-Series ION

The first step of the assembly procedure is to insure that there is good thermal contact between the N-Series ION and the base plate heat sink. For this purpose, a thermal pad will be attached to the ION's metallic heat sink interface.

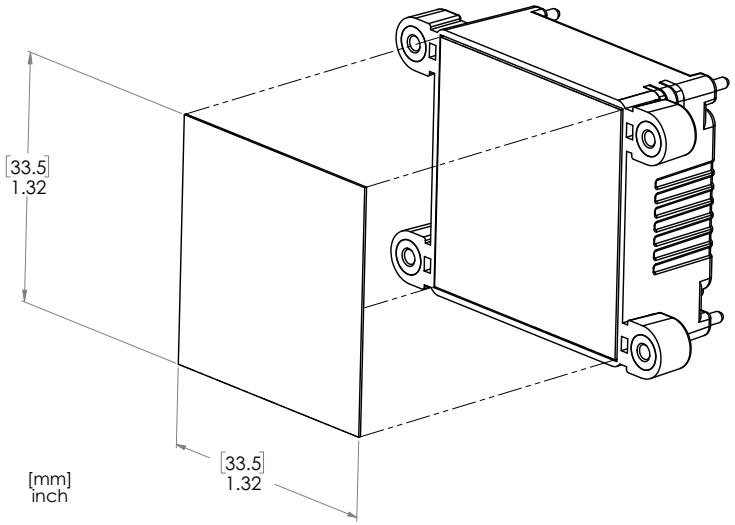


Figure 3-2: Mounting Thermal Pad to N-Series ION

To accomplish this, locate the thermal pad in the developer kit box. Next, carefully remove the thin plastic protective sheets on either side of the thermal pad and mount onto the ION unit, carefully aligning the pad with the ION unit's metallic backing and applying finger pressure to adhere the pads to the metal.

After adherence to the ION's metallic backing the thermal pad should appear flat and without bubbles or bulges. Once pressed in place the pad should stay in place but if required the pad can be removed and remounted.

Mounting the N-Series ION to the base plate

The next step of the assembly process is to mount the N-Series ION with thermal pad attached to the rectangular base plate. Four M2.5 screws and the Allen key are used for this purpose as shown in Figure 3-1. Make sure to orient the base plate so that the rubber feet are away from the ION unit.

When tightening the screws use only modest torquing force, and alternate tightening in an X pattern so that the applied force is increased slowly and equally amongst the four screws. Should you hear or see a snap of the ION unit tab while tightening a screw this means the ION unit's protective fuse tab has engaged because too much torque was applied. If this occurs the N-Series ION unit can not be used. It must be de-installed and discarded, and a new unit installed.

A fuse break event serves as a signal to the operator to revise their procedure so that the tab mounting torque limits are not exceeded during future attachment procedures. For detailed mounting torque specifications refer to Section 3.7.2.2, "Installation & Torque Limits."

Soldering the N-Series ION to the DK PCB

The final step of the DK stack assembly process is to solder the DK PCB to the N-Series ION. To accomplish this place the assembled base plate and N-Series ION onto a level surface with the base plate resting on its rubber pads.

With the PCB oriented so that the connector-side faces up, locate the PCB in the correct mounting position taking note of the location of the hole patterns in the PCB which mate with the N-Series ION. When ready gently push the PCB down onto the ION unit until the bottom of the PCB sits flush with the ION unit's PCB interface surface.

Altogether you will solder three different groups of pins; the four alignment posts located at the corners of the ION unit, the 44 signal connector pins, and the 7 power connector pins. Carefully solder each of these pins into the PCB taking care to insure proper solder flow so that good electrical and mechanical contact is made.

Congratulations! Once soldering has been completed assembly of your N-Series ION developer kit is complete and the DK is ready for operation.

Take special care to insure proper solder flow occurs for the seven power connector pins. These larger pins may require more time to heat or a higher soldering iron temperature setting. To aid confirmation of a proper solder joint the area around the ION unit's power pins is recessed, allowing the technician visual access of the power pins from the underside of the PCB.

