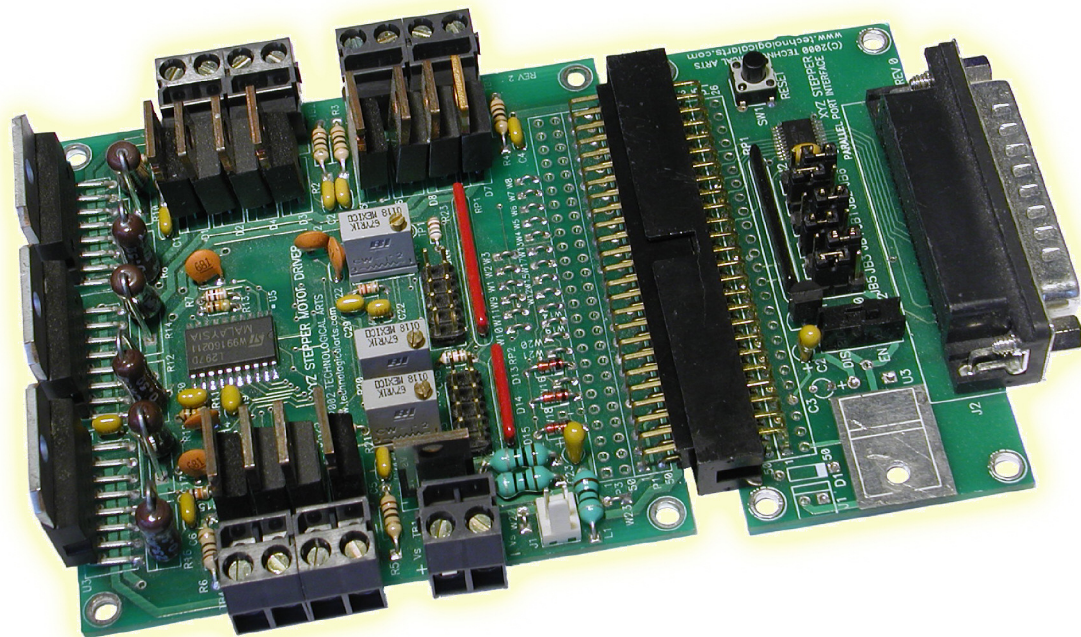


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# Using the STEP3PPI 3-Axis Stepper Motor Controller Package

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[www.technologicalarts.com](http://www.technologicalarts.com)

Revision 0

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### ESD WARNING

This product, like most electronic products, uses semiconductors that can be damaged by electrostatic discharge (ESD). When handling, care must be taken so that the devices are not damaged. Damage due to inappropriate handling is not covered by the warranty.

The following precautions must be taken:

- Do not open the protective conductive packaging until you have read the following, and are at an approved anti-static work station.
- Use a conductive wrist strap attached to a good earth ground.
- Always discharge yourself by touching a grounded bare metal surface or approved anti-static mat before picking up an ESD-sensitive electronic component.
- Use an approved anti-static mat to cover your work surface.

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# 1 INTRODUCTION

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## 1.1 WELCOME!

The **STEP3PPI** package that you have purchased is designed to enable control of up to three bi-polar stepper motors via the parallel port of a PC. The design is taken largely from the application notes of ST Microelectronics, manufacturer of the chip set on which this product is based. Combining this product with a mechanical system and readily available software to be found on the internet, you are well on your way to implementing a CNC machine, engraver, sign-cutter, or any of a number of other useful applications.

### **Product Features:**

- Control up to 3 stepper motors independently
- Supports full and half-step modes
- Current mode driver (chopper) for bipolar stepper motors up to 2 Amp / 36 V
- User-selectable chopper current
- Home and Limit switch inputs for external controls
- High speed interface through PC Parallel Printer Port

## 1.2 SUPPORT

To help you get the most out of this product, and to make the experience as enjoyable and productive as possible, we've put together a comprehensive website, loaded with resources, support, and applications information. If you experience any difficulties, or need help with your application, the World Wide Web is arguably the most valuable resource available to you. There you'll find the latest information, software, and troubleshooting help, as well as discussion groups where you can network with people around the globe to get the answers you need. So if you still need help, or have questions after reading this manual, here are some suggested resources you can access:

- the **STEP3PPI** webpage's Resources tab
- our Support Library: <http://support.technologicalarts.ca/>
- our Support Forum: [www.technologicalarts.net](http://www.technologicalarts.net)
- the ST Microelectronics website: [www.st.com](http://www.st.com)

## 1.3 PRODUCT CONFIGURATION

**STEP3PPI** combines two products: the 3-axis stepper motor controller board (AD12DXYZSM) and a parallel port interface (PPI). Appropriate 50-pin headers have been installed on each, to facilitate their interconnection. It is up to the user to supply stepper motors, mechanical assemblies, home and limit switches, cables, and a suitable power supply (or power supplies).

