J R KERR
AUTOMATION
ENGINEERING

___ *PIC-STEP* Stepper Motor Controller Board_____

The ***PIC-STEP*** board, based on the ***PIC-STEP*** stepper motor controller chip, is an integrated indexer and driver for bipolar stepper motors. It is compatible with the ***PIC-SERVO*** and ***PIC-I/O*** modules and provides the following capabilities:

- Integrated bipolar chopping driver - drives up to 2 amps per phase at up to 46v.
- Full-step and half-step stepping modes.
- Profiled velocity and trapezoidal position modes with programmable velocity and acceleration.
- Step rates up to 50,000 steps per second - the board may also be used with external microstepping drivers.
- Limit switch inputs, e-stop input, thermal sensor input, as well as auxiliary input and output bits.
- RS485 serial interface allows up to 32 ***NMC*** modules (***PIC-STEP***, ***PIC-SERVO*** or ***PIC-I/O***) to be controlled from a single serial port. Connects to an RS232 port through commonly available adapters or using the ***Z232-485*** converter board.
- The 2" x 3" board can be stacked with other ***NMC*** controller boards.
- Test software provided including Window95/98 test example source code.

1. Quick Start

What you will need:

PIC-STEP Board
Z232-485 Converter Board (or equivalent)
2-phase stepper motor
Motor power supply (7.5 - 46vdc)
External heat sink
Logic power supply (7.5 - 12vdc, 500 ma)
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 Windows95/98
Test software -
NMCTest.zip for Windows95/98
(download software from http://www.jrkerr.com)

Interconnections and Jumpers:

Basic interconnections and jumpers are shown in *Figure 1* for both a single module and for a multiple module configuration. Modules may be ***PIC-STEP***, ***PIC-SERVO*** or ***PIC-I/O*** modules. On

CAUTION

The ***PIC-STEP*** 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.

the ***Z232-485*** converter, jumpers JP3 and JP4 are installed in the 1-2 position for use as a simple converter. 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 not using the ***Z232-485*** converter, please refer to the pin definitions for JP1 and JP2 in *Section 2.1* for connecting logic power and RS485 signals from your RS485 COM port.)

On the ***PIC-STEP*** board, jumpers JP6 and JP7 are installed to connect logic power supplied by the communications cable to the board's logic supply. Connector JP8 should be left unconnected. In the *single* module configuration, the three jumpers near the label JP3 (JP3, JP4 and JP5) should be installed as shown. In the *multiple* module configuration, these jumpers should only be installed on *last* module furthest from the PC host; on all other modules, these jumpers should be left *uninstalled*.

The motor power supply should be connected to the two uppermost screw terminals, with 7.5 - 46vdc connected to the terminal towards the edge of the board and GND connected to the adjacent terminal as shown in *Figure 1*.

The motor should be connected to the DB15 connector labeled P1. Please refer to *Section 2.1* for P1 pin definitions.

Heat Sinking - ***Important!***
The heat sink tab of the L298 power amplifier chip must be screwed to an aluminum heat sink to prevent the amplifier from over heating. (The amplifier is thermally protected, but it will not function properly when it gets too hot.) The heat sink should be capable of dissipating 25w. If a simple aluminum plate or part of a metal case is used, it should have approximately 15 sq.in. exposed to ambient air. Note that the heat sink tab is electrically connected to ground, and that a heat sink insulator should be used if you need to isolate the heat sink from ground.

Loading and Running Software:
Unzip (using PKUNZIP) 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. You will be prompted for the COM port and baud rate you would like to use. Choose the appropriate COM port, and initially, use a baud rate of 19200. The program will attempt to locate ***NMC*** (*Networked Modular Control*) modules (***PIC-I/O***, ***PIC-SERVO*** or ***PIC-STEP***), connected to the selected COM port. If no modules are found, make sure that everything is connected correctly, that jumpers are set correctly, and that logic power is applied. Click on “Reset Network” to try again or with a different COM port.

Once modules are found, the list box on the left side of the window will display the list of modules found. Module 1 will be the last controller which is furthest from the host PC. Clicking on different modules in the list will display the status and controls for that particular module. Click on one of your ***PIC-STEP*** modules.

The ***PIC-STEP*** control panel will display all of the module's inputs and allow you to control the outputs. Operation of the ***PIC-STEP*** from this control panel is fairly straightforward, but you can click on the "Help" button for specific details of operation.

