Juno™ Step Motor Control IC DK74113N Developer Kit User Manual
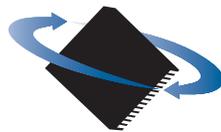
PERFORMANCE
MOTION DEVICES

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Related Documents

Juno Step Motor Control IC User Guide

Complete description of the MC74113, MC74113N, MC75113 and MC75113N step motor control ICs including electrical characteristics, pin descriptions, and theory of operations.

Juno Velocity & Torque Control IC User Guide

Complete description of all members of the Juno Velocity & Torque Control IC family including the MC71112, MC71112N, MC73112, MC73112N, MC74113, MC74113N, MC75113, MC75113N, MC71113, MC73113, and MC78113 ICs. Includes features and functions with detailed theory of operations.

Juno Velocity & Torque Control IC Programming Reference

Description of all Juno family IC commands, with coding syntax and examples, listed alphabetically for quick reference.

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1. Installation

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1.1 Introduction

The PMD DK74113N Developer Kit is an integrated board/software package that serves as an electrical and software design tool for building systems that use the Juno 56-pin VQFN step motor control ICs.

The developer kit supports two ICs in the Juno step motor family, as shown below:

Developer Kit p/n	Installed IC	Motors Supported
DK74113N	MC74113N	Step motor with encoder
DK75113N	MC75113N	Step motor

Both of the above Developer Kit versions share the same physical DK74113N board. They differ in the specific type of Juno step motor control IC that is installed in the board.

1.2 Developer Kit Components List

The DK74113N Developer Kit contains the following components:

- DK74113N Developer Kit board

- 3-pin programming cable

If any of these components are missing, please contact your PMD representative.

1.3   DK74113N Board

The heart of the DK74113N Developer Kit is the DK74113N printed circuit board that contains interface and amplifier circuitry to allow various features of the MC74113N and MC75113N ICs to be accessed. Here is a summary of the features provided by the DK74113N board:

- High performance on-board amplifier with current feedback

- 3-pin UART host communications interface

- Single DC-voltage supply

- Quadrature signal input with Index capture (with MC74113N installed only)

- Overtemperature, overcurrent, over and undervoltage sense

- Pulse & Direction input with AtRest signal

- Compact (2.4" x 1.8") standalone form factor (6.1 cm x 4.5 cm)

1.3.1   Pro-Motion

Pro-Motion is a sophisticated, easy-to-use exerciser program that is included with the DK74113N. It allows all of the Juno control 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

- 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

1.4   Included Hardware Accessories

The DK74113N includes these accessories that you may find useful:

Component PMD Part Number	Description
Cable-USB-3P	3-pin cable. This programming cable provides a USB connection to a PC and plugs into the DK board's 3-pin programming connector.

1.5   Installation Overview

1   Before using the board, the software must be installed. See <u>Section 1.7, "Software Installation"</u> for instructions on installing the software.

2 Next, connect the motor and optional encoder. See Section 1.9, "Connection Summary" for a description of the connections.

3 Connect the DK74113N board to the host PC via the 3-pin cable. See Section 1.9.3, "Communication Connection" 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 1.11, "First-Time System Verification" for a description of this procedure.

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

1.6 Recommended Hardware

To install a DK74113N board the following hardware is recommended.

- Intel (or compatible) processor, 1 Gbyte of available disk space, 256 MB of available RAM, and a CD-ROM drive. The supported PC operating systems are Windows XP, Vista, Windows 7, Windows 8, Windows 10.

- One step motor. This motor may or may not provide encoder position feedback signals. Encoder feedback is not available with MC75113N ICs.

- Cables as required to connect to the motor and the DK74113N board.

- Power supply, power cable.

- The DK74113N board requires only a single voltage supply. The board logic and other circuitry is powered from this input voltage using an on-board DC to DC converter.

1.7 Software Installation

The software distribution for the DK78113 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 "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 desired install programs from the list below. Every first-time installation should install Pro-Motion, and at least one of the two SDK options. However you may install both SDKs if desired. When installing the SDKs you will be given the option to download the documentation and/or the complete SDK content.

- Pro-Motion – an application for communicating to, and exercising PMD ICs, modules, or boards.

- PMD SDK – a software development kit for creating motion applications using the C/C++ programming languages. Also contains PDF versions* of all PMD product documentation.

- CME SDK – a software development kit for creating motion applications using the .NET (C#, VB) programming languages. Also containsPDF versions* of all PMD product 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.

1.8   Board Installation

Figure 1-1 shows the location of various DK74113N components.

Figure 1-1: DK74113N Board Components Location
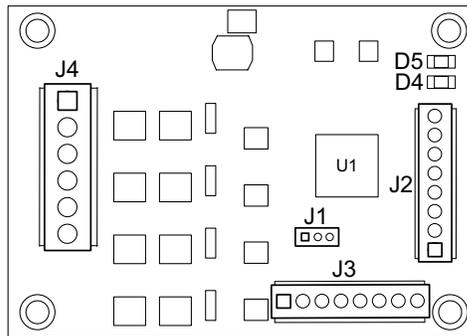
The following table describes these components:

Label	Description
J4	HV Power & Motor Connector
J3	Feedback Connector
J2	Amplifier Signal Connector
J1	3-Pin Programming Connector
D4, D5	Fault and power LED indicators (respectively)

1.8.1   Enabling the Board

The DK74113N requires an active Enable signal to operate. To accomplish this the Amplifier Signal Connector (J2) is used. Connect terminal #8 of J2 (indicated on the board as ~EN) to terminal #6 of J2 (indicated on the board as GND) using a short wire.

For reference the following table provides the pinouts of the J2 terminal block connector:

Pin	Signal	Description
J2 - Amplifier Signal Connector		
1	Vcc	+5V output
2	GND	Ground
3	AtRest	AtRest input signal
4	Direction	Direction input signal
5	Pulse	Pulse input signal
6	GND	Ground

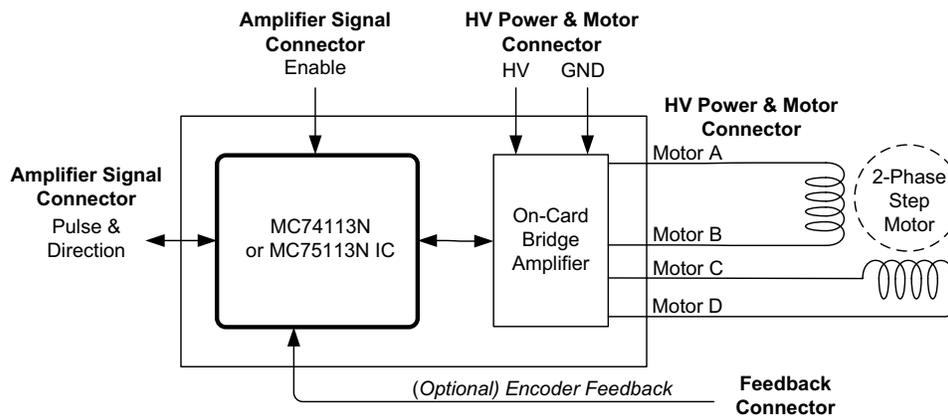| Pin	Signal	Description
7	FaultOut	Active high digital FaultOut output signal
8	Enable	Active low Enable digital input signal

1.9 Connection Summary

1.9.1 Encoder Feedback Connections

The following table summarizes the *encoder* signal connections to the DK74113N. All connections are made through the Feedback Connector (J3).

