PERFORMANCE MOTION DEVICES
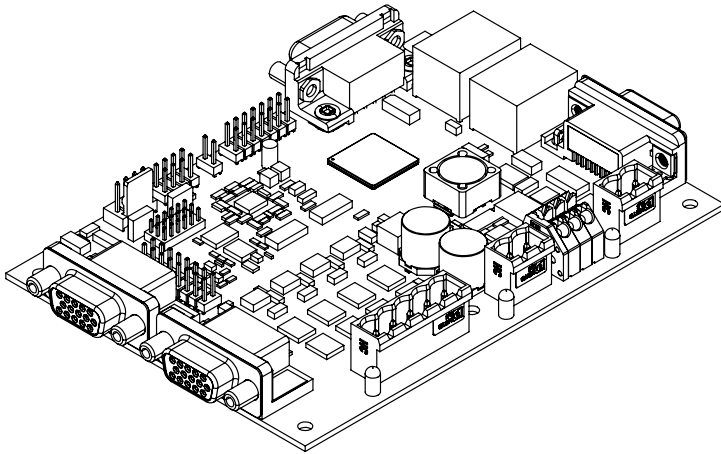
MOTION CONTROL AT ITS CORE

Magellan® Motion Control IC

DK58113 Developer Kit
User Manual

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Related Documents

Magellan® Motion Control IC User Guide

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

MC58113 Electrical Specifications

> Information on physical and electrical characteristics, timing diagrams, pin descriptions, application notes and application schematics of MC58113 IC.

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 PRP Programming Reference

> Description of all Prodigy/CME and ION/CME 500 product commands with software architecture overview, command syntax, and examples.

Atlas Digital Amplifier User Manual

> Description of the Atlas Digital Amplifier electrical and mechanical specifications along with a summary of its operational features.

Atlas Digital Amplifier Complete Technical Reference

> Complete technical and mechanical description of the Atlas Digital Amplifier with detailed theory of operations.

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1. Installation

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1.1 Introduction

The PMD DK58113 Developer Kit is an integrated board/software package that serves as an electrical and software design tool for building systems that use Magellan MC58113-series ICs.

The developer kits support all members of the MC58113 IC family, as shown below:

Developer Kit p/n	Installed IC	Motors supported	Comments
DK58113	MC58113	DC Brush, Brushless DC, step motor	
DK58113S	MC58113S	DC Brush, Brushless DC, step motor	Socketed version of DK58113
DK53113	MC53113	Brushless DC	
DK51113	MC51113	DC Brush	
DK54113	MC54113	Step motor	

All of the above Developer Kit versions share the same physical DK58113 board. They differ in the specific type of MC58113-series IC chip that is installed in the board and in whether the MC58113 IC is socketed or not.

Note that throughout this manual the term MC58113 may be used to mean all members of the MC58113 series including the MC58113, MC53113, MC51113, and MC54113 ICs. The term DK58113 may be used to mean to all members of the DKs including the DK58113, DK53113, DK51113, and DK54113 developer kits.

1.2 Magellan Motion Control IC Family Overview

The following table presents a feature summary of the products in the Magellan Motion Control IC product family:

	MC58000 Series (Except MC58113)	MC55000 Series	MC58113 Series
# of axes	1, 2, 3, 4	1, 2, 3, 4	1+ (primary & aux channel encoder input)
Motor types supported	DC brush, brushless DC, step motor	Step motor	DC brush, brushless DC, step motor
Output format	SPI Atlas, PWM, DAC, Pulse & direction	Pulse & direction	SPI Atlas, PWM, DAC, Pulse & direction
Parallel host communication	✓	✓	
Serial host communication	✓	✓	✓
CAN 2.0B host communication	✓	✓	✓
SPI host communication			✓
Incremental encoder input	✓	✓	✓
Parallel word device input	✓	✓	
Index & Home signals	✓	✓	✓
Position capture	✓	✓	✓
Directional limit switches	✓	✓	✓
PWM output	✓		✓
Parallel DAC output	✓		
SPI Atlas interface	✓		✓
SPI DAC output	✓		✓
Pulse & direction output	✓	✓	✓
Digital current control	✓ (with Atlas)		✓
Field oriented control	✓ (with Atlas)		✓
Under/overvoltage sense	✓ (with Atlas)		✓
I^2T Current foldback	✓ (with Atlas)		✓
DC Bus shunt resistor control			✓
Overtemperature sense	✓ (with Atlas)		✓
Short circuit sense	✓ (with Atlas)		✓
Ground fault detection	✓ (with Atlas)		
Trapezoidal profiling	✓	✓	✓
Velocity profiling	✓	✓	✓
S-curve profiling	✓	✓	✓
Electronic gearing	✓	✓	✓
On-the-fly changes	✓	✓	✓
PID position servo loop	✓		✓
Dual biquad filters	✓		✓
Dual encoder loop	✓ (multi-axis configurations only)		✓
Programmable derivative sampling time	✓		✓
Feedforward (accel & vel)	✓		✓
Data trace/diagnostics	✓	✓	✓
Motion error detection	✓	✓ (with encoder)	✓
Axis settled indicator	✓	✓ (with encoder)	✓
Analog input	✓	✓	✓
Programmable bit output	✓	✓	✓
Software-invertible signals	✓	✓	✓
User-defined I/O	✓	✓	
Internal Trace Buffer			✓
External RAM support	✓	✓	
Multi-chip synchronization	✓		✓

	MC58000 Series (Except MC58113)	**MC55000 Series**	**MC58113 Series**
Chipset configurations	MC58420 (4 axes, 2 ICs)	MC55420 (4 axes, 2 ICs)	MC51113 (1+ axis, 1 IC)
	MC58320 (3 axes, 2 ICs)	MC55320 (3 axes, 2 ICs)	MC53113 (1+ axis, 1 IC)
	MC58220 (2 axes, 2 ICs)	MC55220 (2 axes, 2 ICs)	MC54113 (1+ axis, 1 IC)
	MC58120 (1 axis, 2 ICs)	MC55120 (1 axis, 2 ICs)	MC58113 (1+ axis, 1 IC)
	MC58110 (1 axis, 1 IC)	MC55110 (1 axis, 1 IC)	
IC Package: CP chip	MC58x20: 144 pin TQFP	MC55x20: 144 pin TQFP	100 pin TQFP
	MC58110: 144 pin TQFP	MC55110: 144 pin TQFP	
IC Package: IO chip	MC58x20: 100 pin TQFP	MC55x20: 100 pin TQFP	N/A
	MC58110: NA	MC55110: NA	
Motion control IC developer kit p/n's	DK58420	DK55420	DK51113
	DK58320	DK55320	DK53113
	DK58220	DK55220	DK54113
	DK58120	DK55120	DK58113
	DK58110	DK55110	DK58113S

1.3   Developer Kit Components List

The DK58113 Developer Kit contains the following components:

- DK58113 Developer Kit board

- USB to 9-pin serial cable

- RJ45 to RJ45 CANbus cable

- DB-15 terminal screw breakout board (qty 2)

- 2-pin power & shunt connector terminal screw plug (qty 2)

- 5-pin motor drive connector terminal screw plug

The following software and design materials are part of the DK58113 and can be downloaded from the PMD website. See Section 1.7, "Software Installation" for details:

- Pro-Motion Windows-based exerciser

- C-Motion Magellan Software Developer Kit

- C-Motion PRP Software Developer Kit:

- PDFs of all documentation

1.4   DK58113 Board

The heart of the DK58113 Developer Kit is the DK58113 printed circuit board that contains interface and amplifier circuitry to allow various features of the MC58113-family ICs to be accessed. Here is a summary of the features provided by the DK58113 board:

- Supports step, DC Brush, and Brushless DC motors

- Socketed version of DK (DK58113S) allows MC58113s to be swapped out for testing or user configuration storage

- High performance on-card amplifier with current feedback supports all motor types

- Interfaces to external Atlas, user-designed, or pulse & direction amplifier

- RS-232, RS-485, CANbus, and SPI (Serial Peripheral Interface) host communications

- Single DC-voltage supply

- Primary and auxiliary axis quadrature signal input with Index and Home capture

- Hall sensor, Home, limits, AxisIn and AxisOut signals

- Support for overtemperature, overcurrent, over and undervoltage sense

- High current external shunt resistor support

- Pulse & Direction signals with AtRest for use with external step motor amplifiers

- Compact 3.3" x 4.7" standalone form factor (8.4 cm x 11.9 cm)

1.5   Installation Overview

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

2   For a normal installation of the DK58113 board you will need to configure the board. See Section 1.8, "Preparing the Board for Installation" for a description of configuring the board.

3   Next, connect the system's motor windings, encoder(s), and sensors to operate the motion hardware. See Section 1.9, "Connection Summary" for details.

4   Connect the DK58113 board to the host PC via a Serial cable. This is described in Section 1.9.4, "Communication Connections."

5   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 DK58113 board the following hardware is recommended. Note that this list assumes that the on-card amplifier will be used. For installation of a user-provided off-card amplifier, see Section 2.6, "Connecting to a Remote Amplifier."

- 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, and Windows 8.

- 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 a requirement for DC Brush motors, and is normally used 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, home sensor, and limit switches. If the auxiliary axis is being used, then additional cables will be used to connect to this second encoder.

- Power supply, power cable, and communication cables. The DK58113 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. Although the DK58113 supports serial, CANbus and SPI communications, for first-time installation you will use the card's serial port.

1.7   Software Installation

The software distribution for the DK58113 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.

- C-Motion Magellan SDK – an SDK (Software Developer Kit) for creating motion applications using the C/C++ programming language for PMD products that utilize a direct Magellan or Juno formatted protocol.

- C-Motion PRP SDK – an SDK for creating PC and downloadable user code for systems utilizing either a PRP (PMD Resource Access Protocol) protocol device or a Magellan/Juno protocol device. C-Motion PRP is also used in motion applications that will use the .NET (C#, VB) programming languages.

*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 each of these software packages.

1.7.1   Pro-Motion

Pro-Motion is a sophisticated, easy-to-use exerciser program which allows all Magellan IC 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 Magellan ICs. 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, CANbus, 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

There are two different versions of C-Motion, C-Motion Magellan and C-Motion PRP. C-Motion Magellan is used with PMD products that utilize a direct Magellan or Juno formatted protocol, and C-Motion PRP is used in systems that support both Magellan/Juno protocol device and PRP (PMD Resource Access Protocol) protocol devices. C-Motion PRP is also used in motion applications that will use the .NET (C#, VB) programming languages.

C-Motion Magellan is described in the *C-Motion Magellan Programming Reference* and C-Motion PRP is described in the *C-Motion PRP 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   Preparing the Board for Installation

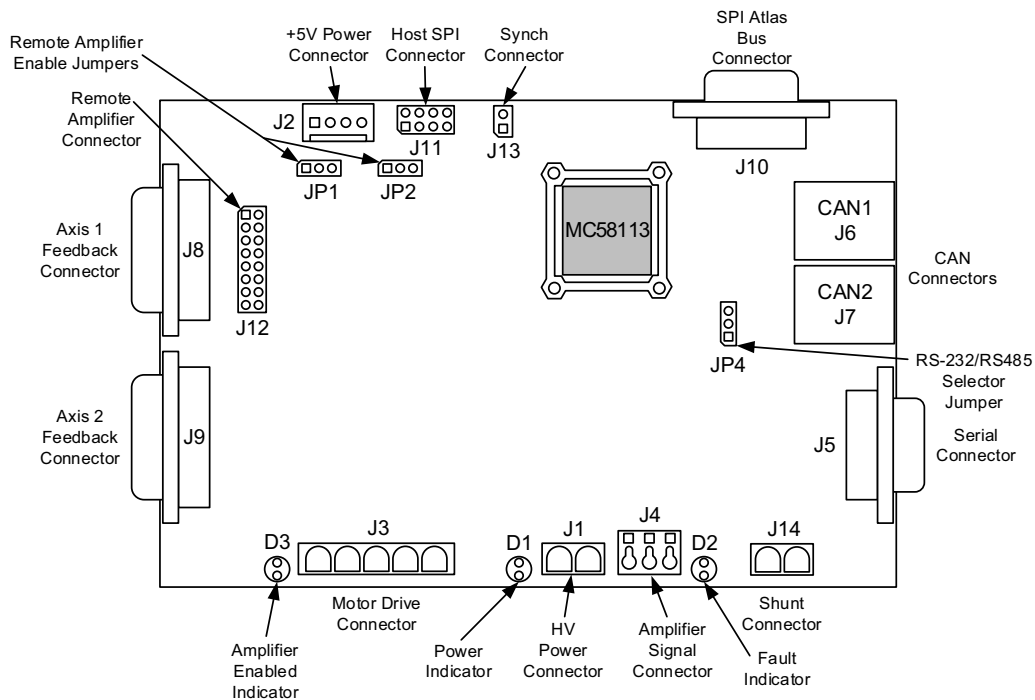Figure 1-1 shows the location of various on-card components such as connectors and jumpers.

Figure 1-1: DK58113 Board Components Location

The following table describes these components:

Label	Description
J1	HV Power Connector
J3	Motor Drive Connector
J8	Axis 1 Feedback Connector
J9	Axis 2 Feedback Connector (auxiliary axis)
J4	Amplifier Signal Connector
J10	SPI Atlas Bus Connector
J12	Remote Amplifier Connector
J14	Shunt Connector
J6, J7	CAN1, CAN2 Connectors (respectively)
J5	Serial Connector
J11	Host SPI Connector
J13	Synch Connector
J2	+5V Power Connector
D1, D2, D3	Power, fault, and amplifier enabled LED indicators (respectively)
JP1, JP2	Remote amplifier enable jumpers
JP4	RS-232/RS-485 selector jumper

There are no jumper changes that need to be made to the board. The DK58113 comes factory-configured to be compatible with the 'first time installation' instructions contained in this chapter.

However, for reference the table below shows the available jumper settings of the DK58113 board:

Jumper ID	Factory Default Setting	Setting &Description	
JP1, JP2	1-2 (on-card amplifier)	1-2	Installing jumpers at 1-2 for JP1 and JP2 configures the DK58113 for operation of the on-card amplifier.
		2-3	Installing jumpers at 2-3 for JP1 and JP2 disables the on-board amplifier, and configures the DK58113 for operation with a user-designed amplifier via the J12 Remote Amplifier Connector, or with an Atlas DK amplifier via the J10 connector.
JP4	1-2 (RS-232)	1-2	Installing a jumper at 1-2 for JP4 configures the DK58113 for RS-232 serial operation.
		2-3	Installing a jumper at 2-3 for JP4 configures the DK58113 for RS-485 serial operation.

1.8.1   Enabling the Board

The MC58113 requires an active Enable signal to operate. To accomplish this the Amplifier Signal Connector (J4) is used. Connect terminal #1 of J4 to terminal #3 of J4 using a short wire. J4 provides convenient push-type connections, so no other hardware is needed to make this connection.

