J R KERR
AUTOMATION
ENGINEERING

____ *PIC-SERVO* Motor Control Board_____

The ***PIC-SERVO*** Motor Control board is a full-function servo control system with the following features:

- ***PIC-SERVO*** chipset providing servo control of DC motors with incremental encoders, including trapezoidal and velocity profiling. The ***PIC-SERVO*** board may also be used with the ***PIC-SERVO CMC*** chipset for multi-axis coordinated control.
- LMD18201 amplifier capable of driving 3 amps continuously, 6 amps peak at up to 48vdc. Built-in thermal, overcurrent and undervoltage protection.
- PWM and DIR signals are provided for use with other external amplifiers.
- RS485 serial interface allows up to 32 ***PIC-SERVO*** controllers to be controlled from a single serial port. Connects to an RS232 port through commonly available full-duplex adapters or using the ***Z232-485*** converter board.
- General purpose analog input channel with pre-amplifier. Two general purpose I/O bits for limit switch inputs or control outputs.
- Its small size (2" x 3") allows it to be mounted near motors, reducing noise and simplifying wiring.
- Windows test software provided including Windows 95/98/NT DLL and C source code. DOS based C code and Basic code are also available.

1. Quick Start

What you will need:

PIC-SERVO Motor Control Board
Z232-485 Converter Board (or equivalent)
DC Motor (48v max., 3 amp continuous current max.) with TTL compatible encoder
Motor power supply (12v min. - 48vdc max.)
Logic power supply (7.5 - 12vdc, 500 ma)
Motor/encoder cable (DB15 male connects to your motor)
10 pin flat ribbon cable with standard IDC socket connectors at both ends
Straight DB9 male / DB9 female cable to PC COM port
PC compatible computer running Windows
Test software - NMCTest for Windows95/98/2000/NT
(available for download from http://www.jrkerr.com)

Most of the cables are available from computer or electronics stores. However, you will probably have to make your own motor/encoder cable to connect to your particular motor. Refer to

CAUTION

The ***PIC-SERVO*** Motor Control Board does not incorporate safeguards for fail-safe operation. As such, this board should not be used in any device which could cause injury, loss of life, or property damage. J.R. Kerr makes no warranties whatsoever regarding the performance, operation, or fitness of this board for any particular purpose.

Section 2.1 for the connector pin definitions. To start off, you only need to connect M+, M-, Encoder A, Encoder B, Encoder +5v and Encoder GND. Other connections can be made as needed. Note that when testing, you may have to swap the M+ and M- leads to correct for the polarity of your motor.

Interconnections and Jumpers:
Basic interconnections and jumpers are shown in *Figure 1* for both a single controller and for a multiple controller configuration. On the ***Z232-485*** converter, jumpers JP3 and JP4 are installed in the 1-2 position for use as a simple converter. (Please refer to the ***Z232-485*** documentation for use with the optional standalone processor cards.) Jumper JP5 is installed to distribute logic power to the controller boards over the communications cable. Logic power is supplied on connector JP6. If you are using a different type of serial port adapter, you may attach power to the pins of JP8 on the ***PIC-SERVO*** board.

On the ***PIC-SERVO*** controller board, jumpers JP6 and JP7 are installed to connect logic power supplied by the communications cable to the board's logic supply. In the *single* controller configuration, the three jumpers labeled JP3, JP4 and JP5 should be installed as shown. In the *multiple* controller configuration, these jumpers should only be installed on *last* controller, furthest from the PC host. On all intermediate controllers, jumpers at JP3, JP4 and JP5 should be left *uninstalled*. Jumper JP9 and connector JP10 are used for an external amplifier and can be left unconnected.

Motor power should be connected to the two screw terminals, with 12 - 48vdc connected to the terminal towards the edge of the board and GND connected to the terminal towards the center as shown in *Figure 1*.

Loading and Running Software:
First unzip NMCTEST.ZIP into a single directory. Before starting up the test code, make sure all of your jumpers and interconnections are as shown in *Figure 1*. Also make sure you have logic power supplied to the ***Z232-485*** converter.

Run the program NMCTest.exe. Select the correct COM port when prompted (leaving the default baud rate at 19200 for now). If you are using a different COM port, you will get an error message saying no modules were found. If this is the case, click on the Reset Network button and set the COM port to the correct value. The program will attempt to locate controllers on the RS485 network and will respond with the number of controllers found. If the number of controllers reported does not match the number connected, re-check the interconnections, jumpers and power, and then try again.