To run your motor, select the "Ignore Limits" and "Ignore E-stop" options in the Motion Parameters panel, and then click on the Set Motion Parameters button. Next, turn on your motor power supply; you should see the Motor Power indicator light up in the Motor Status panel. Lastly, click on the Enable Amp button in the Motor Commands panel; the Amp Enabled indicator should light up, and the motor shaft should be locked into position.

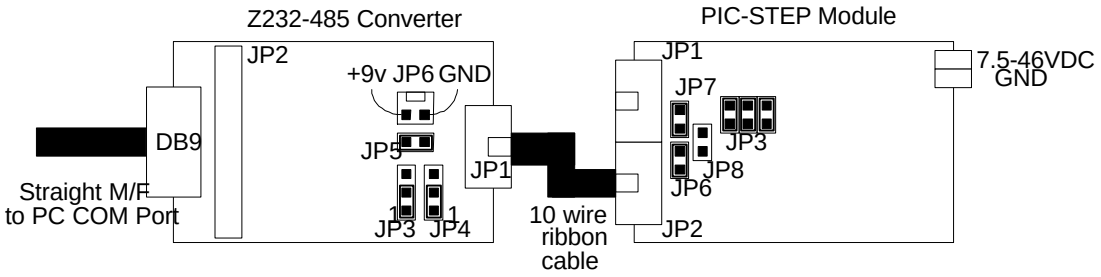
By default, the motor holding current is set to 10 out of 255, and the running current is set to 20 out of 255. A value of 255 corresponds to a current limit of 2.7 amps per phase. Because the continuous current limit for the amplifier is only 2.0 amps per phase, the running and holding current limits should never be set higher than a value of 188 except under special circumstances. For now, try setting the running current limit equal to the motor's rated current (for a rated current of 1.0 amp, you would use a value of 94) and setting the holding current limit to half that value.

Finally, to make the motor actually move, set a motor speed of about 20, an acceleration of 5, select Velocity Mode, and then click on the GO button. The motor should accelerate to a speed of 500 steps per second (20 x 25 steps per second if 1x speed mode is being used.) Clicking on the Stop button will cause the motor to decelerate to a stop. You can also try entering a position, in steps, selecting Position Mode, and then click on GO again. The motor should run to the commanded position and then stop.

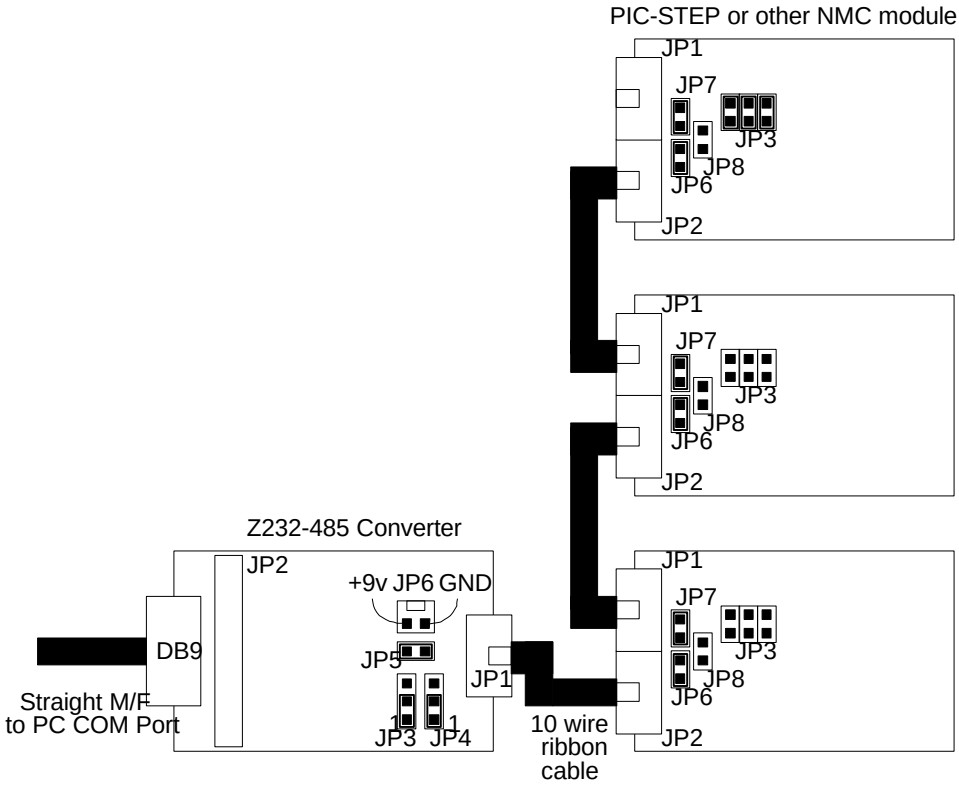
At this point, you should check to make sure that your motor and the amplifier chip are not getting too hot. If they are, lower the running and/or holding current limit values.