For reference the following table provides the pinouts of the J4 terminal block connector:

Setting & Description	Pin #	Description
Enable	1	Enable input. Must be tied low (GND) to enable the MC58113 for full operation.
FaultOut	2	Programmable FaultOut signal output.
GND	3	Digital ground

1.9   Connection Summary

Figure 1-2: Brushless DC Motor Connection Overview
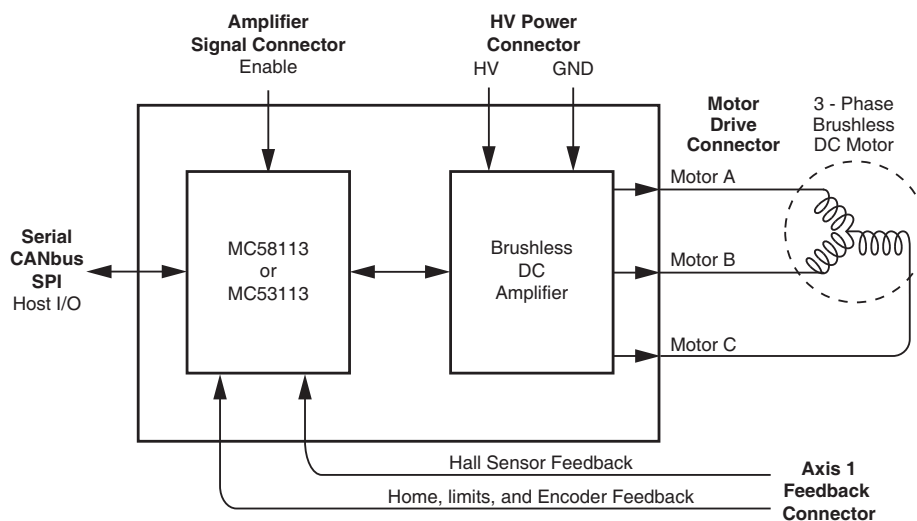
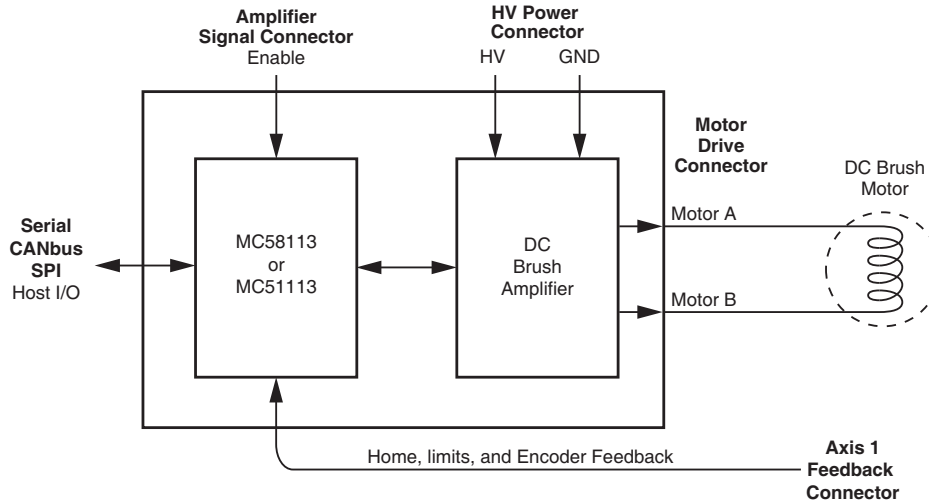**Figure 1-3:
DC Brush
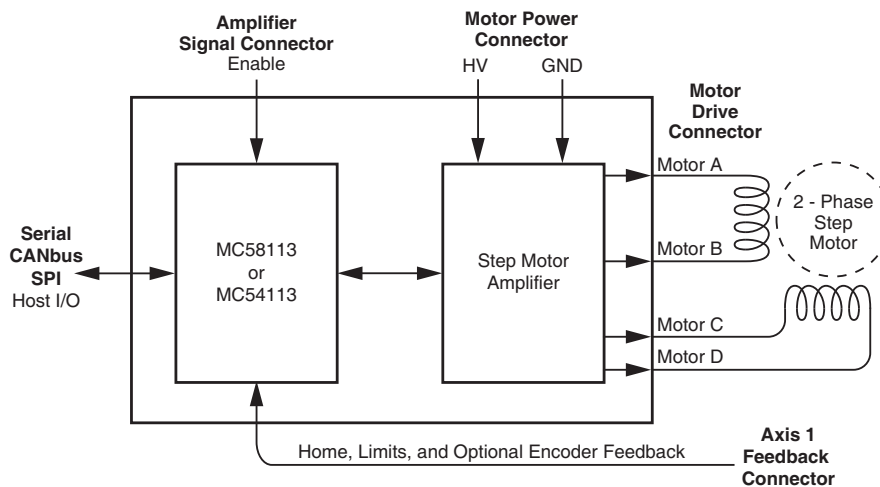Motor
Connection
Overview**

**Figure 1-4:
Step Motor
Connection
Overview**

Figures 1-2 through 1-4 provide general connection overviews for Brushless DC, DC Brush, and step motors.

You will need to connect signals on various connectors to properly install the DK58113 board with the attached motor. The following three sections detail how this should be done.

1.9.1   Axis Feedback Connections

The following table summarizes the Axis signal connections to the DK58113. All connections are made through the Axis Feedback Connector for axis #1 (J8), which is a high density female DB-15. Although you can create your own DB-15 cable to connect these signal wires, many users will use the DB-15 terminal screw breakout board included with the developer kit for convenient terminal screw connection of signal wires.

Pin #	Signal Name	Description
1	QuadA1+	Differential A+ quadrature input. *optional for step motor axes*
2	QuadA1-	Differential A- quadrature input. *optional for step motor axes*
3	QuadB1+	Differential B+ quadrature input. *optional for step motor axes*
4	QuadB1-	Differential B- quadrature input. *optional for step motor axes*

Pin #	Signal Name	Description
5	GND	This is the preferred ground connection for the quadrature and Index signal inputs
6	Index1+	Differential Index+ quadrature input. *optional for step motor axes*
7	Index1-	Differential Index- quadrature input. *optional for step motor axes*
8	Hall1A	Hall signal input phase A. *not used for DC Brush or step motors*
9	Hall1B	Hall signal input phase B. *not used for DC Brush or step motors*
10	Hall1C	Hall signal input phase C. *not used for DC Brush or step motors*
11	Home1	Home signal input (*optional*)
12	PosLim1	Positive position limit input (*optional*)
13	NegLim1	Negative position limit input (*optional*)
14	+5V	+5V power output which may be used to power the motor's encoder circuitry
15	NC	No Connect

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.

1.9.1.2   Auxiliary Encoder Input

J9 is the feedback connector for axis #2, which is the auxiliary axis for the MC58113 IC. This axis provides an additional encoder datastream for use in the MC58113's dual loop control mode or with electronic gear profile mode. In addition various other signals are input via this connector.

For this 'getting started' installation of the DK58113 the auxiliary encoder inputs will not be used. For detailed information on the J9 connector and related electrical functions see Section 3.2.3, "Axis Feedback Connectors (J8, J9)."

1.9.2   Motor Drive Connections

The following table summarizes the motor drive connections from the DK58113 to the motor. The motor drive connector, J3, is designed to connect to all available motor types: Brushless DC, DC Brush, and step motor. There are four motor drive connections and a shield connection. Not every motor type uses all four drive connections however.

The J3 Motor Drive Connector is a male Molex Mini-Fit Plus style connector.

Pin #	Signal Name	Description
1	MotorA	A motor drive lead. Used with all motor types.
2	MotorB	B motor drive lead. Used with all motor types
3	MotorC	C motor drive lead. Used with all motor types except DC Brush
4	MotorD	D motor drive lead. Use with step motors only
5	Case/shield	Connection to motor case/shield. A shield connection is strongly recommended for most motor setups

You may refer to Figures 1-2 through 1-4 or use the table below to determine which leads should be connected for each supported motor type:

Motor type	DK58113 Motor Lead	Motor Coil Connections
Brushless DC	MotorA	A winding connection
	MotorB	B winding connection
	MotorC	C winding connection
	Case/shield	(optional) motor shield connection

Motor type	DK58113 Motor Lead	Motor Coil Connections
DC Brush	MotorA	+ winding connection
	MotorB	- winding connection
	Case/shield	(optional) motor shield connection
Step motor	MotorA	phase A+ winding connection
	MotorB	phase A- winding connection
	MotorC	phase B+ winding connection
	MotorD	phase B- winding connection
	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 (electro static discharge), or electrical noise resulting in motor operation failure.

1.9.3 Motor Power Connections

The following table summarizes the motor power connections from the DK58113 to your power supply. This HV connection is also the power connection from which the card logic power is derived using an on-board DC-DC converter.

All connections are made through the Motor Power Connector, which is a Phoenix Contact 2-circuit terminal block Connector.

Pin #	Signal Name	Description
I	HV	Positive motor voltage power
2	GND	Motor voltage power ground

The HV voltage should be the voltage at which the motor will be driven and must be in the range of 12V - 56V.

1.9.4 Communication Connections

While the DK58113 board can communicate using CANbus, SPI (Serial Peripheral Interface), and one of two serial modes (RS-232 and RS-485), in this first-time installation we will set up the card for serial RS-232 communications. To set up the board for operation in other communication modes, see Chapter 2, "Operation."

A serial port accessory cable is included with the DK58113. This serial cable (PMD p/n Cable-USB-DB9) should be connected to the DK58113 board's J5 Serial Connector, while the opposite end of the serial cable should be connected to one of your computer's USB ports.

1.10 Applying Power

Once you have made your motion hardware, communication, and power connections, hardware installation is complete and the board is ready for operation. When power is applied, the DK58113's green power LED should light. This LED is locatable using Figure 1-1. 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 the board and check the motor and encoder connections. If anomalous behavior is still observed, call PMD or your PMD representative for assistance.

1.11 First-Time System Verification

The first time system verification procedure summarized below has two overall goals. The first is to connect the DK58113 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 trajectory moves. While there are many additional capabilities that Pro-Motion and the DK58113 board provide, these steps 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 manual section.

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

2 Run Pro-Motion's Axis wizard to initialize parameters such as encoder direction and servo gain parameters (if using a servo motor).

3 Execute a simple trajectory profile on each axis demonstrating that it is operating correctly and under stable control.

During this first time system setup you may find it useful to refer to the *Magellan Motion Control IC User Guide* to familiarize yourself with operation of the MC58113 as well as the *MC58113 Electrical Specifications*.

1.11.1 Establishing Serial Communications

To establish serial communications:

1 Make sure the MC58113 board is powered and connected to the PC via the provided USB to serial 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 DK58113 board is connected to the PC. It provides various selectable communication options such as PCI, serial, CANbus, Ethernet.
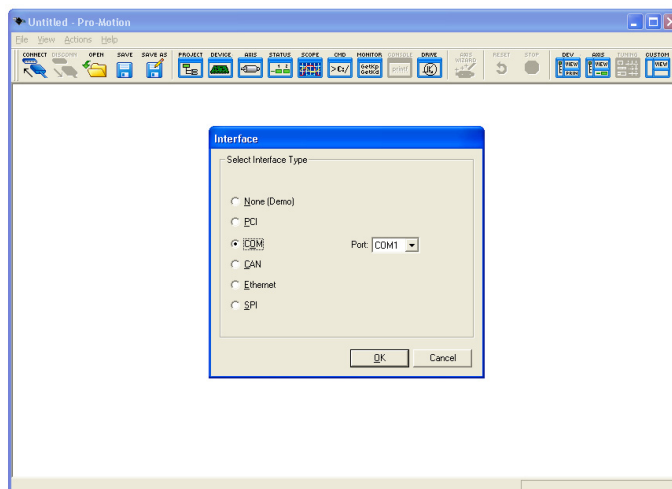
3 Click Serial and view the available COM ports listed in the Port field. If you know which COM port your USB serial cable is connected on, select it.

If you are not sure which of the listed COM ports is the correct one, you may use the following procedure:

- First, unplug the serial cable from your USB port and exit the Interface dialog box. Now re-enter the Interface dialog box, select Serial, and view the COM port list. Record the list of COM ports.

- Next plug the cable back into the USB port and once again exit and re-enter the Interface dialog box. Select Serial and now when you view the COM port list you should see a new COM port listed. This is the COM port that is connected via the USB to serial cable provided with the DK.

- Select this COM port and hit the OK button.

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.
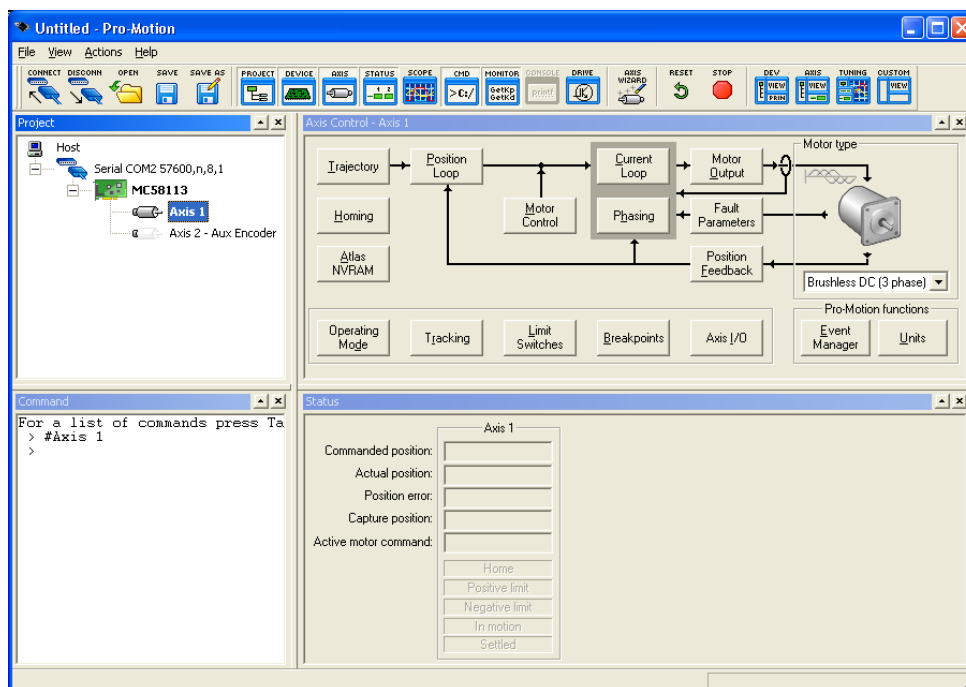
For example, you will see the MC58113 IC name next to an icon of a board, and below that you see an axis icon. Highlighting (single clicking) either the board icon or the axis icons with the mouse is used to select specific cards or axes, and is useful later on in the first time system verification.