For reference, the following table provides the pinouts of the J3 terminal block connector.

Pin	Connection	Description
J3 - Feedback Connector		
I	Vcc	+5V output
2	GND	Ground
3	QuadA+	Quadrature A+ encoder input
4	QuadA-	Quadrature A- encoder input
5	QuadB+	Quadrature B+ encoder input
6	QuadB-	Quadrature B- encoder input
7	Index+	Index+ input
8	Index-	Index- input

1.9.1.1 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.

1.9.2   Power & Motor Connections

The HV voltage is the voltage at which the motor will be driven and must be in the range of +12V to +48V.

The following table summarizes the HV power and motor drive connections for the DK74113N.

Pin	Connection	Description
J4 - HV Power Connector		
I	HV	Provides DC power to the board and on-board switching amplifier
2	GND	Ground
3	Motor A	Motor output signal A+
4	Motor B	Motor output signal A-
5	Motor C	Motor output signal B+
6	Motor D	Motor output signal B-

1.9.3   Communication Connection

**Figure 1-3:
PC to
DK74113N**
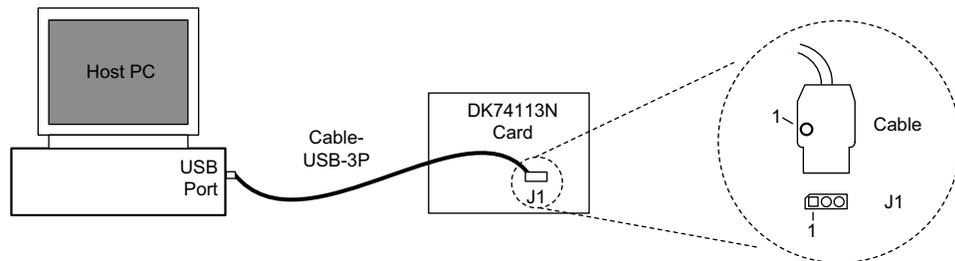
Communication to the board is via a serial UART port.

A 3-pin cable for this purpose is included with the DK74113N. As shown in Figure 1-3 this cable (PMD p/n Cable-USB-3P) should be connected to the DK74113N board's J1 Connector, while the opposite end of the cable should be connected to one of your computer's USB ports. When installing the cable at the DK board make sure the pin 1 orientation is correct. Refer to Figure 1-3 to determine the pin 1 location of the DK74113N board. Pin 1 on Cable-USB-3P is locatable via a small dot at the pin 1 location.

1.10   Applying Power

Once you have made your motor hardware, communication, and power connections, hardware installation is complete and the board is ready for operation. When power is applied, the DK74113N's green power LED should light. This LED is labeled D5 in Figure 1-1. If the LED does not light, re-check connections.

After power up no motor output will be applied. Therefore the motor should remain stationary. If the motor moves or jumps, power down the board and check the motor and encoder connections.

1.11   First-Time System Verification

The first time system verification procedure summarized below has two overall goals. The first is to connect the DK74113N board with the PC that is being used 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 additional

capabilities that Pro-Motion and the DK74113N board provide, these steps will create a foundation for further 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 manual section.

1   Initiate Pro-Motion and establish communication between the PC and the board using the USB to UART communications link.

2   Run Pro-Motion's Axis wizard to initialize parameters such as encoder direction and current loop parameters. As part of the axis wizard setup you will execute a simple profile demonstrating that your motor is operating correctly and under stable control.

1.11.1   Establishing Serial Communications

To establish programming communications:

1   Make sure the DK74113N board is powered and connected to the PC via the 3-pin programming cable.

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 DK74113N board is connected to the PC.
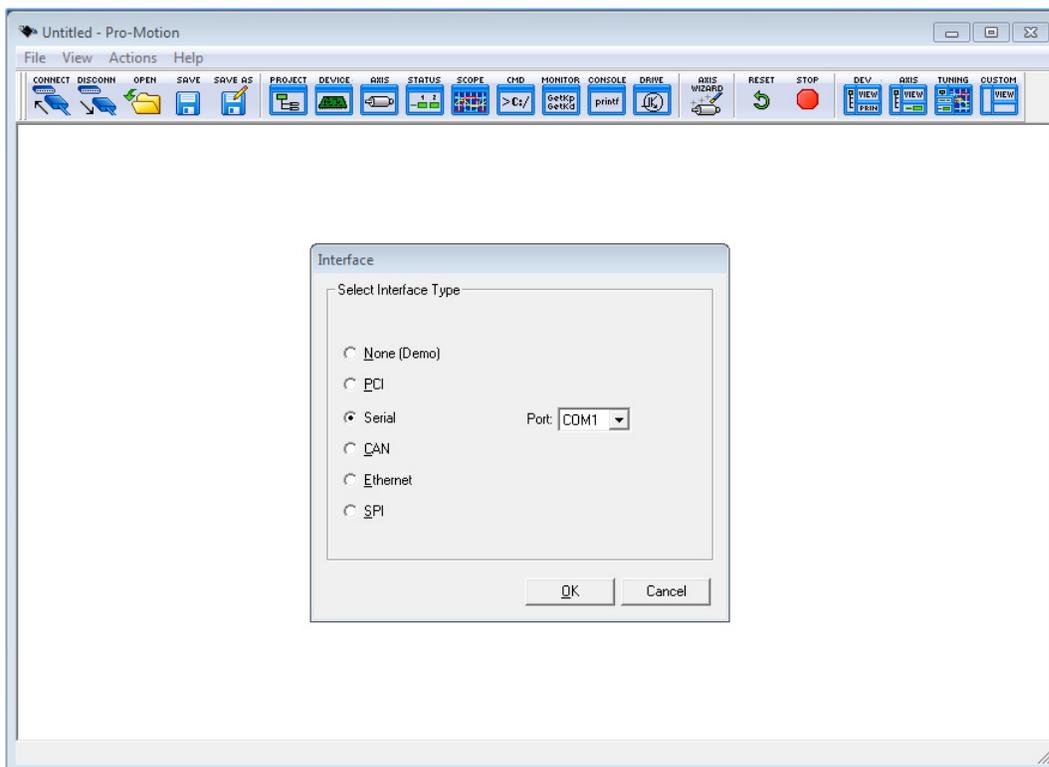

