Magellan™ Motion Processor
Developer's Kit Manual

P M D

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Related Documents

Magellan Motion Processor User's Guide

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

Magellan Motion Processor Programmer's Command Reference

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

Magellan Motion Processor Electrical Specifications

Booklets containing physical and electrical characteristics, timing diagrams, pinouts, and pin descriptions of each series:

MC58000 Series, for DC brush, brushless DC, Microstepping, and Pulse & Direction motion processors

MC55000 Series, for Pulse & Direction motion processors

Atlas Digital Amplifier User's 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 electrical and mechanical description of the Atlas Digital Amplifier with detailed theory of operations.

Pro-Motion User's Guide

User's guide to Pro-Motion, the easy-to-use motion system development tool and performance optimizer. Pro-Motion is a sophisticated, easy-to-use program which allows all motion parameters to be set and/or viewed, and allows all features to be exercised.

Other Documents

ION Digital Drive User's Manual

How to install and configure ION Digital Drives.

Prodigy-PCI Motion Card User's Guide

How to install and configure the Prodigy-PCI motion board.

Prodigy-PC/104 Motion Card User's Guide

How to install and configure the Prodigy-PC/104 motion board.

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1. Installation

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In This Chapter

The PMD Magellan Motion Processor Developer's Kit is an integrated board/software package that serves as an electrical and software design tool for building Magellan-based systems. The developer's kit supports all members of the Magellan family, as shown below:

Developer's Kit	Magellan Motion Processors supported	Installed Motion Processor	Motors Support
DK58420	MC58420, MC58320, MC58220, MC58120	MC58420	DC brush, brushless DC, pulse & direction, microstepping
DK55420	MC55420, MC55320, MC55220, MC55120	MC55420	Pulse & direction
DK58110	MC58110	MC58110	DC brush, brushless DC, pulse & direction, microstepping
DK55110	MC55110	MC55110	Pulse & direction

All of the above Developer's Kit versions share the same physical PC card as well as the same software CD. They differ in the specific type of chip that is installed in the motion card. To build a complete control system the DK card is combined with one or more motion axis amplifiers. For MC58000 developer's kits (DK58420, DK58110), PMD's Atlas Digital Amplifiers are directly supported via a plug-in connector. Alternatively, connectors are provided to integrate other off-the-shelf amplifiers, or user-built amplifier circuitry.

Because the installed chip for each Developer's Kit version supports the maximum number of axes allowed, it can be used to develop systems based on chipsets with fewer axes simply by disabling the unused axes. Alternatively, it is possible to have the Developer's Kit shipped with a different chipset from the same family version (with one, two, or three axes). Contact your PMD representative for details.

1.1 Components List

The Magellan Motion Processor Developer's Kit contains the following components:

- 4-axis PCI-bus Developer's Kit card

- CD-ROM containing C-Motion, Pro-Motion, and documentation in PDF format
- 100-Pin Connector to dual 50-pin header converter cable (3' length)
- DB9 RS-232 cable
- Five rubber standoffs for use in standalone mode

Documentation:

Magellan Motion Processor Developer's Kit Manual

Magellan Motion Processor User's Guide

Magellan Motion Processor Programmer's Command Reference

Magellan Motion Processor Electrical Specifications (either for MC58000 or MC55000, depending on Developer's Kit ordered)

Atlas Digital Amplifier User's Manual (if DK ordered with one or more Atlas amplifiers)

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

1.2 Software

Two major software packages are provided with the Magellan Motion Processor Developer's Kit cards: Pro-Motion, an interactive Windows-based exerciser program and C-Motion, a C-language library which simplifies the development of motion applications for Magellan Motion Processor Developer's Kit cards.

Pro-Motion is a sophisticated, easy to use exerciser program that allows you to set and view all card parameters, and exercise all card features. Pro-Motion features include:

- Motion oscilloscope graphically displays processor parameters in real-time
- Interactive servo tuning
- Atlas amplifier setup and configuration storage
- Project window for accessing card parameters
- Ability to save and load current settings
- Distance and time units conversion
- Motor-specific parameter setup
- Axis shuttle performs continuous back and forth motion between two positions
- Command window for direct text command entry
- Communications monitor that echoes all commands sent by Pro-Motion to the card.

C-Motion provides a convenient set of callable routines that comprise all of the code required for controlling your Magellan Motion Processor Developer's Kit card. C-Motion includes the following features:

- Axis virtualization
- The ability to communicate to multiple Magellan Motion Processor Developer's Kit cards
- Can be easily linked to any "C/C++" application

1.3 Documentation

There are four manuals specifically associated with the Magellan Developer's Kit cards. A brief description of each is listed below.

Part Number	Name	Description
DK5X000UG	Magellan Motion Processor Developer's Kit Manual	This is the first document you will turn to get started, make connections, and exercise the card. This document will answer questions such as “How do I connect my amplifiers and motors to the card?” and “What jumper options do I set to use the card?” This document also provides a complete electrical description of the card, and a description of the associated software products C-Motion and Pro-Motion.
MC5X000UG	Magellan Motion Processor User’s Guide	This is a functional description of the Magellan Motion Processor, which is the chipset that is at the heart of the Magellan Motion Processor Developer’s Kit cards. This document will answer questions such as, “How do I make a trapezoidal move?” or “How do I load servo parameters?”
MC5X000PR	Magellan Motion Processor Programmer’s Command Reference	This document provides a complete listing of all motion commands supported by the Magellan Motion Processors.
MC58000ES MC55000ES	Magellan Motion Processor Electrical Specifications	This document provides electrical specifications for the Magellan Motion Processors. It includes electrical timing diagrams, mechanical packaging, pin lists, and other hardware-related information.

If you will be using PMD’s Atlas amplifiers with your Magellan DK card then these additional manuals will be useful:

Part Number	Name	Description
ATLAS-UM-0113	Atlas Digital Amplifier User’s Manual	This manual provides a functional overview of PMD's Atlas Digital Amplifiers, which are designed to work with Magellan ICs. Atlases provide high performance amplification for DC Brush, Brushless DC, and Step Motors.

To download these documents, or request that they be sent to you, visit the PMD web site at www.pmdcorp.com or contact your PMD representative.

1.4 Installation Sequence

For a normal installation of the Magellan Motion Processor Developer’s Kit card you will need to configure your card for the PC system and motor hardware that you will connect it to.

There are two overall configurations, internally mounted and standalone. When installed internally to the PC your card will utilize PCI bus connections for communication to the card. This option requires that your PC have at least one available PCI bus port. This configuration has the advantage that communication rates to the PC are very high.

When installed in standalone mode, you will utilize a serial connection from the PC to connect to the DK card, and you will provide separate power to the card. In this configuration the card is typically mounted horizontally on a bench top or other flat surface. This configuration has a lower communication rate, but may provide more convenient access to the card. In addition, this configuration is used when no PCI port is available on your PC.

Configuration of the Magellan Motion Processor Developer’s Kit cards is described in Section 1.6, “Preparing the Card for Installation” in detail.

Next you will need to connect your system's motors, encoders, amplifiers, and sensors as desired to operate your motion hardware. See Section 1.7, "Connection Summary" for a description of the connections that are made for the various Magellan Motion Processor Developer's Kit cards.

Once this hardware configuration is complete, you should then install the software. See Section 1.9, "Software Installation" for a description of installation of the software.

The final step to finish the installation is to perform a functional test of the finished system. See Section 1.10, "First Time System Verification" for details.

Once all of the above has been accomplished installation is complete, and you are ready to operate the card.

1.5 Required Hardware

To install a Magellan Motion Processor Developer's Kit card you will need the following hardware:

1. The recommended platform is an Intel (or compatible) processor, Pentium or better, one available PCI slot, 200MB of available disk space, 256MB of available RAM, and a CDROM drive. The PC operating system required is Windows XP/Vista/Windows 7.
2. 1 to 4 Atlas amplifiers, or other pulse and direction, PWM, or analog-input amplifiers. Amplifiers are motor-type specific driving either DC Brush, Brushless DC, or step motors.
3. 1 to 4 step motors or servo motors. These motors may or may not provide encoder position feedback. Servo motors must have encoder feedback, while for step motors encoder feedback is optional.
4. Additional connectors as required to connect the Magellan Motion Processor Developer's Kit card to the amplifiers and the motors. A single 100-pin header-type connector will be needed to interface to your motion hardware such as encoders, limit switches, and other connections. If Atlas amplifiers are used the Magellan DK supports direct connection to Atlas DK cards via a DB9 connector and cable.

1.6 Preparing the Card for Installation

To prepare your card for installation the following user-settable hardware option should be checked.

1.6.1 Resistor Packs

Item	How to Set	Description
Resistor packs RS1, RS2, RS3	Installed *this is the default setting of resistor packs RS1-RS3*	If you are using differential connections leave these resistor packs installed.
	Removed	If you are using single-ended encoder connections, remove the resistor packs.

1.6.2 Motor Type Switch Settings

When using the DK55000 only pulse and direction motors are used, and it is not necessary to set jumpers related to motor type. When using the DK58000 it is possible to support any combination of DC brush, brushless DC, microstepping, and pulse & direction motors all on the same card and dip switches 5 and 6 must be set to indicate the motor type that will be used. When configuring the dip switches and connecting your motors to the Developer's Kit Card, the following information may be helpful:

- *Brushless DC* means the card expects to connect to a brushless DC motor with an encoder, and possibly with Hall sensors. With this connection, the Developer's Kit card performs the commutation and outputs a multi-phase signal, 2 or 3 phases per axis, to the amplifier. For Atlas-connected systems only 2-phase may be selected.

- *Pulse and direction* means the card expects to connect to a step motor which uses an Atlas step motor amplifier or standard pulse and direction amplifier. Quadrature feedback is optional with this type of motor.
- Microstepping means the Developer's Kit card expects to connect to a step motor amplifier with multi-phase signal command input, providing 2 or 3 phases per axis. Quadrature feedback is optional with this type of motor.
- *DC Brush* means the cards expects to connect to a DC brush motor with an encoder, or an externally commutated brushless DC motor (amplifier performs commutation). With this motor type the card outputs one phase per axis.

1.6.2.1 Motor Type Jumper Settings (for DK58000 only)

When referring to the table below the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked **on**.

Item	Switches	Description			
Dip switch S5	S5-1 S5-2 S5-3	Axis #1 Motor type setting Set S5 1-3 dip switches according to the motor type you will be using on axis #1			
		5-1	5-2	5-3	Axis #1
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)
Dip switch S5	S5-5 S5-6 S5-7	Axis #2 Motor type setting Set S5 5-7 dip switches according to the motor type you will be using on axis #2			
		5-5	5-6	5-7	Motor type setting
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)
Dip switch S6	S6-1 S6-2 S6-3	Axis #3 Motor type setting Set S6 1-3 dip switches according to the motor type you will be using on axis #3			
		6-1	6-2	6-3	Motor type setting
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)

Item	Switches	Description			
Dip	S6-5	Axis #4 Motor type setting			
switch	S6-6	Set S6 5-7 dip switches according to the motor type you will be using on axis #4			
S6	S6-7	6-5	6-6	6-7	Motor type setting
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)

Unconnected motors can be left at the default setting of *DC Brush*.

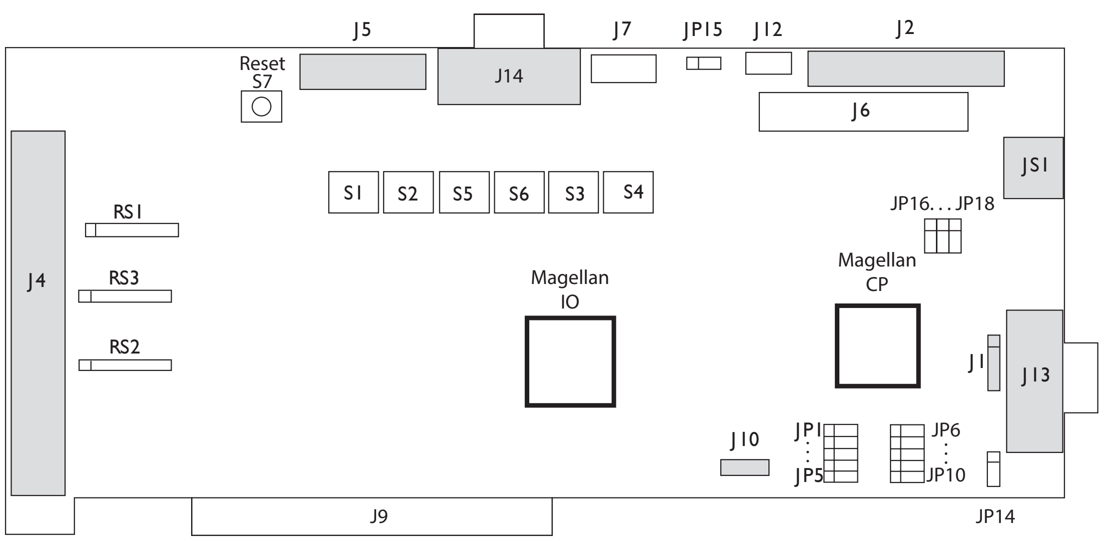
1.6.3 Atlas Amplifier Operation

If you are using Atlas amplifiers with your DK, jumpers JP16, JP17 and JP18 should be set as follows:

Item	Configuration	Description
JP16, JP17, JP18	jumpers installed at 2-3 for all three jumpers	To operate the Magellan DK with Atlas amplifiers, or to operate with Magellan rev. 3.0 or later, jumpers should be installed connecting the 2-3 pins for the JP16, JP17, and JP18 jumpers. See Figure 1-1 for location of jumpers.
	jumpers installed at 1-2	To operate the Magellan DK with Magellans below rev. 3.0, jumpers should be installed connecting the 1-2 pins for the JP16, JP17, and JP18 jumpers. See Figure 1-1.

The following diagram shows the location of the resistor packs RS1, RS2, RS3 and the mode jumper, along with other components such as connectors.

Figure 1-1: Location of Various Board Elements



1.7 Connection Summary

The following sections summarize the connections you should make for various motor types. The connections are broken into two overall groups, connections required when Atlas amplifiers are used, and connections when other amplifiers are used. You may use Atlas amplifiers for certain axes and non-Atlas amplifiers for other axes. In addition, you may use different motor types on each axes.

1.7.1 DC Brush Motor With Atlas Amplifier

The following table summarizes connections to the Magellan Developer's Kit card when DC-brush motors are used with an Atlas amplifier.

Atlas amplifier connections are made via J14, the Atlas DK bus connector. See Appendix A, "Atlas Developer's Kit" for detailed instructions on configuring Atlas amplifier connections.

All other connections are made through connector J4, the primary 100-pin connector indicated in the figure above. See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a detailed list of connections.

Signal Category	Signal Description
Encoder input signals: *(per axis)*	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier signals:	SPI Atlas bus
Other control signals: *(optional, per axis)*	Home signal input Limit switch inputs AxisIn input AxisOut output
Miscellaneous signals:	Digital GND +5 V (for encoder power)

1.7.2 Brushless DC Motor With Atlas Amplifier

'The following table summarizes connections to the Magellan Developer's Kit card when Brushless DC motors are used with an Atlas amplifier.

Atlas amplifier connections are made via J14, the Atlas DK bus connector. See Appendix A, "Atlas Developer's Kit" for detailed instructions on configuring Atlas amplifier connections.

All other connections are made through connector J4, the primary 100-pin connector. See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for detailed signal descriptions.

Signal Category	Signal Description
Encoder input signals: (per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier signals:	SPI Atlas bus
Hall inputs:	Hall (phase A) Hall (phase B) Hall (phase C)
Other control signals: (optional, per axis)	Home signal channel input Positive limit switch input Negative limit switch input AxisIn input AxisOut output
Miscellaneous signals:	GND +5 V (for encoder power)

1.7.3 Step Motor With Atlas Amplifier

The following table summarizes connections to the Magellan Developer's Kit card when two-phase step motors are used with an Atlas amplifier.

Atlas amplifier connections are made via J14, the Atlas DK bus connector. See Appendix A, "Atlas Developer's Kit" for detailed instructions on configuring Atlas amplifier connections.

All other connections are made through connector J4, the primary 100-pin connector, indicated on Figure 1-1. See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for detailed signal descriptions.

Signal Category	Signal Description
Encoder input signals: *(per axis)*	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier signals:	SPI Atlas bus
Other control signals: *(optional, per axis)*	Home signal channel input Positive limit switch input Negative limit switch input AxisIn input AxisOut output
Miscellaneous signals:	GND +5 V (for encoder power)

1.7.4 DC Brush Motor

The following table summarizes connections to the Magellan Developer's Kit card when DC-brush motors are used with a non-Atlas format amplifier.

All connections are made through connector J4, the primary 100-pin connector indicated in the figure above. See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a detailed list of connections.

Signal Category	Signal Description
Encoder input signals: *(per axis)*	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier output signals: *(per axis, if PWM sign, magnitude used)*	PWM direction PWM magnitude
Amplifier output signals: *(per axis, if PWM 50/50 used)*	PWM magnitude
Amplifier output signals: *(per axis, if analog output used)*	Analog out (DAC output)
Other control signals: *(optional, per axis)*	Home signal input Limit switch inputs AxisIn input AxisOut output
Miscellaneous signals:	Digital GND +5 V (for encoder power)

1.7.5 Brushless DC Motors

The following table summarizes connections to the Magellan Motion Processor Developer's Kit card when brushless DC motors are used with a non-Atlas format amplifier. All of these connections are made through connector J4, the primary 100-pin connector. See Chapter 3, “Magellan Developer’s Kit Electrical Specifications” for detailed signal descriptions.

Signal Category	Signal Description
Encoder input signals: (per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier output signals: (per axis, if PWM 50/50 used)	PWM magnitude (phase A) PWM magnitude (phase B) PWM magnitude (phase C)
Amplifier output signals: (per axis, if analog output used)	Analog out (phase A) Analog out (phase B)
Hall inputs:	Hall (phase A) Hall (phase B) Hall (phase C)
Other control signals: (optional, per axis)	Home signal channel input Positive limit switch input Negative limit switch input AxisIn input AxisOut output
Miscellaneous signals:	GND +5 V (for encoder power)

1.7.6 Pulse & Direction Motors

The following table summarizes connections to the Magellan Motion Processor Developer’s Kit card when pulse & direction interface step motors are used. All connections are made through connector J4, the primary 100-pin connector, indicated on *figure 1-1, page 12*. See Chapter 3, “Magellan Developer’s Kit Electrical Specifications” for detailed signal descriptions.

Signal Category	Signal Description
Encoder input signals: (optional, per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier output signals:	Pulse Direction
Other control signals: (optional, per axis)	AtRest signal output Home signal channel input Positive limit switch input Negative limit switch input AxisIn input AxisOut output
Miscellaneous signals:	GND +5 V (for encoder power)

1.7.7 Microstepping Motors

The following table summarizes connections to the Magellan Motion Processor Developer’s Kit card when multi-phase microstepping-interface step motors are used with a non-Atlas format amplifier. All of these connections are made through connector J4, the primary 100-pin connector. See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for detailed signal descriptions.