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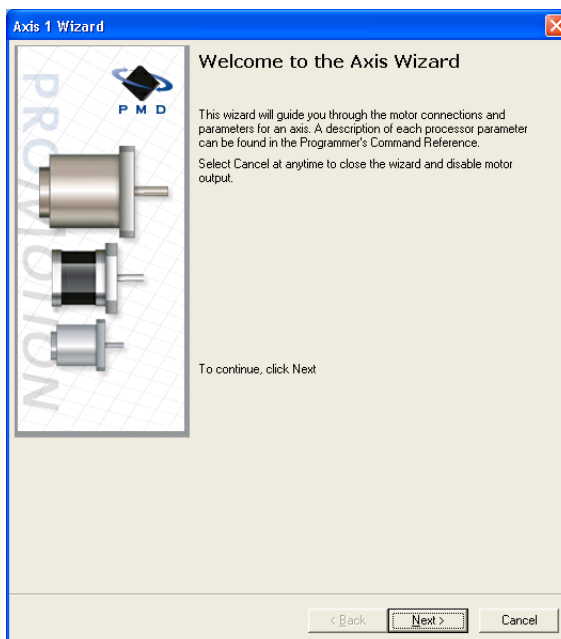
3   Click Next and follow the Axis Wizard instructions for each page of the axis initialization process. A typical Axis Wizard sequence takes 5-10 minutes.

Toward the beginning of the Axis Wizard screen sequence you will be given the option of selecting 'DK58113' as the hardware platform being used. Make sure to select this option because it sets important control and safety values for the board's on-card switching amplifier. If you are using another DK58113 family product such as DK51113, DK53113, or DK54113 you should still select the DK58113 option.

Upon a normal completion of the AxisWizard the axis will be ready to make a controlled move. For step motors this means the pulse & direction connections are working properly, and for servo motors this means the encoder and amplifiers connections have been validated, and stable (but not necessarily optimal, see caution below for more information) servo tuning parameters have been loaded into the card's MC58113 IC. Depending on the signals connected, this may also mean that limit switches, and other hardware connections are functioning properly.

The most common reasons for the Axis Wizard to not complete normally are an inability to auto-tune the servo 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.

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   When completed, 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 covenant to you and select OK to store the configuration established during the Axis Wizard setup.

1.11.3   Performing a Simple Trajectory Move

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

1   Click the Trajectory button in the Axis Control window.

The Trajectory dialog box appears.

2   In the Profile mode list select Trapezoidal, and for the Shuttle mode to the lower left select Single move.

3   Enter trajectory profile values for deceleration, acceleration, velocity, and destination position (Position 1) that are safe for your system and will demonstrate proper motion. The units of these parameters should match the units you requested earlier in the Axis Wizard Setup process. If you would like to change the units you can do this by going to the Axis Control Window and clicking the Units box which is to the far lower right on that window. You should then exit and re-enter the Trajectory dialog box for the units change to be visible.

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

Congratulations! First time system verification is now complete.

1.11.4   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 and Save Project to update the stored configuration file. At this time you may update your existing project file or provide a new one.

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

Operation of the DK58113 without proper safety settings established during Axis Wizard operation may harm the DK58113 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 DK58113 board.

1.12   Going Further With Pro-Motion

The next few sections of this chapter provide a brief guided tour of frequently used features of Pro-Motion. You may find this helpful if you are new to Pro-Motion and PMD's Magellan Motion Control IC, but taking the guided tour is optional and not required to initialize your motor or your setup. Having completed the above sequence your motor is fully initialized and ready for operation.

In this section we provide a quick guided tour of Pro-Motion to help familiarize you with its most commonly used features. We will cover the following areas:

- Axis Control Window
- Trace & Motion Oscilloscope

1.12.1   Axis Control Window

We have already used the Axis Control Window in our getting started procedure. Each selectable box (technically these are Windows buttons) in the Axis Control Window results in a dialog box being opened letting you access a sub-set of the functions provided by the Magellan Control IC. For example there are boxes that access the Magellan IC's trajectory generator (labeled 'Trajectory', the position servo loop (labeled 'Position Loop'), drive safety settings (labeled 'Drive Safety') etc.
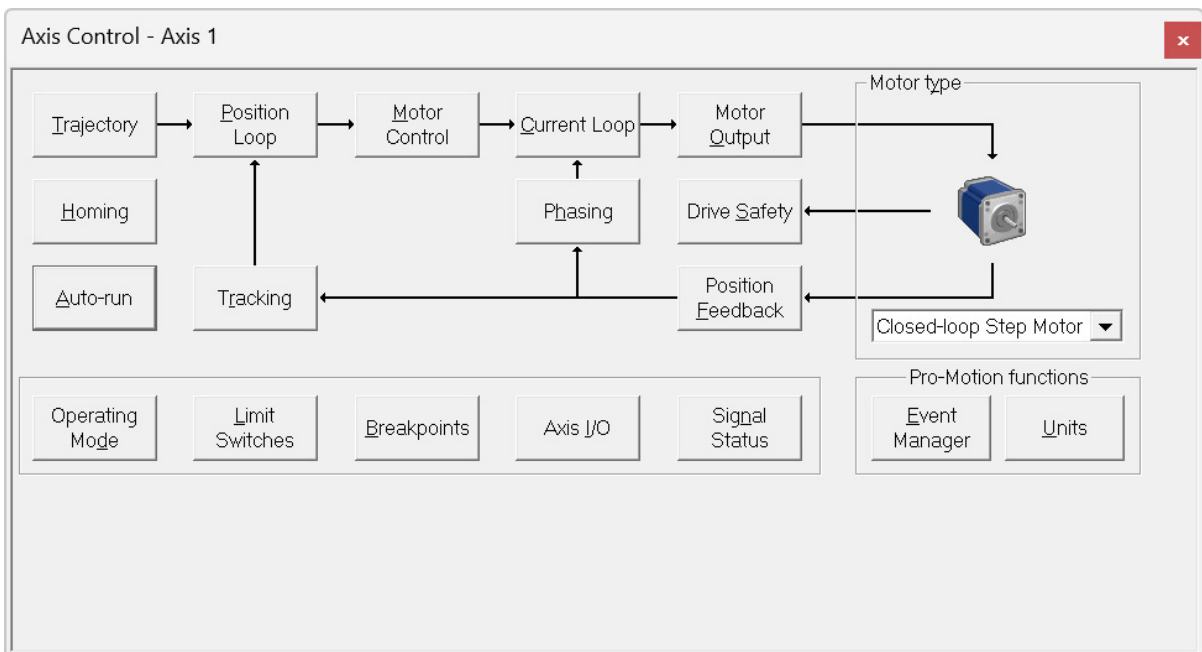
Visually the Axis Window presents these selectable boxes such that the overall control flow for the axis motor type selected is evident. For example an arrow exits the trajectory generator and enters the position loop box, which in turn connects via an arrow to a box called motor control. The boxes and arrows reflect the actual control flow in the Magellan IC. Whether or not specific boxes or connections exist depends on the motor type and control mode selected. For example a step motor driven in microstepping mode does not have a Position Loop box, since microstep drives do not use a position servo loop for control.

Some of the boxes at the bottom of the Axis Control Window are not connected via the control flow arrows because they set or view the status of system-wide functions. These include access to settings for Limit Switches, Breakpoints, Axis I/O, Signal Status, and others.

The box labeled 'Operating Mode' provides control of whether major axis control functions are active. These control functions are trajectory, position loop, current loop, and motor output. Note that motors controlled with a microstepping scheme will not show a position loop option. Generally all of the operating mode functions are active, but there may be circumstances, particularly if a motion error occurs, where some will get disabled by the Magellan IC for safety reasons and you may need to be manually re-enable.

Underpinning the control flow arrows and selectable boxes in the Axis Control Window is the control architecture of PMD's Magellan Motion Control IC. The reference manual that describes this is the *Magellan Motion Control IC User Guide.*

For example if you want to know what Trajectory profile modes are available, and exactly how they function and what parameter settings they require this manual contains this information. The same applies for the other selectable boxes and associated functions within the Axis Control Window. As you become familiar with how the Magellan IC controls the motor axis it will be easier and more intuitive for you to access those motion control functions via Pro-Motion.

1.12.2 Trace & Motion Oscilloscope

Many users of the DK58113 Developer Kit will have a specific performance goal in mind, or will want to characterize the performance of the motor when connected to the hardware in their application.

Both optimizing and measuring performance can be accomplished using Pro-Motion's Scope function. These Oscilloscope functions tie directly to a very powerful feature of the Magellan Motion Control IC called trace, which provides the ability to capture and store in hardware memory up to four motion registers simultaneously, at up to 20 kHz speed.

Once a trace operation is specified the Magellan IC captures the motion values at a programmed time interval and stores these values in its local RAM memory. Once the data has been captured Pro-Motion sends commands to retrieve the data from the Magellan IC and then display this data graphically. In addition to being displayed, traced data can be captured to a file for import to spreadsheets or other graphing and analysis software.

There are over 100 different trace variables selectable, but common traced variables include the motor output command, servo position error, commanded position, commanded velocity, and the actual position.

1.12.2.1 Using Pro-Motion Scope Function

To access the Pro-Motion scope function click the icon at the top bar labeled "Scope". A window will open up which you can resize and move if desired.
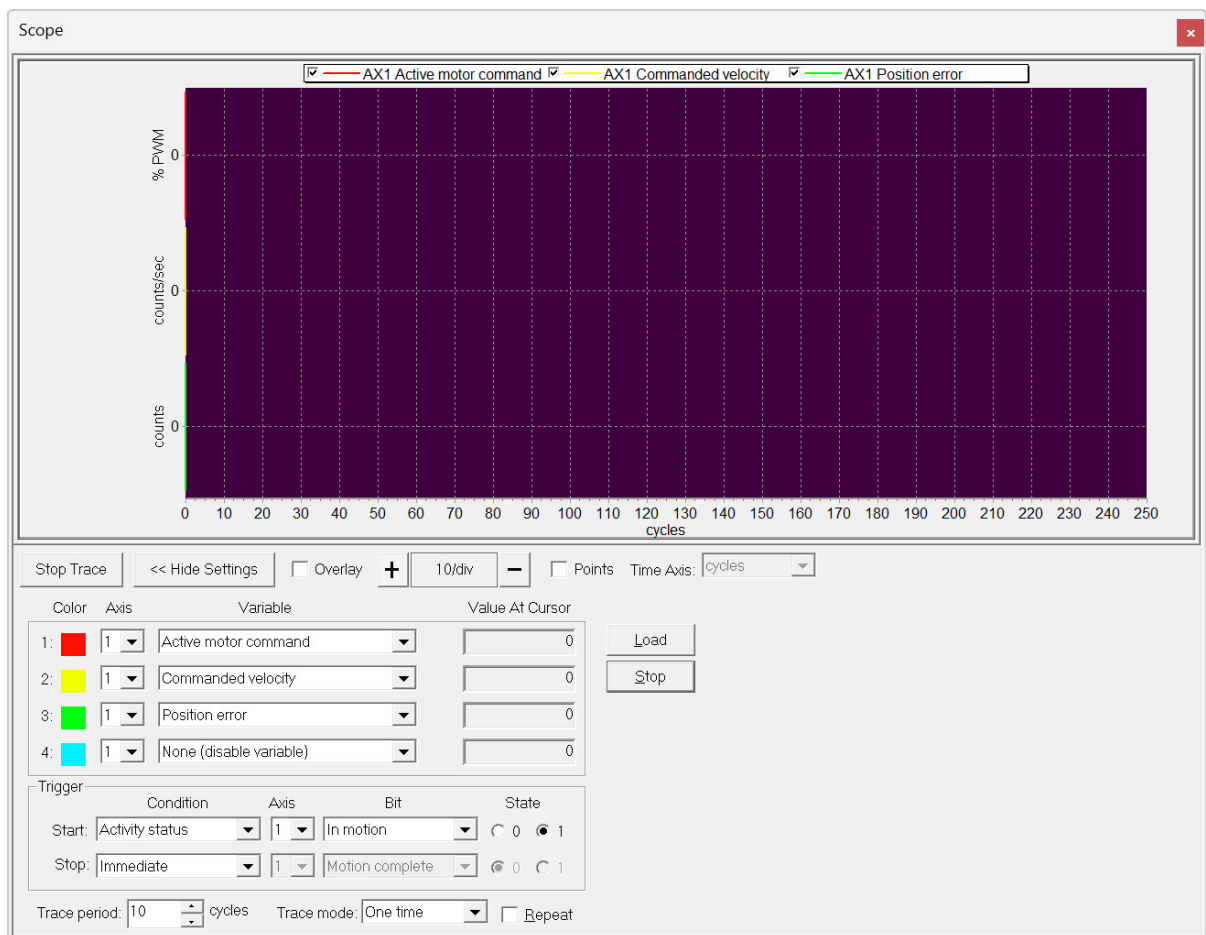
Here are some of the key settable fields of the Scope Window:

Trace Variables – The core of the trace and scope function is the list of motion registers that will be traced and graphed. These are shown as Variables 1 through 4. For each trace variable click the down arrow which in turn displays a list of trace categories such as Commanded Trajectory, Feedback, Position Loop, etc... Selecting one of these categories then shows the specific available traceable motion variables.

Data Graph – The top portion of the scope window graphs captured data. Up to four variables can be graphed at the same time. The horizontal scale is time, with selectable units via the *Time Axis* field of cycles, milliseconds, and seconds.

Trigger Controls – Similar to a regular oscilloscope the conditions by which trace data collection can start or end is settable. Use the down arrow key to see the list of available trigger registers, and the associated bit or signal for each register. Popular bits to start trace on are the In Motion bit of the Activity Status word, specific external signals in the Signal Status Register, and one of the two breakpoint bits of the Event Status register. For each trigger bit selected the specific state, low or high also needs to be set.

Trace Control – Two other fields in the scope window are especially useful. *Trace Period* and *Trace mode*. The trace period is expressed in cycles, which are 51.2 μSec each in length. So specifying a period of 1 cycle captures data at 20 kHz. Trace mode can be set to *One-time* or *Rolling Buffer* Mode. Rolling buffer is useful for monitoring events at slower speeds (higher trace periods). One-time capture fills the trace buffer only once when the trigger conditions are satisfied.

When using Rolling buffer mode caution should be exercised to avoid overflowing the buffer. This can occur if the rate of data being put into the trace buffer by the Magellan IC is faster then the rate at which Pro-Motion can request it. When a buffer overflow occurs a box in the scope window indicates this, and the data being graphed may show a discontinuity. In general selecting One-time capture for the trace mode is recommended unless a particular reason for selecting Rolling buffer exists.

1.12.2.2 Example Performance Optimization Session

Many different optimized control parameter settings can be explored using the trace function's extensive list of traceable variables. In the sequence below we will provide an example that shows how to iteratively find the profile parameters to maximize acceleration speed.

> The specific trajectory values shown in the example below are for illustration purposes only, and may or may not be appropriate for your system. When optimizing control parameters you should always begin with conservative value settings and slowly increase based on observed results.

Our goal is to determine what maximum acceleration a servo motor and attached mechanisms can achieve without exceeding the safe current limit specification for the motor.

1 Start by opening up the Trajectory dialog box, which can be accessed from the Axis Control Window. Specify Trapezoidal profile mode.

2 In the Shuttle mode box at the lower left select Single move.

3 Enter an acceleration value of 500,000 counts/sec^2, a velocity of 50,000 counts/sec and a start velocity of 0. A deceleration of 0 commands the deceleration rate to match the acceleration rate. Enter a destination position of 5,000 counts (assuming the current position is 0).