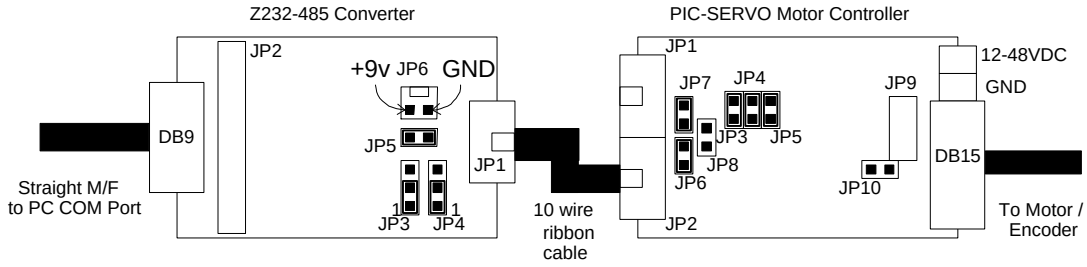
The list box on the left side of the window will display the list of motors found. ***PIC-SERVO*** module 1 will be the last controller which is furthest from the host PC. Clicking on different controllers will display the status and controls for that particular motor. Click on ***PIC-SERVO*** 1 and spin the motor shaft by hand. See that the position changes accordingly in the status panel.

Before enabling the motor servo make sure that the motor is disconnected from any mechanism which might be damaged. To test the motor, first turn on the motor power. You should see the Motor Power box checked in the status panel. Next, click on the Enable Amplifier box in the Motion Command panel. Now click on the STOP! button. Try turning the motor shaft by hand.

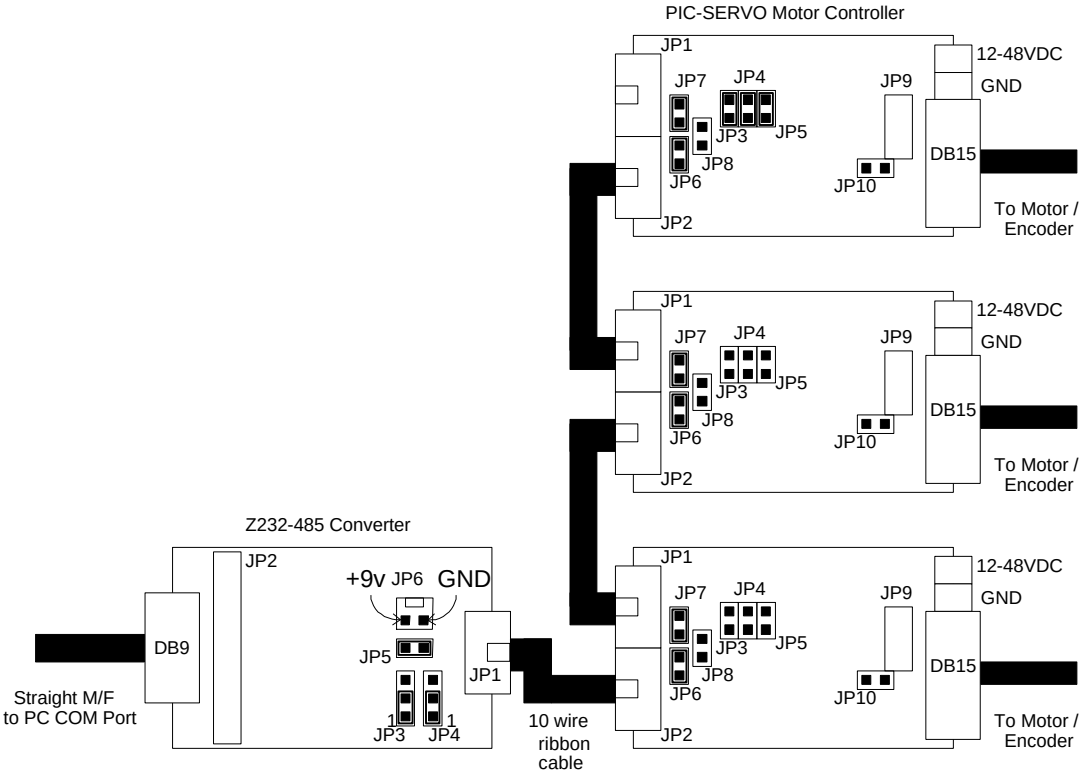
If the motor jerks and stops, or spins out of control, turn off the motor power and try swapping the M+ and M- leads on the motor. Turn the power back on, click on STOP! again. The motor should attempt to hold a fixed position. If it does, click on Pos mode, type in a position value of 1000, and then click on "GO". The motor should move to position 1000 (or close to it, depending on how the gains are set). Try moving to a bunch of different positions until you are satisfied that the motor is moving as it should. (Note that if your motor has a gearhead, the motion of 1000 counts may produce an imperceptibly small motion, and you should use a larger number instead.)