Signal Category	Signal Description
Encoder input signals: (per axis)	A quadrature channel input B quadrature channel input Index pulse channel input
Amplifier output signals: (per axis, if PWM sign, magnitude used)	PWM magnitude (phase A) PWM magnitude (phase B) PWM direction (phase A) PWM direction (phase B)
Amplifier output signals: (per axis, if PWM 50/50 used)	PWM magnitude (phase A) PWM magnitude (phase B)
Amplifier output signals: (per axis, if analog output used)	Analog out (phase A) Analog out (phase B)
Other control signals: (optional, per axis)	Home signal channel input Positive limit switch input Negative limit switch input AxisIn input AxisOut output
Miscellaneous signals:	GND +5 V (for encoder power)

1.7.8 Communication Connections

If the PCI bus is used, communication between the PC and the DK card occurs via the PCI bus and no additional communication connections are needed.

If the card is operated in standalone mode, the included DB9 serial cable should be used to connect a serial port on the PC to the card's serial port connector. At the DK card the serial cable should connect to J13. See Figure 1-1 to locate the J13 connector.

If your PC does not directly support a serial port you may be able to use a USB to serial converter device. Note that PMD provides such a device (p/n Adapt-USB232-01.R). Contact your PMD representative for more information. Whether connected directly into the PC or into a converted device, the provided DB9 connector presents a standard RS-232 signal scheme, and should work without need for a null modem or other signal converter.

The DK card's default serial port baud rate is 57,600 bits per second. This rate should work with most PCs. To set the baud rate to a different value use the S2 switch settings described in section 2.3.2 of this manual. If you still have trouble communicating to the card using the serial port contact PMD for assistance.

1.7.9 Power Connections

1.7.9.1 Power For The DK Card

The final electrical installation step is to provide power to the DK card and to the amplifiers. If you are operating the card from the PCI bus then the DK card receives power from the PC and the only additional required power connection is to the amplifiers.

If you are operating the DK card in standalone mode you must directly provide power to the card as shown in the table below.

Signal	Connector	Description
+5V	J10	J10 is a two-signal (+5V, Gnd) jack-screw-style connector that provides five volts to the DK card during standalone operation. See Figure 1-1 for location of J10 connector. Use a 1.0 Amp supply or greater to ensure adequate power.

1.7.9.2 Power For The Amplifiers

Whether using Atlas amplifiers or another amplifier type you will need to apply power to the amplifiers. To do so, carefully follow the instructions provided for your amplifier to safely connect power and make other necessary connections such as ground or case/shield connections.

In the case of Atlas amplifiers the input voltage range is 12-56 volts. Consult the *Atlas Digital Amplifier User's Manual* for additional information.

1.8 Applying Power

Once you have installed the Magellan Motion Processor Developer' s Kit card in your PC and made the necessary power and signal connections to your external amplifiers, motors, motor encoders, and other signals required for your application, hardware installation is complete and the board is ready for operation.

Most systems will first power the Magellan DK card. Upon power up, the card will be in a reset condition. In this condition the motor output signals provided by the DK card will send a "zero command" signal to the amplifier.

Next, amplifier power is enabled. After power is applied the motors should remain stationary. If the motors move or jump, power down the card and check the amplifier and other connections. If anomalous behavior is still observed, call PMD for application assistance.

1.9 Software Installation

Included in your developer's kit are two CDROMs marked "Pro-Motion" and "Magellan SDK." These CDs contain software to exercise your board and source code that will enable you to develop your own motion applications. The exercise software is designed to work with Windows XP or Windows 7.

If you have autorun enabled, the installation process will start when you insert the Pro-Motion CDROM. The installation program will guide you through installing the software. Upon completion of the installation process, the following components will be installed:

1. Pro-Motion – an application for communicating to and exercising the installed developer's kit.
2. C-Motion – source code that can be used for developing your own motion applications based on the Magellan Motion Processor. These files are installed in the "My Documents\PMD\MagellanSDK\C-Motion" folder.
3. "PDF" versions of the developer's kit manual, programmer's reference and user's guide. The Adobe Acrobat Viewer is required for viewing these files. If the Adobe Acrobat Viewer is not installed on your computer, you can download it from http://www.adobe.com.
4. Reference schematics from the Electrical Specifications manuals. These files are installed in the "Schematics" folder, a sub-folder of the installation folder.

5 Schematics for the Magellan Motion Processor DK board. These files are installed in the “Schematics” folder, a sub-folder of the installation folder.

6 Parts list for the board. The file “Magellan Motion Processor DK LOM.wri” is installed in the “Schematics” folder, a sub-folder of the installation folder.

If the card is to be installed in a PCI slot the PCI drivers will need to be installed. These are found on either CDROM. Execute the driver installation program depending on your Windows version:

- 64-bit Windows: PMDDrivers_x64.msi
- 32-bit Windows: PMDDrivers_x86.msi

1.10 First Time System Verification

The first time system verification procedure summarized below has two overall goals. The first is to connect the DK card with the PC that is being used so that they are communicating properly, and the second is to initialize each axis of the system and bring it under stable control capable of making trajectory moves. While there are many additional capabilities that Pro-Motion and the DK card 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 section.

1 Initiate Pro-Motion and establish communication between the PC and the card using the serial or PCI bus communications link.

2 Run Pro-Motion’s Axis wizard for each axis of your system to initialize parameters such as encoder direction and safe servo 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 other PMD manuals including the *Pro-Motion User’s Guide* for complete information on the Pro-Motion application. You may also want to refer to the *Magellan Motion Processor User’s Guide* to familiarize yourself with operation of the Magellan Motion Processor, which lies at the heart of all PMD Motion cards.

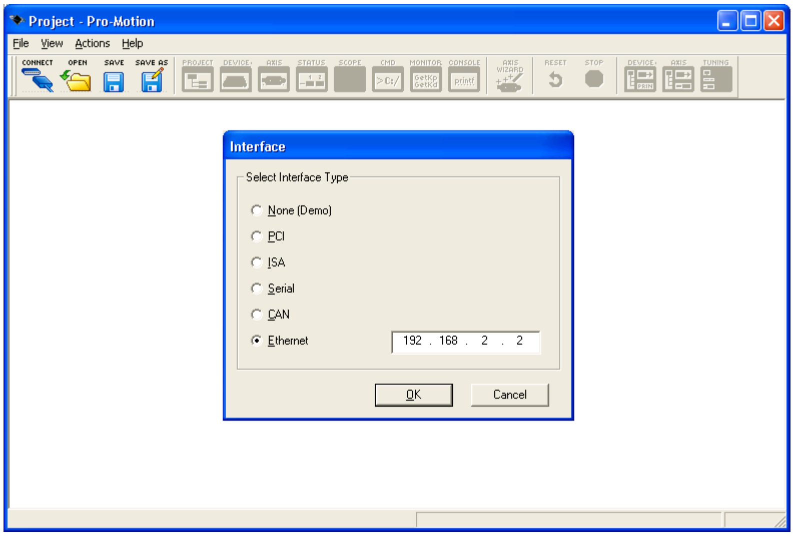
1.10.1 Establishing Communications

To establish PCI bus or serial communications:

1 Make sure the DK card is powered and connected to the PC.

2 On the Start menu, click 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.



3 Click the Connect icon on the toolbar.

Alternatively, on the File menu, click Connect.

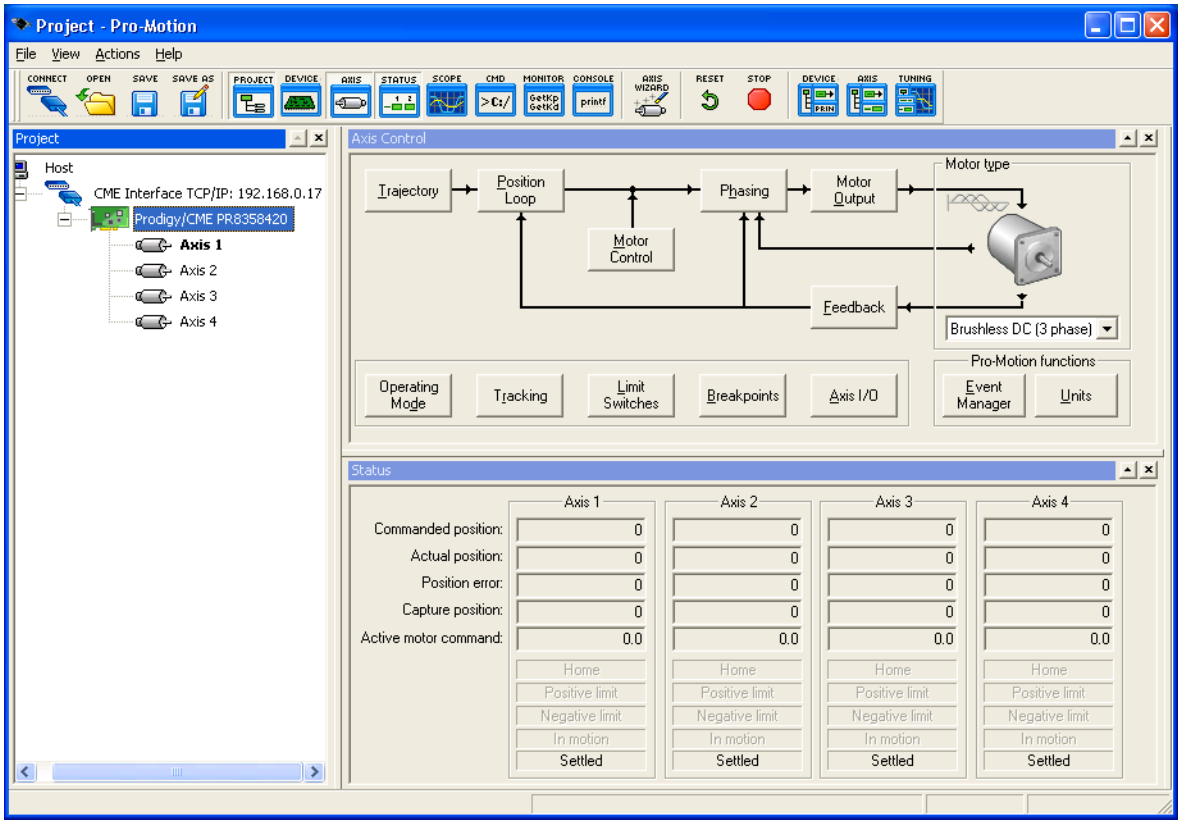
The purpose of the Interface dialog box is to indicate to Pro-Motion how your Magellan DK card is connected to the PC. It provides various selectable communication options such as PCI, serial, CANbus.

4 Click Serial or PCI depending on which is connected, and then click OK.

For serial, a dialog box displays with default communication values of 57,600 baud, no parity, 1 stop bit, and point to point protocol. For PCI, a dialog box displays with a selectable board number

5 Click OK without changing any of these settings.

If 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 for a four axis Magellan DK card, you see the card name next to an icon of a card, and below that you see four axis icons, one for each available axis of the motion card. Highlighting (single clicking) either the card icon or one of 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 communications are not correctly established, after approximately 10 seconds a dialog box appears indicating that a Communications Timeout Error has occurred. If this is the case, recheck your connections and repeat from step 1 above. If after repeated attempts a connection can still not be established, call PMD for assistance.

1.10.2 Initializing Motion Axes

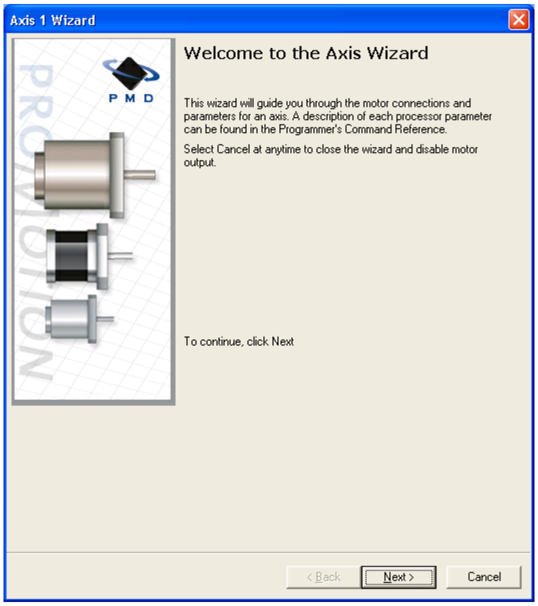
The next step to verify the correct operation of the system is to initialize each axis of the motion system sequentially, thereby verifying correct amplifier connection, encoder feedback connections (if an encoder is used), and other motion functions. All of this can be conveniently accomplished using 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 Click to select the axis icon that you would like to initialize (normally this would be Axis #1) 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. If you have specific questions about the Axis Wizard, refer to *Pro-Motion User's Guide* for detailed information on the axis wizard.

Upon a normal completion of the Axis Wizard, 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 DK card's Magellan Motion Processor. 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 when commutated by the Magellan Motion Processor. Should this happen, it is possible to perform a manual tuning or commutation setup if desired. Refer to the *Pro-Motion User's Guide* for more information, or call PMD for technical assistance.

The Axis Wizard auto tuning routine, which is used with servo motors, is 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 servo 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.

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2. Operation

2

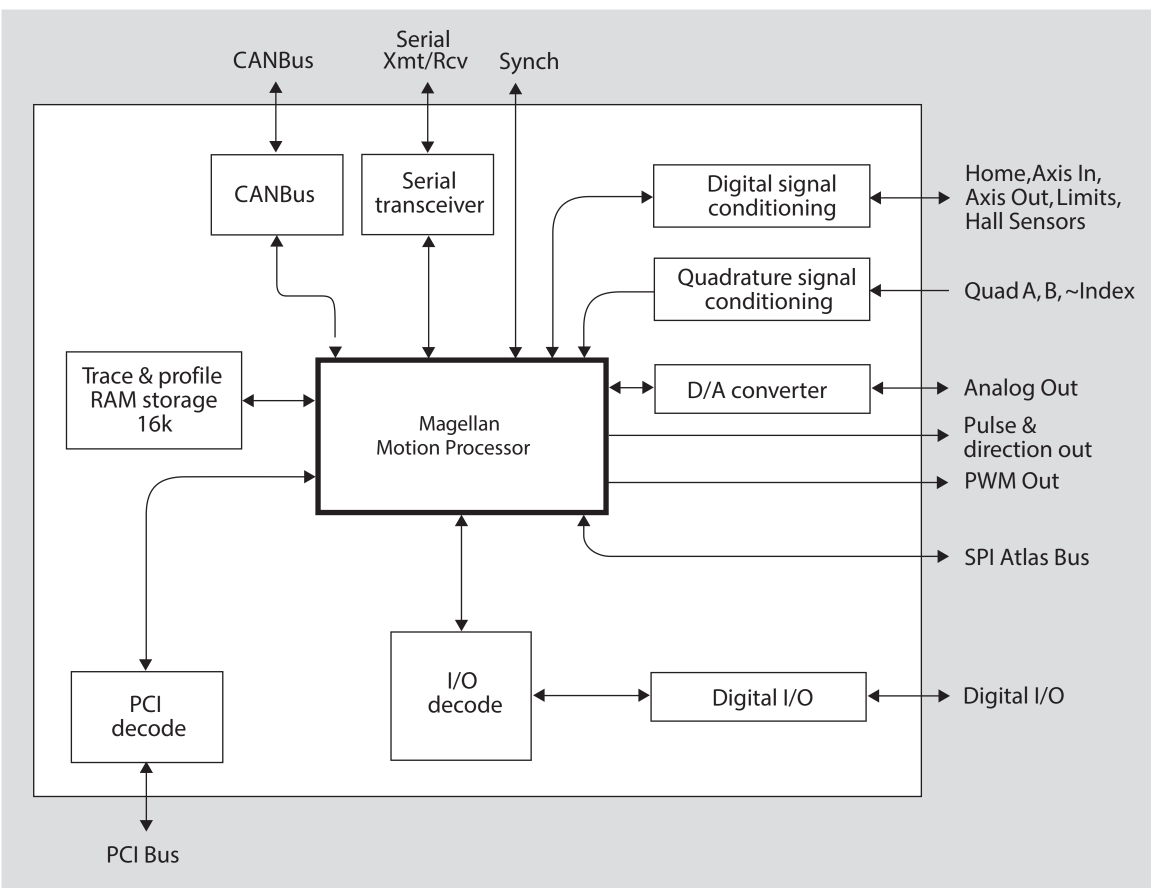
In This Chapter

- Card Function Overview
- Magellan Motion Processor
- Card Specific Functions
- Signal Processing and Hardware Functions

The PMD Magellan Motion Processor Developer's Kit cards are high performance PCI-bus cards that provide motion control for DC brush, brushless DC, and step motors. These cards are based on Magellan Motion Processors which perform motion command interpretation and other real time functions.

The overall card function is divided amongst a number of modules. These modules are indicated in the block diagram below:

Figure 2-1: Magellan Motion Processor Developer's Kit Internal Block Diagram



2.1 Card Function Overview

Magellan Motion Processor Developer's Kit card resources can be broken into three overall categories:

Magellan Motion Processor functions—These are programmable functions which reside in the motion processor such as profile generation, servo loop closure, and much more. These functions are accessed using Magellan Motion Processor commands, of which there are roughly 150 in total, to allow sophisticated control of the card's overall behavior.

Card-specific functions—These are programmable functions which are controlled by the motion processor using commands ReadIO and WriteIO, but which reside in various portions of the card circuitry. These functions include general purpose digital IO, and other card-specific capabilities.

Signal processing & hardware functions—A substantial portion of the card provides signal conditioning and other functions associated with non-programmable, signal-related processing.

2.1.1 Standalone Operation

There are two modes of operating the Magellan Developer's Kit Card: through the PCI bus, and in standalone mode. When operating the card through the PCI bus all required power and communication connections are provided by the interface bus itself.

When operating the card in standalone mode, you must use serial or CANbus communications. In addition, you will need to provide power to the card via an external connection, J10. See Section 3.2.6, "Standalone Power Connector (J10)" for a detailed description. Operating the card in standalone can be useful for a number of reasons, including locating the card closer to the motion hardware, being able to operate several cards simultaneously on a serial multi-drop or CANbus network or not having access to a PCI bus backplane.

2.2 Magellan Motion Processor

The Magellan Motion Processor pictured in Figure 2-1 is comprised of 2 ICs, a CP (command processor) and an IO (input/output) IC. A summary list of the functions provided by the motion processor is as follows:

- Profile generation
- Motor output signal generation (PWM and analog)
- Quadrature counting, index capture
- Servo loop closure (for DC brush or brushless DC motors only)
- Breakpoint processing
- PLC-function processing (AxisIn and AxisOut signals)
- Trace
- Motion error detection, tracking windows, and at-settled indicator
- Limit switches

Access to the Magellan Developer's Kit card may occur through the PCI port, through the serial port, or through the CANbus. In any case, a complete set of C-Motion function calls, one for each Magellan command, is used to communicate to the card. For a complete list of Magellan commands see the *Magellan Motion Processor Programmer's Command Reference.*

The system on which the Magellan Developer's Kit card is installed can control the card through the pre-compiled program Pro-Motion, or through a program of their own construction, using C-Motion calls as the basic interface. During axis setup, the communications method (PCI-bus, serial port, or CANbus) and other parameters are specified, which allow C-Motion to create a virtualized axis handle, that from then on is the reference for all C-Motion commands.