4   Next open up the scope window and enter the following settings:

Trace variable 1 - Active motor command

Trace variable 2 - Commanded velocity

Trace variable 3 - Position error

Trace Period: 10 cycle

Trace mode: One-time

Start trigger condition Activity Status register, In motion bit, State = 1

Stop trigger condition - Immediate

5   Select the Start Trace button in the upper left of the trace window. The data graph display should not change. If it immediately begins to graph data wait till graph display completes and select Start Trace again. When in the proper state the graph area should go blank and although the Start Trace has been activated trace capture (or graphing) does not begin.

6   From the Trajectory dialog box select Go. You should see the trace data graphing area immediately begin to display captured data and continue till a full buffer has been captured. The reason this is the case is that by pressing Go the Magellan trajectory generator is activated and the Activity Status Register In Motion bit goes from 0 (false) to 1 (true).

To manage the data being displayed you can use the scope's **-** or **+** buttons to expand or reduce the horizontal scale. Alternatively if more data is being displayed than desired, or if you would like to speed up the trace buffer update, see Section 1.12.2.3, "Trace Buffer Display Optimization" for suggestions.

7 The image below shows an example of what the resultant trace may look like after you have optimized the acceleration:
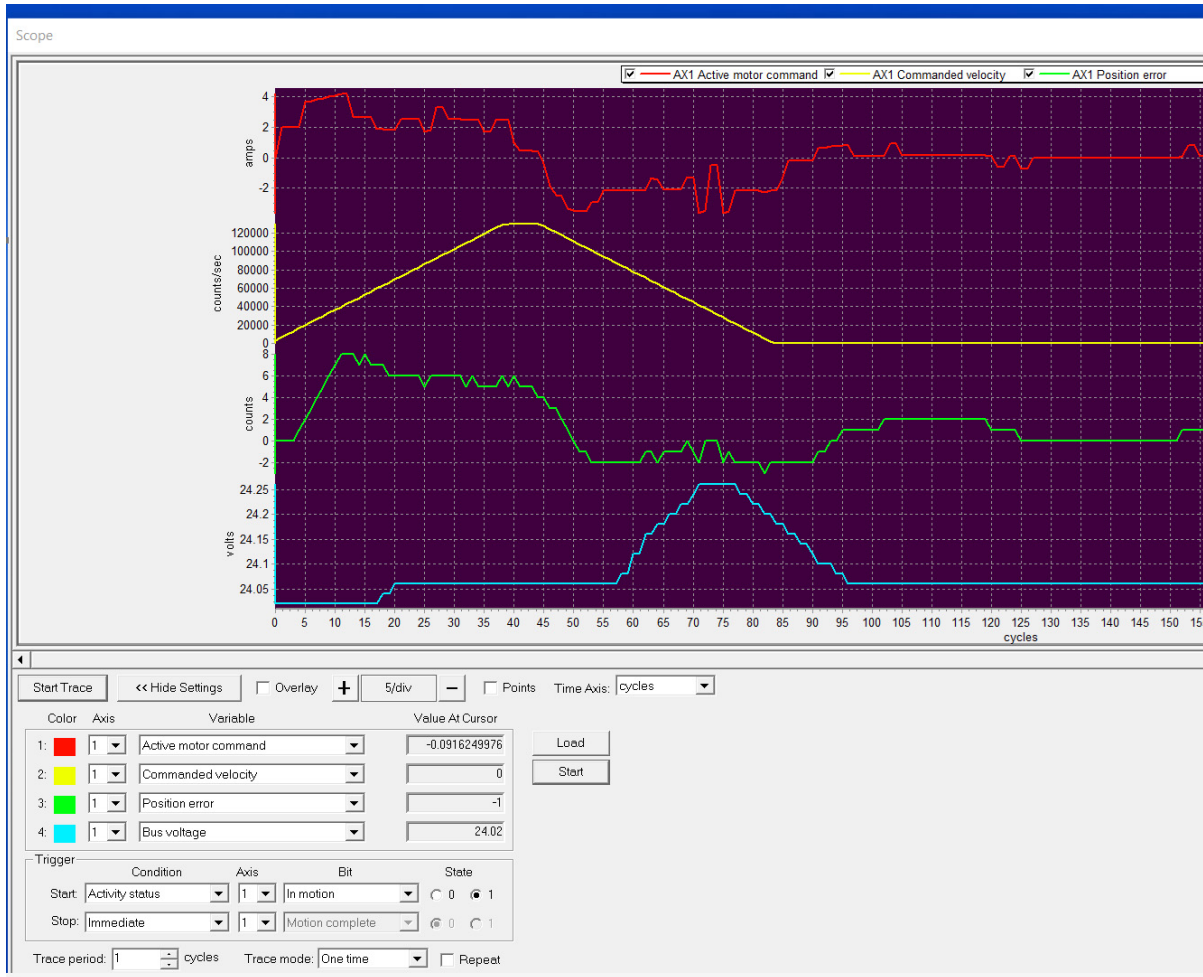
This screen capture shows data from an actual motor with a current drive limit of 4 amps, optimized to accelerate as fast as possible without saturating (exceeding the current drive limit). The resultant point-to-point trapezoidal move traverses 300 counts in approximately 4 milliseconds. Note that despite this very aggressive move the on-the-fly position error never exceeds 8 encoder counts, and the motor settles to within 2 counts error after 85 cycles, which corresponds to 4.25 mSec.

In a typical session a series of profile moves would be made exploring the effect of different accelerations. The limit of the acceleration profile command is determined by the motor's safe current limit, which can be used while initializing the control setting, via the Axis Wizards, or via the Motor Output box in the Axis Control Window. If too high the motor output limit is exceeded (saturates) and the motor command value results in rapid increases in the position error.

Other parameters that are commonly optimized to develop the highest possible performance of the motion hardware include the position loop gain settings, the acceleration feed forward values, the maximum velocity, and the servo settling time.

1.12.2.3 Trace Buffer Display Optimization

The speed of the scope display update is related to the size of the buffer that fills with data in the Magellan IC, and the speed with which the Windows PC can retrieve this data. For higher speed interfaces such as CAN or Ethernet

optimizing these settings is usually not needed. However for serial interface operation, improving the update speed may be useful.

To reduce the size of the buffer memory used for trace select the Device icon from the left side of Pro-Motion's top bar of icons. The following dialog box will display:
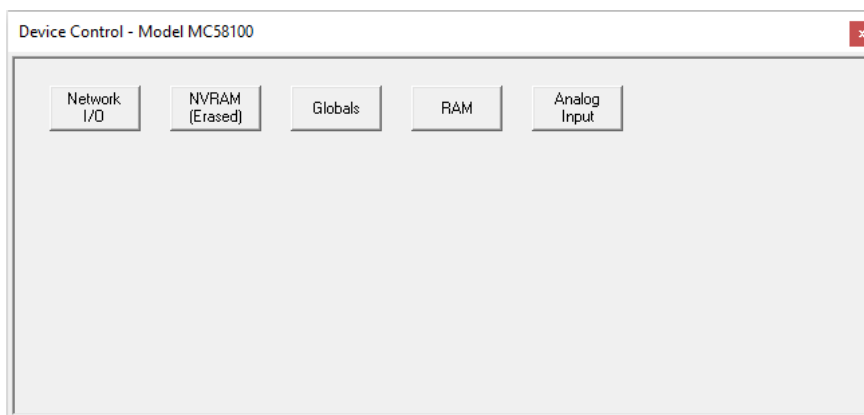
Select the Globals box and then change the Buffer memory parameter from 32,768 to a smaller number, perhaps 5,000 bytes. Note that the total number of traceable points is the specified buffer size divided by 4, since all trace variables are saved as 32-bit numbers.

This same dialog box can be used to select a higher serial baud rate for the serial port. To do this click the Network I/O box and select the Serial tab. You will see a list of available baud rates with the current setting at 57,600 baud. Note that selecting higher baud rates may result in an increased rate of communication errors, particularly if driving the motor with high currents. If you observe this you should lower the baud rate.

The selected baud rate is stored into the MC58113 IC's NVRAM but does not take effect until the DK board is re-powered. So after setting this baud rate and selecting OK you should select the Disconnect icon in the upper left of the top icon bar and power down and then re-power the N-Series ION unit. When you connect again be sure to choose your newly-programmed baud rate in the Pro-Motion Serial Port dialog box.

1.12.3 Summary

Hopefully this brief guided tour of Pro-Motion has been useful to help you to better understand Pro-Motion and the N-Series Drive. For more information on the MC58113 IC, refer to the *Magellan Motion Control IC User Guide*. For information on Magellan command mnemonics and script syntax refer to the *C-Motion Magellan Programming Reference*.

2. Operation

In This Chapter

▶ DK58113 Block Diagram
▶ Communication Ports
▶ Switching Motor Amplifier
▶ Drive Protection and Control Signals
▶ DC Bus
▶ Connecting to a Remote Amplifier
▶ Connecting to an Atlas Amplifier
▶ Motor Feedback Signals
▶ Enable and FaultOut Signals
▶ Multi-board Synchronization
▶ On-IC NVRAM Configuration Storage

2.1   DK58113 Block Diagram

The DK58113 Developer Kit board provides a complete functioning MC58113-series IC exerciser and development system. It directly interfaces to a host computer using serial, CANBus, or SPI communication, and to all power and feedback signals required to drive a DC Brush, Brushless DC, or step motor.

The DK58113 incorporates several major subsystems including the MC58113-series IC itself, communications interface circuitry, a high performance MOSFET-based motor amplifier, a DC Bus conditioning system, and various other circuitry.

The following sections describe these major sections of the DK58113 board. For a complete description of the MC58113 IC, see the *Magellan Motion Control IC User Guide*, *MC58113 Electrical Specifications*, and the *C-Motion Magellan Programming Reference*.

**Figure 2-1:
DK58113 Block
Diagram**
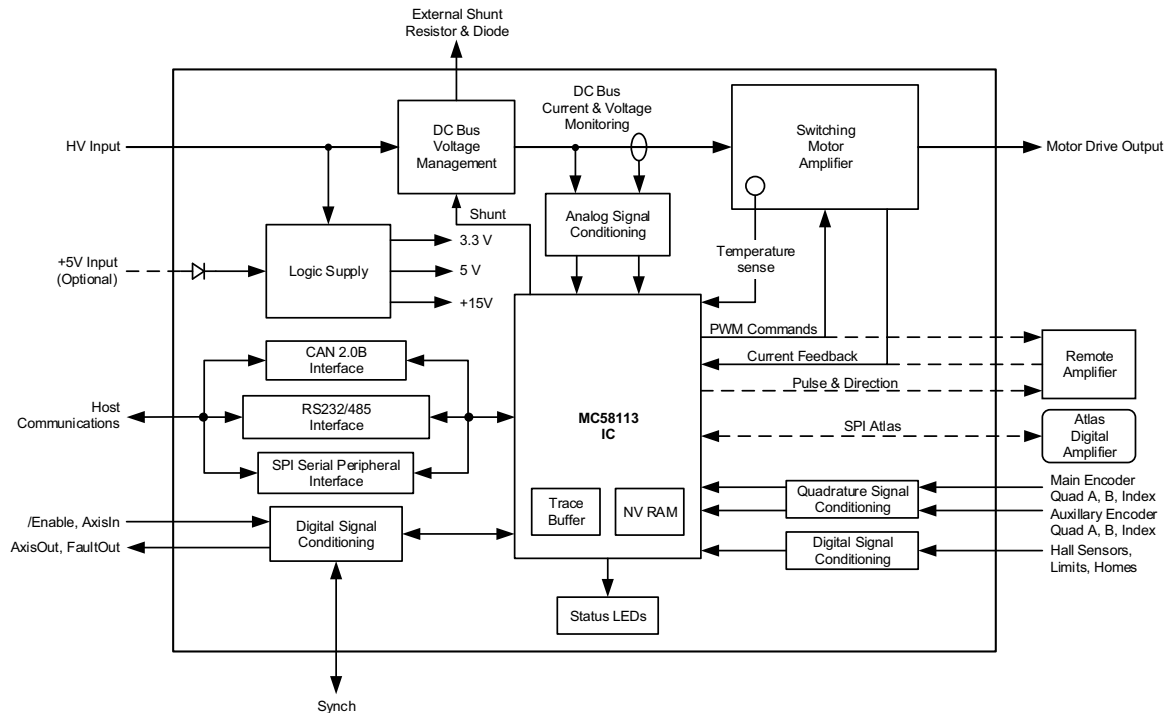
2.2 Communication Ports

2.2.1 RS-232/485

The DK58113 supports both the RS-232 and RS-485 protocols. Jumper JP4 is used to select between RS-232 and RS-485 operation. For RS-232, JP4 is connected at 1-2, and for RS-485 operation, JP4 is connected at 2-3.

The DK58113 supports point-to-point and multi-drop networking in RS-485, and point-to-point only in RS-232.

All DK58113 board communication functions are controlled by the MC58113 IC. For information on how to change serial port settings see the *Magellan Motion Control IC User Guide*.

For RS-485 the DK58113 supports 4-wire full duplex operation

> The DK58113 does not have built-in termination for RS-485. If a network application requires termination at the serial connector, the resistors must be added in the network wiring.

2.2.2 Serial Peripheral Interface

The DK58113 supports an SPI (Serial Peripheral Interface) connection for host communications via its J13 connector.

The user may use this connector to directly communicate with the DK58113 from their own custom hardware design, or alternatively, communicate to the SPI port via a Windows-based PC. Figure 2-2 shows this. While SPI is not recommended as a general inter-card interface, it may be useful in various circumstances such as to debug SPI-specific problems with a user-designed card.
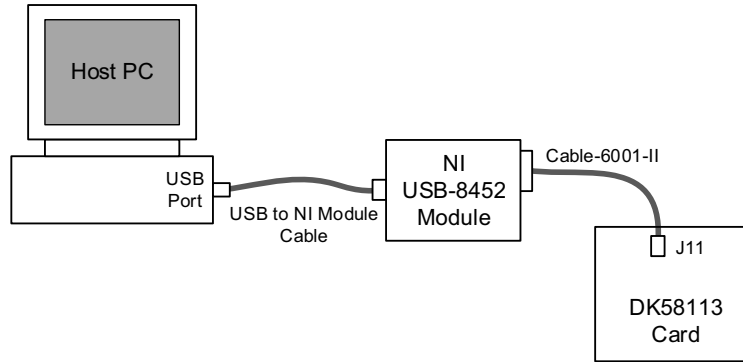
Figure 2-2:
PC to DK58113
SPI Connection
Summary

The major components required for PC to DK58113 SPI communications are listed below:

Item	Part number	Manufacturer	Description
J13 to SPI interface module Cable	Cable-6001-01	PMD	This cable interconnects the National Instruments USB-8452 module to the DK58113's J13 connector
SPI interface module	NI USB-8452	National Instruments	This module generates SPI signals compatible with the MC58113'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

Once these hardware items are installed PMD's Pro-Motion exerciser can be set for SPI communication mode, and thereafter will communicate to the DK58113 via the SPI interface.