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## 2 GETTING STARTED

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### 2.1 POWER OPTIONS

**Option 1:** For low motor supply voltage (e.g. 5V to 12V), a single power supply may be used to power both the motors and the logic voltage regulator, via the pluggable terminal block, TB1. The power supply should be capable of supplying at least 250 mA more than the maximum combined stall current of the three motors you are planning to use. *CAUTION! Make sure you have the polarity correct!*

**Option 2:** For a higher motor supply voltage (i.e. above 12V), the logic voltage regulator will overheat. Instead, you should use two separate power supplies-- one for the motors and another for the logic voltage regulator. Before applying any power, carefully cut or remove wire link W22 on the circuit board (adjacent to TB1). For the logic voltage regulator, you'll need a DC power supply with an output voltage somewhere in the range of 6 to 12 Volts, with a minimum current rating of 300 mA. An example of a suitable power supply is the typical plug-in-the-wall power adapters commonly used with most household electronic devices. This will eventually be applied to power connector J1 (located near TB1), so prepare it by splicing its output wires to the red and black cable assembly (#PCJ1-8) supplied. Connect your motor supply voltage securely to the screws of the pluggable terminal block (TB1) but don't plug it in yet. *CAUTION! Double-check your connections before applying power.*

### 2.2 SETTING THE PEAK CURRENT LIMIT

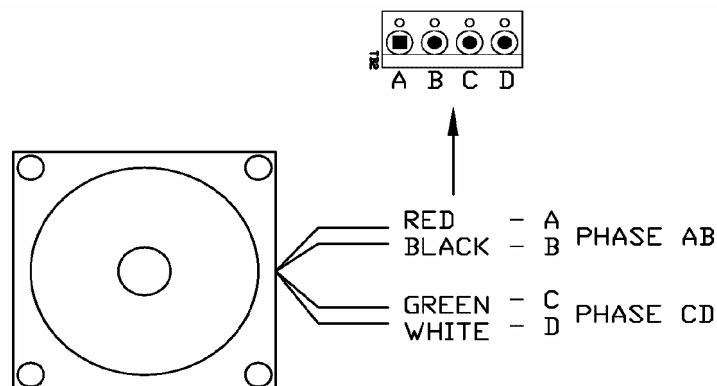
On the XYZ stepper board you'll find multi-turn potentiometers R19, R20, and R21. They control the value of a reference voltage which in turn sets the peak current applied to the motor windings. A voltage drop appears across half-Ohm resistors R10, R14 and R18 for each axis, with corresponding test points TP1, TP2, and TP3 provided for easy adjustment. The formula is

$$\text{Voltage Drop} = 0.51 \text{ Ohms} \times I_{pk} \quad (\text{where } I_{pk} \text{ is peak current})$$

To set these up, decide on the value of  $I_{pk}$  you want to implement. Make sure no motors are plugged into the terminal blocks, and then apply logic voltage to J1 (or motor voltage to TB1, if following Option 1, above). Use a volt meter to measure test points TP1, TP2 and TP3. Adjust the potentiometers for each to match the Voltage Drop you calculated above. Disconnect power from the board.

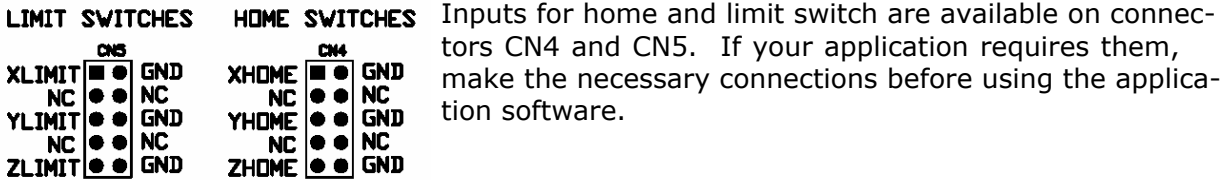
### 2.3 CONNECTING THE MOTORS

Referring to the diagram below, connect motor wires to terminal blocks TB2 through TB4.