Available C-Motion commands correspond one-for-one with those listed in the *Magellan Motion Processor Programmer's Command Reference.* All C-Motion commands preface the Magellan command with the letters "PMD," so the Magellan command (for example) SetPosition becomes the C-callable routine.

PMDSetPosition

Example

The following simple example, to set up and execute a simple trapezoidal profile, illustrates just a small part of the overall command set.

```
PMDSetProfileMode(axis_handle, trapezoidal);
PMDSetPosition(axis_handle, position_value);
PMDSetVelocity(axis_handle, velocity_value);
PMDSetAcceleration(axis_handle, acceleration_value);
PMDSetDeceleration(axis_handle, deceleration_value);
PMDUpdate(axis_handle);
```

Two separate manuals describe how the Magellan Motion Processor operates and how it is programmed, the *Magellan Motion Processor User's Guide* and the *Magellan Motion Processor Programmer's Command Reference.*

2.3 Card Specific Functions

Card-specific functions are those functions that are mapped through the motion processor's ReadIO and WriteIO facility, but are implemented in the card circuitry.

Card-specific functions are detailed in this document rather than the *Magellan Motion Processor User's Guide* or the *Magellan Motion Processor Programmer's Command Reference.*

2.3.1 General Purpose Digital IO

In addition to numerous special-purpose digital signals that are input or output to the card such as ***AxisIn, AxisOut, Home, QuadA,*** etc., the Magellan Developer's Kit cards support 8 general-purpose inputs, and 8 general-purpose outputs. These signals provide a convenient way of accessing additional general purpose digital IO. Although access to these signals occurs through the motion processor's ReadIO and WriteIO command, the signals present at these various connections do not directly affect the motion processor's behavior. Thus the motion processor simply passes them through.

ReadIO and WriteIO Commands

The 8 inputs and outputs are read using the ReadIO command and WriteIO command, with an IO address of 0. The table below shows this, along with the bit locations of the input and output signals.

Command	Bit location	Signals
ReadIO 0	0-7	DigitalIn0-7
WriteIO 0	0-7	DigitalOut0-7

To read the 8 general purpose digital I/Os, a ReadIO command is performed at address offset 0. The 16 bit read word returns the current output values (set using the WriteIO command) in bits 0-7. To write new signal values to the 8 digital outputs, a WriteIO command to address offset 0 is sent, and the values on bits 0-7 will be output to the signal connections. The value of bits 8-15 are ignored.

Example

To write a sequence 0xaa to bits 0-7, the C-Motion command PMDWriteIO(axis_handle, 0, 0xaa) is used. Assuming that a signal pattern of 0x55 is present on the 8 input connections, if the command PMDReadIO(axis_handle, 0, &load_reg) is used, load_reg will contain 0x55.

Connections & Associated Signals

The general-purpose IO signals are direct single-signal digital inputs and outputs. There are no associated connections that need to be made for these signals to function properly; however, one or more of the digital grounds must be connected. The default value, upon powerup, for all general-purpose digital outputs is low.

See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a complete description of the pinout connections to/from the card.

2.3.2 Serial Transceiver

This module and associated signals provide the capability to operate the Magellan Motion Processor Developer's Kit card using an asynchronous serial port, or to allow certain monitoring operations to be performed through the serial port, even while the PCI bus is used to command motion sequences.

Two connectors provide serial port signals from the Developer's Kit card to external devices. J13 is a standard DB-9 connector, and is used for point-to-point serial communications. This connector is designed such that it can directly connect to a PC serial port without a null modem. J1 is a 5-pin connector which is used for multi-drop communications with an external driver card. For more information on external driver cards for multi-drop communications, contact your PMD representative.

Regardless of which connector is used, the following information is useful to select baud rates and set other parameters associated with serial pot communications.

The serial port can be operated at various baud rates from 1,200 to 460,800, and different configurations of stop, start, and parity codes. In addition, three connection modes are provided, point-to-point, multi-drop (address bit mode), and multi drop (idle line mode). The following table shows how these parameters can be set on the card.

Switch block S1 sets the transmission rate, parity, stop bits, and protocol. Switch block S2 selects the device address when using the multi-drop protocol. When referring to the table below, the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked **on**.

		S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8	S2-1
Transmission rate (bits per second)	1200	up	up	up	up					
	2400	down	up	up	up					
	9600	up	down	up	up					
	19200	down	down	up	up					
	57600	up	up	down	up					
	115200	down	up	down	up					
	250000	up	down	down	up					
	416667	down	down	down	up					
Parity	None					up	up			
	Odd					down	up			
	Even					up	down			
Stop bits	1							up		
	2							down		
Protocol	Point-to-point								up	up
	Address bit								up	down
	Idle line								down	down

See Figure 1-1 for locations of switches S1 and S2.

2.3.3 S2: Serial Device Address

Switch block S3 sets the device address for multi-drop protocol systems. When referring to the table below, the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked **on**.

> S2-2 and S2-3 must be left in the up position.

Multi-drop address selection (S2)

Address	S2-4	S2-5	S2-6	S2-7	S2-8
0	up	up	up	up	up
1	down	up	up	up	up
2	up	down	up	up	up
3	down	down	up	up	up
4	up	up	down	up	up
5	down	up	down	up	up
6	up	down	down	up	up
7	down	down	down	up	up
8	up	up	up	down	up
9	down	up	up	down	up
10	up	down	up	down	up
11	down	down	up	down	up
12	up	up	down	down	up
13	down	up	down	down	up
14	up	down	down	down	up

Multi-drop address selection (S2)					
Address	S2-4	S2-5	S2-6	S2-7	S2-8
15	down	down	down	down	up
16	up	up	up	up	down
17	down	up	up	up	down
18	up	down	up	up	down
19	down	down	up	up	down
20	up	up	down	up	down
21	down	up	down	up	down
22	up	down	down	up	down
23	down	down	down	up	down
24	up	up	up	down	down
25	down	up	up	down	down
26	up	down	up	down	down
27	down	down	up	down	down
28	up	up	down	down	down
29	down	up	down	down	down
30	up	down	down	down	down
31	down	down	down	down	down

2.3.4 CANbus Transceiver

In addition to a serial port, it is possible to operate the Magellan Motion Processor Developer's Kit by CANbus. The CANbus interface is useful to communicate to the card when one or more cards co-exist on the same network. In addition, compared to a RS-485 interconnect, CANbus communication is faster and more robust.

The following table shows how to configure the CANbus port. When referring to the table below, the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked **on**.

> S3-8 and S4-1 through S4-5 should be left in the on position.

Switches		Description
S3	1-7	Node ID Setting Switches 1-7 of the S3 DIP switch control the CANbus nodeID, allowing the card to be uniquely addressed on the CANbus network. Switches 1-7 are set binary-encoded, with total range of allowed values 0 - 127, and with 1 being least significant, 7 most significant. If a switch is up, it encodes a bit value of 0 and if it is down it encodes a bit value of 1.

S3-1	*S3-2*	*S3-3*	*S3-3*	*S3-4*	*S3-5*	*S3-6*	*S3-7*	*NodeID*
up	up	up	up	up	up	up	up	0
down	up	up	up	up	up	up	up	1
up	down	up	up	up	up	up	up	2
down	down	up	up	up	up	up	up	3
up	up	down	up	up	up	up	up	4
down	up	down	up	up	up	up	up	5
up	down	down	up	up	up	up	up	6
down	down	down	up	up	up	up	up	7
. . .								
down	down	down	down	down	down	down	down	127

Switches		Description			
S4	8-16	Communication rate. These switches set the CANbus communication rate as follows:			
		S4-6	*S4-7*	*S4-8*	*Baud setting*
		up	up	up	1,000,000 baud
		down	up	up	800,000 baud
		up	down	up	500,000 baud
		down	down	up	250,000 baud
		up	up	down	125,000 baud
		down	up	down	50,000 baud
		up	down	down	20,000 baud
		down	down	down	10,000 baud

If the attached CANbus device is the last node on the CAN network, then JP15 should be left in the default position of 2-3 jumpered. If this it is not the last device, then it should be installed with 1-2 jumpered.

C-Motion Commands

CANbus parameters can also be set using C-Motion commands through the CANbus interface or another interface. Although this is not commonly done, it can be useful to test communication ports.

C-Motion Command	Argument(s)	Description
SetCANMode	axis_handle	Sets the CAN mode communication information. The binary word sent *mask* is encoded per the bit field above.
GetCANMode	axis_handle	Gets the CAN mode communication information. The returned word is encoded per the bit field described above

Connections & Associated Signals

A special DIN-style 4-pin connector is used to connect to the CANbus port. *Section 5.2.8 CANBUS Connector, page 65* provides a detailed description.

See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a complete description of the pinout connections to/from the card.

2.3.5 Reset

The Developer's Kit card can be reset manually as well as electrically. To reset the card manually, depress the reset button on the card. This button can be located using Figure 1-1.

Although a reset occurs automatically during power up, a user-initiated reset can also be performed explicitly through the card's PCI-bus interface. There are two methods by which this can be done. They are summarized in the table below:

Method	Type of reset	Description
Reset through motion processor	Soft reset	The C-Motion command PMDReset sends the command Reset to the motion processor, which causes a "soft" reset of the motion processor only. See the *Magellan Motion Processor User's Guide* for more information.

Method	Type of reset	Description
Reset through PCI bus	Hard reset	The C-Motion command PMDHardReset uses the PCI bus to perform a "hard" reset of both the card circuitry and the motion processor. *See table below for more information.* In this context "hard" vs "soft" means decoded externally to the motion processor, or coded through the motion processor. Both types result in the motion processor being reset, however.

After a reset occurs, the motion processor and other related output signals will be driven to known states, depending on the type of reset performed. These are summarized in the table below:

Signal name	Reset condition	
AxisOut1-4	High	
PWMMag1A-4C	DC Brush motor:	Low
	Brushless DC motor:	50/50 High/Low
	Microstepping motor:	Low
PWMSign1A-4B	DC Brush motor:	High
	Brushless DC motor:	Low
	Microstepping motor:	High
DAC1A-DAC4B	0.0 volts	

If Atlas amplifiers are used, a Magellan reset will result in the commanded output torque being set to a zero value. A Magellan reset does not result in an explicit reset of connected Atlas units. If, for whatever reason, an explicit reset of the Atlas units is desired a command can be sent via the Magellan and addressed to the Atlas, or power to the Atlas can be cycled. To learn more about sending Atlas commands via an attached Magellan IC see the *Magellan Motion Processor User's Guide*.

C-Motion Commands

The available C-Motion callable functions for this feature are:

C-Motion Command	Arguments	Function Description
PMDHardReset	axis_handle	This function causes a "hard"' reset of the motion processor. Unlike all other card-specific commands, this command is processed directly through the PCI card interface.
PMDReset	axis_handle	This function causes a "soft" reset of the motion processor.

2.4 Signal Processing and Hardware Functions

Signal processing and hardware functions are card functions which are not directly user-programmable. These are card characteristics which are encoded in hardware. Primarily this consists of various types of signals. The following sections lists these related groups of signals and provides information that may be helpful when connecting your motion system.

2.4.1 Home, AxisIn, AxisOut, Limits, Hall Sensors

These signals are conditioned by the card, but are output or input directly to the motion processor. The *Magellan Motion Processor User's Guide* explains the functions provided in connection with these various signals. Most of the signals are optional, and are connected depending on the nature of the application being used.

These signals are named ***Home1-4***, ***AxisIn1-4***, ***AxisOut1-4***, ***PosLim1-4*** (positive direction limit input), ***NegLim1-4*** (negative direction limit input), and ***Hall1A-4C*** (12 signals in all).

Connections & Associated Signals

This group of signals are direct single-signal digital inputs to the card, with the exception of ***AxisOut***, which is a single-ended output. There are no associated connections that need to be made for these signals to function properly; however, one or more of the digital grounds must be connected. The default value, upon powerup, for all ***AxisOut*** signals, is high.

See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a complete description of the pinout connections to/from the card.

2.4.2 QuadA, QuadB, Index

This group of signals provides position feedback to the controller which is used to track motor position, and for servo motors, to generate a motor command. For DC brush and brushless DC motors, they are required for proper operation. For microstepping or pulse and direction motors, they are optional.

The encoder-processing circuitry provides a multi-pass digital filter of the ***QuadA***, ***QuadB***, and ***Index*** signals for each axis. This provides additional protection against erroneous noise spikes, thereby improving reliability and motion integrity.

These signals are named ***QuadA1+*** through ***QuadB4-*** (16 signals), and ***Index1+*** through ***Index4-*** (8 signals).

Connections & Associated Signals

This group of signals are connected in one of two ways. Single-ended termination means that only one wire per signal is used, while differential (dual) mode means two wires encode each signal (labeled + and -). Differential encoding is generally recommended for the highest level of reliability because it provides greater noise immunity than a single-ended connection scheme.

If single-ended connections are used only the + signal is connected, and the - signal should be left floating. For example, in connecting to the A quadrature input, ***QuadA1+*** connects to the signal, and ***QuadA1-*** is left floating. If differential connections are used, both the + and - signals are used.

Differential or single-ended termination must be selected through resistor pack installation. (See table in Section 1.6.1, "Resistor Packs" for details.) Note that all quadrature and index connections should be in either single-ended or differential mode. It is not possible to mix on a signal-by-signal basis.

When using the system with differential connections, if desired, the polarity of the differential signal can be reversed by swapping the + and - connections. This may be useful for altering the motor and/or encoder direction; however, this same function can also be accomplished through commands to the motion processor. See the *Magellan Motion Processor User's Guide,* for more information.

Associated connections that are supported by the card are the +5V output signals. These are provided as a convenience, as they are generally connected to a corresponding input on the encoder, to power its circuitry. As was the case for the digital input signals, one or more of the digital grounds must also be connected.

See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a complete description of the pinout connections to/from the card.

2.4.3 Pulse & Direction Input Over QuadA, QuadB

The Magellan DK card supports an alternate decoding scheme for the QuadA and QuadB position input signals consisting of pulse & direction position feedback interpretation.

Normally, the QuadA and QuadB signals are interpreted to be quadrature encoded. After passing through the differential receiver circuitry they are output as digital logic levels directly to the Magellan IC, which only supports quadrature encoded signals at these two pins.

The Magellan DK includes logic circuitry external to the Magellan IC which, when enabled, converts incoming pulse & direction signals into corresponding quadrature encoded signals. After conversion, these quadrature-encoded signals are passed to the Magellan IC where they are used to accumulate the feedback position in the normal manner.

This capability can be set on a per-axis basis, meaning that some axes can be set to input quadrature-encoded signals, and other axes can input pulse & direction-encoded signals. Selection of standard (no conversion) or converting (pulse & direction to quadrature conversion) signal processing is controlled via dip switches S5.4, S5.8, S6.4 and S6.8.

The primary use of this feature is to allow position command input from external pulse & direction output motion controllers. Inputting this position data stream into Magellan is useful for:

- Electronic gear or cam position command input
- Analysis of an external controller's pulse & direction profile
- Setup and optimization of systems that will use Atlas amplifiers in pulse & direction signal input mode.

The table below shows hot to set the QuadA and QuadB input mode:

Item	Switch	Description
Dip switch S5-4	up	Sets QuadA and QuadB interpretation for Axis 1 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 1 to pulse & direction
Dip switch S5-8	up	Sets QuadA and QuadB interpretation for Axis 2 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 2 to pulse & direction
Dip switch S6-4	up	Sets QuadA and QuadB interpretation for Axis 3 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 3 to pulse & direction
Dip switch S6-8	up	Sets QuadA and QuadB interpretation for Axis 4 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 4 to pulse & direction

2.4.4 Analog Input

The *Analog0-7* signals provide general purpose input of 8 analog signals. If connected, the voltages present at these various connections do not directly affect the motion processor's behavior. However they can be read through the motion processor, and thus provide a convenient way of bringing in analog signal levels that may be acted upon by the user's application code located on the PC. These signals are read using the Magellan command ReadAnalog. In conjunction with the *Analog0-7* signals, the user must also provide a number of other signals that provide analog reference scaling to the Magellan Motion Processor. These signals are summarized in the table below:

Signal name	Function
AnalogRefLow	Provides minimum allowed analog voltage input signal. Has an allowed range of 0 to 3.3V. Generally connected to 0 volts.
AnalogRefHigh	Provides maximum allowed analog voltage input signal. Has an allowed range of 0 to 3.3V, but must be greater than ***AnalogRefLow***. Generally connected to 3.3 volts.
AnalogGND	Provides ground return for reference and analog input signals

All of the analog signals described in this section are directly connected to the corresponding pins on the Magellan Motion Processor. For more information on reading the value of these analog inputs, see the *Magellan Motion Processor User's Guide*.

Connections & Associated Signals

For analog voltages to be read correctly, in addition to the analog signals ***Analog0-7*** themselves, ***AnalogRefLow***, ***AnalogRefHigh***, and ***AnalogGND*** must be connected. See the preceding table for more information.

2.4.5 SPI Atlas Bus

Atlas amplifiers are directly supported via SPI Atlas bus signals. This bus connects the Magellan to the Atlas amplifier units, and allows bi-directional communication so that Magellan may continually specify the desired amplifier output command as well as query Atlas for parameters or other control/status information. Communication on the SPI Atlas bus is in the form of packets using a command protocol defined by the Atlas amplifiers.

The bus hardware signaling is the same regardless of motor type. Motor-specific differences are represented in the command protocol rather than differences in signal connections. For detailed information on SPI hardware timing and command protocols refer to the *Atlas Digital Amplifier Complete Technical Reference*.

Connections & Associated Signals

There are seven signals associated with the SPI Atlas bus: SPIClock, SPIXmt, SPIRcv, and SPIEnable1, SPIEnable2, SPIEnable3, and SPIEnable4. All of these signals directly connect to the Magellan chipset.

This group of signals, along with ground connections, are available at J14, and comprise an interface directly compatible with the Atlas Developer's Kit cards. See Appendix A, "Atlas Developer's Kit" for a complete description of the Atlas DK system. See Section 2.4.5, "SPI Atlas Bus" for a detailed description of J14, the SPI Atlas bus connector.

2.4.6 Pulse and Direction Out

For pulse & direction amplifiers these signals provide an output stream of pulse and direction data compatible with a wide variety of off-the-shelf step motor amplifiers. These signals are directly generated by the Magellan motion processor. For more information on output waveforms, pulse rates, and related information, see the *Magellan Motion Processor User's Guide,* "Open Loop Stepper Control."

These signals are named ***pulse1-4, direction1-4***.

The default value, upon powerup, for all pulse & direction output signals is high.

Connections & Associated Signals

This group of signals are direct single-signal digital outputs. There are no associated connections that need to be made for these signals to function properly; however, one or more of the digital grounds must be connected.