> The special hardware items listed above, which are required for SPI communications between Pro-Motion and the DK58113 board, are not included with the standard DK58113. 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.

2.2.3 CANbus

The DK58113 has a dual RJ45 connector (J6, J7) to allow daisy-chaining of MC58113s in a CANbus network. All pins in each port are connected to the corresponding pin in the other port. CAN_SHLD, CAN_V+ and the two Reserved pins are not used by DK58113 but are passed through from one port to the other. When the DK58113 module is the last node of a CANbus network, the network can be terminated by plugging a RJ45 terminator into the unused port.

Standard UTP (unshielded twisted pair) CAT5 Ethernet cabling can be used in most CAN applications. For added noise immunity, shielded cable can be used with the shield routed through the CAN_SLD pins.

2.3   Switching Motor Amplifier

The DK58113 board contains a high-efficiency MOSFET power stage with PWM input control and leg current feedback. A different configuration is used for each motor type:

- Brushless DC motors are driven in a 3-phase bridge configuration consisting of 6 MOSFETs and 3 leg current sensors
- DC Brush motors are driven in an H-Bridge configuration consisting of 4 MOSFETs and 2 leg current sensors
- Step motors are driven with two H-Bridges, one for each phase, for a total of 8 MOSFETs and 4 leg current sensors

To operate the DK58113's on-card amplifier the JP1 and JP2 jumpers must be installed in the 1-2 position.

2.3.1   Brushless DC Motor Drive

Figure 2-3 shows the arrangement of the DK58113's amplifier stage when the MC53113 IC is used or when the MC58113 IC is used with the Brushless DC motor type selected.

Figure 2-3: Brushless DC Motor Bridge Configuration

As shown in the table below six PWM output signals and three analog feedback signals interface between the MC58113 IC and the DK58113's switching amplifier.

MC58113 signal	Description
PWMHigh1A	Digital high side drive output for motor phase A
PWMLow1A	Digital low side drive output for motor phase A

PWMHigh1B	Digital high side drive output for motor phase B
PWMLow1B	Digital low side drive output for motor phase B
PWMHigh1C	Digital high side drive output for motor phase C
PWMLow1C	Digital low side drive output for motor phase C
Current1A	Analog input containing the current flow through the low side of the switching bridge for phase A.
Current1B	Analog input containing the current flow through the low side of the switching bridge for phase B.
Current1C	Analog input containing the current flow through the low side of the switching bridge for phase C.

2.3.2   DC Brush Motor Drive

Figure 2-4 shows the arrangement of the DK58113's amplifier stage when the 51113 IC is used, or when the MC58113 IC is used with the DC Brush motor type selected.
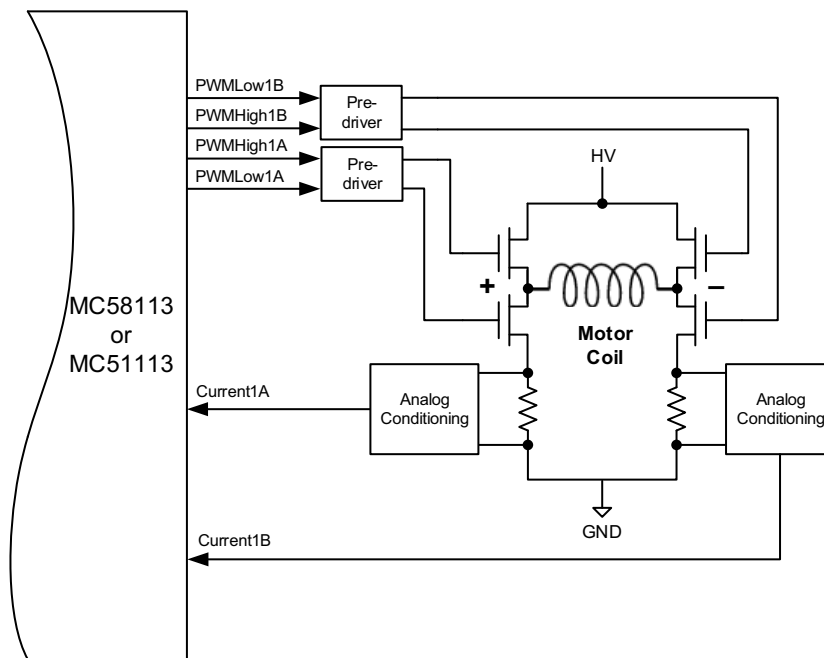

**Figure 2-4:
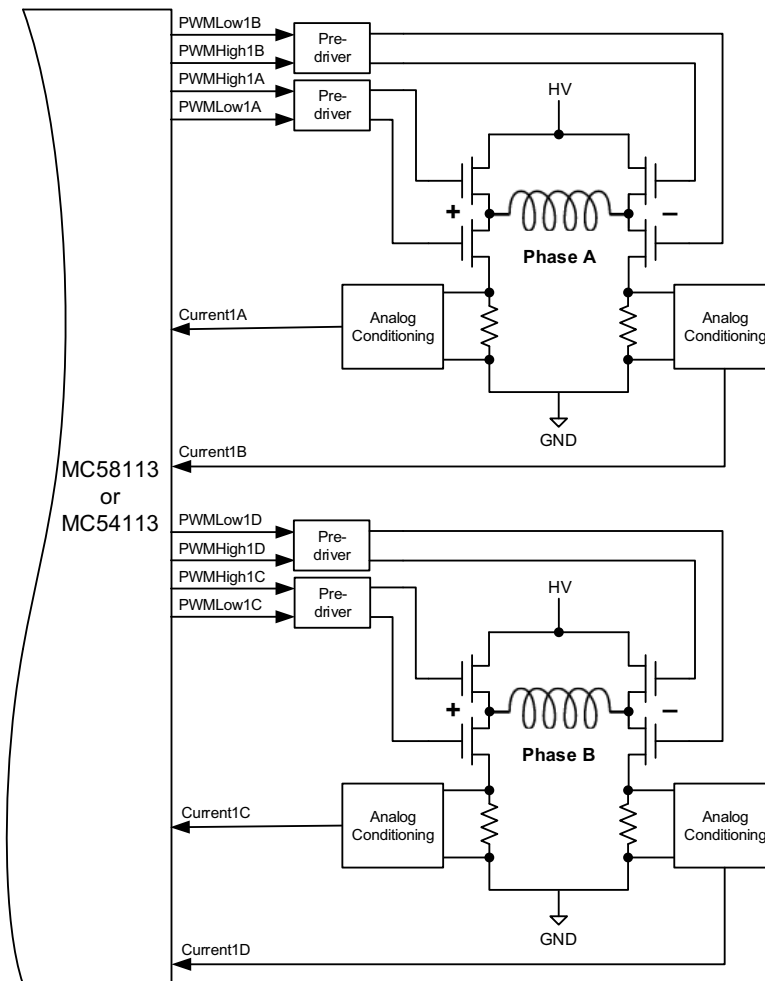DC Brush
Motor Bridge
Configuration**

As shown in the table below four PWM output signals and two analog feedback signals interface between the MC58113 IC and the DK58113's switching amplifier.

MC58113 signal	Description
PWMHigh1A	Digital high side drive output for positive coil terminal
PWMLow1A	Digital low side drive output for positive coil terminal
PWMHigh1B	Digital high side drive output for negative coil terminal
PWMLow1B	Digital low side drive output for negative coil terminal
Current1A	Analog input containing the current flow through the positive leg of the bridge
Current1B	Analog input containing the current flow through the negative leg of the bridge

2.3.3   Step Motor Drive

Figure 2-5 shows the arrangement of the DK58113's amplifier stage when the MC54113 IC is used, or when the MC58113 IC is used with the two-phase step motor type selected.

As shown in the table below eight PWM output signals and four analog feedback signals interface between the MC58113 IC and the DK58113's switching amplifier.

MC58113 signal	Description
PWMHigh1A	Digital high side drive output for motor phase A, positive coil terminal
PWMLow1A	Digital low side drive output for motor phase A, positive coil terminal
PWMHigh1B	Digital high side drive output for motor phase A, negative coil terminal
PWMLow1B	Digital low side drive output for motor phase A, negative coil terminal
PWMHigh1C	Digital high side drive output for motor phase B, positive coil terminal
PWMLow1C	Digital low side drive output for motor phase B, positive coil terminal
PWMHigh1D	Digital high side drive output for motor phase B, negative coil terminal
PWMLow1D	Digital low side drive output for motor phase B, negative coil terminal
Current1A	Analog input containing the current flow through the positive leg of phase A bridge
Current1B	Analog input containing the current flow through the negative leg of phase A bridge
Current1C	Analog input containing the current flow through the positive leg of phase B bridge
Current1D	Analog input containing the current flow through the negative leg of phase B bridge

2.3.4 Amplifier-Related Settings

There are a number of MC58113 IC settings which are used to set or control various aspects of the DK58113's on-card switching amplifier and related current sense circuitry. If a remote amplifier (via the J12 connector) is

connected the value of these settings will likely change, and if an Atlas amplifier is used, other than the motor output mode these parameters do not need to be specified.

The following table shows the 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-card amplifier. For remote amplifier operation PWM High/Low, 50/50 PWM, or sign/magnitude PWM may be selected. SPI Atlas is selected for use with an off-card Atlas Digital Amplifier. Pulse & Direction is selected for use with an off-card step motor amplifier supporting those input signals.
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 or 80 kHz to reduce current ripple and minimize heat generation.
PWM Dead Time	540 nSec	For correct operation of the DK58113's on-card switching amplifier this parameter must be set to this value.
PWM Refresh Time	2,000 nSec	To ensure sufficient time to recharge the on-card 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-card amplifier's high side switches this parameter must be set to this value
PWM Signal Sense	Active High	For correct operation of the on-card amplifier all PWM outputs must be set to active high.
Minimum Current Read Time	2,000 nSec	To ensure sufficient minimum current read time with BLDC motors this parameter must be set to this value.

PWM High/Low motor output mode must be selected to use the DK58113's on-card amplifier. If any other motor output mode is selected the on-card amplifier must be disabled by installing JP1 and JP2 in the 2-3 position. See Section 1.5, "Installation Overview" for more information.

All of the MC58113 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.

2.3.5   DK58113 Current Scale Value

To correctly control or trace motor current it is useful to know the DK58113'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 entered so that the motor current can be traced and displayed correctly in amps.

All of the MC58113 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 MC58113 uses current feedback to implement I^{2}t current limiting. This feature protects the on-card 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 MC58113 will automatically fold back the phase currents to a user programmable continuous current limit value. Alternatively, the MC58113 can be configured to fault and disable the output stage when the I^{2}t energy limit is exceeded. See the *Magellan Motion Control IC User Guide* for details.

2.4.1.1 I^{2}t Limits

To safely operate the on-card DK58113 amplifier it is necessary to specify I^{2}t limits.

Parameter	Value & Units	Comments
Brushless DC motor: Foldback Continuous Current Limit	5.0 A	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Brushless DC motor: Foldback Total Energy Limit	125 A^{2}sec	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
DC Brush motor: Foldback Continuous DC Current Limit	5.0 A	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
DC Brush motor: Foldback Total Energy Limit	125 A^{2}sec	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Step motor: Foldback Continuous Current Limit	5.0 A	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Step motor: Foldback Maximum Energy Limit	125 A^{2}sec	This value should be entered to ensure the on-card 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 DK58113's on-card 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 DK58113 card is capable of driving motors at 7 amps continuously or higher, in which case these limits can be increased. Contact PMD for details.

If a remote amplifier (via the J12 connector) is used the value of these settings will likely change. If an Atlas amplifier is used these parameters do not need to be specified.

> 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 DK58113 heat sinking scheme and motor setup being used.

All of the MC58113 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.

2.4.2   Overtemperature Protection

The DK58113 uses a temperature sensor to continuously monitor the temperature of the on-card power MOSFETs.

2.4.2.1   Converting Temperature Readings into Degrees C

The MC58113 IC inputs temperature readings via its Temperature analog input and performs related functions such as over temperature checking without converting the readings from the attached temperature sensor into degrees C. It does this by comparing temperature in units of 'counts,' meaning the numerical value of the Temperature signal converted by the MC58113's on-chip A/D.

While using Pro-Motion however, it is convenient to be able to view and trace the amplifier temperature in units of degrees C. This is accomplished by providing a conversion table to Pro-Motion.

Note that use of this table is optional and is only required if display of temperature via Pro-Motion is desired with units of degrees C. In any case, for the DK58113, the table "DK58113 Temp Table.txt" should be selected.

2.4.2.2   Temperature Limit

The following temperature limit is required to safely operate the DK58113 board.

Parameter	Value & Units	Comments
Temperature limit	75.0 C	This value should be entered to ensure that the amplifier does not operate above the maximum safe temperature

If an Atlas amplifier is used these temperature limit values do not need to be specified.

> The DK58113's temperature sensor is located on the DK58113 board and therefore will not function correctly when a remote amplifier is used.

All of the MC58113 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 DC Bus
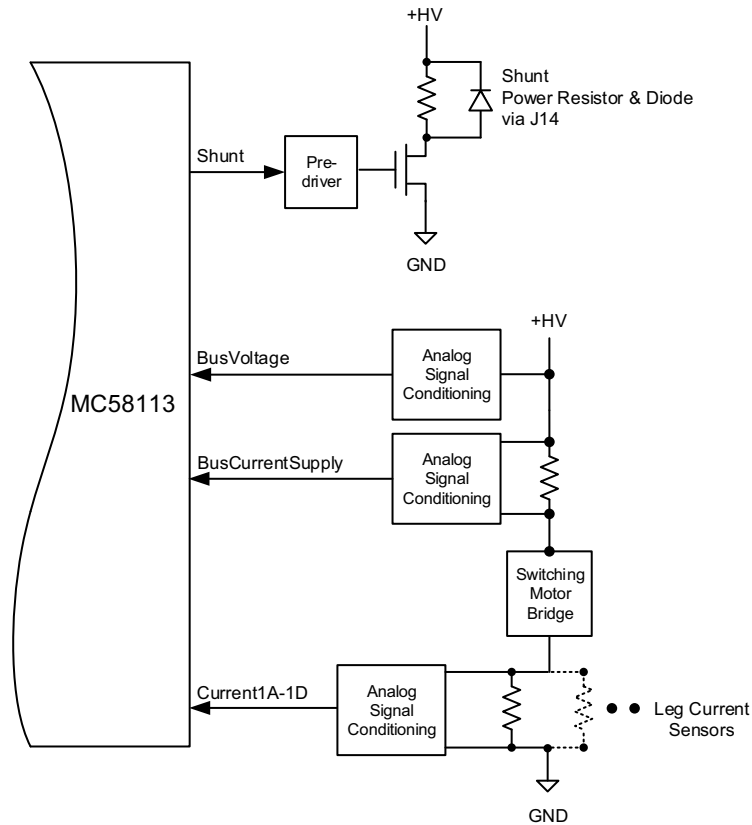
Figure 2-6:
DC Bus
Monitoring
Circuitry

Figure 2-6 shows the DC bus monitoring circuitry used with the DK58113 board. This circuitry is designed to work with the MC58113's DC bus management and protection logic. These functions include overcurrent protection, over and under voltage detection, ground fault detection, and shunt resistor control.