The control gains, and maximum velocities and accelerations are set to default values which are reasonable for most small motors. Please refer to the ***PIC-SERVO*** datasheet for details on the values for the gains, velocities and accelerations. The online help also has a great deal of information about the ***PIC-SERVO*** controller.

Single Controller Configuration



Multiple Controller Configuration



CAUTION: Connecting communications cables incorrectly, or installing jumpers JP3, JP4 and JP5 (on the *PIC-SERVO* board) in the wrong location may damage the *PIC-SERVO* or other NMC controller chip!

Figure 1 - Basic Interconnections.

2. Connectors and Jumpers

2.1 Pinouts

Motor Connector: ***PIC-SERVO*** Motor Control Board P1

Pin	*Definition*
1	Motor Output (M+)
2	Motor Output (M+)
3	LED power - pulled up to 5v with a 330 ohm resistor (for use with opto-interrupt type switches)
4	Limit Switch 1 (pulled up to 5v with a 4.7k resistor)
5	Encoder Channel A
6	Encoder Channel B
7	Limit Switch 2 (pulled up to 5v with a 4.7k resistor)
8	Encoder Index (pulled up to 5v with a 4.7k resistor)
9	Motor Output (M-)
10	Motor Output (M-)
11	GND
12	GND
13	GND (supplied to encoder)
14	+5v (supplied to encoder)
15	GND

Network Connectors: ***PIC-SERVO*** Motor Control Board JP1, JP2

Pin	*Definition*
1	***PIC-SERVO*** RCV+
2	***PIC-SERVO*** RCV-
3	***PIC-SERVO*** XMT+
4	***PIC-SERVO*** XMT-
5	***PIC-SERVO*** ADDR_IN on JP1, ADDR_OUT on JP2
6	GND
7	Logic power (7.5 - 12vdc)
8	GND
9	Logic power (7.5 - 12vdc)
10	GND

External Amplifier Connector: ***PIC-SERVO*** Motor Control Board JP9

Pin	*Definition*
1	PWM Output
2	Direction Output
3	Amplifier Enable Output
4	Analog Input (to inverting pre-amplifier - see *Section 3.4*)
5	+5v
6	GND

Motor Power Connector: ***PIC-SERVO*** Motor Control Board Screw Terminals

Pin	*Definition*
1	Motor Power 12 - 48vdc (at edge of board)
2	Motor Power Ground (connected internally to logic ground)

Logic Power Connector: ***PIC-SERVO*** Motor Control Board JP8
(Use only if logic power is **not** supplied via the network communications cable.)

Pin	*Definition*
1	7.5 - 12vdc (pin towards the lower edge of the board)
2	Ground (pin towards the center of the board)

2.2 Jumpers

PIC-SERVO Motor Control Board Jumpers:

Jumper	*Description*
JP3	Connects ADDR_IN to GND. Insert jumper for the last ***PIC-SERVO*** on the network (or if only 1 ***PIC-SERVO*** is used)
JP4, JP5	Enables termination resistors on RX and TX. Insert these jumpers for the last ***PIC-SERVO*** on the network (or if only 1 ***PIC-SERVO*** is used).
JP6,JP7	Logic power interconnection. Inserting JP6 connects logic power to network connector JP2. Inserting JP7 connects logic power to JP1. These are used to control the distribution of logic power over the network cables. Normally both these jumpers are installed.
JP10	Amp Enable pull-down. This jumper supplies a pull-down resistor for external amplifiers requiring one for when motor power is on and logic power is off.
JP11	For use with LMD18200 type amplifier - connects current sense output of amplifier to analog input. *(Only on boards labeled PIC-SERVO v2)*

3. *PIC-SERVO* Motor Control Board Description

The ***PIC-SERVO*** Motor Control board is a complete motor servo control system including a servo controller, amplifier, serial communications interface, optical encoder interface, limit switch inputs, and an auxiliary analog input with pre-amplifier. The board is designed so that up to 32 controllers can be connected directly to a single standard serial port (using an RS232-RS485 converter if necessary).

3.1 *PIC-SERVO* Chipset

The ***PIC-SERVO*** chipset forms the core of the controller. The ***PIC-ENC*** performs the time critical encoder counting task, while the ***PIC-SERVO*** executes the servo control, the communications interface, and outputs a 20 KHz PWM and Direction signal to the amplifier. Please refer to the ***PIC-SERVO*** chipset data sheet for complete details on the theory of operation of the servo control and motion profiling algorithms. You should also refer to the ***PIC-SERVO*** Programmer's Application Note for details on sending commands and receiving data from the ***PIC-SERVO***.