See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a complete description of the pinout connections to/from the card.

2.4.7 PWM Out

For servo or microstepping motors these signals provide PWM (pulse width modulated) motor command signals when the motor output mode is set to **PWMSignMagnitude** or **PWM5050Magnitude**. See the *Magellan Motion Processor User's Guide* for complete information. The number of signals per axis varies depending on the motor type being connected to, the number of phases that the motor has, and the motor drive method (sign/magnitude or 50/50).

Chapter 3, "Magellan Developer's Kit Electrical Specifications" has complete connection tables for various motor configurations.

These signals are named *PWMMag1A-4C* (12 signals) and *PWMSign1A-4B* (8 signals).

Connections & Associated Signals

This group of signals are direct single-signal digital outputs. There are no associated connections that need to be made for these signals to function properly; however, one or more of the digital grounds must be connected.

See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a complete description of the pinout connections to/from the card.

2.4.8 Motor Command

For servo or microstepping motors, these signals contain the analog motor command when the motor output mode is set to DAC (digital to analog converter). These signals vary between -10V and +10V. See the *Magellan Motion Processor User's Guide* for more information. The number of signals per axis varies depending on the motor type being connected to.

These signals are named *DAC1A - DAC4B* (8 signals).

Connections & Associated Signals

For analog voltages to be output correctly, *GND* (motor command ground) must be connected.

See Chapter 3, "Magellan Developer's Kit Electrical Specifications" for a complete description of the pinout connections to/from the card.

3. Magellan Developer's Kit Electrical Specifications

In This Chapter

- Magellan Configuration Switch Blocks
- Magellan Connectors
- Outputs to Motor Amplifiers
- Encoder Inputs

Figure 3-1 shows the locations of the principal components of the developer's kit board. The component side of the board is shown, with the PCI slot connector at the bottom. All component locations in this manual refer to this orientation. In Figure 3-1 the motion processor's CP chip and IO chip are identified for reference. All other components of interest to the user are identified by their board label:

- Switch blocks S1 and S2 set the serial interface configuration and multi-drop address
- Switch blocks S3 and S4 set the CANbus interface configuration
- Switch blocks S5 and S6 select the motor type (used with MC58000 family products only) along with the encoding format of the QuadA and QuadB signals
- Resistor Packs RS1-RS3 select whether single-ended or differential encoder are connected
- Jumper JP15 selects whether CANbus node is last in the network
- Jumpers JP16-18 configure the board to work with Atlas-compatible Magellans, or with pre-Atlas Magellans
- Connectors J1, J2, J4, J5, J10, J13, J14 and JS1 provide connections to and from external components

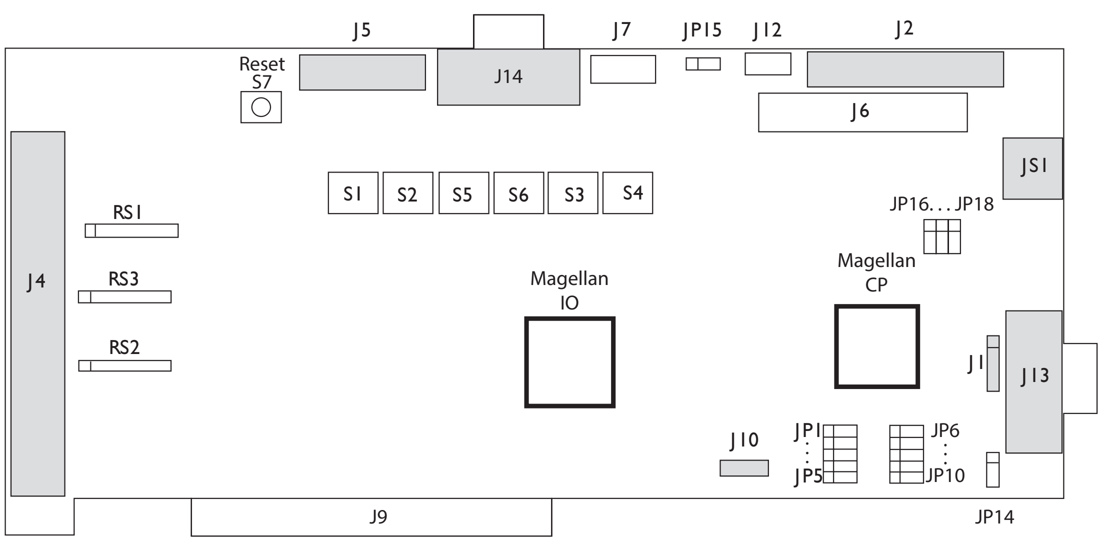


Figure 3-1: Location of Various Board Elements

3.1 Magellan Configuration Switch Blocks

These switch blocks are oriented horizontally on the developer's kit board; on is up.

3.1.1 S1: Serial Transmission Parameters

Switch block S1 sets the transmission rate, parity, stop bits, and protocol. Switch block S2 selects the device address when using the multi-drop protocol. When referring to the table below, the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked **on.**

		S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8	S2-1
Transmission rate (bits per second)	1200	up	up	up	up					
	2400	down	up	up	up					
	9600	up	down	up	up					
	19200	down	down	up	up					
	57600	up	up	down	up					
	115200	down	up	down	up					
	250000	up	down	down	up					
	416667	down	down	down	up					
Parity	None					up	up			
	Odd					down	up			
	Even					up	down			
Stop bits	1							up		
	2							down		
Protocol	Point-to-point								up	up
	Address bit								up	down
	Idle line								down	down

3.1.2 S2: Serial Device Address

Switch block S3 sets the device address for multi-drop protocol systems. When referring to the table below, the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked **on**.

> S2-2 and S2-3 must be left in the up position.

Multi-drop address selection (S2)

Address	S2-4	S2-5	S2-6	S2-7	S2-8
0	up	up	up	up	up
1	down	up	up	up	up
2	up	down	up	up	up
3	down	down	up	up	up
4	up	up	down	up	up
5	down	up	down	up	up

Multi-drop address selection (S2)

Address	S2-4	S2-5	S2-6	S2-7	S2-8
6	up	down	down	up	up
7	down	down	down	up	up
8	up	up	up	down	up
9	down	up	up	down	up
10	up	down	up	down	up
11	down	down	up	down	up
12	up	up	down	down	up
13	down	up	down	down	up
14	up	down	down	down	up
15	down	down	down	down	up
16	up	up	up	up	down
17	down	up	up	up	down
18	up	down	up	up	down
19	down	down	up	up	down
20	up	up	down	up	down
21	down	up	down	up	down
22	up	down	down	up	down
23	down	down	down	up	down
24	up	up	up	down	down
25	down	up	up	down	down
26	up	down	up	down	down
27	down	down	up	down	down
28	up	up	down	down	down
29	down	up	down	down	down
30	up	down	down	down	down
31	down	down	down	down	down

3.1.3 CANbus Transceiver

The following table shows how to configure the CANbus port. When referring to the table below, the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked **on**.

> S3-8 and S4-1 through S4-5 should be left in the on position.

Switches		Description								
S3	1-7	Node ID Setting Switches 1-7 of the S3 DIP switch control the CANbus nodeID, allowing the card to be uniquely addressed on the CANbus network. Switches 1-7 are set binary-encoded, with total range of allowed values 0 - 127, and with 1 being least significant, 7 most significant. If a switch is up, it encodes a bit value of 0 and if it is down it encodes a bit value of 1.								
		S3-1	*S3-2*	*S3-3*	*S3-3*	*S3-4*	*S3-5*	*S3-6*	*S3-7*	*NodeID*
		up	up	up	up	up	up	up	up	0
		down	up	up	up	up	up	up	up	1
		up	down	up	up	up	up	up	up	2
		down	down	up	up	up	up	up	up	3
		up	up	down	up	up	up	up	up	4
		down	up	down	up	up	up	up	up	5
		up	down	down	up	up	up	up	up	6
		down	down	down	up	up	up	up	up	7
		. . .								
		down	down	down	down	down	down	down	down	127
S4	8-16	Communication rate. These switches set the CANbus communication rate as follows:								
		S4-6	*S4-7*	*S4-8*	*Baud setting*					
		up	up	up	1,000,000 baud					
		down	up	up	800,000 baud					
		up	down	up	500,000 baud					
		down	down	up	250,000 baud					
		up	up	down	125,000 baud					
		down	up	down	50,000 baud					
		up	down	down	20,000 baud					
		down	down	down	10,000 baud					

If the attached CANbus device is the last node on the CAN network, then JP15 should be left in the default position of 2-3 jumpered. If this it is not the last device, then it should be installed with 1-2 jumpered.

3.1.4 Motor Type Switch Settings

When using the DK55000 only pulse and direction motors are used, and it is not necessary to set jumpers related to motor type. When using the DK58000 it is possible to support any combination of DC brush, brushless DC, microstepping, and pulse & direction motors all on the same card. To accomplish this dip switches 5 and 6 must be set to indicate the motor type that will be used for each axis.

When configuring the dip switches and connecting your motors to the Developer's Kit Card, the following information may be helpful:

- *Brushless DC* means the card expects to connect to a brushless DC motor with Hall sensors and an encoder. With this connection, the Developer's Kit card performs the commutation and outputs a multiphase signal, 2 or 3 phases per axis, to the amplifier. For Atlas-connected axes only 2 phase may be selected.
- *Pulse and direction* is used with step motor Atlas amplifiers, or to connect to a step motor which uses a standard pulse and direction amplifier. Quadrature feedback is optional with this type of motor.

- *Microstepping* means the Developer's Kit card outputs a multi-phase signal, 2 or 3 phases per axis, to a step motor amplifier that can accept this type of output. Quadrature feedback is optional with this type of motor.
- *DC Brush* means the cards expects to connect to a DC brush motor with an encoder, or an externally commutated brushless DC motor. With this motor type the card outputs one phase per axis.

Motor Type Jumper settings (for DK58000 only)

When referring to the table below the switch up position is relative to the bottom of the board where the PCI connector is located. The up position on the switch is marked on.

Item	Switches	Description			
Dip	S5-1	Axis #1 Motor type setting			
switch	S5-2	Set S5 1-3 dip switches according to the motor type you will be using on axis #1			
S5	S5-3	5-1	5-2	5-3	Axis #1
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)
Dip	S5-5	Axis #2 Motor type setting			
switch	S5-6	Set S5 5-7 dip switches according to the motor type you will be using on axis #2			
S5	S5-7	5-5	5-6	5-7	Motor type setting
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)
Dip	S6-1	Axis #3 Motor type setting			
switch	S6-2	Set S6 1-3 dip switches according to the motor type you will be using on axis #3			
S5	S6-3	6-1	6-2	6-3	Motor type setting
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)
Dip	S6-5	Axis #4 Motor type setting			
switch	S6-6	Set S6 5-7 dip switches according to the motor type you will be using on axis #4			
S5	S6-7	6-5	6-6	6-7	Motor type setting
		up	up	up	Brushless DC (3 phase)
		down	up	up	Brushless DC (2 phase)
		up	down	up	Microstepping (3 phase)
		down	down	up	Microstepping (2 phase)
		up	up	down	Pulse & direction
		down	down	down	DC brush (default setting)

Unconnected motors can be left at the default setting of *DC brush*.

3.1.5 QuadA, QuadB Signal Interpretation

The QuadA and QuadB position feedback signals can be provided to the Magellan as is, or after conversion from pulse & direction encoding to quadrature encoding. For quadrature encoders and most position feedback devices, the default encoding of quadrature should be used.

To input position information via the QuadA and QuadB signals from pulse & direction controllers, enable the conversion by selecting pulse & direction encoding.

Item	Switch	Description
Dip switch S5-4	up	Sets QuadA and QuadB interpretation for Axis 1 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 1 to pulse & direction
Dip switch S5-8	up	Sets QuadA and QuadB interpretation for Axis 2 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 2 to pulse & direction
Dip switch S6-4	up	Sets QuadA and QuadB interpretation for Axis 3 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 3 to pulse & direction
Dip switch S6-8	up	Sets QuadA and QuadB interpretation for Axis 4 to quadrature
	down	Sets QuadA and QuadB interpretation for Axis 4 to pulse & direction

3.1.6 Resistor Packs

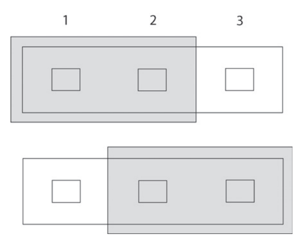
To prepare your card for installation the following user-settable hardware option should be checked:

Item	How to set	Description
Resistor packs -	Installed this is the default setting of resistor packs RS1-RS3	If you are using differential connections leave these resistor packs installed.
RS1, RS2, RS3	Removed	If you are using single-ended encoder connections, remove the resistor packs.

3.1.7 CANbus Termination Jumper (JP15)

If you are using the Magellan Developer's Kit card with a CANbus network, then the CANbus Termination Jumper (JP15) should be set.

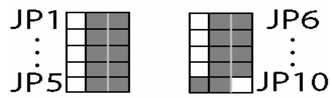
Jumper 1-2 if this card is not the last node on the network, and jumper 2-3 (default jumpering) if card is the last (or only) node on network. See diagram below for more details.



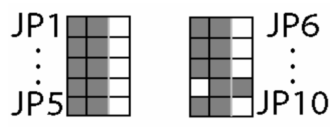
3.1.8 Device Type Selection Jumpers (JP1-JP10)

These jumpers are used to select signal connection paths appropriate for the type of Magellan Motion Processor that is installed. These jumpers are set at the factory and should not be changed unless a motion processor is installed that requires alternate settings. If this is the case a PMD representative will provide specific instructions on the new jumper settings.

Jumper positions for the MC58110 and MC55110



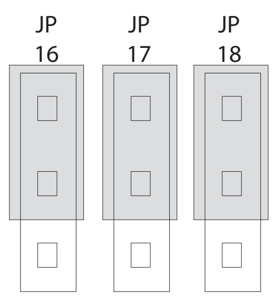
Jumper positions for the MC58x20 and MC55x20



3.1.9 Atlas-Compatible Magellan Jumpers (JP16-JP18)

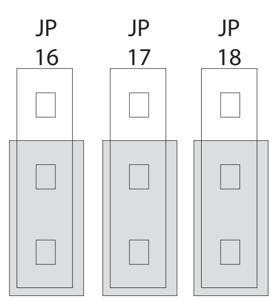
These jumpers are used to select signal connection paths appropriate for Magellan Processors rev 3.0 or later, which are Magellan processors that support Atlas Digital Amplifiers.

For installed Magellan Motion Processors prior to rev 3.0, jumpers JP16, JP17, and JP18 should be connected at the 1-2 position. For installed Magellan Motion Processors rev 3.0 or higher, jumpers JP16, JP17, and JP18 should be connected at the 2-3 position.



Jumper positions for Atlas-compatible Magellan

Figure 3-2: JP16-18 in 2-3 Position



Jumper positions for pre-Atlas Magellans (lower than rev 3.0)

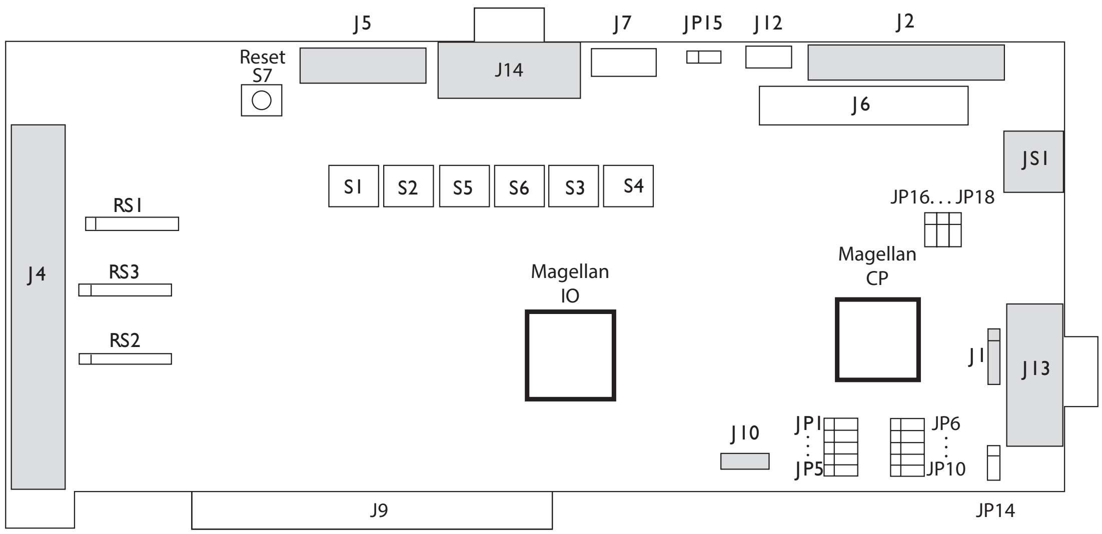
Figure 3-3: JP16-18 in 1-2 Position

3.2 Magellan Connectors

This section describes the pinouts for the following cable connectors on the Magellan Motion Processor Developer's Kit card (shaded areas in diagram below):

J1	5-pin serial communication connector
J2	16-pin analog input connector
J4	100-pin main connector containing encoder input, Hall input, AxisIn signals, AxisOut signals, Motor output signals, and limit switch inputs
J5	20-pin user-defined digital I/O connector
J10	4-pin 5v power connector
J13	9-pin DB-9 serial port connector
J14	9-pin DB-9 SPI ATLAS connector
JS1	4-pin CANbus connector

Figure 3-4: Connector Locator



3.2.1 Serial Communications Connector (J1)

J1 is a 5-pin single row header (0.1" spacing).

> Connector J1 is used with multi-drop serial communications. Connector J13 is used with serial point-to-point communications. See Section 2.3.2, "Serial Transceiver" for more information.

Pin number	Signal name
1	SrlXmt (CP pin 44)
2	SrlRcv (CP pin 43)
3	SrlEnable (CP pin 99)
4	GND
5	3.3V

3.2.2 Analog Input Connector (J2)

This is a 16-pin header (2x13, 0.1" spacing).

Pin number	Signal name	Pin number	Signal name
1	Analog0	9	AnalogRefHigh
2	Analog1	10	AnalogRefLow
3	Analog2	11	AnalogGND
4	Analog3	12	AnalogGND
5	Analog4	13	AnalogVcc
6	Analog5	14	~HostIntrpt*
7	Analog6	15	Gnd*
8	Analog7	16	3.3V*

*~HostIntrpt, along with Gnd and 3.3V are connected to the corresponding pins on the Magellan Motion Processor. They can be used to externalize the ~HostIntrpt signal from the Magellan Motion Processor if this is desired.

3.2.3 Motion Peripherals Connector (J4)

For use with 2-IC Magellan Processor Developer Kits (DK58420, DK55420)

This is a 100-pin high-density connector (2x50, 0.05" spacing). The accompanying cable assembly supplied with your developer's kit consists of two 36" flat ribbon cables terminating together at one end in the matching 100-pin connector. At the other end, each ribbon terminates in a 50-pin header (2x25, 0.1" spacing). The ribbons are labeled Hdr1 and Hdr2. Pins 1-50 on Hdr1 connect to pins 1-50 of J4. Pins 1-50 of Hdr2 connect to pins 51-100 of J4.