3.6 Physical Dimensions

3.6.1 N-Series ION Unit

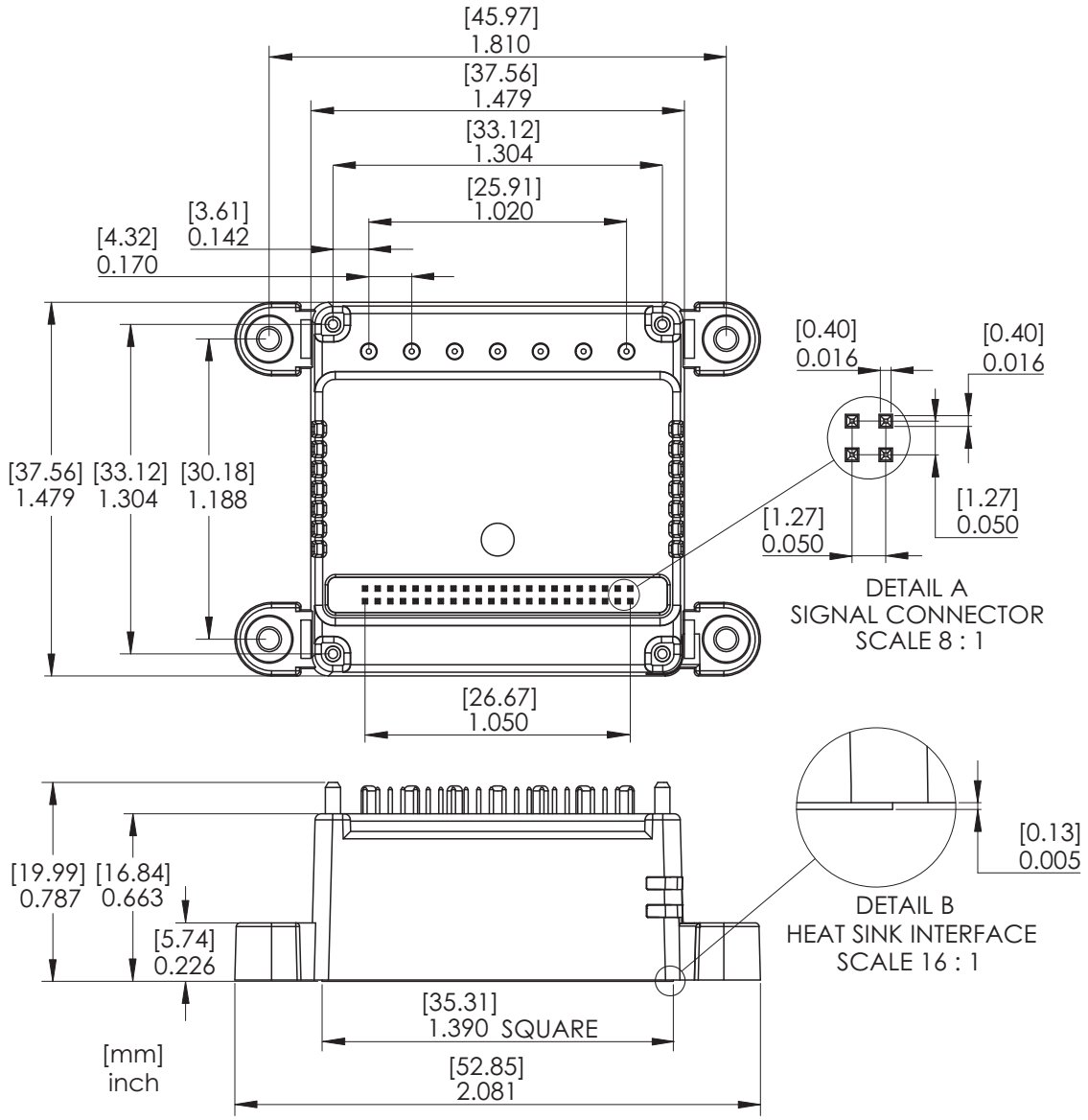
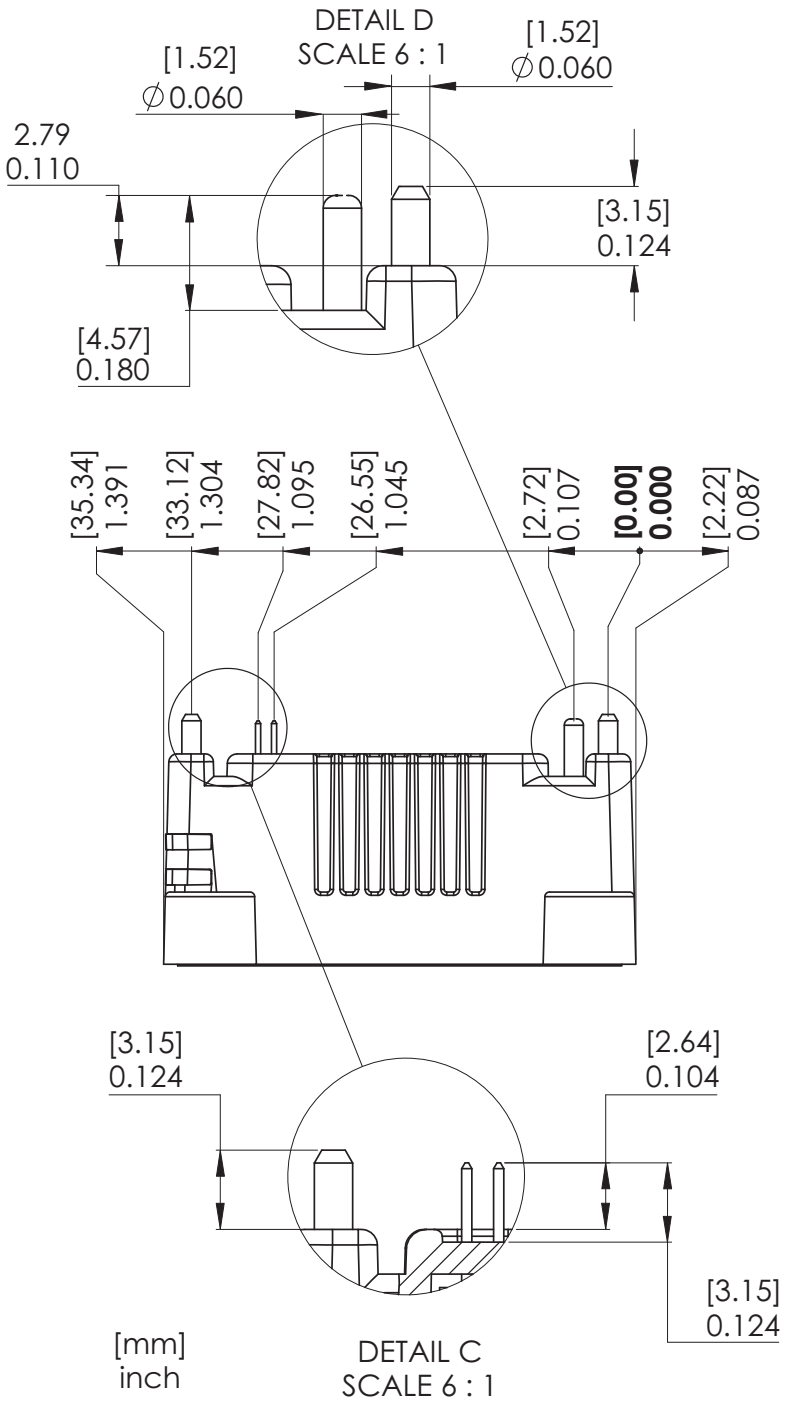