2.5.1 DC Bus Current Monitoring

DK58113 monitors both the positive and negative 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 DK58113 board are required to correctly operate the DC bus current monitoring functions:

Parameter	Value & Units	Comments
Bus current supply conversion	.505 mA/count	This value should be entered so that the DC bus current supply can be traced and displayed correctly in amps.
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 MC58113 DC bus current limits are required to safely operate the DK58113 board:

Parameter	Value & Units	Comments
Bus Current Supply Limit	20.0 A	This value should be entered to ensure safe operation of the DK58113.
Bus Current Return Limit	20.0 A	This value should be entered to ensure safe operation of the DK58113.

Note that these values are designed to protect the DK58113 circuitry. Lower values may be used to protect the motor. If an Atlas amplifier is used these DC bus current scale and limit values do not need to be set.

> DC bus current monitoring functions will not work when a remote amplifier is used.

All of the MC58113 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

DK58113 monitors the main DC bus voltage for overvoltage and undervoltage conditions. These thresholds are user-settable within the voltage operating range of the drive. DC bus voltage monitoring may operate even when a remote amplifier is used, as long as the +HV supply is still connected to the DK58113.

2.5.2.1 DC Bus Voltage Monitoring Scale Values

To correctly monitor the DK58113 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	.966 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 MC58113 DC bus voltage limits are required to safely operate the DK58113 board:

Parameter	Value & Units	Comments
Undervoltage Limit	10.0 V	This value should be entered to ensure safe operation of the DK58113.
Overvoltage Limit	60.0 V	This value should be entered to ensure safe operation of the DK58113.

Note that these values are designed to protect the DK58113 circuitry. More restrictive values may be used to protect the motor.

All of the MC58113 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.

2.5.3 Shunt Resistor & Diode

J14 provides a connection for a shunt resistor and diode that may be used to regulate overvoltage conditions on the DC bus. Such conditions can occur during deceleration of a motor with a large inertia.

As shown in Figure 2-6 the MC58113 provides a shunt PWM output, which in turn drives a MOSFET switch on the DK58113 board.

The resistor connected at J14 should have a resistance such that the current flow through the Shunt MOSFET does not exceed 10 amps. For example with an HV supply of 48 Volts, this means a resistance of no less than 4.8 ohms. The diode, which is connected in parallel to the resistor, should have a voltage and current rating at least equal to those of the MOSFET. For the DK58113 this means a voltage and current rating of 100 volts and 10 amps or higher.

Beyond this limit, the actual resistance used is application specific and depends on the nature of the anticipated over voltage generating conditions, the power supply used, and the wattage rating of the resistor.

Example: a shunt resistor with a resistance of 10 ohms is connected through the J4 shunt connector and a comparison value of 51 Volts and a PWM duty cycle of 75% are specified. When the +HV voltage exceeds 51.0 Volts, HV will be connected to GND via the shunt resistor resulting in an effective average current flow of (51.0V * .75)/10 ohms = 3.825 amps.

The default value of the shunt comparison mechanism is disabled. To enable, both a voltage comparison value and a PWM output duty cycle are specified.

> It is the responsibility of the user to connect and to specify a shunt-related resistor and diode that are safe for the application being controlled.

2.6 Connecting to a Remote Amplifier

Figure 2-7: DK58113 to Remote Amplifier Card Connections
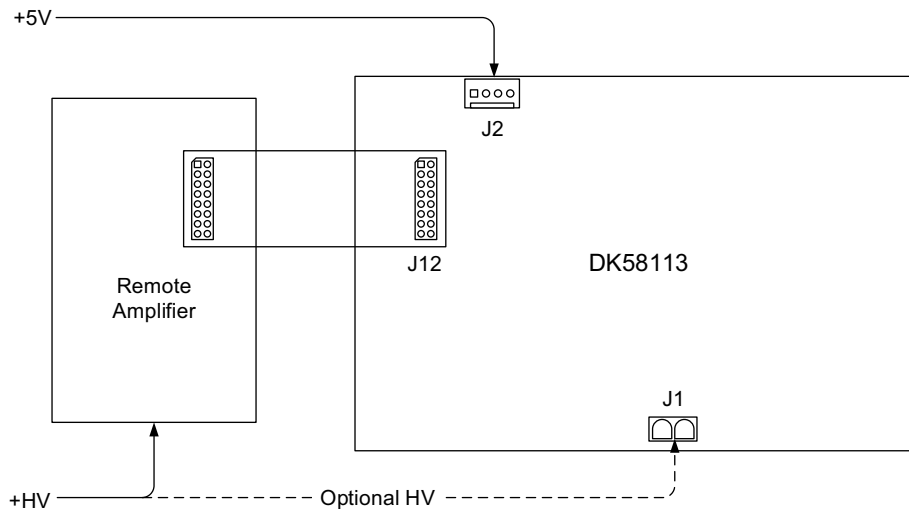
In addition to the DK58113's on-card switching amplifier, J12 provides connections for an external remote switching amplifier. This connector is typically used to interface with user-designed amplifiers that service higher power motors, or motor or actuators that require a special bridge configuration. Such an external amplifier connection is shown in Figure 2-7.

Note that connection of the remote amplifiers HV supply to the DK58113 card is optional. Doing so allows use of the DK58113's over and undervoltage check feature.

> The DK58113's on-card amplifier must be disabled via JP1 and JP2 for remote amplifier operation. See Section 1.5, "Installation Overview" for details.
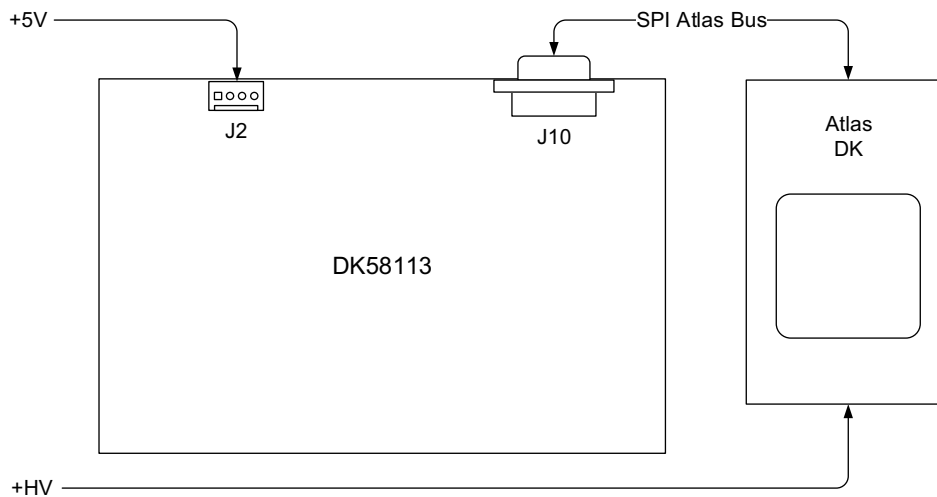
2.7 Connecting to an Atlas Amplifier

Connector J10 provides a DB-9 connection that is compatible with PMD's Atlas Digital Amplifier single-axis DK card. Any Atlas motor type (DC Brush, Brushless DC, or step motor) can be driven, and Atlas's full SPI communications capabilities are supported.

> The DK58113's on-card amplifier must be disabled via JP1 and JP2 for Atlas Amplifier operation. See Section 1.5, "Installation Overview" for details.

2.8 Motor Feedback Signals

The Axis Feedback connector contains the main encoder signals as well as Hall commutation signals. These signals are buffered and filtered in the Quadrature Signal Conditioning and Digital Signal Conditioning blocks, respectively, as shown in the block diagram. DK58113 supports incremental quadrature encoders with count rates up to 25 Mcounts per second.

2.8.1 Encoder Inputs

The differential input circuitry for the encoder A, B and Index signals is shown in Figure 2-9. This circuit accepts both differential and single-ended signals in the range of 0 – 5 V. For single-ended operation, the unused input should be left floating.
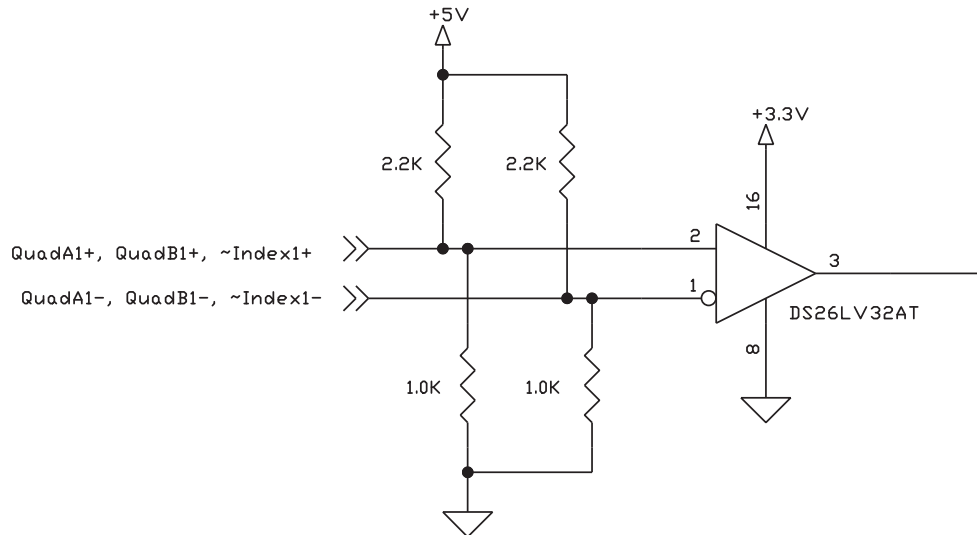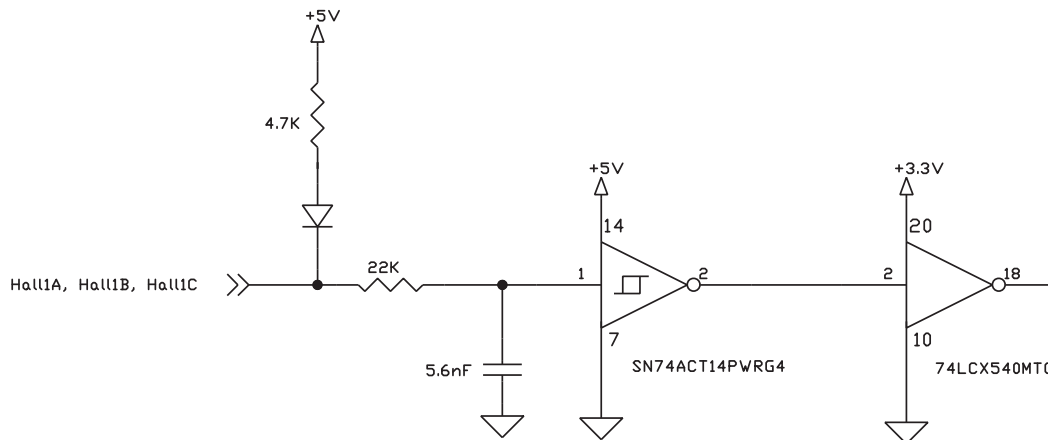
2.8.2   Hall Inputs

The input buffer for the Hall A, B and C signals is shown in Figure 2-10. 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 sources without the need for an external pull-up resistor and an R-C low pass filter to reject noise.

The Hall signals are only used with Brushless DC motors. They are used to directly commutate the motor in 6-step commutation mode or to provide an absolute phase reference for sinusoidal commutation.

2.8.3   Limit and Home Inputs

The input buffer for the end-of-travel Limit and Home signals is shown in Figure 2-11. 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 sources without the need for an external pull-up resistor and a 1.3 kHz R-C low pass filter to reject noise.

**Figure 2-11:
Limit and Home
Input Circuits**

2.8.4   AxisIn and AxisOut Signals

The input buffer for the AxisIn signal is shown in Figure 2-12. 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 sources without the need for an external pull-up resistor and a 13 kHz R-C low pass filter to reject noise.
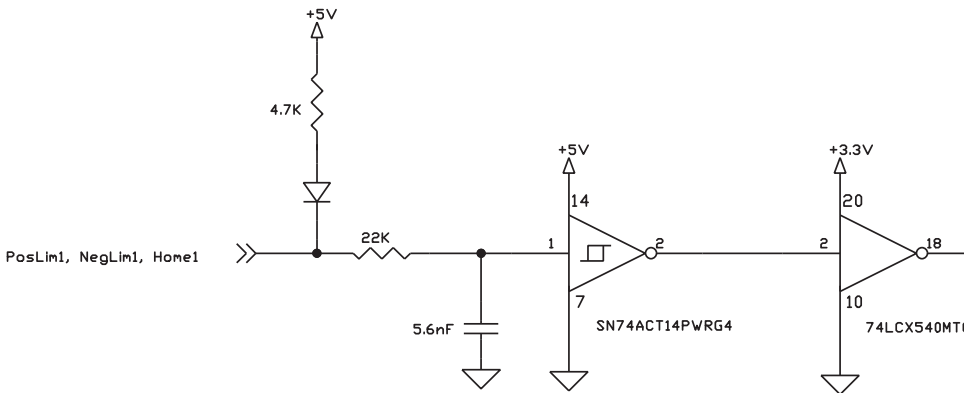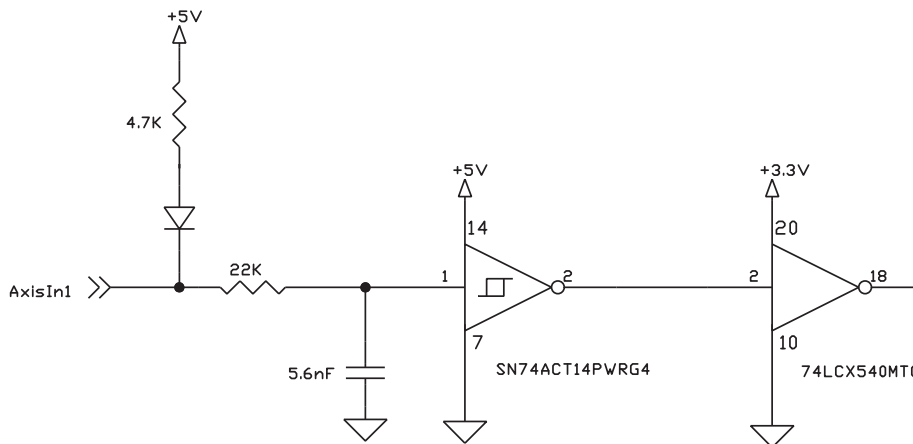
**Figure 2-12:
AxisIn Circuit**

The output driver for the AxisOut signal is shown in Figure 2-13. 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 2-13:
AxisOut Circuit
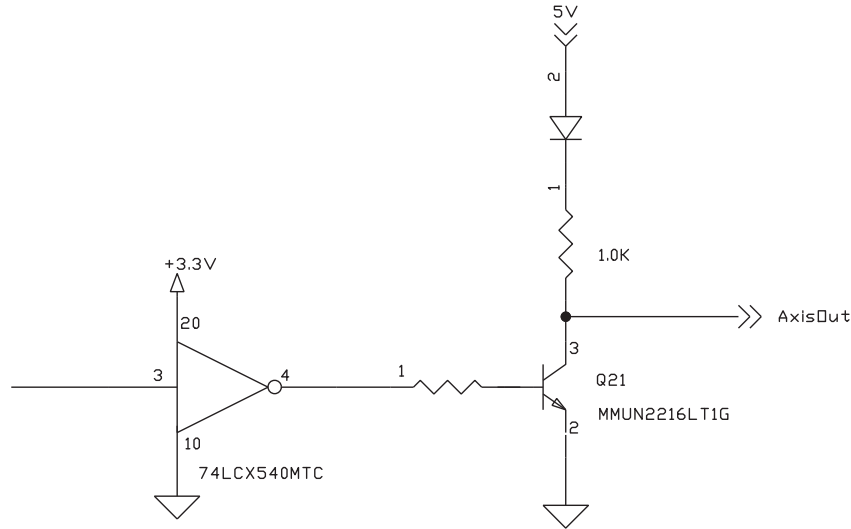
AxisIn and AxisOut are versatile I/O signals. They are not dedicated to any particular motion control function but can be programmed to implement a wide array of system integration functions. See the *Magellan Motion Control IC User Guide* for more information on configuring and programming these signals.