Header 1 (to J4 pins 1-50)				Header 2 (to J4 pins 51-100)			
Pin	Signal name	Pin	Signal name	Pin	Signal name	Pin	Signal name
1	QuadA1+	26	QuadA2+	1	QuadA3+	26	QuadA4+
2	QuadA1-	27	QuadA2-	2	QuadA3-	27	QuadA4-
3	QuadB1+	28	QuadB2+	3	QuadB3+	28	QuadB4+
4	QuadB1-	29	QuadB2-	4	QuadB3-	29	QuadB4-
5	Index1+	30	Index2+	5	Index3+	30	Index4+
6	Index1-	31	Index2-	6	Index3-	31	Index4-
7	Vcc (encoder)	32	Vcc (encoder)	7	Vcc (encoder)	32	Vcc (encoder)
8	GND (encoder)	33	GND (encoder)	8	GND (encoder)	33	GND (encoder)
9	Hall1A	34	Hall2A	9	Hall3A	34	Hall4A
10	Hall1B	35	Hall2B	10	Hall3B	35	Hall4B
11	Hall1C	36	Hall2C	11	Hall3C	36	Hall4C
12	GND (Hall)	37	GND (Hall)	12	GND (Hall)	37	GND (Hall)
13	PosLim1	38	PosLim2	13	PosLim3	38	PosLim4
14	NegLim1	39	NegLim2	14	NegLim3	39	NegLim4
15	Home1	40	Home2	15	Home3	40	Home4
16	AxisIn1	41	AxisIn2	16	AxisIn3	41	AxisIn4
17	AxisOut1	42	AxisOut2	17	AxisOut3	42	AxisOut4
18	PWMMagA1/Pulse1	43	PWMMagA2/Pulse2	18	PWMMagA3/Pulse3	43	PWMMagA4/Pulse4
19	PWMMagB1	44	PWMMagB2	19	PWMMagB3	44	PWMMagB4
20	PWMMagC1/ PWMsignB1/ AtRest1	45	PWMMagC2/ PWMsignB2/ AtRest2	20	PWMMagC3/ PWMsignB3/ AtRest3	45	PWMMagC4/ PWMsignB4/ AtRest4
21	PWMsignA1/ Direction1	46	PWMsignA2/ Direction2	21	PWMsignA3/ Direction3	46	PWMsignA4/ Direction4

Header 1 (to J4 pins 1-50)				Header 2 (to J4 pins 51-100)			
22	DACA1*	47	DACA2*	22	DACA3*	47	DACA4*
23	DACB1*	48	DACB2*	23	DACB3*	48	DACB4*
24	GND (DAC)	49	GND (DAC)	24	GND (DAC)	49	GND (DAC)
25	N.C.	50	N.C.	25	N.C.	50	N.C.

Unused signals may be left unconnected. Each converter cable has labels to indicate HDR1 and HDR2.

For use with single-IC Magellan Processor Developer Kits (DK58110, DK55110)

This is a 100-pin high-density connector (2x50, 0.05" spacing). The accompanying cable assembly supplied with your developer's kit consists of two 36" flat ribbon cables terminating together at one end in the matching 100-pin connector. At the other end, each ribbon terminates in a 50-pin header (2x25, 0.1" spacing). The ribbons are labeled Hdr1 and Hdr2. Pins 1-50 on Hdr1 connect to pins 1-50 of J4. Pins 1-50 of Hdr2 connect to pins 51-100 of J4.

Header 1 (to J4 pins 1-50)				Header 2 (to J4 pins 51-100)			
Pin	Signal name	Pin	Signal name	Pin	Signal name	Pin	Signal name
1	QuadA1+	26	N.C.	1	N.C.	26	N.C.
2	QuadA1-	27	N.C.	2	N.C.	27	N.C.
3	QuadB1+	28	N.C.	3	N.C.	28	N.C.
4	QuadB1-	29	N.C.	4	N.C.	29	N.C.
5	Index1+	30	N.C.	5	N.C.	30	N.C.
6	Index1-	31	N.C.	6	N.C.	31	N.C.
7	Vcc (encoder)	32	N.C.	7	N.C.	32	N.C.
8	GND (encoder)	33	N.C.	8	GND	33	N.C.
9	Hall1A	34	N.C.	9	PWMSign1B	34	N.C.
10	Hall1B	35	N.C.	10	PWMMag1C	35	N.C.
11	Hall1C	36	N.C.	11	N.C.	36	PWMMag1A/Pulse1
12	GND (Hall)	37	N.C.	12	N.C.	37	N.C.
13	PosLim1	38	N.C.	13	N.C.	38	N.C.
14	NegLim1	39	N.C.	14	N.C.	39	N.C.
15	Home1	40	N.C.	15	N.C.	40	N.C.
16	AxisIn1	41	N.C.	16	PWMMag1B/ AtRest1	41	N.C.
17	AxisOut1	42	N.C.	17	N.C.	42	PWMSign1A/ Direction1/SPIEnable
18	N.C.	43	N.C.	18	N.C.	43	N.C.
19	N.C.	44	N.C.	19	N.C.	44	N.C.
20	N.C.	45	N.C.	20	N.C.	45	N.C.
21	N.C.	46	N.C.	21	N.C.	46	N.C.
22	DACA1	47	N.C.	22	N.C.	47	N.C.
23	DACB1	48	N.C.	23	N.C.	48	N.C.
24	GND (DAC)	49	N.C	24	N.C.	49	N.C.
25	N.C.	50	N.C.	25	N.C.	50	N.C.

3.2.4 Connector Pin Layout

The following diagram shows the pin layout for the two 50-pin header cables used with the Magellan board.

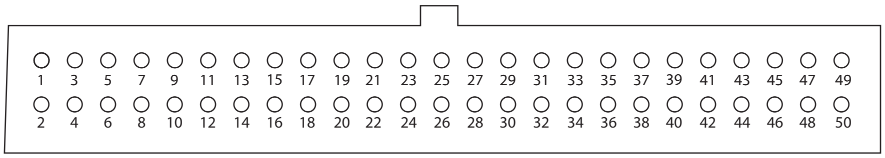


Figure 3-5: Bottom view of 50-pin Header Connector

For testing purposes, this connector can be mated with a terminal block. PMD suggests Phoenix Contact (http://www.phoenixcon.com/), part number FLKM 50 (Digi-Key part number 2281089-ND).

3.2.5 User-defined Digital IO Connector (J5)

These general-purpose IO signals source up to 4mA and can sink up to 8mA. These pins are accessed using the Magellan commands ReadIO/WriteIO.

This is a 20-pin header (2x10, 0.1" spacing).

Pin number	Signal name	Pin number	Signal name
1	PrlIn0	10	PrlOut4
2	PrlOut0	11	PrlIn5
3	PrlIn1	12	PrlOut5
4	PrlOut1	13	PrlIn6
5	PrlIn2	14	PrlOut6
6	PrlOut2	15	PrlIn7
7	PrlIn3	16	PrlOut7
8	PrlOut3	17, 19	GND
9	PrlIn4	18, 20	3.3V

3.2.6 Standalone Power Connector (J10)

This is a green 2-connection terminal block.

Pin number	Signal name
1	+5V
2	GND

3.2.7 Serial Port Connector (J13)

This is a male DB-9 connector.

> Connector J1 is used with multi-drop serial communications. Connector J13 is used with serial point-to-point communications. See Section 2.3.2, "Serial Transceiver" for more information.

Pin number	Signal name
1	No connection
2	Serial Transmit
3	Serial Receive
4	No connection
5	Gnd
6	No connection
7	No connection
8	No connection
9	No connection

3.2.8 SPI Atlas Bus Connector (J14)

This is a female DB-9 connector.

This connector is designed to be compatible with the Atlas DK bus system of cables and cards. See Appendix A, "Atlas Developer's Kit" for more information on Atlas DKs

Pin number	Signal name
1	SPIEnable3
2	SPIEnable2
3	GND
4	GND
5	SPIRcv
6	SPIEnable1
7	SPIEnable4
8	SPIClock
9	SPIXmt

3.2.9 CANbus Connector (JS1)

This is a 4-pin mini-DIN connector.

Pin number	Signal name
1	CANH
2	CANL
3	GND
4	No connection

3.3 Outputs to Motor Amplifiers

When connecting any axis to an Atlas amplifier the SPI ATLAS bus connector (J14) is used.

For axes that are not connected to Atlas amplifiers, there are four types of output to the motor amplifiers:

DAC	Analog signals from the on-board D/A converters
PWM 50/50	Pulse-width modulated square-wave signals with a 50% duty cycle
PWM sign-magnitude	Pulse-width modulated signals with definable duty cycle and direction
Pulse & direction	Step-motor output digital pulse and direction signals

These outputs should be connected from the designated J4 pins to the appropriate amplifier inputs, as shown in the following tables. The names of the input pins may vary among amplifiers; common names are shown.

3.3.1 DK58420

Brushed Servo Motors

			J4 connection (Header-pin)			
	Signal name	*Amplifier input*	*Axis 1*	*Axis 2*	*Axis 3*	*Axis 4*
DAC	DACA*n*	Ref+ or V+	Hdr1-22	Hdr1-47	Hdr2-22	Hdr2-47
	GND*n*	Ref- or Gnd	Hdr1-24	Hdr1-49	Hdr2-24	Hdr2-49
PWM sign/magnitude	PWMMagA*n*	PWM magnitude	Hdr1-18	Hdr1-43	Hdr2-18	Hdr2-43
	PWMSignA*n*	PWM direction	Hdr1-21	Hdr1-46	Hdr2-21	Hdr2-46
	GND	GND	Hdr1-8	Hdr1-33	Hdr2-8	Hdr2-33

3.3.2 Brushless Servo Motors

			J4 connection (Header-pin)			
	Signal name	*Amplifier input*	*Axis 1*	*Axis 2*	*Axis 3*	*Axis 4*
DAC	DACA*n*	Ref1+ or V1+	Hdr1-22	Hdr1-47	Hdr2-22	Hdr2-47
	DACB*n*	Ref2+ or V2+	Hdr1-23	Hdr1-48	Hdr2-23	Hdr2-48
	GND*n*	Ref- or Gnd	Hdr1-24	Hdr1-49	Hdr2-24	Hdr2-49
PWM 50/50	PWMMagA*n*	PWM phase 1	Hdr1-18	Hdr1-43	Hdr2-18	Hdr2-43
	PWMMagB*n*	PWM phase 2	Hdr1-19	Hdr1-44	Hdr2-19	Hdr2-44
	PWMMagC*n*	PWM phase 3	Hdr1-20	Hdr1-45	Hdr2-20	Hdr2-45
	GND	GND	Hdr1-8	Hdr1-33	Hdr2-8	Hdr2-33

3.3.3 Microstepping Motors

			J4 connection (Header-pin)			
	Signal name	*Amplifier input*	*Axis 1*	*Axis 2*	*Axis 3*	*Axis 4*
DAC	DACA*n*	Ref+ or V+	Hdr1-22	Hdr1-47	Hdr2-22	Hdr2-47
	DACBn	Ref+ or V+	Hdr1-23	Hdr1-48	Hdr2-23	Hdr2-48
	GND*n*	Ref- or Gnd	Hdr1-24	Hdr1-49	Hdr2-24	Hdr2-49
PWM sign/magnitude	PWMMagA*n*	PWM magnitude	Hdr1-18	Hdr1-43	Hdr2-18	Hdr2-43
	PWMSignA*n*	PWM direction	Hdr1-21	Hdr1-46	Hdr2-21	Hdr2-46
	PWMMagB*n*	PWM magnitude	Hdr1-19	Hdr1-44	Hdr2-19	Hdr2-44
	PWMSignB*n*	PWM direction	Hdr1-20	Hdr1-45	Hdr2-20	Hdr2-45
	GND	GND	Hdr1-8	Hdr1-33	Hdr2-8	Hdr2-33

3.3.4 DK58420 and DK55420

Pulse & Direction Motors

		J4 connection (Header-pin)			
Signal name	*Amplifier input*	*Axis 1*	*Axis 2*	*Axis 3*	*Axis 4*
Pulse *n*	Pulse or step	Hdr1-18	Hdr1-43	Hdr2-18	Hdr2-43
Direction *n*	Direction	Hdr1-21	Hdr1-46	Hdr2-21	Hdr2-46
GND	GND	Hdr1-8	Hdr1-33	Hdr2-8	Hdr2-33

3.3.5 DK58110

Brushed Servo Motors

			J4 connection (Header-pin)
	Signal name	*Amplifier input*	*Axis 1*
DAC	DACA1	Ref+ or V+	Hdr1-22
	GND	Ref- or Gnd	Hdr1-24
PWM sign/magnitude	PWMMag1A	PWM magnitude	Hdr2-36
	PWMSign1A	PWM direction	Hdr2-42
	GND	GND	Hdr2-8

3.3.6 Brushless Servo Motors

			J4 connection (Header-pin)
	Signal name	*Amplifier input*	*Axis 1*
DAC	DACA1	Ref1+ or V1+	Hdr1-22
	DACB1	Ref2+ or V2+	Hdr1-23
	GND	Ref- or Gnd	Hdr1-24
PWM 50/50	PWMMag1A	PWM phase 1	Hdr2-36
	PWMMag1B	PWM phase 2	Hdr2-16
	PWMMag1C	PWM phase 3	Hdr2-10
	GND	GND	Hdr2-8

3.3.7 Microstepping Motors

			J4 connection (Header-pin)
	Signal name	*Amplifier input*	*Axis 1*
DAC	DACA1	Ref+ or V+	Hdr1-22
	DACB1	Ref+ or V+	Hdr1-23
	GNDn	Ref- or Gnd	Hdr1-24
PWM sign/magnitude	GND	PWM magnitude	Hdr2-36
	PWMMag1A	PWM direction	Hdr2-42
	PWMMag1B	PWM magnitude	Hdr2-16
	PWMMag1C	PWM direction	Hdr2-9
	GND	GND	Hdr2-8

3.3.8 DK58110 and DK55110

Pulse & Direction Motors

		J4 connection (Header-pin)
Signal name	*Amplifier input*	*Axis 1*
Pulse1	Pulse or step	Hdr2-36
Direction1	Direction	Hdr2-42
GND	GND	Hdr2-8

3.4 Encoder Inputs

Resistor packs RS1 - RS3

These three resistor packs are at the left end of the developer's kit board, next to the 100-pin connector J4. When using differential encoders, leave these packs in place. When using open-ended encoders, remove all three packs and connect encoder signals to the positive encoder input only. The negative input can be left unconnected. Encoder connections are shown below.

Encoder connections when using differential encoder input

Signal	J4 pin connections			
	Axis 1	Axis 2	Axis 3	Axis 4
QuadAn+	Hdr1-1	Hdr1-26	Hdr1-51	Hdr1-76
QuadAn-	Hdr1-2	Hdr1-27	Hdr1-52	Hdr1-77
QuadBn+	Hdr1-3	Hdr1-28	Hdr1-53	Hdr1-78
QuadBn-	Hdr1-4	Hdr1-29	Hdr1-54	Hdr1-79
Indexn+	Hdr1-5	Hdr1-30	Hdr1-55	Hdr1-80
Indexn-	Hdr1-6	Hdr1-31	Hdr1-56	Hdr1-81
Vcc	Hdr1-7	Hdr1-32	Hdr1-57	Hdr1-82
GND	Hdr1-8	Hdr1-33	Hdr1-58	Hdr1-83

Encoder connections when using single-ended encoder input

Signal	J4 pin connections			
	Axis 1	Axis 2	Axis 3	Axis 4
QuadAn	Hdr1-1	Hdr1-26	Hdr1-51	Hdr1-76
QuadBn	Hdr1-3	Hdr1-28	Hdr1-53	Hdr1-78
Indexn	Hdr1-5	Hdr1-30	Hdr1-55	Hdr1-80
Vcc	Hdr1-7	Hdr1-32	Hdr1-57	Hdr1-82
GND	Hdr1-8	Hdr1-33	Hdr1-58	Hdr1-83

3.5 Environmental and Electrical Ratings

All ratings and ranges are for both the IO and CP chips.

Dimensions	4.25" x 9.25", PCI Adapter
Storage Temperature	-40 °C to 125 °C
Operating Temperature	0 °C to 70 °C*
Power Consumption	1A @ 5V; 83mA @ 12V
Supply Voltage Limits	-0.3V to +7.0V
Supply Voltage Operating Range	4.75V to 5.25V
Analog Output Range	-10.0V to 10.0V
Analog Input Range	0.0V to 3.3V
Digital Output Range	0.0V to 3.3V

3.6 PLX PCI Chip Information

The Developer's Kit utilizes the PCI 9030 interface chip from PLX technology. For information on the operation of this device please refer to the PLX documentation available from http://www.plxtech.com/.

The following table lists the relevant PLX local configuration register values. For further information refer to the PLX documentation.

Space	Range	Remap	Descriptor	Chip Select
0 (DPRAM)	0FFFC000	00000001	00402081	00008001
1 (CP)	0FFFFFE1	00010001	00410080	00010011

The following variables are used to access each space.

PCI_IOSPACE0_BASE = Second memory range as reported by the OS
PCI_IOSPACE1_BASE = Second IO range as reported by the OS

Dual_port_RAM= PCI_IOSPACE0_BASE

PMD_data_port = PCI_IOSPACE1_BASE + 0
PMD_cmd_status_port= PCI_IOSPACE1_BASE + 2

If the OS (Operating System) is MS Windows, the assigned IO spaces can be viewed in Device Manager/PMD PCI DK1/Resources.

A. Atlas Developer's Kit

A

In This Appendix

- Overview
- Installation and Getting Started
- Atlas Carrier Card Reference Information
- L-Bracket

A.1 Overview

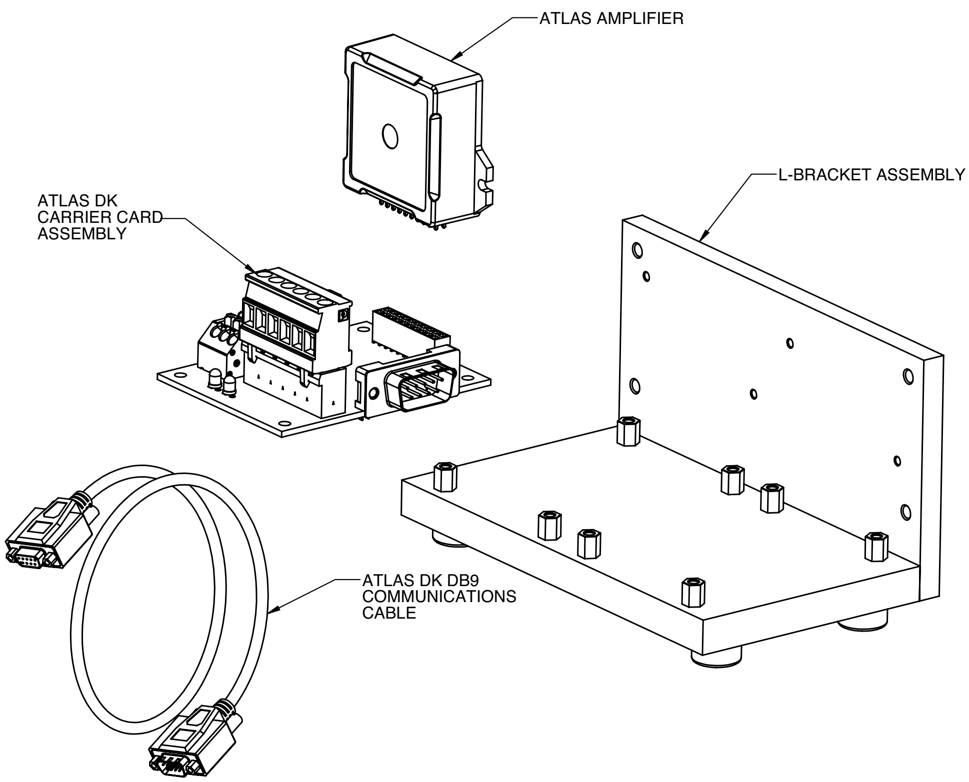


Figure A-1: Developer Kit Components

To simplify development with Atlas Amplifiers a Developer's Kit (DK) is available.