Now that you are up and running, you should review the rest of this document, as well as reading the ***PIC-STEP*** chip data sheet for a complete description of its features and operation.

Single Module Configuration



Multiple Module Configuration



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

Figure 1 - Basic Interconnections.

2. Connectors and Jumpers

2.1 Pinouts

Motor Connector P1 (DB15 female)

Pin	*Definition*
1	Phase A+
2	Phase B+
3	LED Drive 1 (connects to +5v through a 330 ohm resistor)
4	Limit switch 1 input (active HIGH)
5	Limit switch 2 input (active HIGH)
6	E-Stop input (active HIGH)
7	Thermistor input
8	+5v (output)
9	Phase A-
10	Phase B-
11	LED Drive 2 (connects to +5v through a 330 ohm resistor)
12	Limit Switch 1 return (GND)
13	Limit Switch 2 return (GND)
14	E-Stop return (GND)
15	Thermistor return (GND)

Power Connector P2 (Screw Terminals)

Pin	*Definition*
1	Motor power input (7.5 - 46vdc) - *at upper edge of board*
2	Ground

External Amplifier Connector P3 (0.100” 8-pin header)

Pin	*Definition*
1	Step signal output (*on left*)
2	Direction signal output
3	Output 2
4	Output 3
5	Output 4
6	Output 5
7	Input 1
8	GND (*on right*)

Network Connectors JP1, JP2 (10 pin shrouded header - 2 x 5, 0.100" spacing)

Pin	*Definition*
1	RCV+ (***Z232-485*** XMT+)
2	RCV- (***Z232-485*** XMT-)
3	XMT+ (***Z232-485*** RCV+)
4	XMT- (***Z232-485*** RCV-)
5	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

2.2 Jumpers

PIC-STEP Board Jumpers:

Jumper	*Description*
JP3	Connects ADDR_IN to GND. Insert jumper for the last module on the network (or if only 1 module is used)
JP3,JP4	Enables termination resistors on RX and TX. Insert these jumpers for the last module on the network (or if only 1 module 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 of these jumpers are installed.

2.3 Board Dimensions

Board dimensions:	3.1" x 2.1"
Overall dimensions (LxWxH):	3.75" x 2.1" x 1.0"
Mounting holes:	0.156 dia
	4 places (1.80" x 2.45")

2.4 Ordering Information

Part Number	***Description***
KAE-T3V1-BDV1	***PIC-STEP*** Stepper Motor Controller Board

3. *PIC-STEP* Board Description

The ***PIC-STEP*** board is an integrated stepper motor driver and indexer compatible with ***PIC-SERVO*** and ***PIC-I/O*** controller modules. The board is designed so that up to 32 modules can be connected directly to a single standard serial port (using an RS232-RS485 converter if necessary).

3.1 *PIC-STEP* Controller Chip

The heart of the ***PIC-STEP*** controller board is the ***PIC-STEP*** controller chip. It controls all of the communications, motion profiling functions and interfaces directly to the stepper amplifier. Please

refer to the ***PIC-STEP*** data sheet for details on the ***PIC-STEP*** command set and communications protocol.

3.2 On-board Amplifier

The ***PIC-STEP*** board includes an integrated bi-polar chopping amplifier for driving 2-phase stepper motors in full-step or half-step modes. The amplifier will drive up to 2 amps/phase from a supply voltage ranging from 7.5 to 46vdc. The amplifier may be over driven for short periods (less than 2 seconds) with currents up to 2.7 amps per phase. The current limit can be set using the ***PIC-STEP*** controllers "Set Parameters" command. A running or holding current value of 255 corresponds to the full 2.7 amps/phase. The running and holding currents should both be set to below a value of 188 (corresponding to 2 amps per phase) to insure save operation.