2.9 Enable and FaultOut Signals

These dedicated signals are typically used to implement a safety interlock between the DK58113 board and other control portions of the system. /Enable is an active-low input that must be tied or driven low for the DK58113 output stage to be active.

FaultOut indicates a serious problem. When DK58113 is operating properly FaultOut is inactive. The polarity of these signals is fixed and cannot be changed via software.

The input buffer for the /Enable input is shown in Figure 2-14. 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 2-14:
Enable Input Circuit
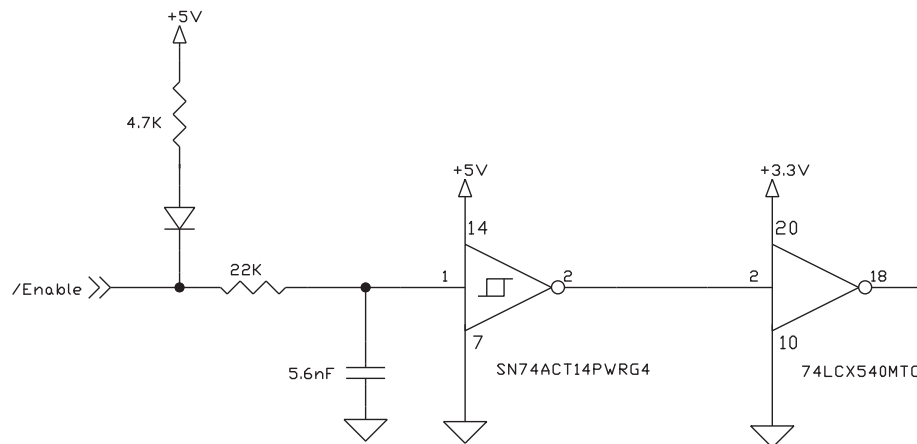
The output driver for FaultOut is shown in Figure 2-15. This circuit can continuously sink over 100 mA and source 4mA from a pull-up resistor to 5V. The diode in series with the pull-up resistor allows loads powered from up to 24 VDC to be switched. The FET driver is internally protected from shorts up to 30 V.
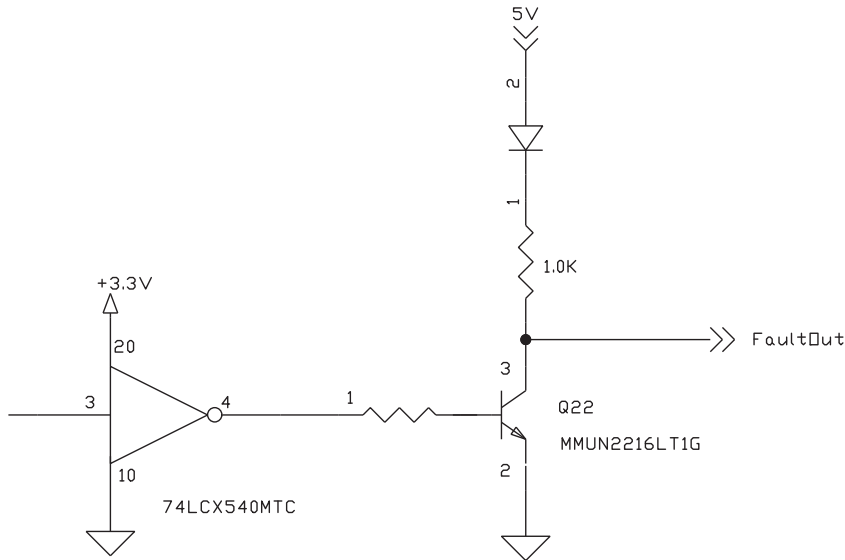
2.10   Multi-board Synchronization

The Synch connector located on the DK58113 board (J13) allows for the synchronization of multiple DK58113 boards within a single system.

To connect two or more DK58113 boards for synchronization a cable is required. This cable is connected to the Synch connector on the board. The Synch connector is wired in a "T" configuration as shown in Figure 2-16. For more information on synchronizing multiple DK58113 cards see the *Magellan Motion Control IC User Guide*.

The following diagram shows three synchronized cards.
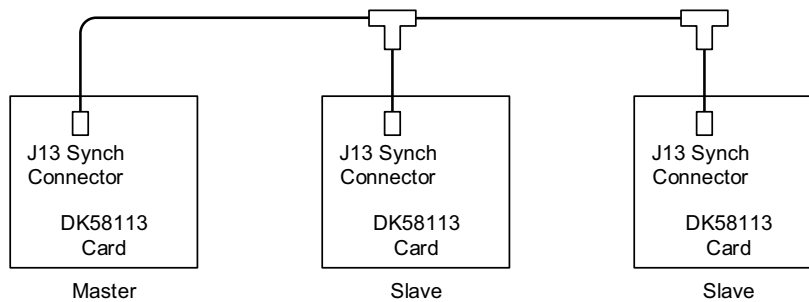
2.11   On-IC NVRAM Configuration Storage

The MC58113-series 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 MC58113's active configuration registers at each power-up. When used in an actual control system the NVRAM may therefore be useful to reduce or eliminate communications to the MC58113 IC during powerup. See the *Magellan Motion Control IC User Guide* for more information on MC58113-series ICs powerup.

While developing a new MC58113-based application it is not recommended that the on-IC NVRAM be used to store configuration data. Pro-Motion can store a wide variety of configuration parameters using its Save Project and Load Project menu functions, and this generally represents a more flexible and general purpose approach.

Nevertheless, when ready, MC58113 configuration parameter programming or re-programming can be conveniently accomplished using Pro-Motion.

3. Electrical Reference

In This Chapter

▶ User-Settable Components

▶ Connectors

▶ Motor Connection Quick Reference

▶ Absolute Maximum Ratings

▶ Environmental and Electrical Ratings

▶ DK58113 On-Board Amplifier Quick Reference

3.1 User-Settable Components

The following table details the available DK58113 jumper settings, which are the DK58113's only user-settable hardware components:

Jumper ID	Factory Default Setting	Setting & Description	
JP1, JP2	1-2 (on-card amplifier)	1-2	Installing jumpers at 1-2 for JP1 and JP2 configures the DK58113 for operation of the on-card amplifier.
		2-3	Installing jumpers at 2-3 for JP1 and JP2 disables the on-card amplifier, and configures the DK58113 for operation with a user-designed amplifier via the J12 Remote Amplifier Connector, or with an Atlas DK amplifier via the J10 connector.
JP4	1-2 (RS-232)	1-2	Installing a jumper at 1-2 for JP4 configures the DK58113 for RS-232 serial operation.
		2-3	Installing a jumper at 2-3 for JP4 configures the DK58113 for RS-485 serial operation.

3.2   Connectors

**Figure 3-1:
DK58113
Board
Component
Location**
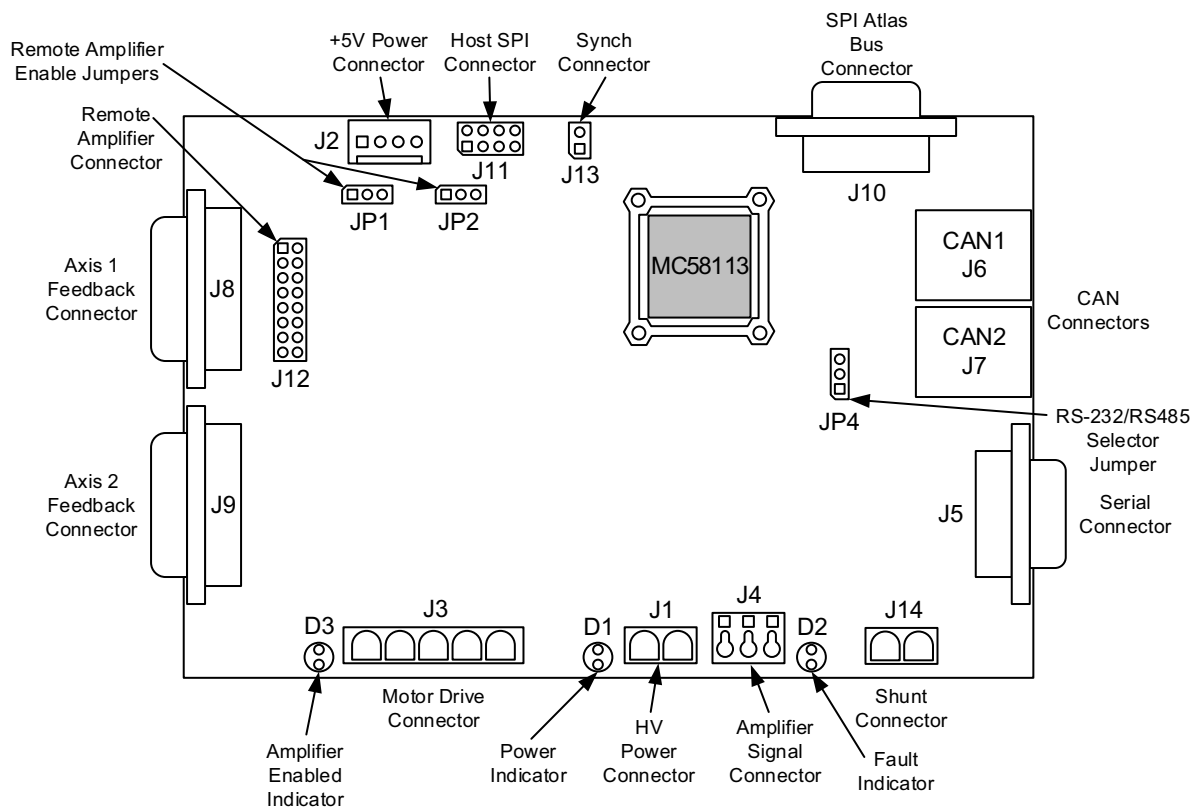
There are 14 user-accessible connectors on the DK58113 board. See Figure 3-1 for the specific locations of the connectors on the board. The connectors and their functions are outlined in the following table:

Connector Name	Connector #	Description
HV Power	J1	HV power to the board. Accepts DC supply in the range of +12 to 56 VDC
Motor Drive	J3	Motor drive signals that connect directly to the motor's coil connections
Axis 1 Feedback	J8	Primary axis feedback signals such as Quad A/B, Index, Hall A/B/C, PosLim and NegLim
Axis 2 Feedback	J9	Auxiliary axis feedback signals such as Quad A/B and Index, as well as AxisIn and AxisOut signals for the primary axis
Amplifier Signal	J4	Provides Enable input and FaultOut output signals to/from the MC58113 IC
SPI Atlas Bus	J10	Interconnect signals for SPI Atlas bus-compatible amplifiers
Remote Amplifier	J12	Provides signals to allow connection to a user-designed external amplifier
Shunt	J14	Switched HV supply voltage that connects to an external shunt resistor or other load for controlling HV overvoltage
CAN1, CAN2	J6, J7	Provides connections to a CAN2.0B host network
Serial	J5	Serial port for RS-232 or RS-485 host connections
Host SPI	J11	Provides host SPI (Serial Peripheral Interface) bus signals

Connector Name	Connector #	Description
Synch	J13	Provides signals that allow synchronization of the MC58113 with external controllers
+5V Power	J2	Provides logic power to the board when HV Power is not available or is not being used

3.2.1   HV Power Connector (J1)

The DK58113 board uses a dedicated 2-pin HV power connector (J1) that accepts input voltage in the range of +12 to 56 VDC. This connector is a Phoenix Contact 2-circuit pluggable terminal block connector.

Note that there is also a +5V power connector (J2) on the board. Users can power the DK58113 board with +5V supply when HV is not available. However, this will not power the on-board switching amplifier. When HV is present, the +5V supply via J2 should not be used.

Pin	Connection	Description
		J1 - HV Power Connector
1	HV	Provides DC power to the board and on-card switching amplifier
2	GND	Ground

3.2.2   Motor Drive Connector (J3)

The Motor Drive connector (J3) provide motor output signals for use with Brushless DC, DC Brush, or step motors. This is a Phoenix Contact 5-circuit pluggable terminal block connector.

Pin	Connection	Description
		J3 - Motor Drive Connector
1	Motor A	Motor output signal A
2	Motor B	Motor output signal B
3	Motor C	Motor output signal C
4	Motor D	Motor output signal D
5	GND	Ground

3.2.3   Axis Feedback Connectors (J8, J9)

The Axis1 Feedback Connector (J8) and Axis2 Feedback Connector (J9) provide connections to various motor feedback signals. The Feedback Connectors use 15-pin high density DB connectors, which can be connected to the PMD MC-HW-05 breakout board accessories.

Axis 1 Feedback Connector

Pin	Connection	Description
		J8 - Axis1 Feedback Connector
1	QuadA1+	Axis 1 Quadrature A+ encoder input*
2	QuadA1-	Axis 1 Quadrature A- encoder input*
3	QuadB1+	Axis 1 Quadrature B+ encoder input*
4	QuadB1-	Axis 1 Quadrature B- encoder input*
5	GND	Ground
6	Index1+	Axis 1 Index+ input
7	Index1-	Axis 1 Index- input
8	Hall1A	Axis 1 Hall A input
9	Hall1B	Axis 1 Hall B input
10	Hall1C	Axis 1 Hall C input
11	Home1	Axis 1 Home input
12	PosLim1	Axis 1 Positive direction limit switch input
13	NegLim1	Axis 1 Negative direction limit switch input
14	Vcc	+5V output
15	NC	No Connect

*These signals may alternatively input pulse and direction signals to provide the axis position. To select pulse & direction signal interpretation the **SetEncoderSource** command is used. In this mode **Pulse** signals are connected to the **QuadA** signal inputs and **Direction** signals to the **QuadB** inputs.*

Axis 2 Feedback Connector

Axis 2 is used to provide auxiliary encoder input for the MC58113's electronic gear mode, or with dual loop servo control mode. In addition, this connector contains the AxisIn and AxisOut signals for Axis 1 as well as a Home signal for axis 2.