In addition to documentation and software distribution media, the major elements of the DK are:

- Atlas carrier card
- Atlas DK DB9 communications cable
- Optional L-bracket base and vertical member for heat sink attachment with associated mounting hardware (comes in 1, 2, or 4 axis version)

The L-bracket is optional but highly recommended because it provides a stable mechanical base from which you can connect and operate your prototype system. With the vertical plate option installed the Atlas units have additional heat sinking, which can be extended further by connecting the vertical plate to your own heat sink or cold plate.

A.2 Installation and Getting Started

In these instructions it is assumed that you have purchased a Magellan DK (Developer's Kit), which comes with the Pro-Motion exerciser and tuning software. If you have not purchased a Magellan DK then you will still find these instructions useful, however you will use the detailed connections detailed in Section A.3, "Atlas Carrier Card Reference Information" to connect your system and begin operation.

A.2.1 Setting Atlas SPI Bus Addresses

If your Atlas DK came with an L-bracket, the Atlas units are pre-loaded on the L-bracket hardware and each Atlas is pre-addressed with axis number labeled. You can therefore skip to Section A.2.2, "SPI Bus Connections" of these getting started instructions.

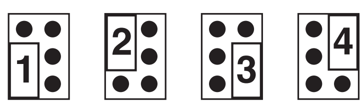
If you are not using an L-bracket, you will need to set the SPI bus address using jumper J6 on each Atlas carrier card.

For vertical Atlas units you can set the jumper without removing the Atlas from the carrier card. For horizontal Atlas units you must remove Atlas from the socket, select a jumper, and then carefully remount the Atlas into the socket.

Refer to Figure A-2 to select an address.

> Each Atlas must have a unique address from 1 to 4, and this number directly corresponds to the axis number addressed by the Magellan Motion Processor.

Figure A-2: Setting ATLAS SPI Bus Addresses



A.2.2 SPI Bus Connections

If you are using an L-bracket you should plug in the provided 12" DB9 cable at J5, the female DB9 connection of the carrier card. Do not plug in at the male DB9 connection, J4. Doing so will mean that you will not be able to connect your Atlas units to the Magellan DK card. Once you have plugged in the DB9 cable, you can skip forward to Section A.2.3, "Motor Connections" and continue from there.

> The DB9 connections used with the Atlas DK are not compatible with standard RS-232 serial ports. Do not attempt to plug this connector directly into your PC.

If you did not order an L-bracket, you will need to first connect the Atlas units together, and then connect the provided 12" cable.

Connecting Atlas units together is easily accomplished by plugging them directly into each other in a chain, without any intervening cable at the J5 (female) and J4 (male) DB9 connections. Up to four Atlas units can be plugged together in this manner. Once this has been accomplished, the male end of the 12" DB9 cable should be connected at the open Atlas carrier card J5 (female) connector. Note that there is no termination required for the opposite J4 (male) DB9 connector at the end of the chain. This connector is simply left unconnected. This is shown in Figure A-3.

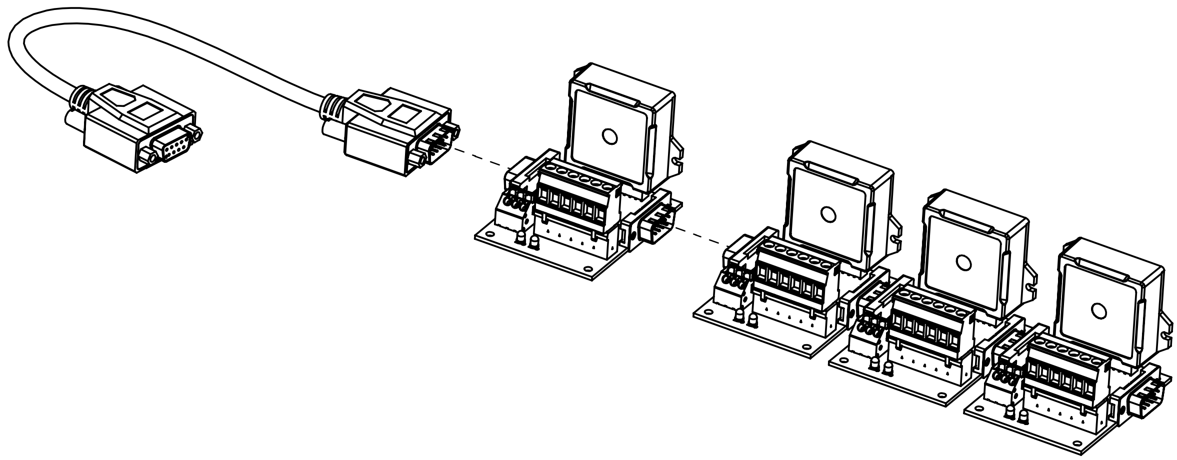


Figure A-3: Chain of DK Carrier Cards

When assembling the Atlas unit chain, the position in the chain has no bearing on the selected Atlas address. This address is determined entirely by the jumper. See Section A.2.1, "Setting Atlas SPI Bus Addresses" for a description. In assembling your own chain, you may therefore find it useful to label the carrier cards with an easily readable axis # to avoid confusion when connecting motors.

A.2.2.1 Connecting an Atlas Chain By Cables

There may be circumstances where you prefer not to connect all of the Atlas carrier cards directly to each other, but rather via cables. If this is the case, care should be taken not to exceed the total cable length specification for the SPI bus of 2.0 feet. This is the total length from the Magellan DK card connection point to the last Atlas in the chain including the length of the carrier cards and all connecting cables.

> The maximum allowed SPI bus length is 2.0 feet. Exceeding this specification may result in communication errors and unreliable Atlas operation.

> The SPI bus is not designed to operate external modules by cable connection, and therefore in production applications it is recommended that Atlas units be located on the same printed circuit card. Regardless of where Atlas is located, it is the responsibility of the user to ensure that SPI signals are noise free and within Atlas unit's timing specifications.

A.2.3 Motor Connections

For each Atlas, connect the motor using the chart below and the J1 6-terminal jack screw plug on the carrier card. Use copper wire gauge 14AWG or larger to ensure that all current output requirements can be met.

Motor Type	Use Motor Connections	J1 Jackscrew Plug Labels
Brushless DC	Motor A, Motor B, Motor C	Mtr A, Mtr B, Mtr C
DC Brush	Motor A, Motor B	Mtr A, Mtr B
Step Motor	phase A: Motor A, Motor B phase B: Motor C, Motor D	Mtr A, Mtr B, Mtr C, Mtr D

A.2.4 Power Connections

For each Atlas, connect the bus supply voltage (HV) and the associated return ground signal at the J6 jack screw plug. Once again, utilize AWG 14 or larger to ensure that full current demand can be met while operating the unit. The power signals are labeled +HV and GND.

For most installations you will use a single, common power supply to power all Atlas units. However this is not required. If desired, you can operate different Atlas units at different voltages by connecting to different DC supplies.

While connecting power signals make sure that the power supply is off.

A.2.5 Enable Signal Connection

You must provide an 'active' enable signal to allow Atlas to operate. There are a few options to accomplish this, depending on how you plan to operate your system. The simplest approach is to use a short piece of AWG 20 or larger wire to connect the GND signal of jackscrew plug J2 to the Enable input (labeled ~Enab).

For safety reasons, you may prefer to wire the enable input into a separate switch or E-stop button. Regardless of how it is accomplished, the enable signal must be driven active (low) for Atlas to operate.

A.2.6 Installing and Connecting to the Magellan DK Card

To set up and install the Magellan DK card refer to the *Magellan Motion Processor Developer's Kit Manual*. This manual will help you select jumper settings and make connections to the motor's encoders and other connections.

To install Atlas DKs to the Magellan DK connect the SPI bus cable to the Magellan DK card via the DB9 cable to J14 of the Magellan DK card.

Once all connections have been made you should power up the PC (but not the Atlas units) and follow the manual's direction for installing Pro-Motion software. You can run Pro-Motion, check for encoder feedback, etc…. but for axes that utilize Atlas amplifiers, motor output will not yet be operational.

A.2.7 Powering Up the Atlas Units

Once all connections are made and Pro-Motion is installed and running you are ready to provide power to the Atlas units.

Upon doing so verify that there is no motor movement, all power LEDs are lit, and none of the fault out LED indicators are lit. If any of these conditions is not true, power the Atlas units down and recheck connections.

Once a normal power-up is achieved the Atlas units are ready for operation. You may now use Pro-Motion's Axis Wizard to install and operate your motors, or perform direct manual operations using Pro-Motion's various control menus.

Congratulations! You have successfully installed the Atlas DK.

A.3 Atlas Carrier Card Reference Information

The following sections provides detailed information on the electrical characteristics of the Atlas DK carrier card.

There are two different designs of carrier card, one for the vertical Atlas units and one for horizontal units. Electrically these two cards are similar, differing only in the socket connections to the Atlas unit.

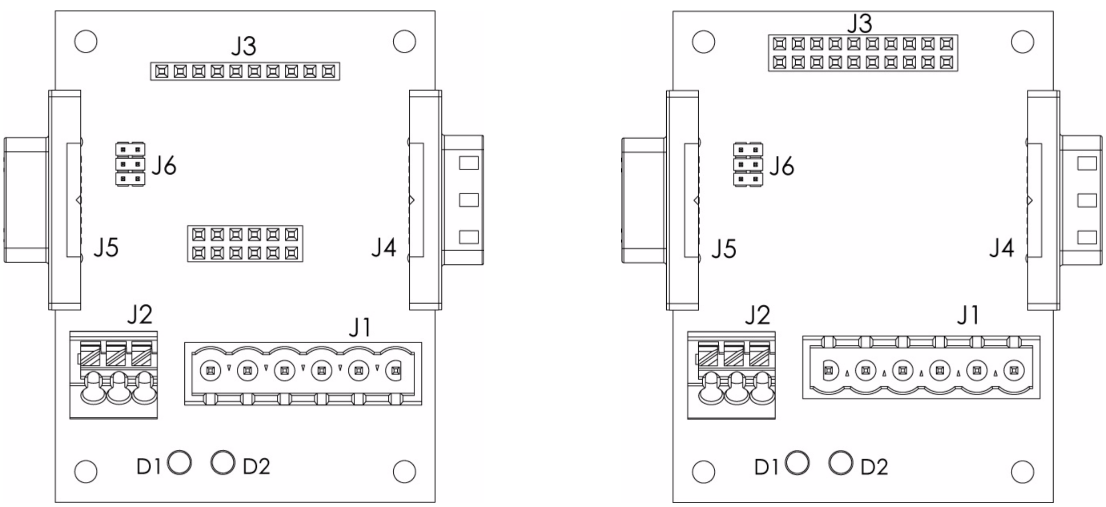


Figure A-4: Top Outline View of Horizontal and Vertical DK Card

A.3.1 J1 & J2 Jack Screw Connectors

J1 and J2 provide jack screw-style connections to various Atlas signals. The following table shows this:

J1 Connector		
Carrier Card Label	**Name**	**Description**
Mtr D	Motor D	D Motor connection
Mtr C	Motor C	C Motor connection
Mtr B	Motor B	B Motor connection
Mtr A	Motor A	A Motor connection.
GND	Mtr_Gnd	Ground return for Motor and HV
+HV	HV	Motor supply voltage

J2 Connector		
Carrier Card Label	**Name**	**Description**

~Enab	Enable	Enable input
Flt	FaultOut	FaultOut output
GND	GND	Ground return for *Enable* and *FaultOut* signals

A.3.1.1 Quick Connect Motor Type Chart

Motor Type	Connections
Brushless DC	Motor A, Motor B, Motor C
DC Brush	Motor A, Motor B
Step Motor	phase A: Motor A, Motor B phase B: Motor C, Motor D

A.3.2 J4 & J5 DB9 Connectors

A.3.2.1 SPI Communications

J4 and J5 are used to provide SPI communications between multiple Atlas DK cards and a Magellan DK card or the user's motion control system. J5 is female, and J4 is male. This arrangement facilitates connection of multiple Atlas units in a direct physical chain.

Here are the pinouts for J4 & J5 when used for SPI communications

J4 & J5 Connector		
Pin	**Name**	**Description**
1	~SPICS3	SPI chip select for Atlas #3
2	~SPICS2	SPI chip select for Atlas #2
3	Shield	Cable shield connection
4	GND	Ground
5	SPISO	SPI Slave Out
6	~SPICS1	SPI chip select for Atlas #1
7	~SPICS4	SPI chip select for Atlas #4
8	SPIClk	SPI Clock
9	SPISI	SPI Slave In

A.3.2.2 Pulse & Direction Mode

J4 or J5 are also used to provide pulse & direction signals to a single Atlas. In this mode, multiple Atlas DKs can not be connected to each other and the J6 address selector jumper should be set to an address of 1.

In this mode either J4 or J5 may be used for connection, the only difference being the gender of the connector.

Here are the pinouts for J4 & J5 when used in pulse & direction signal mode

J4 & J5 Connector		
Pin	**Name**	**Description**
1	not used	
2	not used	
3	Shield	Cable shield connection
4	GND	Ground
5	not used	
6	AtRest	Pulse & direction mode *AtRest* signal
7	not used	

8	Pulse	Pulse & direction mode *Pulse* signal
9	Direction	Pulse & direction mode *Direction* signal

A.3.3 J6 Address Selector

J6 is a jumper that programs the address of a particular carrier card when using the SPI bus. The carrier card backplane supports up to four separate Atlas units via four individual chip select signals. To communicate to a particular carrier card, the external controller's chip select signal must match the address selected via this jumper.

Figure A-5 shows how this jumper is programmed to select addresses 1 through 4.

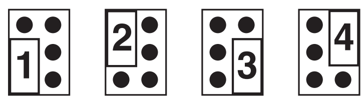


Figure A-5: J6 Address Selector

A.3.4 Atlas Connections

The carrier cards connect to the Atlas unit via sockets at J3. The tables below show the Atlas connections for these connectors

A.3.4.1 Vertical Unit Connections

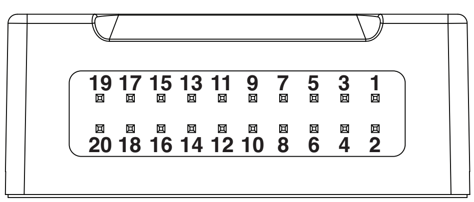


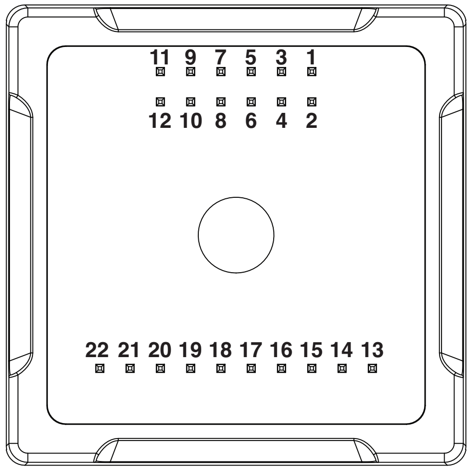
Figure A-6: Vertical Unit Pinouts

Pin	Name	Pin	Name
1	Pwr_Gnd	2	Pwr_Gnd
3	HV	4	HV
5	Motor A	6	Motor A
7	Motor B	8	Motor B
9	Motor C	10	Motor C
11	Motor D	12	Motor D
13	~Enable	14	FaultOut
15	5V	16	GND
17	~SPICS/AtRest	18	SPISI/Direction
19	SPIClk/Pulse	20	SPISO

The pins are 0.1 inch spacing and 0.025 inch pin width.

A.3.4.2 Horizontal Unit Connections

Figure A-7: Horizontal Unit Pinouts



Pin	Name	Pin	Name
1	Motor D	2	Motor D
3	Motor C	4	Motor C
5	Motor B	6	Motor B
7	Motor A	8	Motor A
9	HV	10	HV
11	Pwr_Gnd	12	Pwr_Gnd
13	5V	14	GND
15	~Enable	16	FaultOut
17	GND	18	~SPICS/AtRest
19	SPISO	20	SPISI/Direction
21	SPIClk/Pulse	22	GND

The pins are 0.1 inch spacing and 0.025 inch pin width.

A.3.5 LED Indicators

The Atlas DK carrier card has two LEDs. The green LED, when lit, indicates that Atlas is receiving valid power input power at HV. The red LED, when lit, indicates that an Atlas FaultOut condition is active.

A.4 L-Bracket

The Atlas DK can be ordered with L-brackets that provide extra mechanical stability and heat sinking during prototyping. Depending on the type of Atlas that you are using, you may use just the base plate or the base plate and vertical plate in the "L" configuration.

L-bracket hardware is available in a one axis configuration, two axis configuration, and four axis configuration.

Normally, the Atlas units and carrier cards are fully assembled into the L-brackets. If you ordered your DK components not assembled however, you can assemble these components yourself. To assist with this, an assembly drawing is shown in Figure A-8. All needed assembly components should be included with the shipment. In addition, you will need 1.5 mm and 2 mm hex wrenches to assemble the carrier cards, Atlas units, and L-bracket together.