Figure 3-3: ION/CME N-Series Digital Drive Physical Dimensions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1.045
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0.000
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0.124
[mm]
inch
DETAIL C
SCALE 6 : 1

3.6.2 Developer Kit

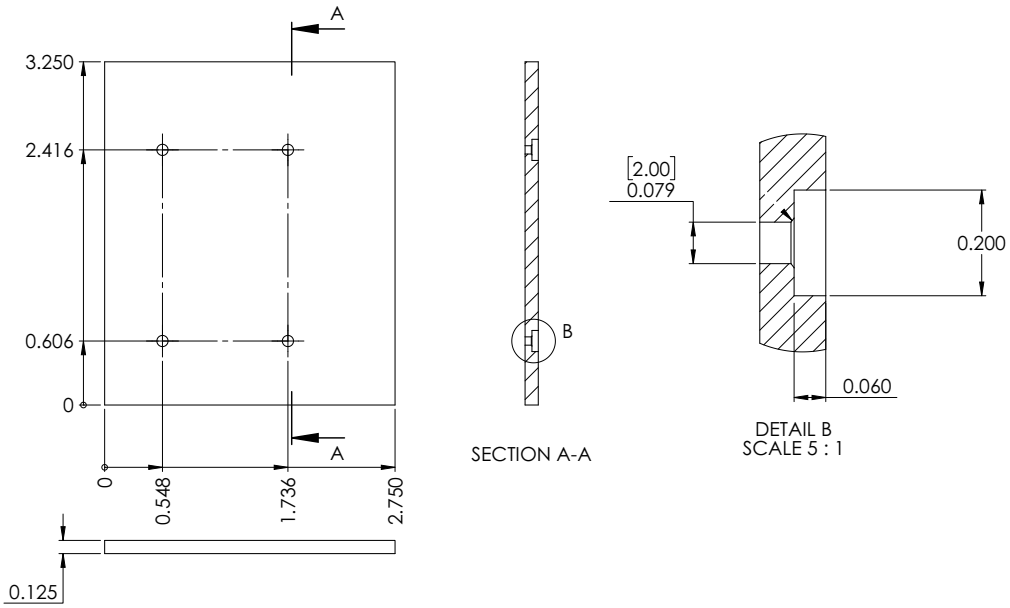


Figure 3-4: DK Base Plate Dimensions

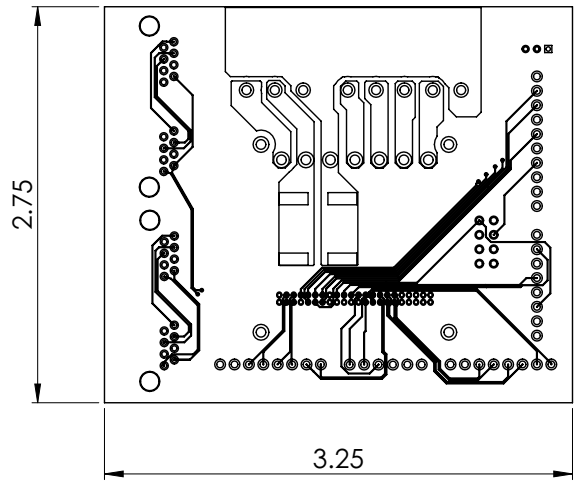


Figure 3-5: DK Interconnect Board Dimensions

3.7 Mechanical Mounting

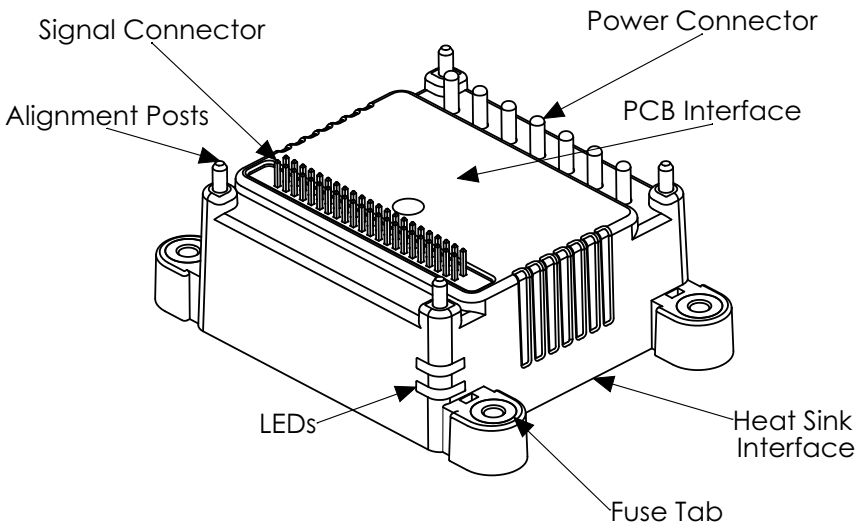


Figure 3-6: Mechanical Elements of N-Series ION Drive

The N-Series Drives are designed to be used in a wide variety of operating conditions. As shown in Figure 3-6 they have a robust mechanical design that allows rigid mechanical attachment at the two primary interface points; the interface between the N-Series Drive and the user PCB, and the interface between the N-Series Drive and the heat sink or cold plate also called a supporting plate. The following sections describe how mechanical attachment at both these interfaces occurs.

3.7.1 Attachment to the User PCB

Attachment at the PCB is accomplished by soldering the PCB to the N-Series Drive's four mechanical alignment posts. While these posts do not serve an electrical function, they provide a rigid attachment of the PCB to the N-Series ION, and thereby reduce strain that may occur in the solder connections between the user PCB and the Power and Signal Connectors of the N-Series ION. Use of the four PCB alignment posts are recommended for all applications.