Pin	Connection	Description
		J9 - Axis2 Feedback Connector
1	QuadA2+	Axis 2 Quadrature A+ encoder input*
2	QuadA2-	Axis 2 Quadrature A- encoder input*
3	QuadB2+	Axis 2 Quadrature B+ encoder input*
4	QuadB2-	Axis 2 Quadrature B- encoder input*
5	GND	Ground
6	Index2+	Axis 2 Index+ input
7	Index2-	Axis 2 Index- input
8	NC	no connect
9	NC	no connect
10	NC	no connect
11	Home2	Axis 2 Home input
12	AxisIn	Axis 1 AxisIn signal input
13	AxisOut	Axis 1 AxisOut signal output
14	Vcc	+5V output
15	GND	Ground

*These signals may alternatively input pulse and direction signals to provide the axis position. To select pulse & direction signal interpretation the **SetEncoderSource** command is used. In this mode **Pulse** signals are connected to the **QuadA** signal inputs and **Direction** signals to the **QuadB** inputs.*

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	J8 - Axis 1 Feedback Connector	J9 - Axis 2 Feedback Connector
QuadAn+	J8-1	J9-1
QuadAn-	J8-2	J9-2
QuadBn+	J8-3	J9-3
QuadBn-	J8-4	J9-4
Indexn+	J8-6	J9-6
Indexn-	J8-7	J9-7
Vcc	J8-14	J9-14
GND	J8-5	J9-5

Encoder connections when using single-ended encoder input:

Signal	J8 - Axis 1 Feedback Connector	J9 - Axis 2 Feedback Connector
QuadAn	J8-1	J9-1
QuadBn	J8-3	J9-3
Indexn	J8-6	J9-6
Vcc	J8-14	J9-14
GND	J8-5	J9-5

3.2.4   Amplifier Signal Connector (J4)

The Amplifier Signal Connector provides an Enable input to the MC58113 IC as well as the FaultOut from the MC58113. This connector provides convenient jack screw access to these signals, making it easy to (for example) connect the GND signal to the Enable signal with a short wire.

Pin	Signal	Description
		J4 - Amplifier Signal Connector
1	Enable	Active low Enable digital input signal
2	FaultOut	Active high digital FaultOut output signal
3	GND	Ground

3.2.5   SPI Atlas Bus Connector (J10)

This connector is compatible with PMD's Atlas DK boards. See the *Atlas Digital Amplifier User Manual* for more information. This connector is a male DB-9 connector.

Pin	Signal	Description
		J4 - SPI Atlas Bus Connector
1	NC	no connect
2	NC	no connect
3	Shield	Cable Shield Connection
4	GND	Ground
5	AmpSPIRcv	AmplifierSPIRcv signal to MC58113
6	AmpSPIEnable1	~AmplifierSPIEnable signal from MC58113
7	NC	no connect
8	AmpSPIClock	AmplifierSPIClock signal from MC58113
9	AmpSPIXmt	AmplifierSPIXmt signal from MC58113

3.2.6   Remote Amplifier Connector (J12)

This connector provides signals that allow an external switching amplifier to be connected to the DK58113. This connector is not used if the on-card amplifier is used, or if an Atlas amplifier is used.

If a remote amplifier is used jumpers JP1 and JP2 must be set to the 2-3 position. In addition, it is not necessary to provide HV power to the board, only +5V via J2 is required.

Pin	Signal	Description
		J12 - Remote Amplifier Connector
1	AmplifierEnable1	AmplifierEnable1 output signal from MC58113
2	PWMOutputDisable	PWMOutputDisable input signal to MC58113
3	PWMHigh1A	PWMHigh1A output signal from MC58113
4	PWMLow1A	PWMLow1A output signal from MC58113
5	PWMHigh1B	PWMHigh1B/Pulse1 output signal from MC58113
6	PWMLow1B	PWMLow1B/Direction1 output signal from MC58113
7	PWMHigh1C	PWMHigh1C/AtRest output signal from MC58113
8	PWMLow1C	PWMLow1C output signal from MC58113
9	PWMHigh1D	PWMHigh1D output signal from MC58113
10	PWMLow1D	PWMLow1D output signal from MC58113
11	GND	Ground
12	AGND	Analog Ground
13	Current1A	Current1A analog input signal to MC58113
14	Current1B	Current1B analog input signal to MC58113
15	Current1C	Current1C analog input signal to MC58113
16	Current1D	Current1D analog input signal to MC58113

3.2.7   Shunt Connector (J14)

The DK58113 board uses a dedicated high current 2-pin connector for connection to a shunt resistor or similarly functioning component in applications where it may be desirable to remove excess voltage from the DC bus.

This connector is a Phoenix Contact 2-circuit pluggable terminal block.

Pin	Signal	Description
		J14 - Shunt Connector
1	HV	+HV
2	Shunt	Switched connection to ground

3.2.8   CAN Connectors (J6, J7)

The DK58113's controller are a network (CAN) transceivers are designed for use in applications employing the CAN serial communication physical layer in accordance with the ISO11898 standard. The transceiver provides differential transmit and differential receive capability to/from a CAN controller at speeds up to 1 Mbps.

There are two connectors, J6, and J7, providing electrically identical signals. These two connectors are designed to make it easy to connect the DK58113 board in a daisy-chain configuration. Termination at each end of the cable run is generally recommended unless cable lengths are very short and speed is slow. ISO-11898 requires 120 Ohm termination at each end of the bus. Note that it is up to the customer to verify their network topology and operating parameters.

The CANbus connector is a female RJ45 type connector.

See Section 2.2.3, "CANbus" for more information on the functionality of the CANbus port.

The pinouts for both the J6 and J7 CAN connector are as follows:

Pin	Signal	Description
		J6, J7 - CANbus Connectors
1	CAN+	Positive CAN signal connection
2	CAN-	Negative CAN signal connection
3	GND	Ground
4	No Connect	Pass-through signal
5	No Connect	Pass-through signal
6	No Connect	Pass-through signal
7	GND	Ground
8	No Connect	Pass-through signal

3.2.9   Serial Connector (J5)

The Serial Connector (J5) provides connections to an RS-232 or RS-485 serial port. Electrically these connectors provide access to the same signals, however they have different physical connectors and wiring. The following sections provide information for the serial connector, and provide pinouts when operated in RS-232 mode or RS-485 full-duplex mode.

Pin	Connection	RS-232	RS-485 Full Duplex
			J5 - Serial Connector
1	NC	No Connect	No Connect
2	SrlXmt	Serial transmit output	No Connect
3	SrlRcv	Serial receive input	No Connect

Pin	Connection	RS-232	RS-485 Full Duplex
4	NC	No Connect	No Connect
5	GND	Ground	Ground
6	RS-485Rcv+	No Connect	Positive (non-inverting) receive input
7	RS-485Rcv-	No Connect	Negative (inverting) receive input
8	RS-485Xmt+	No Connect	Positive (non-inverting) transmit output
9	RS-485Xmt-	No Connect	Negative (inverting) transmit output

3.2.10 Host SPI Connector (J11)

This connector provides host SPI (Serial Peripheral Interface) signals when the MC58113's SPI host communication is used. This connector is an unshrouded 8-position double-row male header, .1" spacing.

Pin	Signal	Description
		J11 - Host SPI Connector
1	HostSPIXmt	Host SPI bus synchronous transmit signal from MC58113
2	HostSPIRcv	Host SPI bus synchronous receive signal to MC58113
3	HostSPIClock	Host SPI bus synchronous clock input
4	HostSPIEnable	Host SPI bus active low enable signal input
5	HostInterrupt	Host interrupt output from MC58113 can be programmed to indicate an event requiring attention from the host
6	HostSPIStatus	This signal indicates when an SPI response is available.
7	GND	Ground
8	Reset	Active low reset signal for MC58113 IC.

3.2.11 Synch Connector (J13)

This connector provides a synch signal connection which can be used to synchronize the MC58113 with external controllers including other MC58113s.

This connector is an unshrouded 2-position double-row male header, .1" spacing.

Pin	Signal	Description
		J13 - Synch Connector
1	Synch	This pin inputs or outputs a synchronization signal that can be used to synchronize the loop rates of multiple MC58113s with each other or with another external source.
2	GND	Ground

3.2.12 +5V Connector (J2)

This connector provides the DK58113 board with power to operate the on-card logic whenever HV power (J1) is not provided. Note that +5V should not be provided to the board when +HV power is provided. Connecting both power sources (+HV as well as +5V) at the same time may result in incorrect operation or damage to the DK58113 board.

The on-card switching amplifier is not operable when only +5V power is provided. The primary use of this +5V power input is when an external amplifier is used such that on-card amplification is not needed.

Pin	Signal	Description
		J2 - +5V Connector
1	+5V	+5 volts
2	+5V	+5 volts

Pin	Signal	Description
3	GND	Ground
4	GND	Ground

3.2.13 Connector Parts Reference

The following table is supplied as a reference only.

Label	Connector Name	Connector Part Number	Connector Mate
J1	HV Power	Phoenix Contact 2-circuit pluggable terminal block p/n 1924305	Phoenix Contact 2-circuit mating terminal, 5.08mm pitch. p/n 1912401
J3	Motor Drive	Phoenix Contact 5-circuit pluggable terminal block p/n 1924334	Phoenix Contact 5-circuit mating terminal, 5.08mm pitch. p/n 1912430
J8	Axis 1 Feedback	High density D-sub 15-position, female	High density D-sub 15-position, male
J9	Axis 2 Feedback	High density D-sub 15-position, female	High density D-sub 15-position, male
J4	Amplifier Signal	Phoenix Contact 3-circuit pluggable terminal blockp/n 1985205	N/A
J10	SPI Atlas Bus	DB-9, male	DB-9, female
J12	Remote Amplifier	2 by 8 un-shrouded header, male, .1" spacing	Samtec socket, 16-position, .1" spacing. p/n: ISDM-08
J14	Shunt	Phoenix Contact 2-circuit pluggable terminal block, p/n 1924305	Phoenix Contact 2-circuit mating terminal, 5.08mm pitch. p/n 1912401
J6, J7	CAN1, CAN2	RJ45	RJ45 connector plug
J5	Serial	DB-9, female	DB-9, male
J11	Host SPI	2 by 4 unshrouded header, male, .1" spacing	Samtec socket, 8-position, .1" spacing. p/n: ISDM-04
J13	Synch	2 position unshrouded header, male, .1" spacing	Samtec socket, 2-position, .1" spacing. p/n: ISSM-02
J2	+5V Power	Molex KK254 solid header single row, p/n 22-27-2041	Molex KK254 crimp housing, single row, 4 circuits. p/n: 22-01-2041

3.3 Motor Connection Quick Reference

The following sections show typical motor connection names and the associated DK58113 connector and pin numbers.

3.3.1 Brushless DC Motor Connections

Connection Name	DK58113 Pin
Motor A	J3-1
Motor B	J3-2
Motor C	J3-3
Case/Shield	J3-5

3.3.2 DC Brush Motor Connections

Connection Name	DK58113 Pin
Motor+	J3-1
Motor-	J3-2
Case/Shield	J3-5

3.3.3   Step Motor Connections

Connection Name	DK58113 Pin
Motor A+	J3-1
Motor A-	J3-2
Motor B+	J3-3
Motor B-	J3-4
Case/Shield	J3-5

3.4   Absolute Maximum Ratings

HV voltage range:	0V to +60V
+5V voltage range:	-0.3V to +5.5V
Storage Temperature:	-40 to +150 C

3.5   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 + 56V operating range
Motor amplifier continuous current limit[*]:	5.0 A
Motor amplifier peak current limit:	10.0 A
Optional +5V requirement:	4.75V to 5.25V DC operating range
Digital I/O voltage range:	0V to 5V, TTL thresholds, inputs pulled up to 5V through 4.7 kOhm resistors
Digital outputs drive capacity:	Output source current: 4mA, sinking current 100mA
CAN communications:	2.0B compliant, non-isolated, 1 Mbps
Serial communications:	RS-232 signaling or RS-485 Full or Half Duplex (data only)

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

3.6   DK58113 On-Board Amplifier Quick Reference

The DK58113 comes with a standard MC58113 IC, and is thus not tailored for the amplifier and safety-related circuitry located on the DK58113 board. Therefore to use the MC58113/DK58113 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 Wizard setup sequence, however they are also useful if you decide to write your own software that operates the DK58113 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-card amplifier. For remote amplifier control operation PWM High/Low, 50/50 PWM, or sign/magnitude PWM may be selected. SPI Atlas is selected for use with an off-card Atlas Digital Amplifier. Pulse & Direction is selected for use with an off-card step motor amplifier supporting those input signals.
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 or 80 kHz to maximize current control accuracy and minimize heat generation.
PWM Dead Time	540 nsec	For correct operation of the DK58113's on-card switching amplifier this parameter must be set to this value.
PWM Refresh Time	2,000 nSec	To ensure sufficient time to recharge the on-card 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-card amplifier's high side switches this parameter must be set to this value
PWM Signal Sense	Active High	For correct operation of the on-card amplifier all PWM outputs must be set to active high.
Minimum Current Read Time	2,000 nSec	To ensure sufficient minimum current read time with BLDC motors this parameter must be set to this value.
Leg Current Conversion	.733 mA/count	This value should be entered so that the leg current can be traced and displayed correctly in amps.
Brushless DC Motor: Foldback Continuous Current Limit	5.0 A	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Brushless DC Motor: Foldback Total Energy Limit	125 A^2sec	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
DC Brush Motor: Foldback Continuous DC Current Limit	5.0 A	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
DC Brush Motor: Foldback Total Energy Limit	125 A^2sec	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Step Motor: Foldback Continuous Current Limit	5.0 A	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Step Motor: Foldback Maximum Energy Limit	125 A^2sec	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Temperature Limit	75.0 C	This value should be entered to ensure the on-card amplifier does not operate above the maximum safe current output.
Bus Current Supply Conversion	.505 mA/count	This value should be entered so that the DC bus current supply can be traced and displayed correctly in amps.
Bus Current Supply Limit	20.0 A	This value should be entered to ensure safe operation of the DK58113.
Bus Current Return Limit	20.0 A	This value should be entered to ensure safe operation of the DK58113.

Parameter	Value & Units	Comments
Bus Voltage Display	.966 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 DK58113.
Overvoltage Limit	60.0 V	This value should be entered to ensure safe operation of the DK58113.

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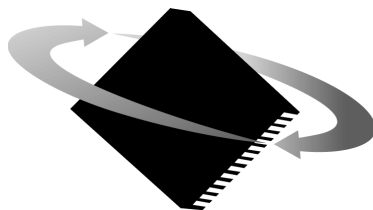Trace & Motion Oscilloscope 23
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For additional information, or for technical assistance,
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