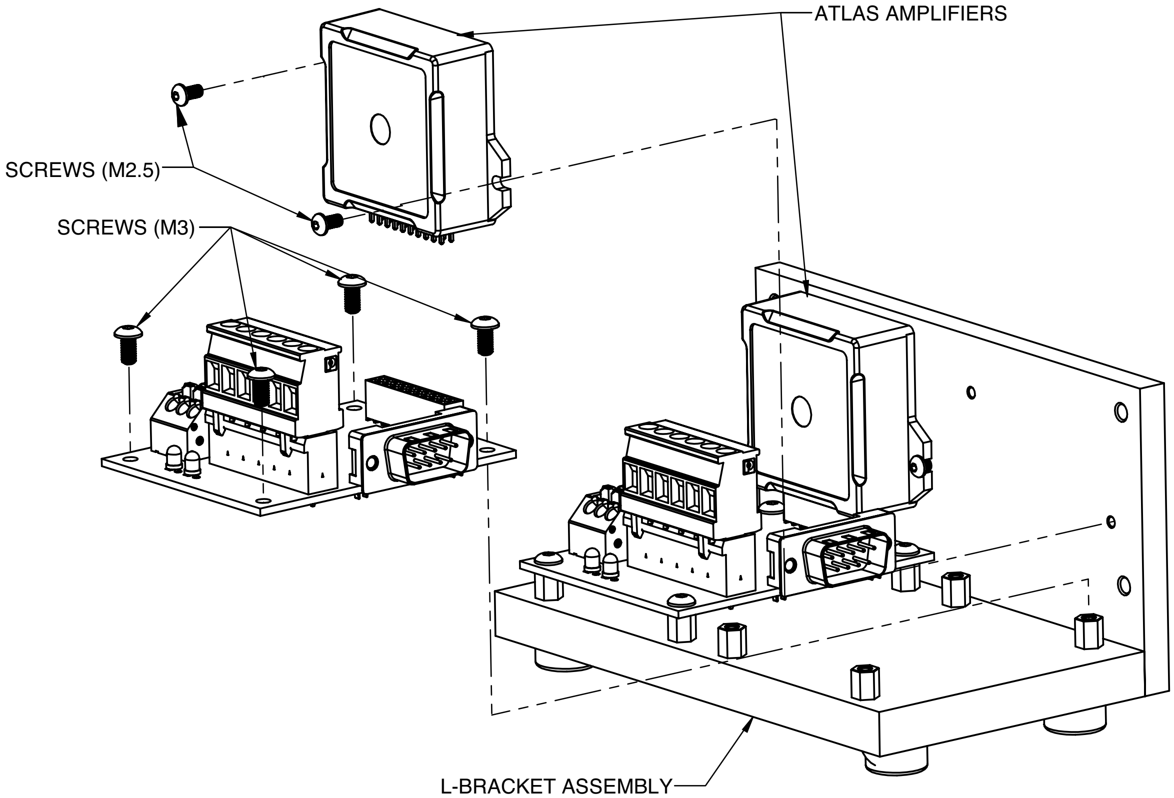


Figure A-8: Mounting Atlas to Vertical Plate

A.4.1 Mounting Atlas to Vertical Plate

For vertical units with mounting tabs, two M2.5 BHCS (Button Head Cap Screws) or similar are used to attach the Atlas unit to the vertical plate, assuming it has been included with the DK. This is shown in Figure A-8. While optional, mechanically connecting the Atlas units to the L-bracket is highly recommended to provide the best heat flow from the Atlas unit, and to increase the mechanical robustness of the development system.

For best thermal performance, a material such as Sil-Pad, thermal grease, or phase change material should be utilized between metal interfacing layers.

For horizontal units, and for vertical units without mounting tabs, the Atlas unit is seated in the carrier via a socket. No mechanical hardware is used to attach the Atlas.

A.4.2 Mounting L-bracket to Other Hardware

To maximize heat sinking capacity you may choose to mount the vertical L-bracket piece to your own hardware. For best thermal performance, a material such as Sil-Pad thermal grease or phase change material should be utilized between metal interfacing layers.

To connect to the vertical plate use four (4) M4 screws threaded into the provided threaded holes in the vertical plate or use four (4) M3 screws with nuts and washers to fasten through from the front.

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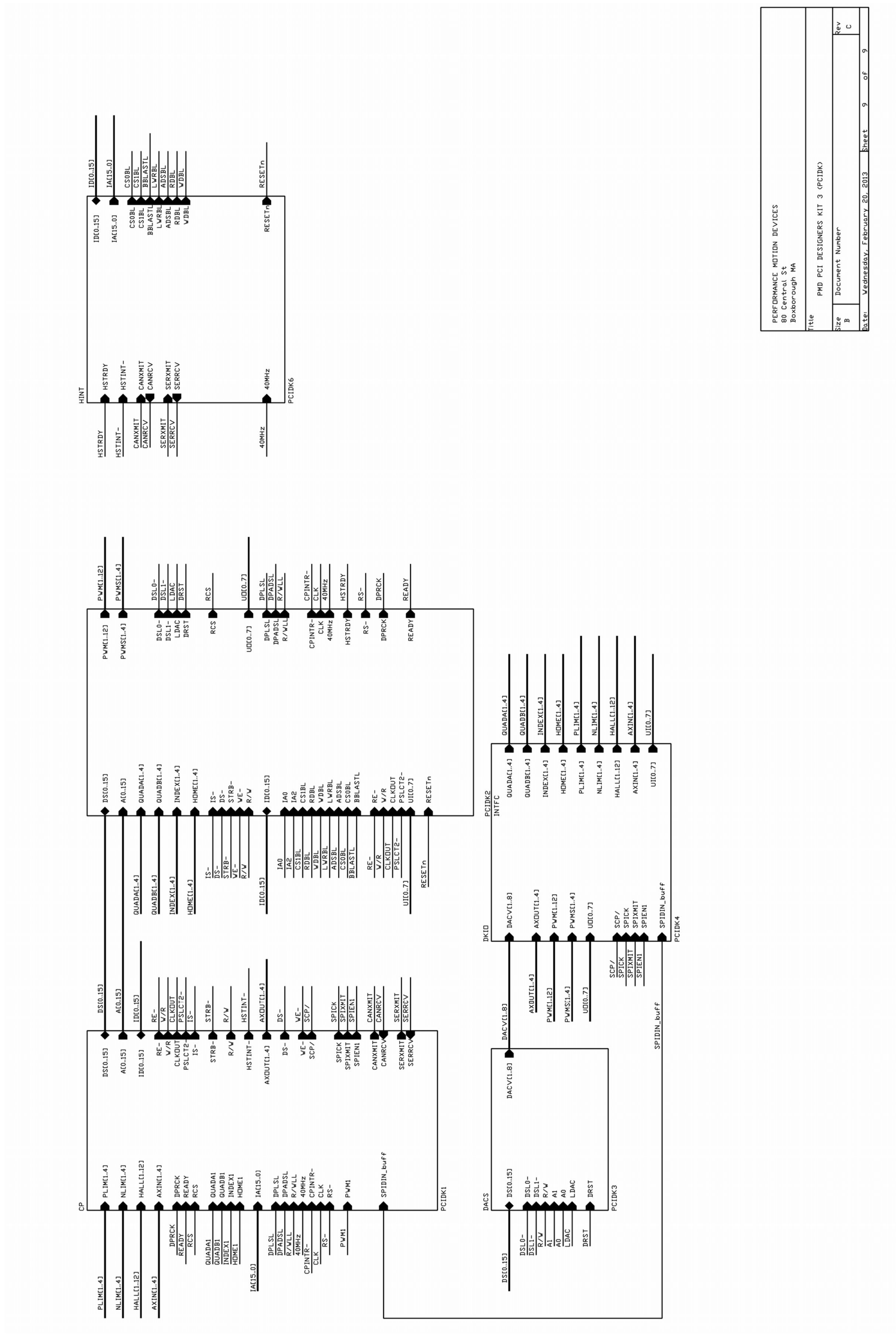
B. Reference Schematics

B

Figure B-1: Developer's Kit overview schematic



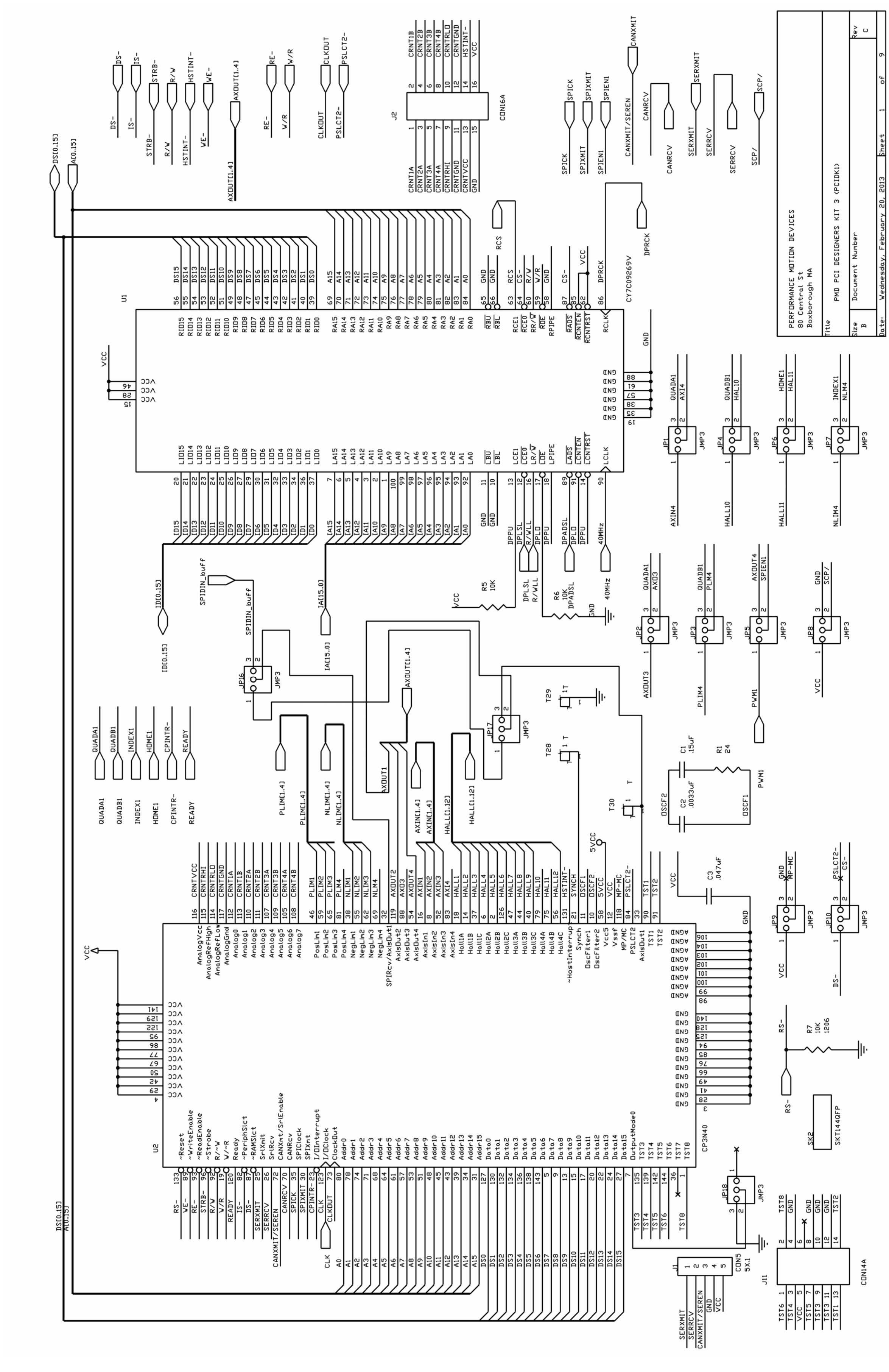
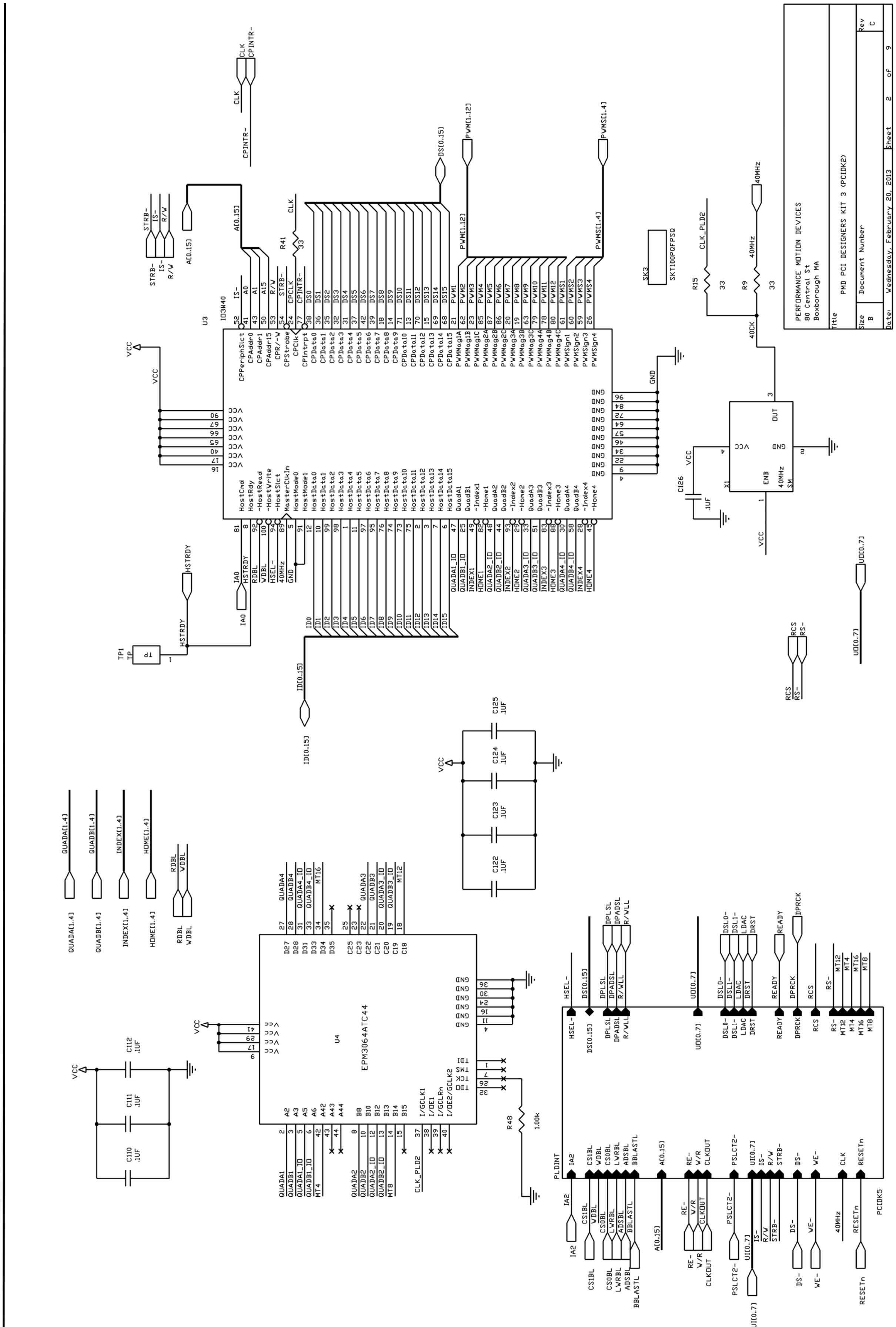


Figure B-2: Magellan Motion Processor CP and DPRAM schematic

Figure B-3: Developer's Kit I/O schematic



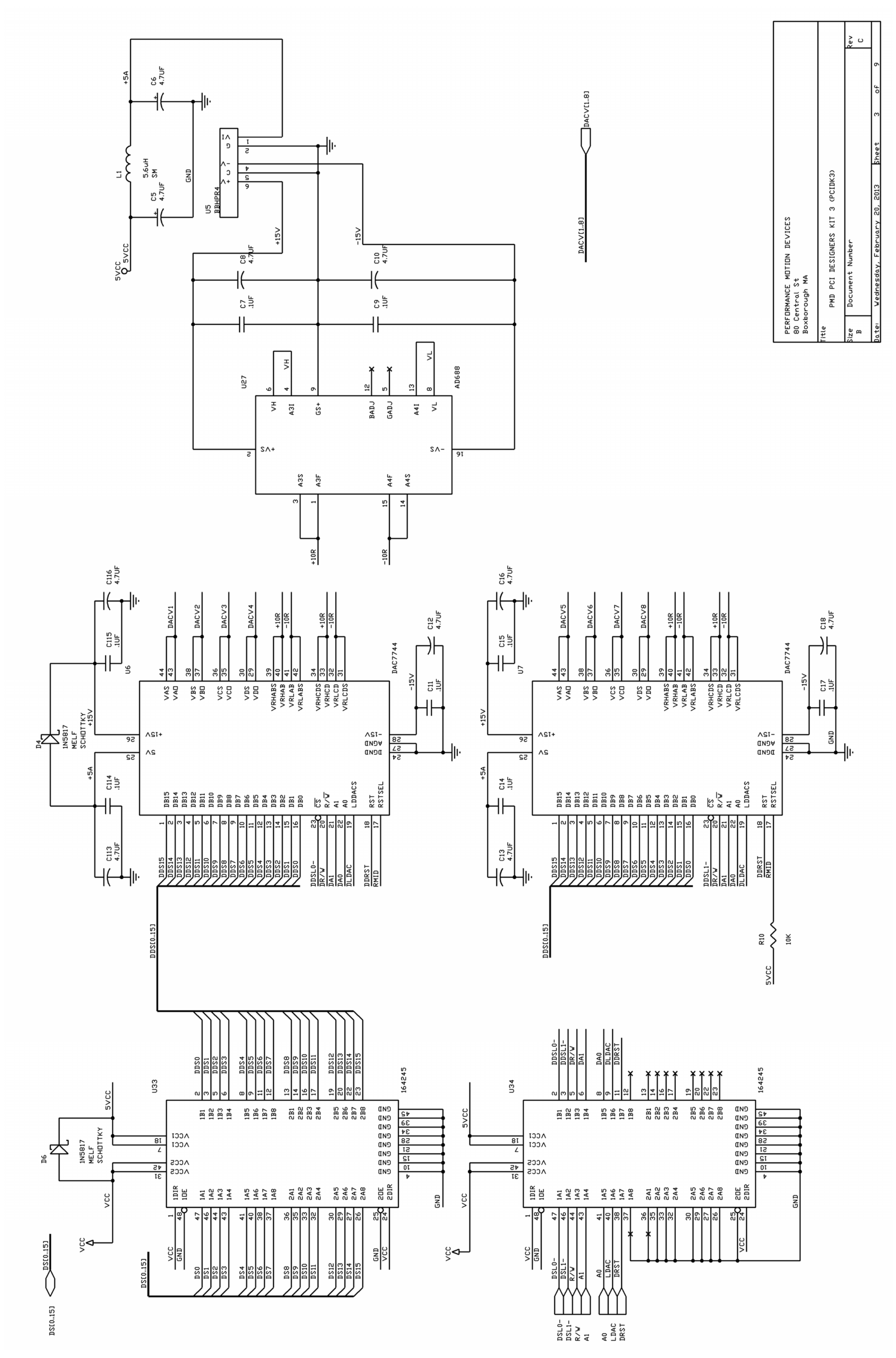
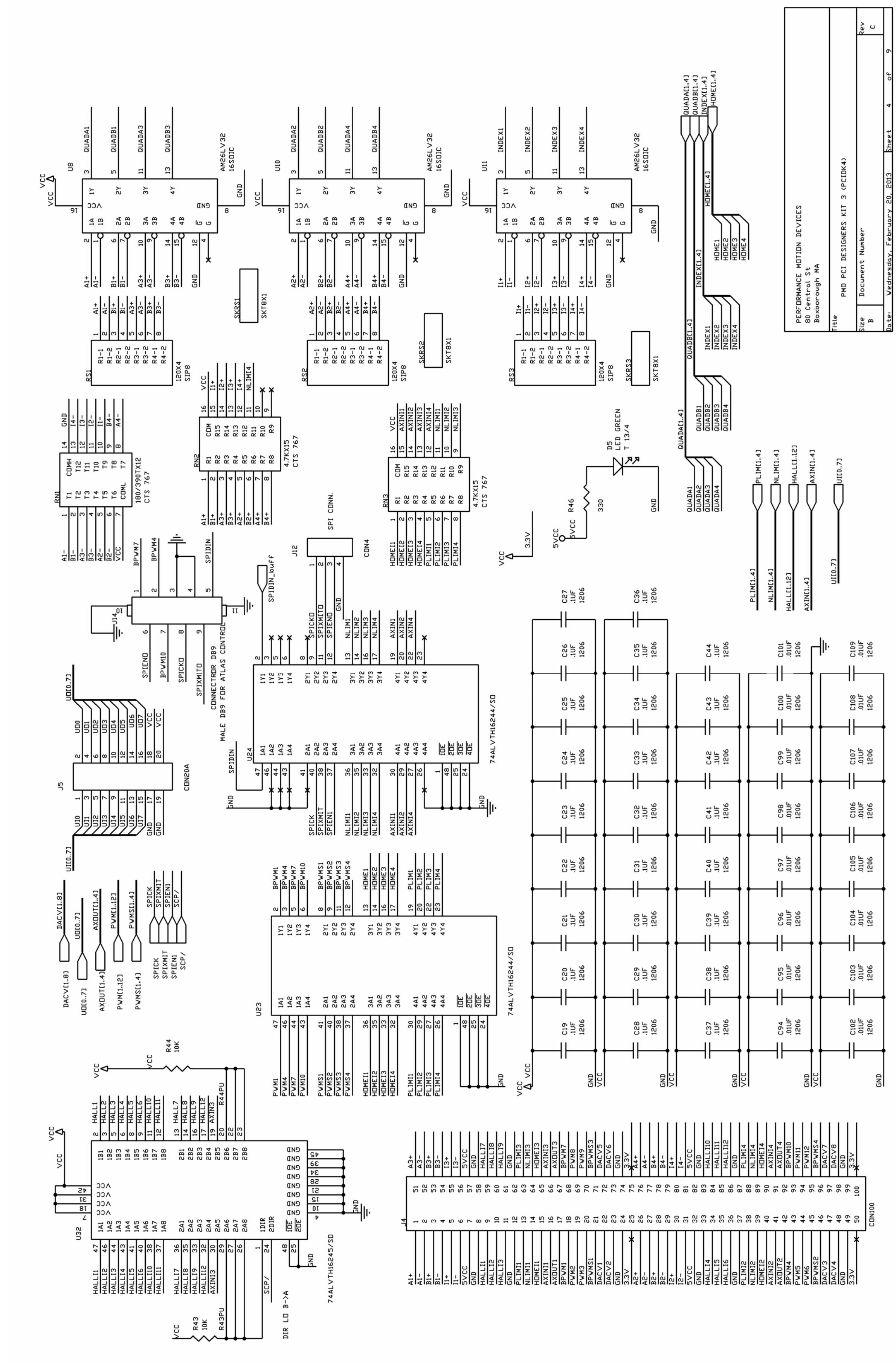