3   Click Serial, select the com port that the DK is connected to, and then click OK.

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.
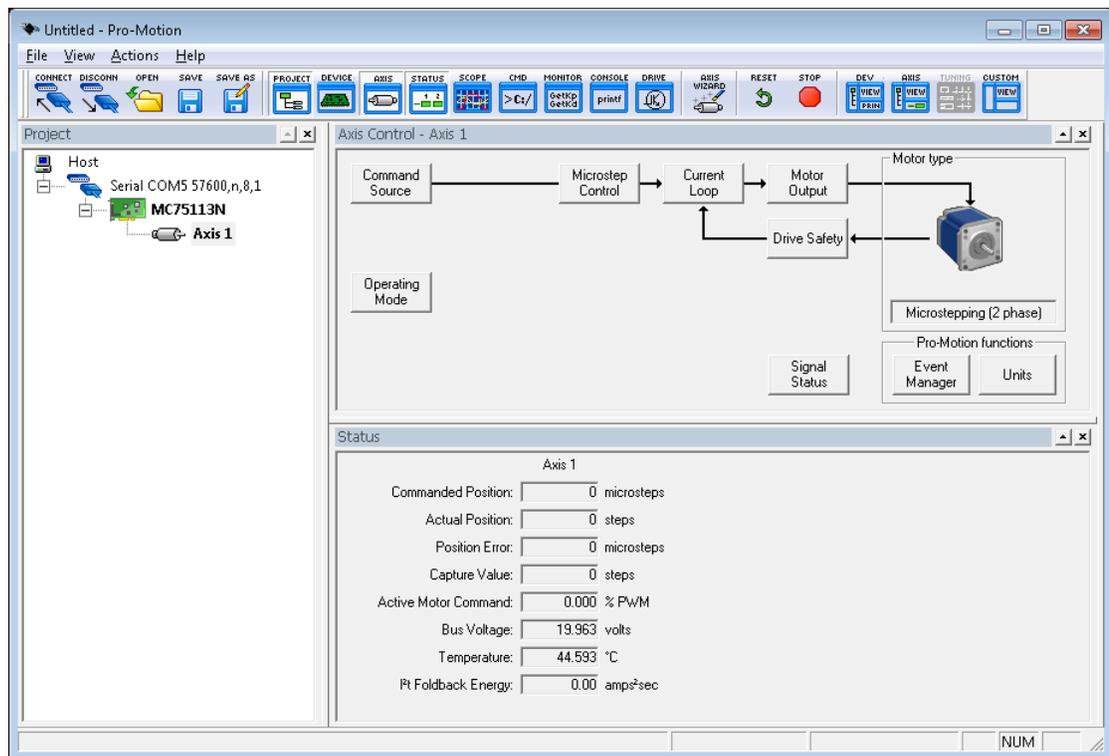
For example, you will see the MC74113N or MC75113N IC name next to an icon of a board, and below that you see an axis icon. Highlighting (single clicking) either the board icon or the axis icons with the mouse is used to select specific boards or axes, and is useful later on in the first time system 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.

1.11.2 Initializing Motion Axis

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.

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.
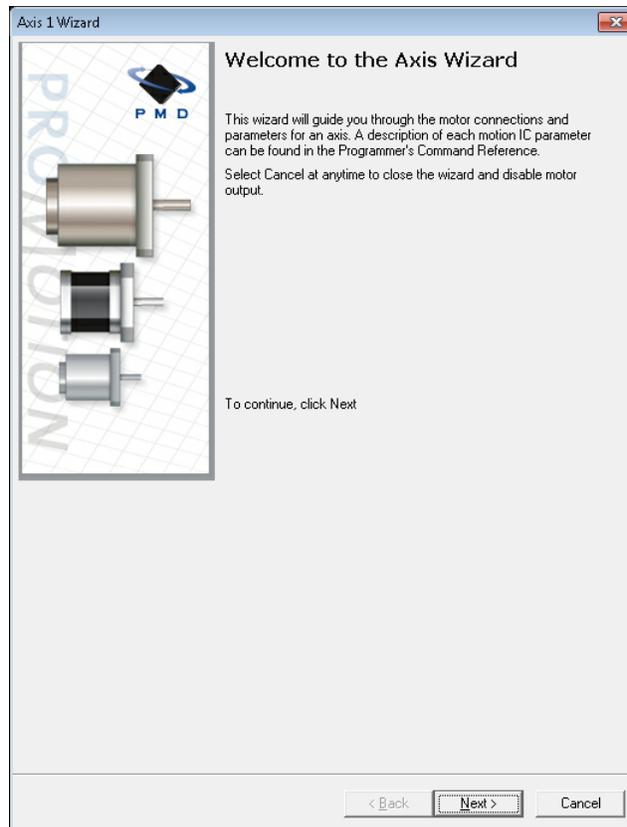
3 Click Next and follow the Axis Wizard instructions for each page of the axis initialization process.

A typical Axis Wizard sequence takes 3-5 minutes.

Important! In addition to application specific parameters, you will be prompted to enter various board-specific control parameters during Axis Wizard setup. These board-specific parameters can conveniently be selected as a group from within the Axis Wizard. It is highly recommended that you select use of the DK74113N default parameters.

Upon a normal completion of the AxisWizard the axis will be ready to make a controlled move.

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

The Axis Wizard auto tuning routines are designed to provide stable, but not optimal, parameters for motion. Pro-Motion provides a wealth of functions including a high speed hardware trace oscilloscope that can assist you in determining optimal parameters. Values provided by the Axis Wizard during auto tuning may or may not be safe for your system, and it is up to the user to determine if and when they should be used.

4 The "Command Source and System Activation" screen, which is one of the last setup screens in the wizard, provides the opportunity to perform a simple profile move.

The Command Source and System Activation screen appears as follows.

To perform a simple move select the command source as profile generator, and from the "Internal Profile" section of this screen enter motion profiles for deceleration, acceleration, and velocity that are safe for your system and will demonstrate proper motion. Negative values of velocity will move the motor in the negative direction.

Pro-Motion provides various selectable units for distance and time, but defaults to microsteps 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 1.8° step motor that has 64 µsteps/full step to perform a symmetric trapezoidal move with a top speed of 5 rotations per second and with an acceleration time of two seconds, the parameters in the Command Source dialog box would be set as follows:

Deceleration: 32,000 µsteps/sec^2

Acceleration: 32,000 µsteps/sec^2

Velocity: 60,000 µsteps/sec

Click Go and confirm that the motion occurred in a stable and controlled fashion. To change the profile once moving simply enter new profile parameters. To stop motion click on the "Stop" button when it appears once motion is occurring.