3.7.2 Attachment to the Heat Sink

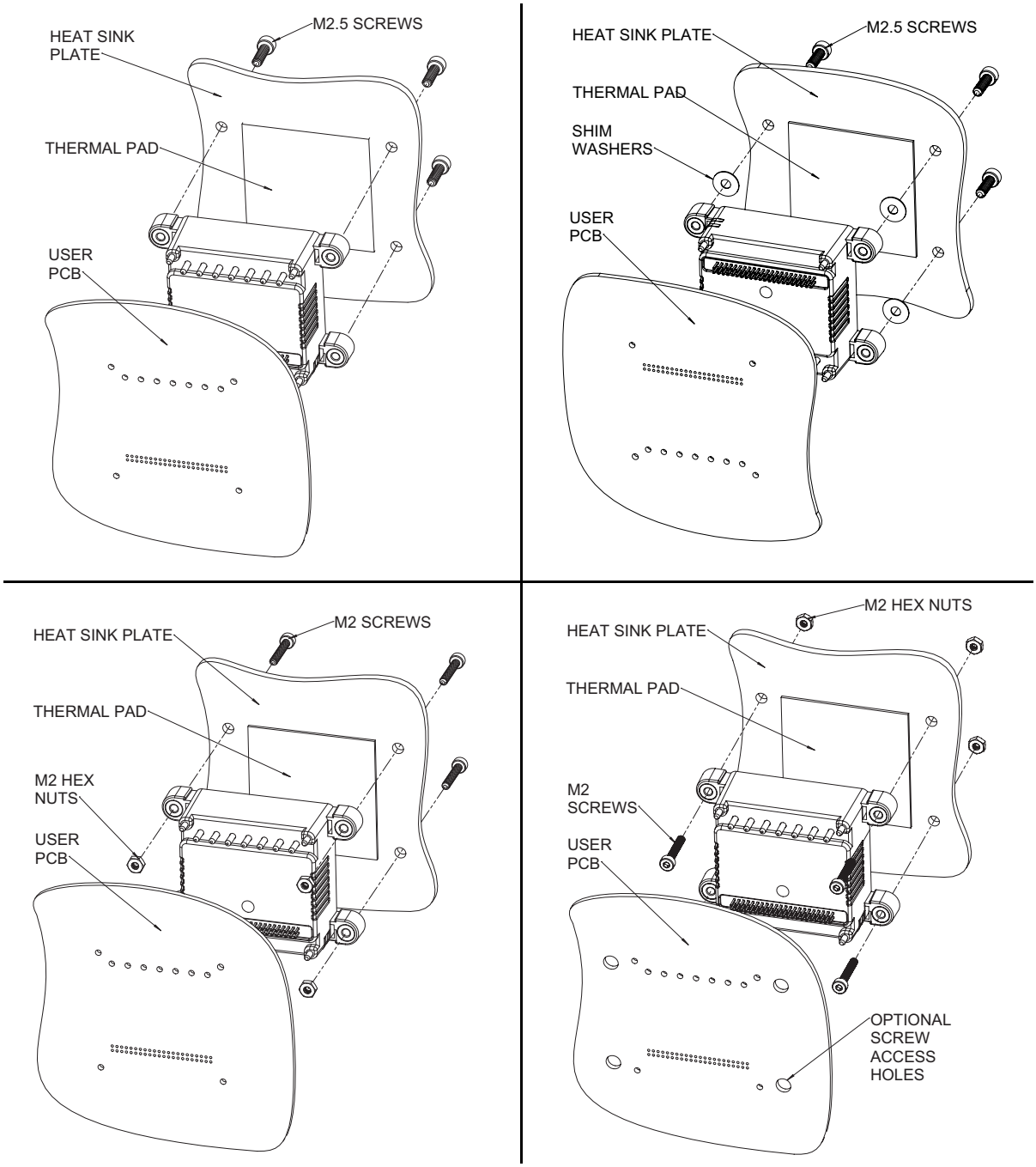


Figure 3-7: N-Series ION Mounting Options

3.7.2.1 Installation Overview

Attachment to the heat sink or supporting plate is accomplished via screws at the N-Series ION's four mounting tabs. As shown in Figure 3-7 there are four typical approaches to mechanically attaching to the heat sink.

The first is mounting from the heat sink side. In this approach M2.5 screws are installed directly into the ION's tab which is threaded for a M2.5 screw. A variation of this option may be used when greater mounting rigidity is desired, typically because the application environment has higher g forces. This mounting method locates shim washers under the tabs to limit tab deflection and to increase the amount of torque that can be applied to tighten down the tabs.

When using this method the thickness of the shim washer should be determined by the type and thickness of thermal transfer material used to create a vibration resistant mount, while maintaining optimal thermal transfer. Note that in this approach, the N-Series ION's fuse tab mechanism, which normally acts to limit the maximum force that can be applied via the tabs, is effectively bypassed. Therefore it is up to the user to ensure that the force applied to the ION unit's heat sink interface, the limits for which are provided in the table below, are not exceeded. For more information on PMD's patented fuse tab design see Section 3.7.2.3, "N-Series Drive Fuse Tab Design."

To achieve the shim function using washers, the recommended dimensions are .280" (7.0 mm) outer diameter and .105" (2.5 mm) inner diameter. Representative suppliers for washers such as this include Bokers, Superior Washer, and Phoenix Specialty.

When using shim washers or other approaches that raise the mounting interface under the N-Series ION tabs, the ION unit's force-limiting fuse tab design is effectively disabled. It is therefore up to the user to ensure that the mounting force limit on the ION unit's heat sink interface plate is not exceeded.

Two other mounting options use a nut and a screw. Most commonly M2 screws are used which go through the tab's M2.5 thread without engaging the thread, with the nut used to capture the M2 screw. The two possible orientations of the nut and screw represent these two different mounting options. Note that if the preferred mounting orientation is to have the screw heads facing the user PCB, it may be desirable to have holes in the PCB to give access to the ION screw hardware. However if the ION is mechanically mounted first, and then soldered onto the user PCB, these access holes may not be necessary.

3.7.2.2 Installation & Torque Limits

Before mating the N-Series Drive to the heat sink, in a typical installation a thermal transfer material will first be installed to enhance thermal contact. Refer to Section 3.7.2.4, "Thermal Transfer Materials," for more information on selection of these materials.

Once this material is in place the tabs can be tightened under careful torque limit control. The table below shows the recommended maximum torque for both M2 and M2.5 screws along with equivalent force values if an alternate attachment method such as a clamp is used, or if shim washers are used as described above. These torque values were determined using 18-8 stainless steel screws.

Type	Minimum	Recommended	Maximum
M2 screw torque	0.082 N-m (0.722 in-lb)	0.094 N-m (0.836 in-lb)	0.113 N-m (1.00 in-lb)
M2.5 screw torque	0.113 N-m (1.00 in-lb)	0.130 N-m (1.15 in-lb)	0.147 N-m (1.30 in-lb)
Force	25 kgs (55 lbs)	29 kgs (68 lbs)	33 kgs (71 lbs)

Exceeding the N-Series ION's mechanical attachment specifications indicated above may cause a failure of the drive unit at the time of installation, or at a later time in the field.