Figure B-4: Developer's Kit DAC amplifiers schematic

Figure B-5: Developer's Kit connector and quadrature schematic



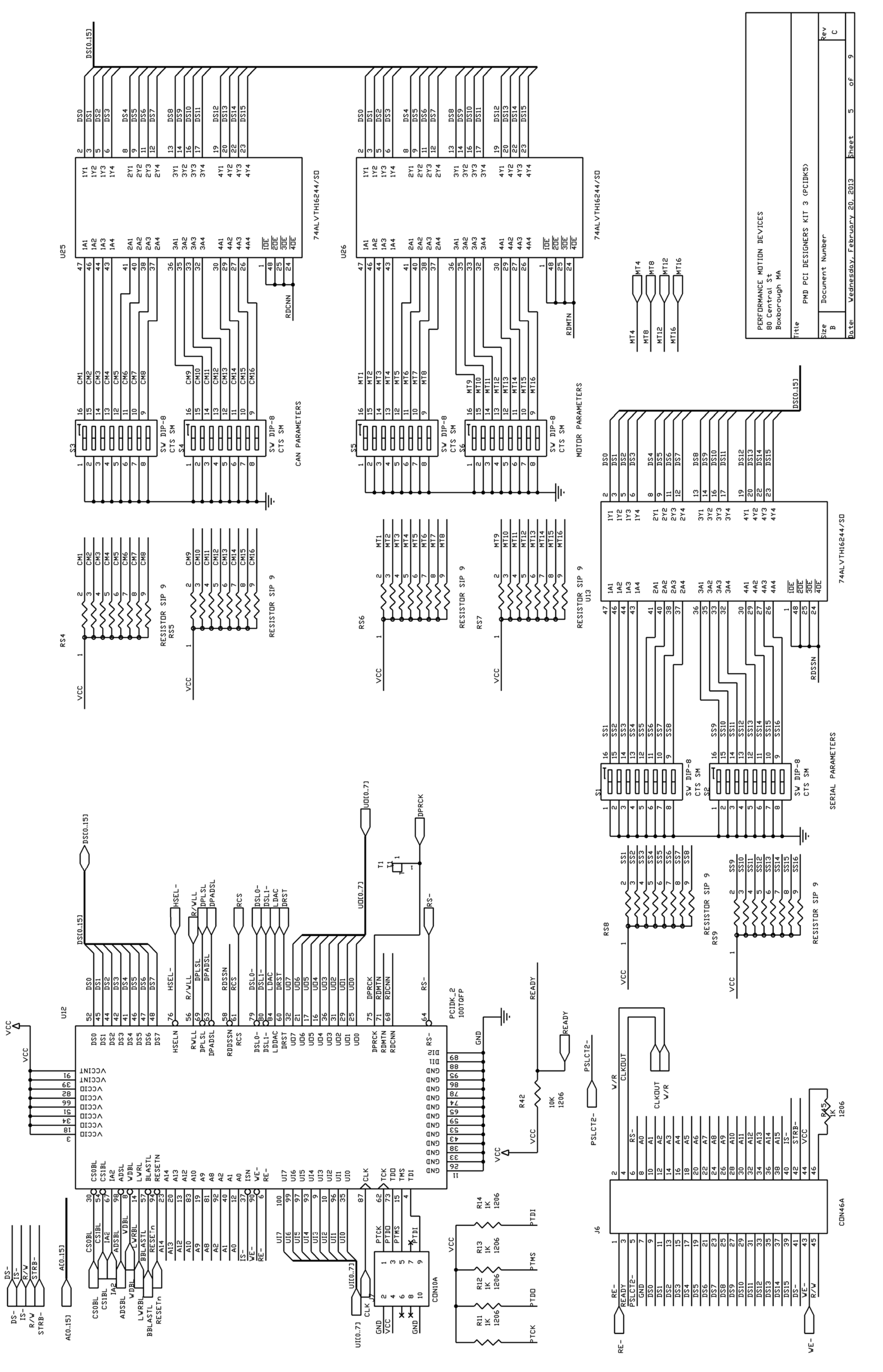
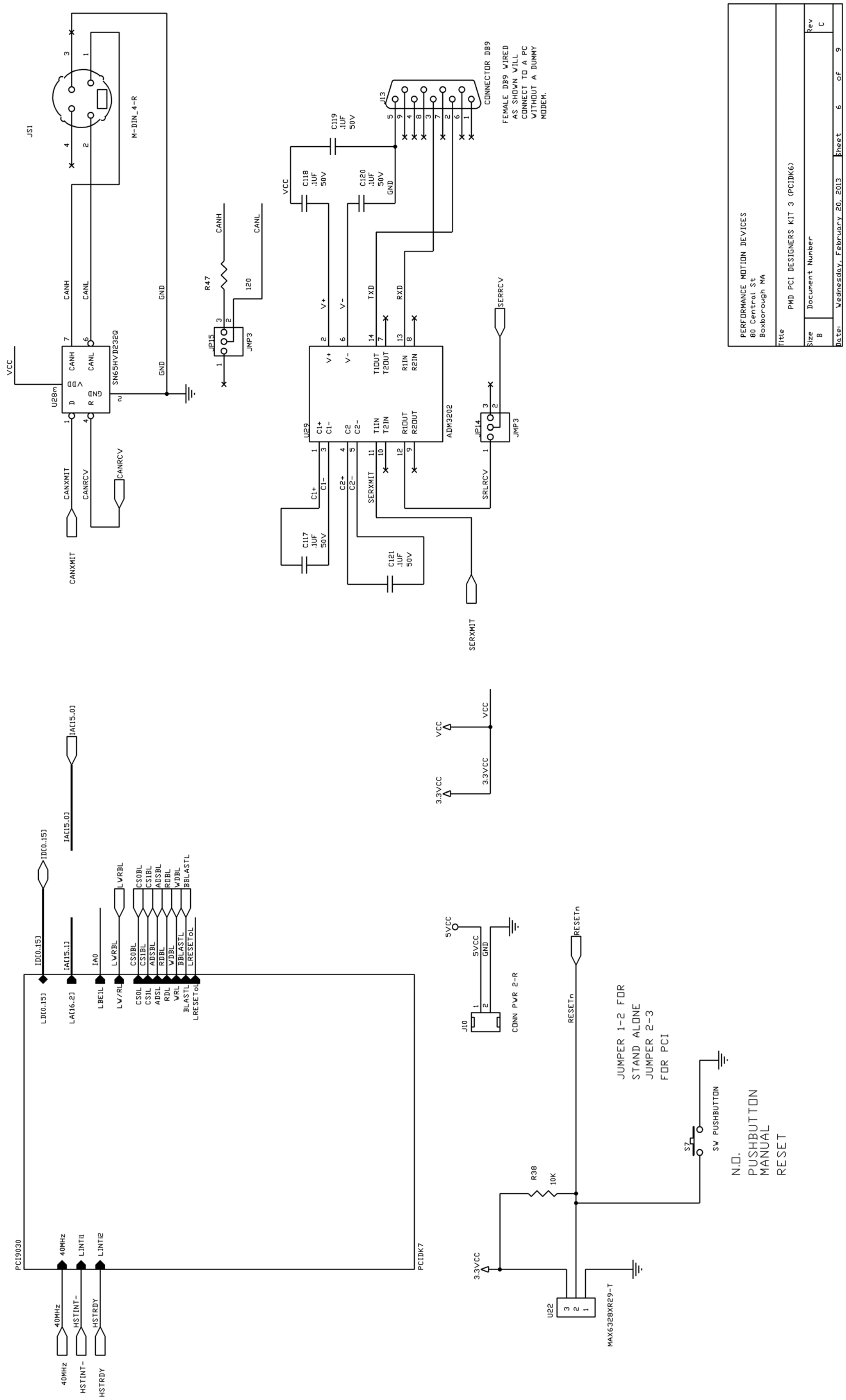


Figure B-6: Developer's Kit PLD schematic

Figure B-7: Developer's Kit transceivers schematic



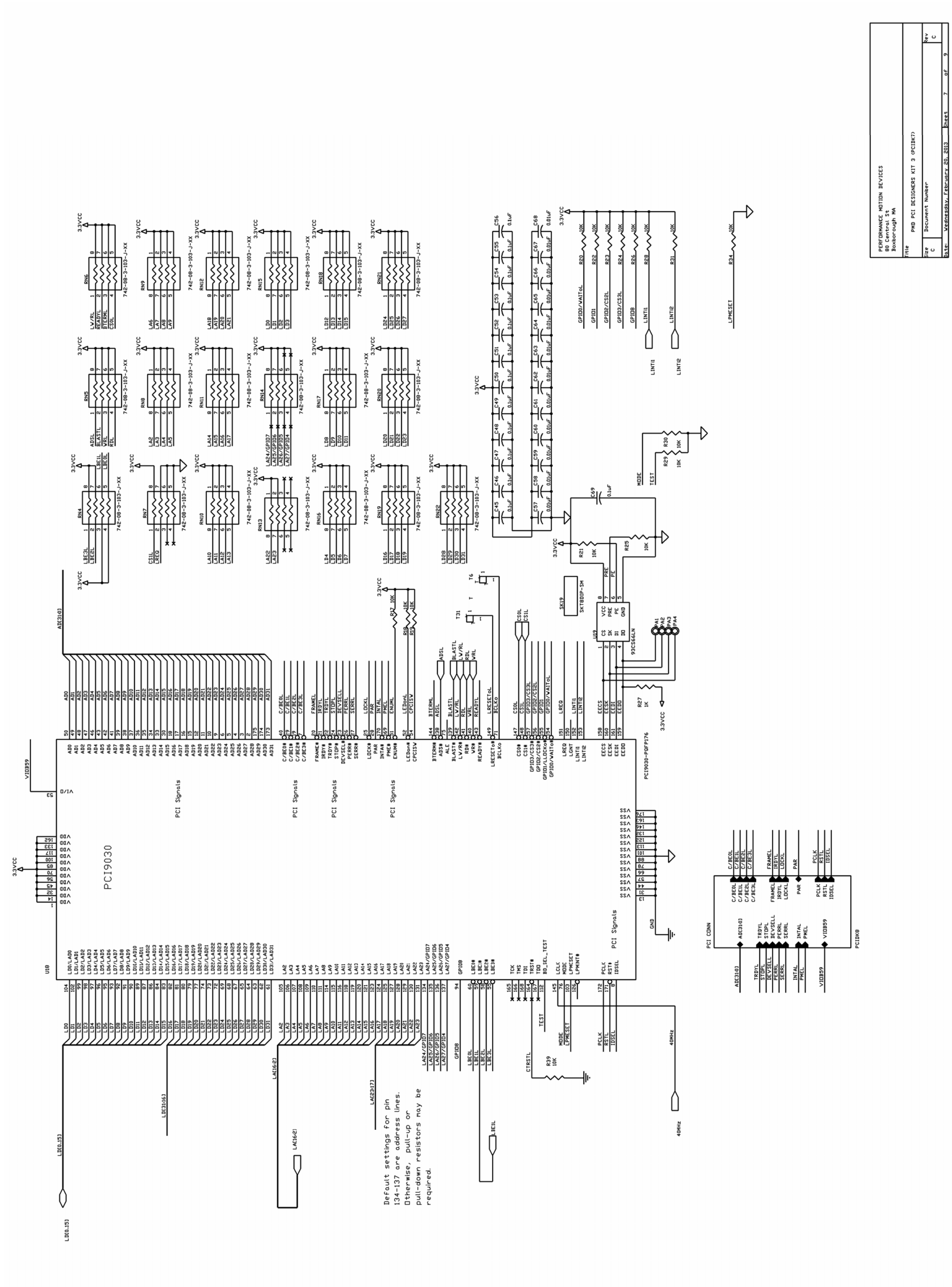
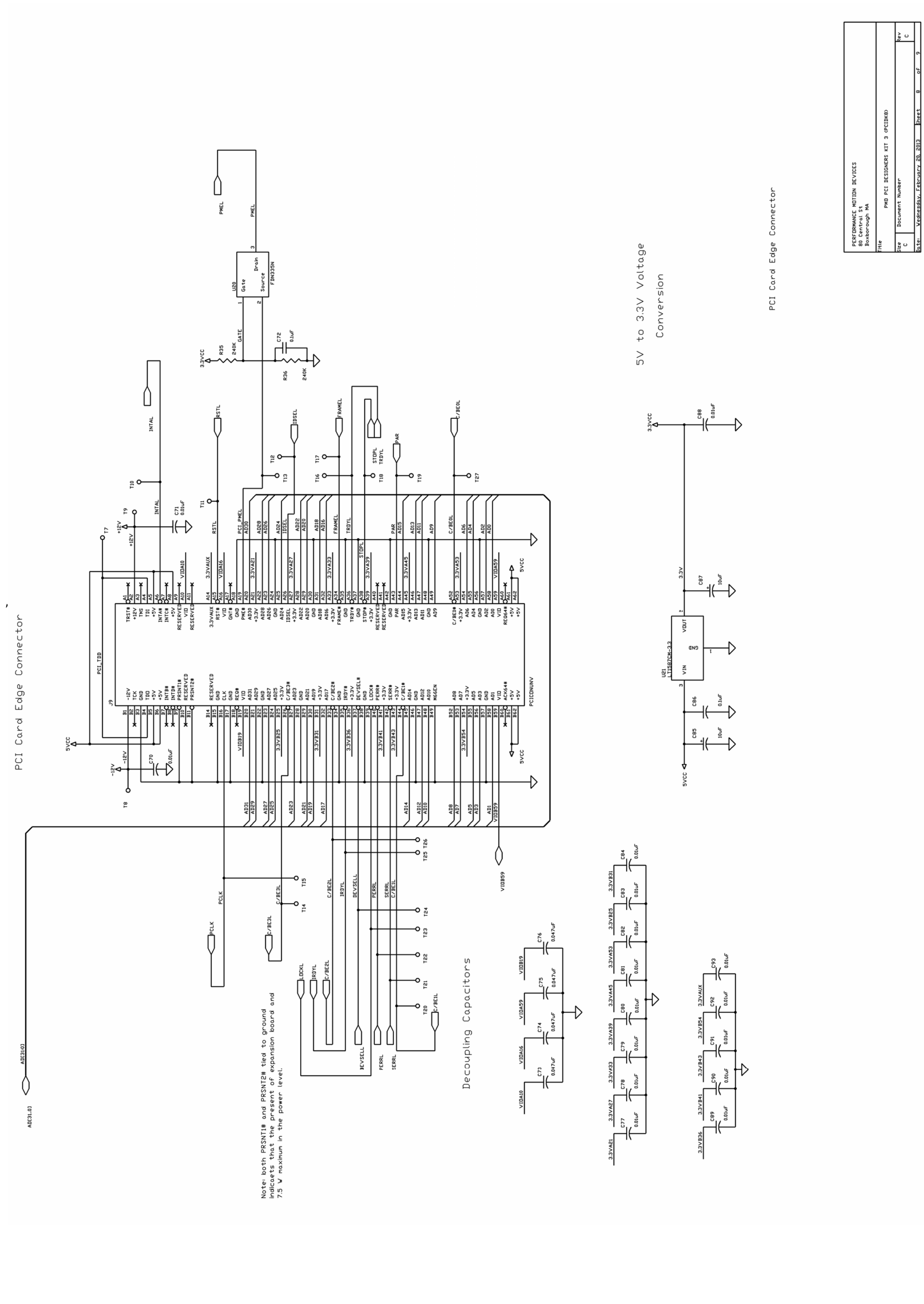


Figure B-8: Developer's Kit PLX9030 schematic

Figure B-9: Developer's Kit PCI edge connector schematic



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