5   When ready, select "Next" at the bottom of the screen and you will get to a screen called "Completing the Axis Wizard." Click Finish with the "Save settings to file" checkbox checked. You will now be

prompted to specify a name of a project file. Choose a name that is convenient to you and select OK to store the configuration established during the Axis Wizard setup.

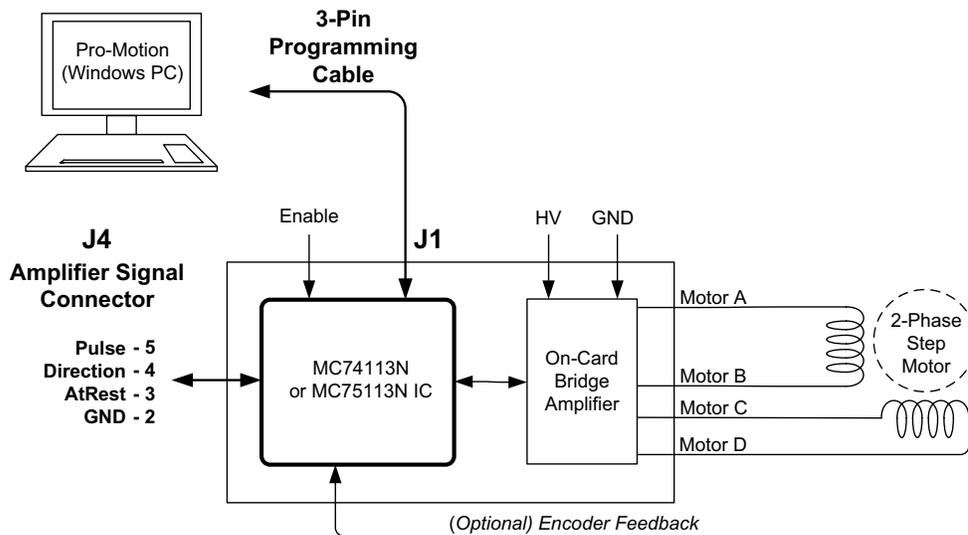# 1.12 Pulse & Direction Operation

Figure 1-4: Pulse & Direction Amplifier Connections

The previous first time system verification section uses the Juno Step Motor Control IC's internal profile generator to generate motion of the step motor. This is convenient because it requires a minimum of external control signals, and allows motion speeds and direction to be controlled from the Pro-Motion exercisor program.

The most common control mode of the DK74113N however uses external pulse, direction, and (optional) at rest signals to control the motor motion. The external pulse & direction signals may be generated by a user-created motion controller, by an off-the-shelf third party motion controller, or by one of PMD's motion controllers that generate pulse & direction output such as the Magellan MC50000 series chipset.

Figure 1-4 shows a DK74113N driven by pulse & direction signals while being connected to Pro-Motion. This is a common and very useful way to use the DK74113N. In addition to setting the command source to pulse & direction, Pro-Motion can be used to monitor the controller performance, tune current loop parameters, and trace various system characteristics during your application development.

From Pro-Motion, to select pulse & direction as the command source for the MC74113N or MC75113N ICs, at the top of the "Command Source and System Activation" screen that you previously used to enter profile parameters, change the command source from profile generator to pulse & direction.

A command position register will now be displayed which holds the command position from the external pulse & direction signals. Once your external profile generator is active you should see this command position change.

You can also exercise the at rest signal if you have programmed separate drive current and holding current values and confirm that the polarity of the at rest signal is correct.

If any of these functions do not operate as expected recheck electrical connections and retry.

1.12.1 Restarting Pro-Motion

After first time verification is complete you may continue, in the same Pro-Motion session, to exercise your motion system or optimize control parameters as desired. Alternatively, whether immediately after additional interactions with Pro-Motion, you may wish to exit Pro-Motion for restart at a later time.

If you have changed additional control parameters and would like to save these parameters use File/Save Project As to save the current configuration to a file.

When restarting Pro-Motion it is important that you restore the configuration that you have saved, particularly the on-board amplifier limits and scale factors established during Axis Wizard setup. Do this by selecting File/Open Project, selecting the correct file previously stored.

> Operation of the DK74113N without proper safety settings established during Axis Wizard operation may harm the DK74113N board or the application hardware. To avoid this be sure to restore saved control settings using the File/Open Project menu item before operating the DK74113N board.

1.12.2 Next Steps

In addition to managing configuration setup and storage Pro-Motion has extensive performance trace facilities that can be accessed from its main control windows along with other step motor control functions. You can use these facilities to further checkout and optimize your system's performance.

When ready, you can store the motor configurations you develop into named files, thereby making it easy to work on multi-motor systems with different motor and system control needs for various parts of the overall machine.

2. Operation

In This Chapter

▶ DK74113N Block Diagram
▶ Communication Port
▶ Switching Motor Amplifier
▶ Drive Protection and Control Signals
▶ DC Bus
▶ Miscellaneous Signal Processing
▶ Pulse, Direction, & AtRest
▶ Enable & FaultOut
▶ On-IC NVRAM Configuration Storage

2.1   DK74113N Board Block Diagram

The DK74113N Developer Kit board provides a complete functioning MC74113N and MC75113N IC exerciser and development system. It directly interfaces to a host computer using USB to serial communication, and provides all power, motor drive, control, and feedback signals required to drive a step motor.

The DK74113N incorporates several major subsystems including the MC74113N or MC75113N ICs themselves, a high performance MOSFET-based motor amplifier, a DC Bus conditioning and monitoring system, and various other circuitry.

The following sections describe these major sections of the DK74113N board.

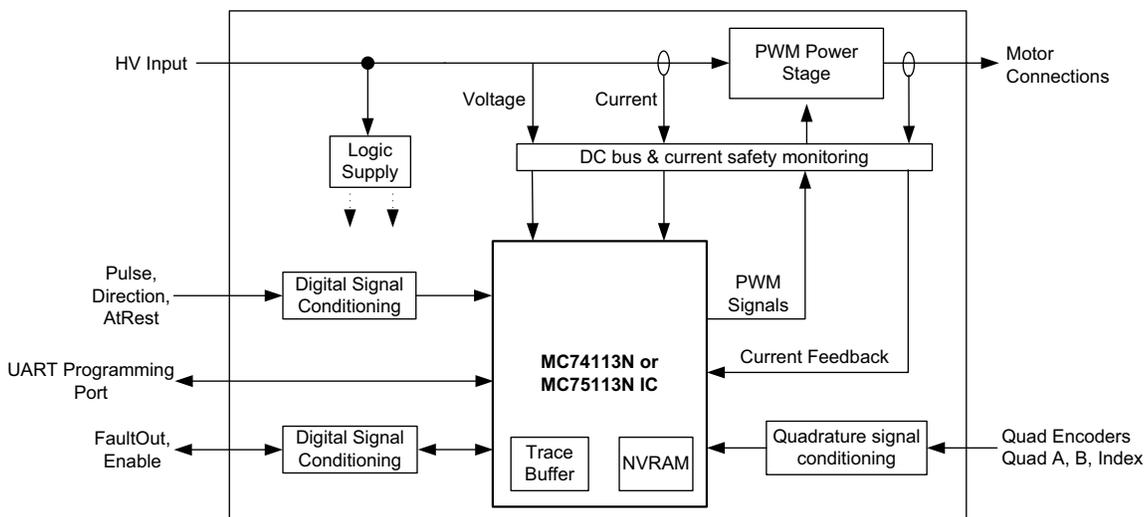For a complete description of the MC74113N and MC75113N ICs, see the *Juno Step Motor Control IC User Guide*.