The ***PIC-SERVO*** board may also be used with the ***PIC-SERVO CMC*** chipset which supports coordinated motion control. The ***PIC-SERVO*** chip may be replaced with a ***PIC-SERVO CMC*** chip; the ***PIC-ENC*** chip is the same for both chipsets and need not be changed. Please refer to the ***PIC-SERVO CMC*** chipset data sheet for additional details.

3.2 Communications Interface

The ***PIC-SERVO*** uses an RS485 multi-drop interface for allowing multiple control modules to communicate over the same RS485 communication port. The host computer sends commands out over a dedicated pair of transmit wires, and all data comes back over a shared pair of receive wires. Because the host has a dedicated transmit line, a standard RS232 serial port can be used with simple RS242-RS485 converter.

With multiple controllers on a single network, each controller must have a unique address for sending commands. Rather than using dip switches or jumpers to assign addresses, the ***PIC-SERVO*** uses a method of daisy-chaining an ADDR_IN signal and an ADDR_OUT signal for dynamically assigning addresses. With the controllers interconnected as shown in *Figure 1*, the ADDR_OUT signal of one board is connected to ADDR_IN of the next board. The very last board has ADDR_IN jumpered to GND. On power-up, all boards with ADDR_IN held high will have their communications disabled. Therefore, only the last board will be able to communicate with a default address of 0.

To initialize the network, a command is sent to the last controller (with address 0) to change its address to a value of 1. This has the side effect of causing its ADDR_OUT to lower, enabling communications with the next controller. The next command sent to address 0 will now be sent to the second-to-last controller. This process of assigning addresses is repeated until all controllers have been given a unique address.

3.3 Amplifier

The ***PIC-SERVO*** Motor Control board uses an LMD18201 H-bridge amplifier to drive DC brush-type motors with up to 3 amps continuously, 6 amps peak, with a supply voltage of 12 to 48vdc. This amplifier has overcurrent, overtemperature and undervoltage protection. If you are driving more than 500 ma, however, you will likely need to mount a heat sink to the tab of the amplifier.

This tab is connected to GND, so it may also be bolted directly to a metal enclosure if your case ground is connected to your power ground.

Optionally, an LMD18200 amplifier can be installed in place of the LMD18201. The LMD18200 provides a current sense output which can be used for current limiting. If you do install an LMD18200 amplifier, you should replace the wire jumper at the location R3 with a 2.7K ohm resistor, and you should install a jumper at JP11.

If greater than 3 amps is required, the ***PIC-SERVO*** Motor Control board can be used with an external amplifier. External amplifiers may be for brush or *brushless* motors. PWM, Direction and enable signals are provided on connector JP9. This connector also has a pin connected to the analog input pre-amplifier for use with amplifiers that have current sense feedback. This feedback can be used by the ***PIC-SERVO*** to prevent the amplifier from latching up in an overcurrent protection mode. Jumper JP10 connects a pull-down resistor to the amplifier enable pin of the external amplifier connector. This prevents some amplifiers from being enabled when motor power is on but logic power is off. Installation of this jumper may not be necessary with all external amplifiers.

3.4 Analog Input

One of the pins on JP9 is connected to an analog input pre-amplifier. The pre-amplifier consists of a high impedance follower, followed by an inverting amplifier. The potentiometer at the edge of the board, R6, is used to adjust the amplifier offset. The potentiometer inboard, R5, is used to adjust the amplifier gain. The output of this amplifier goes to the A/D input pin of the ***PIC-SERVO*** where it is converted to an 8-bit value. This A/D input can be used as a general purpose analog input, or if connected to the current sense output of an external amplifier, it can be used to limit the amplifier output current. The analog input range is 0 - +5v. Please refer to the schematic diagram in *Figure 2* for amplifier details.

3.5 Physical Dimensions

The ***PIC-SERVO*** Motor Control board is 2.1" x 3.1" with four 0.156" dia. mounting holes at 1.8" x 2.45". Board height is approximately 1.0".

4. Contact Information

Additional information may be found from these sources:

J R Kerr Web Site **www.jrkerr.com**
Datasheets, application notes and test code may be downloaded from: "http://www.jrkerr.com/docs.html". Technical support is provided via e-mail. Send your questions to "techsupport@jrkerr.com".

Microchip **www.microchip.com**
The ***PIC-SERVO*** is based on the Microchip PIC16C73 microcontroller and the ***PIC-ENC*** is based on the PIC16C54 microcontroller. Please refer to the Microchip data sheets for these devices for complete electrical, timing, dimensional and environmental specifications.