Heat Sinking

The ***PIC-STEP*** board is shipped without a heat sink attached to the power tab of the amplifier chip (L298) because the size of the heat sink required will vary considerably with the application. At full power, the heat sink should be able to dissipate at least 25w of heat. The maximum case temperature of the L298 should not exceed 75°C. For very small motors drawing less than 100 ma, no heat sink is necessary. The L298 amplifier does have internal over temperature protection, but a heat sink is still required for normal operation for most applications.

Amplifier Mode Control

The ***PIC-STEP*** has several outputs connected to the L297 amplifier controller chip to specify its mode of operation:

Signal	*Description*
AMP_EN	Connects to the enable input of the L297. Setting this output HIGH or LOW (using the "Stop Motor" command) turns on or off the current to the motor.
CUR_LIM	This PWM output of the ***PIC-STEP*** connects to the Vref input of the L297 through a resistor network to control the running and holding current driving the motor. Use the "Set Parameters" command with running and holding current limit values of less than 188 for safe operation.
HSTEP	OUTPUT2 of the ***PIC-STEP*** is connected to the half-step/full-step control pin of the L297. Setting this pin HIGH using the "Set Outputs" command will specify half-step mode.
DECAY	OUTPUT3 of the ***PIC-STEP*** is connected to fast/slow decay mode control for the L297. This output should always be set using the "Set Outputs" command to specify the slow decay mode. Fast decay mode should not be used.
SETHOME	OUTPUT4 of the ***PIC_STEP*** is connected to Reset pin of the L297, forcing the driver into state 1 of its 4 (or 8) state step cycle. This bit should be set using the "Set Outputs" command for normal operation.

The HSTEP, DECAY, and SETHOME signals, as well as the STEP and DIRECTION signals appear on connector P3 for controlling the mode of an external stepper driver. An additional auxiliary output also appears on this connector.

Please refer to the data sheet for the L297 stepper motor controller chip from SGS Thompson (www.st.com) to learn more about the various control modes.

3.3 Control Inputs

The ***PIC-STEP*** board has several inputs for responding to external events:

Signal	*Description*
LIMIT1, LIMIT2	These limit switch inputs can be used for homing or for automatically stopping the ***PIC-STEP*** on over-travel. A mechanical switch or an open-collector *NPN* transistor can be placed between these inputs and ground. The limit switches can also be ignored using the "Set Parameters" command.
E-STOP	This input can be used as an emergency stop signal to stop the motion of the motor. E-Stop can be ignored using the "Set Parameters" command.
THERM	This input can be connected to a 10 KOhm *Negative Temperature Coefficient* thermistor mounted on the motor (the other thermistor lead connects to ground) to cause the ***PIC-STEP*** amplifier to shut down automatically when a temperature limit is exceeded. The actual temperature limit is programmable using the "Set Parameters" command. Because the thermistor lowers in resistance as the temperature increases, a lower thermal limit value will correspond to a higher temperature threshold. A thermal limit value of zero will disable the external thermal overload protection.
HOME	The HOME_SWITCH input of the ***PIC_STEP*** is connected to HOME output of the L297. This input goes HIGH whenever the amplifier is in state 1 of its 4 or 8 state step cycle. This input can be used in conjunction with the limit switches for more accurate homing.
AUXIN	This undedicated input can be read through the ***PIC-STEP***'s serial interface

The LIMIT1, LIMIT2, E_STOP and THERM inputs appear on connector P1, and AUXIN appears on connector P3. LIMIT1, LIMIT2, E_STOP, THERM and AUXIN all have 4.7KOhm pull-up resistors to +5vdc.