3.7.2.3 N-Series Drive Fuse Tab Design

N-Series IONs utilize a patented fuse-tab design to reduce the chance that overtightening of the tab attachment hardware will cause damage to the N-Series ION unit.

This is achieved by the tab deliberately breaking (snapping) under conditions of over tightening. Such a protective fuse break event (snap) of the tab should be audible to the operator during tightening. While an N-Series Drive unit that has undergone a fuse break event during tightening is no longer usable, it serves as a signal to the operator to check

and revise their torque control procedure so that the tab mounting torque limits are not exceeded during future attachment procedures.

An ION/CME N-Series Digital Drive which has undergone a fuse tab event (snap) during installation must be de-installed and discarded. It is not possible to repair or to otherwise use an N-Series Drive unit which has undergone a fuse snap event.

The N-Series ION's fuse-tab functions when there is an air gap between the bottom of the tab and the surface that it is mounted to. If there is no air gap, or if the air gap is too small then the fuse/snap function may not occur even though the recommended mounting torque limit may have been exceeded. In all cases it is the responsibility of the user to determine that the recommended mounting torque limits or force indicated in Section 3.7.2.2, "Installation & Torque Limits," are not exceeded.

3.7.2.4 Thermal Transfer Materials

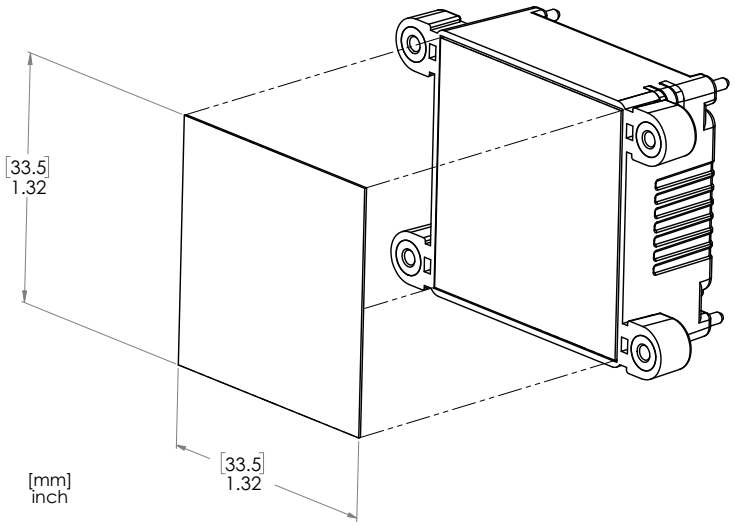


Figure 3-8: Recommended N-Series ION Thermal Transfer Material Dimensions

Thermal transfer materials in the form of thermal tape, pads, paste, or epoxy may be used to improve thermal transfer between the N-Series Drive's metal plate and an attached heat sink or supporting plate. These materials improve thermal conductivity by filling in air gaps that form when two metallic surfaces are mated.

Figure 3-8 shows a typical application of a thermal transfer material between the drive unit and a heat-removing metal surface. The following guidelines may be helpful in selecting and sizing the thermal transfer material best-suited to your application.

The capacity of thermal transfer materials to transfer heat (known as the bulk conductivity) is much lower than that of metals such as aluminum or copper. Therefore, in general, the thinner the transfer material the better. Thickness of the material is only precisely controllable for thermal pads and thermal tapes, with thermal pads providing the thinnest available interfaces beginning at 5 mils (.127 mm) or even less. For use with N-Series IONs thermal transfer materials that are thicker than 40 mils (1.0 mm) are not recommended regardless of the material used.

When using thermal paste or thermal epoxy glue the thickness should be carefully controlled via a silk screen or other wet film application process. The N-Series unit itself should not be used to squeeze non-uniformly applied paste or epoxy flat during installation. Doing so may result in damage to the unit.

Whether using tape, pads, paste, or epoxy, as shown in Figure 3-8, the thermal transfer material that is used as the interface should not extend to the area under the N-Series ION's tabs because this may reduce the amount of compression that occurs in the thermal transfer area. The following table provides dimensions for the applied thermal transfer material for N-Series IONs:

Parameter	Maximum Pad Dimensions
Value	33.5 mm x 33.5 mm (1.32" x 1.32")

3.7.3 Additional Mounting Information

There are a number of additional precautions and procedures that should be followed to maintain the electrical and mechanical integrity of the N-Series ION unit during installation.