National Semiconductor **www.national.com**
Datasheet for the LMD18201 PWM amplifiers.

Servo Systems **1-800-922-1103**

Their catalog contains a good selection of new and surplus motors, gearheads, encoders and amplifiers.

HdB Electronics **1-800-287-9432**
Distributor of ***PIC-SERVO*** products as well as of other electronic components, accessories and tools. Fax: 1-650-368-1347, Phone (from outside US): 1-650-368-1388.

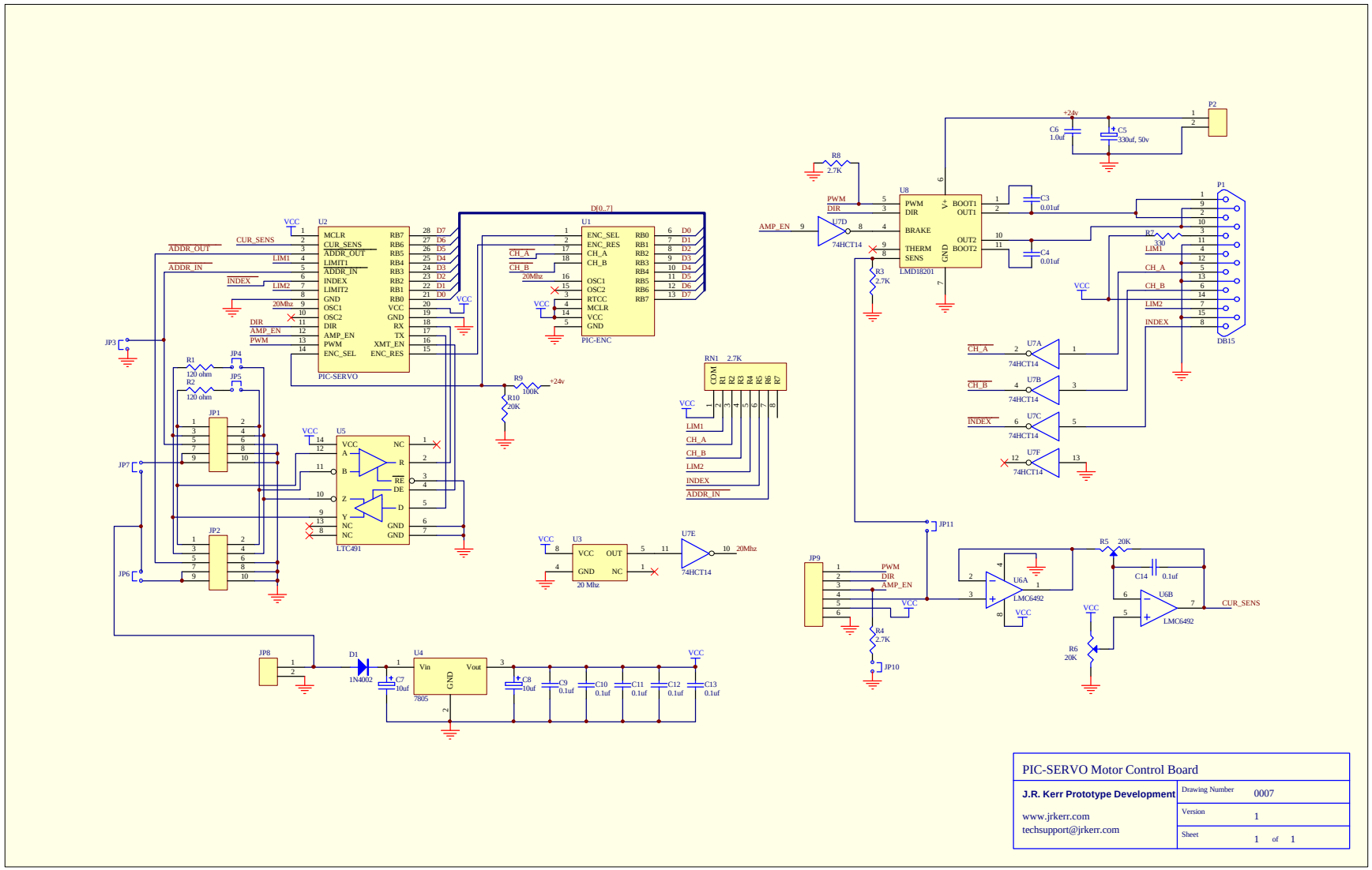


Figure 2 - ***PIC-SERVO*** Motor Control Board Schematic