4. Contact Information

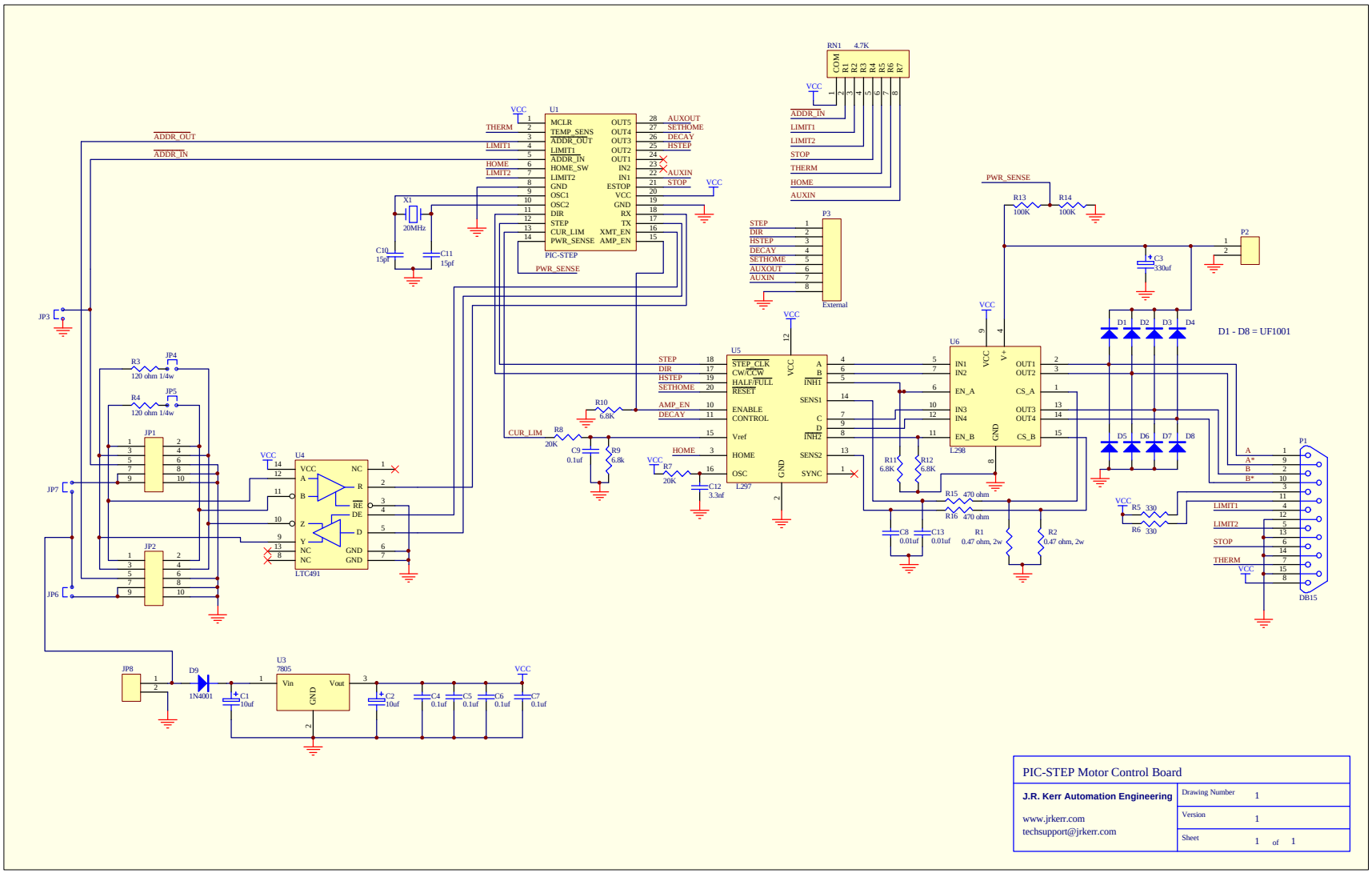
Additional information may be found from these sources:

J R Kerr Automation Engineering **www.jrkerr.com**

Information about the ***PIC-SERVO*** and ***PIC-STEP*** motor controllers and related products including ordering information, product documentation and test software. Data sheets, application notes and test code may be downloaded from the page: **http://www.jrkerr.com/docs.html**. Technical support is provided via e-mail. Send your questions to **techsupport@jrkerr.com**.

HdB Electronics **www.hdbelectronics.com**

Distributor of the ***PIC-STEP*** and ***PIC-SERVO*** products as well as of other electronic components, accessories and tools.


PIC-STEP Motor Control Board
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Drawing Number 1
Version 1
Sheet 1 of 1
D1 - D8 = UF1001
PIC-STEP
LTC491
L297
L298
External
DB15
20MHz
1N4001
ADDR_OUT
ADDR_IN
PWR_SENSE
CUR_LIM
LIMIT1
LIMIT2
STOP
THERM
HOME
AUXIN
AUXOUT
SETHOME
DECAY
HSTEP
AMP_EN
STEP
DIR
VCC