Soldering N-Series ION units in place. Applications that involve N-Series ION units mated to a supporting plate should take special care to insure that the solder joints are not stressed by the supporting plate once installed. The recommended method to achieve this is to mechanically mate the unit to the supporting plate before soldering into the PCB. If, for whatever reason, this is not possible, then special care should be taken to insure that the N-Series ION is aligned with the supporting plate after soldering and before mechanical attachment so that upon mechanical attachment no stress is placed on the ION unit, the solder contacts, or the PCB.

Mounting surface flat and clean. Thermal performance as well as safe operation of the N-Series ION requires that the heat sink or supporting plate surface that it is mounted to be flat and clean, free of dust, grease, or foreign objects. The recommended maximum deviation of the mating surface flatness is 3 mils (.076 mm).

Progressive tightening. N-Series ION units that are mated to a heat sink or supporting plate should be attached by progressively tightening each of the unit's four tabs. This means that one screw may be tightened, followed by the others, than back to the first etc. until the desired torque at each screw has been achieved. Following this procedure is particularly important when installing N-Series ION units over paste or epoxy, where the subsurface layer will undergo compression and movement before settling to a final installed position.

It is the responsibility of the user to ensure that all N-Series ION units have been installed within the prescribed mechanical stress limits and following the above described procedures. Failure to observe any of the above recommended procedures and limits may result in incorrect operation or failure of the unit during operation.

4. DK Interconnect Board Schematics

In This Chapter

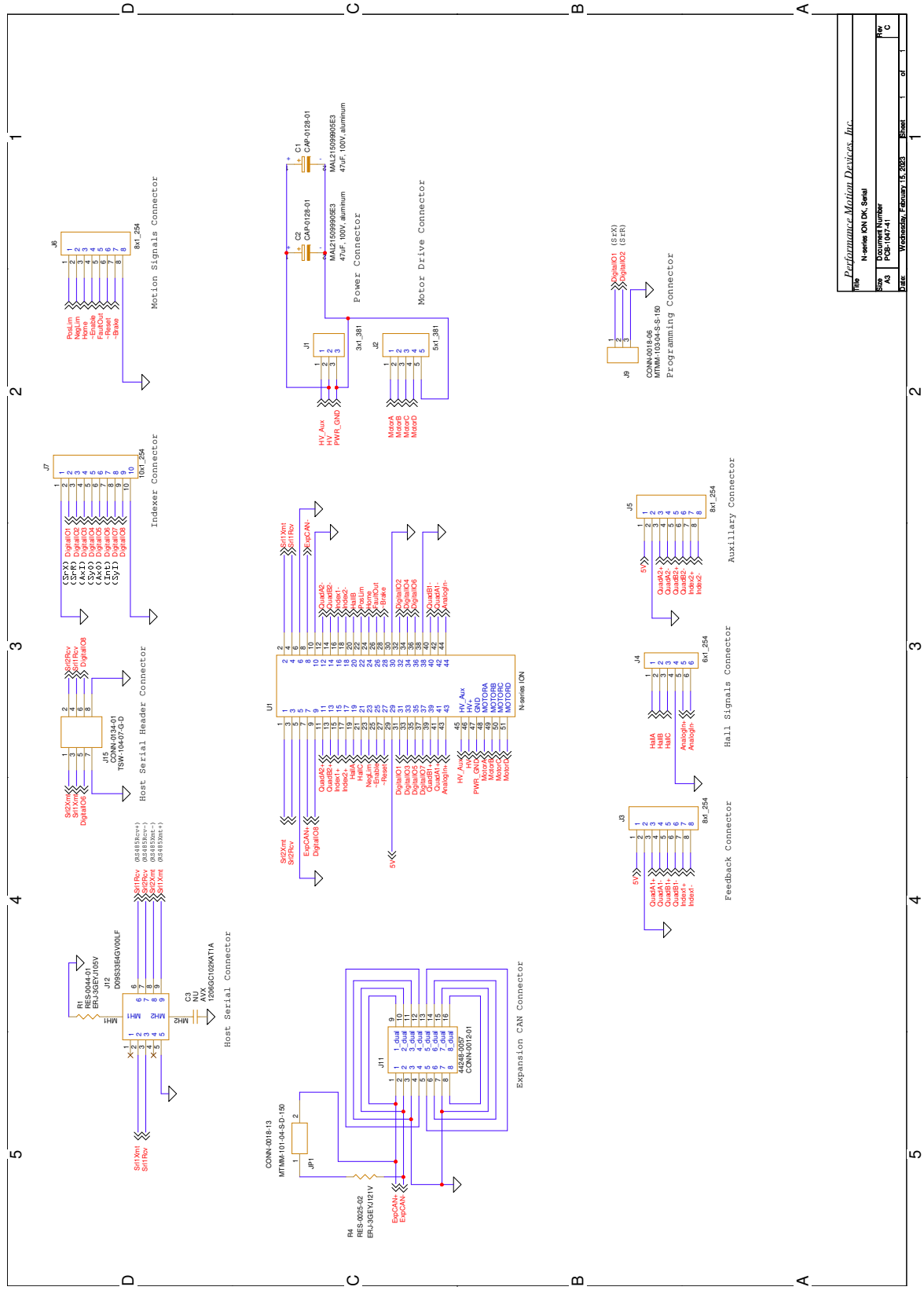
4.1 DK Interconnect Board Schematics

The schematics on the next three pages are the designs for the ION/CME N-Series Digital Drive Developer Kit's printed circuit board, differing by the host communication variant.