Figure 2-1: DK74113N Block Diagram

2.2　Communication Port

The DK74113N supports a UART serial interface via its J1 connector. This port is primarily used for setup of the MC74113N or MC75113N's control parameters.

All DK74113N communication functions are controlled by the MC74113N or MC75113N IC. For information on serial port function see the *Juno Step Motor Control IC User Guide.*

2.3　Switching Motor Amplifier

The DK74113N contains a high-efficiency MOSFET power stage with PWM input control and leg current feedback. Step motors are driven with two H-Bridges, one for each phase, for a total of 8 MOSFETs and 4 leg current sensors

2.3.1　Step Motor Drive

Figure 2-2 shows the arrangement of the DK74113N's amplifier stage.

**Figure 2-2:
Two-Phase
Step Motor
Bridge
Configuration**
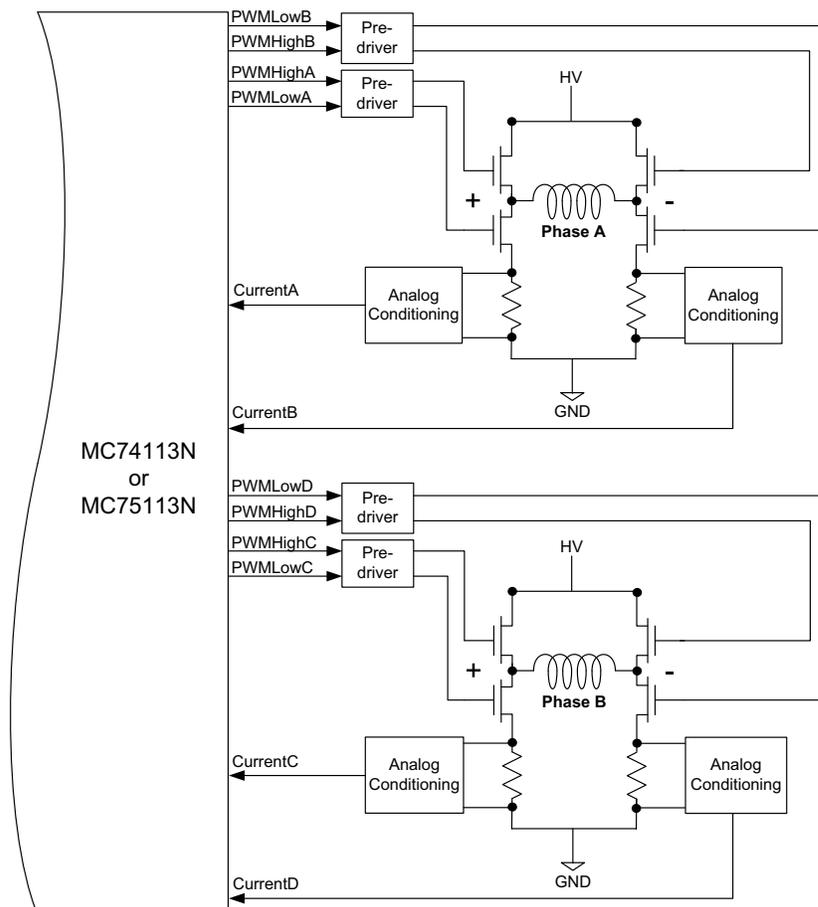
As shown in the table below eight PWM output signals and four analog feedback signals interface between the MC74113N IC or MC75113N and the DK74113N's switching amplifier.

Signal	Description
PWMHighA	Digital high side drive output for motor phase A, positive coil terminal
PWMLowA	Digital low side drive output for motor phase A, positive coil terminal
PWMHighB	Digital high side drive output for motor phase A, negative coil terminal
PWMLowB	Digital low side drive output for motor phase A, negative coil terminal
PWMHighC	Digital high side drive output for motor phase B, positive coil terminal
PWMLowC	Digital low side drive output for motor phase B, positive coil terminal
PWMHighD	Digital high side drive output for motor phase B, negative coil terminal
PWMLowD	Digital low side drive output for motor phase B, negative coil terminal
CurrentA	Analog input containing the current flow through the positive leg of phase A bridge
CurrentB	Analog input containing the current flow through the negative leg of phase A bridge
CurrentC	Analog input containing the current flow through the positive leg of phase B bridge
CurrentD	Analog input containing the current flow through the negative leg of phase B bridge

2.3.2   Amplifier-Related Settings

There are a number of MC74113N or MC75113N IC settings which are used to set or control various aspects of the DK74113N's on-board switching amplifier and related current sense circuitry.

The following table shows the default values and recommended (or required) settings for amplifier-related parameters:

Parameter	Value & Units	Comment
Motor Output Mode	PWM High/Low	Set the motor output mode to PWM High/Low for operation with the on-board amplifier.
PWM Switching Frequency	20 kHz	This setting is motor-specific. Higher inductance motors should be set for 20 kHz. Lower inductance motors may use 40, 80, or 120 kHz to reduce current ripple and minimize heat generation.
PWM Dead Time	540 nSec	For correct operation of the DK74113N's on-board switching amplifier this parameter must be set to this value.
PWM Refresh Time	2,000 nSec	To ensure sufficient time to recharge the on-board amplifier's high side switches this parameter must be set to this value.
PWM Refresh Period	8 cycles	To ensure sufficient time to recharge the on-board amplifier's high side switches this parameter must be set to this value
PWM Signal Sense, high	Active High	For correct operation of the on-board amplifier all high PWM outputs must be set to active high.
PWM Signal Sense, low	Active Low	For correct operation of the on-board amplifier all low PWM outputs must be set to active low.

All of the DK74113N parameters described in this section can be specified using Pro-Motion via the Axis Wizard. See Section 1.11, "First-Time System Verification" for more information.

2.3.3   DK74113N Current Scale Value

To correctly control or trace motor current it is useful to know the DK74113N's amplifier-specific current conversion factor. The following table shows this:

Parameter	Value & Units	Comments
Leg Current Conversion	.733 mA/count	This value should be specified so that the motor current can be traced and displayed correctly in amps.

All of the DK74113N parameters described in this section can be conveniently specified using Pro-Motion via the Axis Wizard. See Section 1.11, "First-Time System Verification" for more information.

2.4   Drive Protection and Control Signals

2.4.1   I^{2}t Current Foldback Protection

The MC74113N and MC75113N use current feedback to implement I^{2}t current limiting. This feature protects the on-board amplifier by controlling its ability to operate above specific selected continuous current ratings.

When the current loop is enabled and the I^{2}t energy limit is exceeded, the MC74113N and MC75113N will automatically fold back the phase currents to a user programmable continuous current limit value. Alternatively, the MC74113N and MC75113N can be configured to fault and disable the output stage when the I^{2}t energy limit is exceeded

2.4.1.1   I^{2}t Limits

To safely operate the on-board amplifier it is necessary to specify I^{2}t limits.

Parameter	Value & Units	Comments
Step motor: Foldback Continuous Current Limit	10.0 A	This value should be entered to ensure the on-board amplifier does not operate above the maximum safe current output.
Step motor: Foldback Maximum Energy Limit	50 A^{2}sec	This value should be entered to ensure the on-board amplifier does not operate above the maximum safe current output.

For use with motors that have current and energy limits lower than those specified above, it may be useful to reduce these parameters.

> These limits are designed to be safe for operation of the DK74113N's on-board amplifier when cooled with a 110 CFM (or higher) fan and with an ambient room temperature of 25 degrees C. For use without a fan, or in higher ambient temperature environments, these values should be lowered.
>
> If special heatsinking is used the DK74113N board is capable of driving motors at 14 amps continuously or higher, in which case these limits can be increased. Contact PMD for details.

> It is the responsibility of the user to set the Foldback Continuous Current and Foldback Energy Limit parameters to values that are safe for the DK74113N heat sinking scheme and motor setup being used.

All of the parameters described in this section can be conveniently specified using Pro-Motion via the Axis Wizard. See <u>Section 1.11, "First-Time System Verification"</u> for more information.
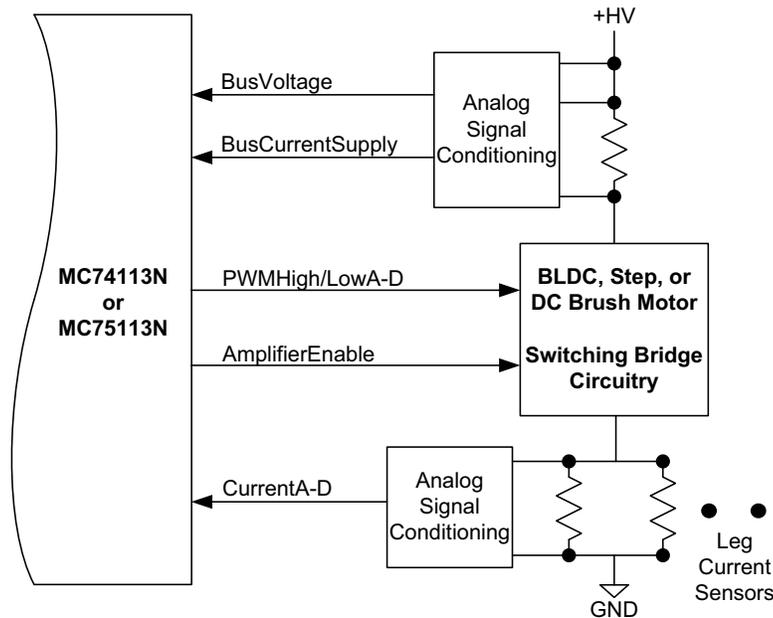
2.5 DC Bus

Figure 2-3: DC Bus Monitoring Circuitry

Figure 2-3 shows the DC bus monitoring circuitry used with the DK74113N board. This circuitry is designed to work with the MC74113N and MC75113N's DC bus management and protection logic. These functions include overcurrent protection, over and under voltage detection, and ground fault detection.

2.5.1 DC Bus Current Monitoring

DK74113N monitors both the supply and return DC bus current to detect overcurrent conditions including: line-to-line, line-to-power supply, and line-to-ground short circuits.

2.5.1.1 DC Bus Current Monitoring Scale Values

The following DC bus current monitoring scale values for the DK74113N board are required to correctly operate the DC bus current monitoring functions:

Parameter	Value & Units	Comments
Leg current return conversion	.733 mA/count	This value should be entered so that the DC bus current return can be traced and displayed correctly in amps.

2.5.1.2 DC Bus Current Limits

The following DC bus current limits are required to safely operate the DK74113N board:

Parameter	Value & Units	Comments
Bus Current Return Limit	23 A	This value should be entered to ensure safe operation of the DK74113N.

Note that these values are designed to protect the DK74113N circuitry. Lower values may be used to protect the motor.

All of the parameters described in this section can be conveniently specified using Pro-Motion via the Axis Wizard. See Section 1.11, "First-Time System Verification" for more information

2.5.2   DC Bus Voltage Monitoring

DK74113N monitors the main DC bus voltage for overvoltage and undervoltage conditions. These thresholds are user-settable within the voltage operating range of the drive.

2.5.2.1   DC Bus Voltage Monitoring Scale Values

To correctly monitor the DC bus voltage it is necessary to know the DC bus voltage scale factor. The following table provides this value.

Parameter	Value & Units	Comments
Bus Voltage Display	1.424 mV/count	This value should be entered so that the DC bus voltage can be traced and displayed correctly in volts.

2.5.2.2   DC Bus Voltage Limits

The following DC bus voltage limits are required to safely operate the DK74113N board:

Parameter	Value & Units	Comments
Undervoltage Limit	10.0 V	This value should be entered to ensure safe operation of the DK74113N.
Overvoltage Limit	52.0 V	This value should be entered to ensure safe operation of the DK74113N.

Note that these values are designed to protect the DK74113N circuitry. More restrictive values may be used to protect the motor.

All of the parameters described in this section can be conveniently specified using Pro-Motion via the Axis Wizard. See Section 1.11, "First-Time System Verification" for more information.

2.6   Miscellaneous Signal Processing

The following sections detail the signal processing circuitry provided by the DK74113N board for various signal connections.

2.6.1   Encoder Inputs

The MC74113N's encoder input signals provide processing of quadature encoder A, B feedback along with an Index signal. By default a valid index is recognized when Index is low however the interpretation of this signal as well as the A, B quadrature signals can be user programmed.