As the N-series ION is designed to limit the requirement for external components, the interconnect boards simply provide connectors to all pins on the N-series ION, similar to a breakout board. Aside from host communication pins, which use common connectors, all signals are accessible through screw terminals.

4.1.1 Serial Host Interface Type

Figure 4-1: Serial Host Interface DK Interconnect Board Schematic



4.1.2 CAN/SPI Host Interface Type

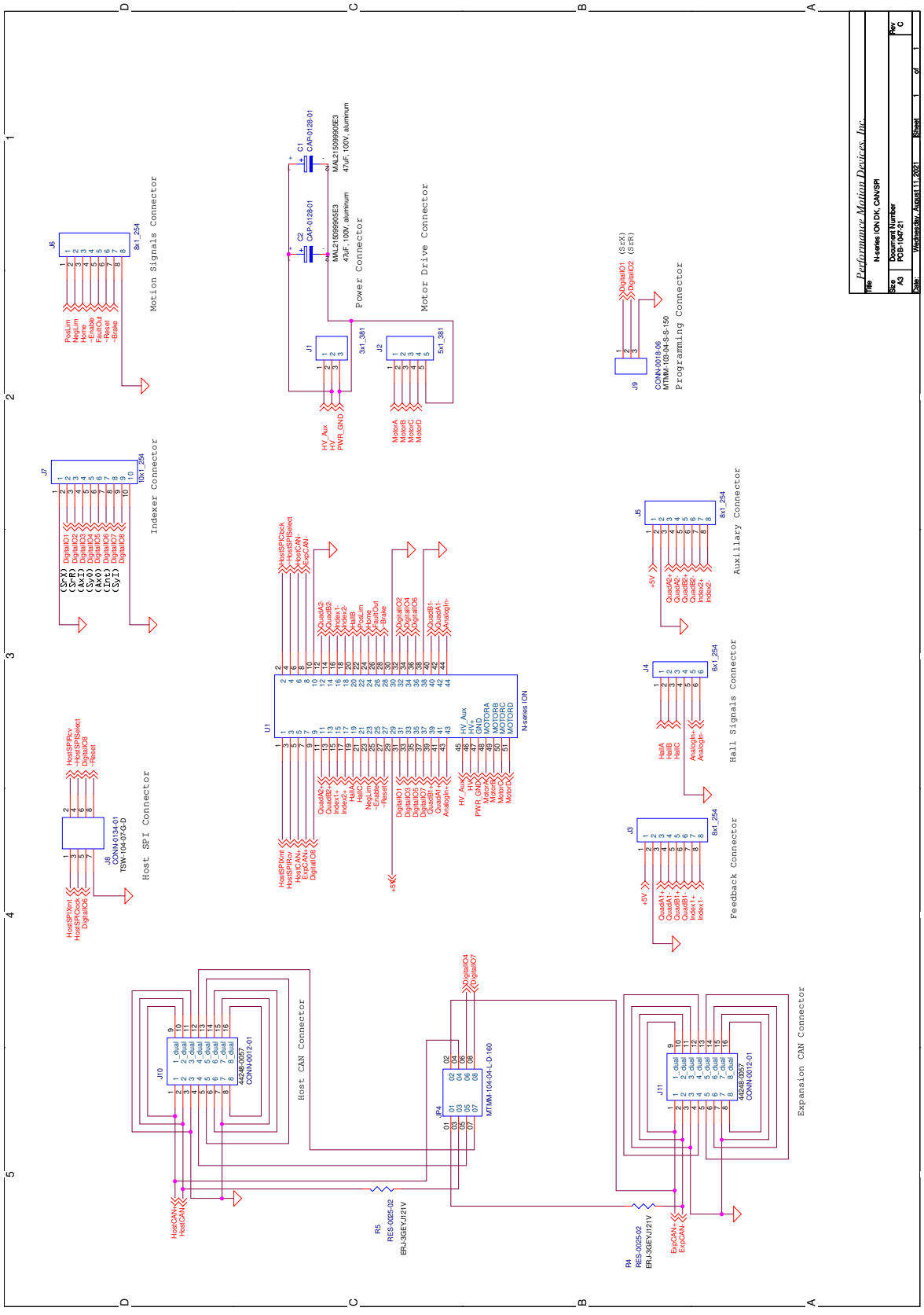


Figure 4-2: CAN/SPI Host Interface DK Interconnect Board Schematic

4.1.3 Ethernet Host Interface Type

Figure 4-3: Ethernet Host Interface DK Interconnect Board Schematic