The differential input circuitry for the encoder A, B and Index signals is shown in Figure 2-4. This circuit accepts both differential and single-ended signals in the range of 0 – 5 V. For single-ended operation, only the positive connection is used and the negative connection is left unconnected.
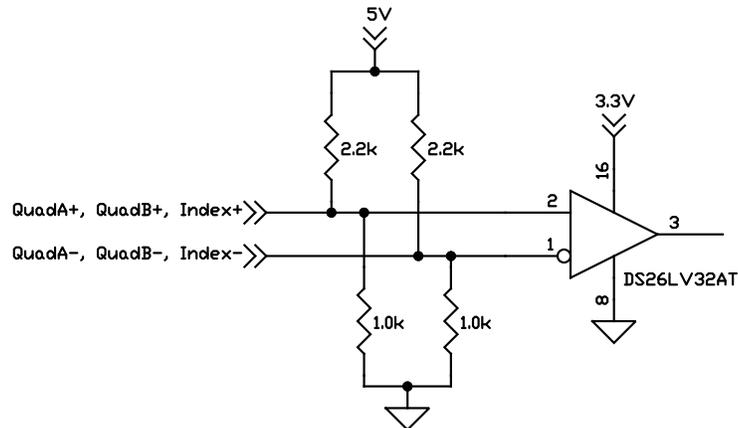
**Figure 2-4:
Main Encoder
Input Circuits**

2.7 Pulse, Direction, & AtRest

Pulse & Direction are digital input signals that provide a continuous command position to the DK74113N IC. The AtRest signal, if used, indicates whether the active torque level should be used or the lower holding torque level. By default a step occurs when the Pulse signal transitions from high to low, a high level on the Direction signal indicates a move in the positive direction, and a high level on the AtRest signal indicates the axis is at rest. All of these default signal interpretations can be user programmed.

Figure 2-5 shows the input processing provided by the DK board for Pulse, Direction and AtRest signals. For all of these signals the input range is up to 5.5V and is TTL compatible.
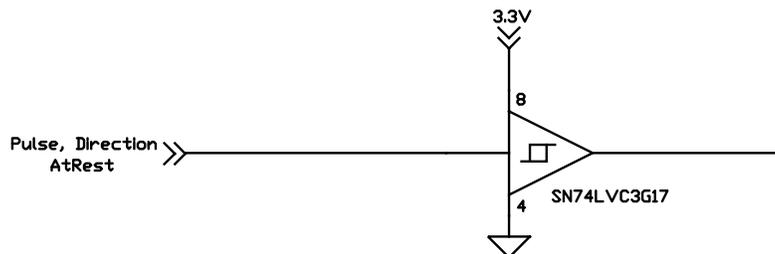
**Figure 2-5:
Pulse,
Direction, &
AtRest**

2.8 Enable & FaultOut

These dedicated signals are typically used to implement a safety interlock between the DK74113N board and other control portions of the system. /Enable is an active-low input that must be tied or driven low for the DK74113N output stage to be active.

FaultOut indicates a serious problem. When DK74113N is operating properly FaultOut is inactive. The polarity of this signal is fixed and cannot be user programmed.

The input buffer for the /Enable input is shown in Figure 2-6. This circuit accepts signals in the range of $0 - 24$ V and has TTL compatible, Schmitt trigger thresholds. It has a pull-up to 5V to allow direct interfacing to open collector enable sources without the need for an external pull-up resistor and a 1.3 kHz R-C low pass filter to reject noise.

**Figure 2-6:
Enable Input
Circuit**
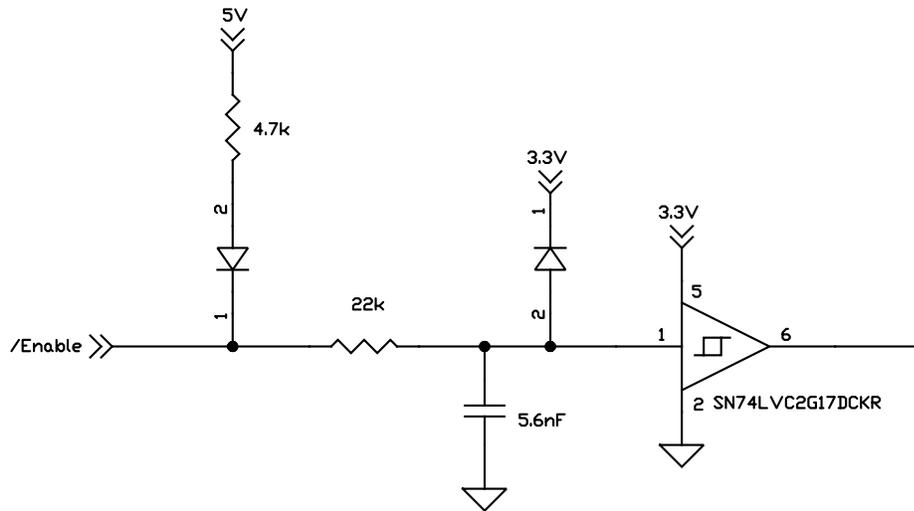
The output driver for FaultOut is shown in Figure 2-7. This circuit can continuously sink over 100 mA and source 4mA from a pull-up resistor to 5V. The diode in series with the pull-up resistor allows loads powered from up to 24 VDC to be switched. The FET driver is internally protected from shorts up to 30 V.

**Figure 2-7:
FaultOut
Circuit**
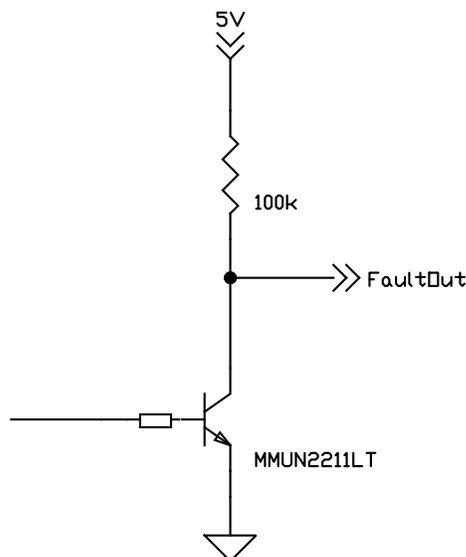
2.9   On-IC NVRAM Configuration Storage

The MC74113N and MC75113N ICs provide the ability to directly store configuration information such as gain parameters, drive-related safety parameters, and other parameters. This setup information, once loaded, is automatically initialized into the active configuration registers at each power-up. See the *Juno Step Motor Control User Guide* for more information.

3. Electrical Reference

In This Chapter

▶ Connectors

▶ Motor Connection Quick Reference

▶ Absolute Maximum Ratings

▶ Environmental and Electrical Ratings

▶ DK74113N Control Settings Quick Reference

3.1   Connectors
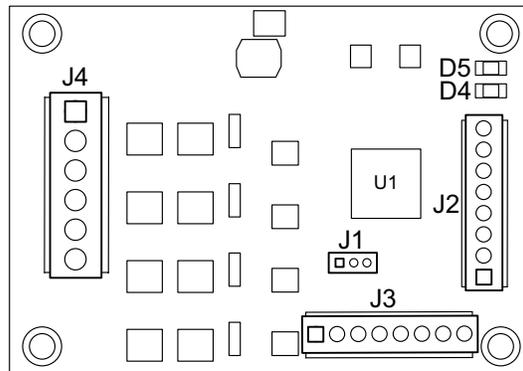
Figure 3-1: DK74113N Board Component Location

There are four user-accessible connectors on the DK74113N board. See Figure 3-1 for the specific locations of the connectors on the board. The connectors and their functions are outlined in the following table:

Label	Description
J4	HV Power & Motor Drive Connector
J3	Feedback Connector
J2	Amplifier Signal Connector
J1	UART Programming Port
D4 & D5	Fault and power LED indicators (respectively)

3.1.1   HV Power & Motor Drive Connector (J4)

The DK74113N connector (J4) accepts HV input voltage in the range of +12 to 48 VDC and also provides the step motor winding connections. This connector is a terminal block.

Pin	Connection	Description
J4 - HV Power Connector		
1	HV	Provides DC power to the board and on-board switching amplifier
2	GND	Ground
3	Motor A	Motor output signal A+
4	Motor B	Motor output signal A-
5	Motor C	Motor output signal B+
6	Motor D	Motor output signal B-

3.1.2   Feedback Connector (J3)

The Feedback Connector (J3) provides connections to the motor encoder. The Feedback Connector consists of a 2.54 mm pitch 8-circuit terminal block.

Pin	Connection	Description
J3 - Feedback Connector		
1	Vcc	+5V output
2	GND	Ground
3	QuadA+	Quadrature A+ encoder input
4	QuadA-	Quadrature A- encoder input
5	QuadB+	Quadrature B+ encoder input
6	QuadB-	Quadrature B- encoder input
7	Index+	Index+ input
8	Index-	Index- input

3.1.2.1   Notes on Encoder Connections

Encoder inputs may be connected differentially, with two wires for QuadA, QuadB, and Index signals, 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.

The following tables show this:

Encoder connections when using differential encoder input:

Signal	J3 Feedback Connector
QuadA+	J3-3
QuadA-	J3-4
QuadB+	J3-5
QuadB-	J3-6
Index+	J3-7
Index-	J3-8
Vcc	J3-1
GND	J3-2

Encoder connections when using single-ended encoder input:

Signal	J3 Feedback Connector
QuadA+	J3-3
QuadB+	J3-5

Signal	J3 Feedback Connector
Index+	J3-7
Vcc	J3-1
GND	J3-2

3.1.3   Amplifier Signal Connector (J2)

The Amplifier Signal Connector provides the Pulse, Direction, and AtRest inputs along with an Enable input and the FaultOut. This connector is a 2.54 mm pitch 8-circuit terminal block.

Pin	Signal	Description
J2 - Amplifier Signal Connector		
1	Vcc	+5V output
2	GND	Ground
3	AtRest	AtRest input signal
4	Direction	Direction input signal
5	Pulse	Pulse input signal
6	GND	Ground
7	FaultOut	Active high digital FaultOut output signal
8	Enable	Active low Enable digital input signal

3.2   Absolute Maximum Ratings

HV voltage range:	0V to +52V

3.3   Environmental and Electrical Ratings

Storage temperature:	-40 to +125 degrees C (-40° F to +257°F)
Operating temperature:	0 to +70 degrees C (32° F to +158°F)
HV power requirement:	+12V to + 48V operating range
Motor amplifier continuous current limit[*]:	10.0 A
Motor amplifier peak current limit:	14.0 A
Digital input voltage range:	0V to 5V, TTL thresholds

* Current rating at 25 C ambient and with 110 CFM air flow on board. Significantly higher currents are possible with additional heat sinking. Contact your PMD representative for details.

3.4   DK74113N Control Settings Quick Reference

The DK74113N comes with a standard MC74113N or MC75113N IC, and is thus not tailored for the amplifier and safety-related circuitry located on the DK74113N board. Therefore to use the DK74113N circuitry safely and to view results conveniently via Pro-Motion you will need to set various limits and conversion constants.

These parameters are generally entered when using Pro-Motion's Axis DK74113N setup sequence, however they are also useful if you decide to write your own software that operates the DK74113N board.

Parameter	Value & Units	Comments
Motor Output Mode	PWM High/Low	Set the motor output mode to PWM High/Low for operation with the on-board amplifier. For remote amplifier control operation PWM High/Low, 50/50 PWM, or sign/magnitude PWM may be selected.
PWM Switching Frequency	20 kHz	This setting is motor-specific. Larger motors (some NEMA 23 and most NEMA 34) should be set for 20 kHz. Smaller motors may use 40, 80, or 120 kHz to maximize current control accuracy and minimize heat generation.
PWM Dead Time	540 nsec	For correct operation of the DK74113N's on-board switching amplifier this parameter must be set to this value.
PWM Refresh Time	2,000 nSec	To ensure sufficient time to recharge the on-board amplifier's high side switches this parameter must be set to this value.
PWM Refresh Period	8 cycles	To ensure sufficient time to recharge the on-board amplifier's high side switches this parameter must be set to this value
PWM Signal Sense, high	Active High	For correct operation of the on-board amplifier all high PWM outputs must be set to active high.
PWM Signal Sense, low	Active Low	For correct operation of the on-board amplifier all low PWM outputs must be set to active low.
Leg Current Conversion	.733 mA/count	This value should be entered so that the leg current can be traced and displayed correctly in amps.
Step Motor: Foldback Continuous Current Limit	10.0 A	This value should be entered to ensure the on-board amplifier does not operate above the maximum safe current output.
Step Motor: Foldback Maximum Energy Limit	50 A^2sec	This value should be entered to ensure the on-board amplifier does not operate above the maximum safe current output.
Temperature Limit	75.0 C	This value should be entered to ensure the on-board amplifier does not operate above the maximum safe current output.
Bus Current Return Limit	23 A	This value should be entered to ensure safe operation of the DK74113N.
Bus Voltage Display	1.424 mV/count	This value should be entered so that the DC bus voltage can be traced and displayed correctly in volts.
Undervoltage Limit	10.0 V	This value should be entered to ensure safe operation of the DK74113N.
Overvoltage Limit	52.0 V	This value should be entered to ensure safe operation of the DK74113N.

All of the above settings may be selected at once via the Pro-Motion Axis wizard by specifying that you are using the DK74113N board.