Note: the figure above shows common wire colors for a 4-wire bi-polar stepper motor. If your motor doesn't match the above depicted color configuration, an easy way of identifying phase wires is by using an Ohmmeter. Look for a pair of wires that have continuity and measure their resistance. You will find 2 sets with low resistance. Mark them as A and B (Phase AB). Repeat this operation for the second set of wires and mark them as C and D (Phase CD). Once phases have been identified, you can connect the wires to the motor winding terminal block with terminals A, B, C and D.

## 2.4 CONNECTING LIMIT AND HOME SWITCHES



## 2.5 PARALLEL PORT INTERFACE

**Caution!** It is very important to properly align connector P1 of the Parallel Port Interface (PPI) with connector P1 of the XYZ stepper board. Any misalignment may damage the PPI.

Ensure that the PPI is properly connected to the XYZ Stepper Motor Board, such that pin 1 of the 50-pin connector on both boards is aligned.

### Description of Features:

SW2 is used to disengage the stepper control signals when power is first applied or present in the logic circuit.

Configuration of JB1, JB3, JB5:

*Low:* the chopper acts on INH1 and INH2

*High:* the chopper acts on phase A, B, C and D

Configuration of JB2, JB4, JB6:

*Low:* energizing steps are *half*

*High:* energizing steps are *full*

SW1 (Reset): resets the logic circuit, re-initializes all three L297 chips.

The PPI has a standard DB25 to connect via a printer cable to the parallel printer port on a PC.

### Follow this sequence every time you use STEP3PPI:

- 1) Make sure the power to the stepper motor board is off.
- 2) Slide SW2 on the PPI to UNLOCK to isolate the port.
- 3) Connect the PPI to computer parallel port (if not already connected)
- 4) Launch your PC software (e.g. CNC program)
- 5) Apply logic power via J1 (if using Power Option 2, above).
- 6) Slide SW2 to the LOCK (ENGAGE) position to enable the motors.
- 7) Apply motor supply voltage via TB1.

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## 3 FUNCTIONAL DESCRIPTION

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### 3.1 HOST INTERFACE AND COMMUNICATION WITH PC

#### Stepper Motor Controller IC

The heart of the stepper motor control is the LM297 from ST. This takes care of all the functions necessary to control the stepper motor, digital input and output.

#### Power Driver Section

All the stepper motors are driven by L298 H-bridge ICs. This chip is a high voltage, high current, dual full-bridge driver. It can handle up to 2 Amps of current and is controlled to work as a current mode chopper. Winding currents can be tightly controlled according to the value set by the onboard potentiometer. This current can be set by the user to any value between 50 mA and 2 Amps. Free-wheeling diodes are connected to the H-bridge legs, so that a very fast turn off time is achieved, permitting high-speed motor stepping.

#### Determining the Optimum Power-Supply

The motor power supply must meet stepper motors requirements in terms of torque, driving method and speed. Depending on whether the motors are going to be operated in constant current mode or not, the voltage must meet the requirement of the chopping circuit. That means that in order to achieve a high stepping rate, the motor's power supply voltage should be high enough for decreasing the turn on time on the windings. A typical voltage for most NEMA23 motors is 36 VDC. This power supply must also be able to provide the peak current at which the motor is rated. For instance, suppose the motor has a rating of 3.3 V at 2 Amps per winding to provide the rated static torque. The equivalent winding resistance is:

$$\text{Equivalent Resistance} = 3.3\text{V}/2 \text{ A} = 1.15 \text{ Ohms}$$

Increasing the voltage from the nominal value of 3.3 V to 36 V will decrease the time constant by about a factor of ten. This reduction in the time constant will allow the motor to reach a pull-in rate very much higher than when using a 3.3 VDC power supply. The acceleration rate and pullout torque at high stepping rates will also benefit from this configuration.

#### Software Library and Examples

A dynamic linked library (DLL) and a demonstration program are downloadable from many website. Here are a few links:

<http://www.deskam.com/download.html>

<http://www.metalworking.com/shareware.html>

#### Going Further:

If you want to gain a thorough understanding of stepper motors and various ways to control them, we recommend that you consult the very comprehensive set of application notes and device data sheets available from ST Microelectronics ([www.st.com](http://www.st.com)):

AN281 Driving DC Motors

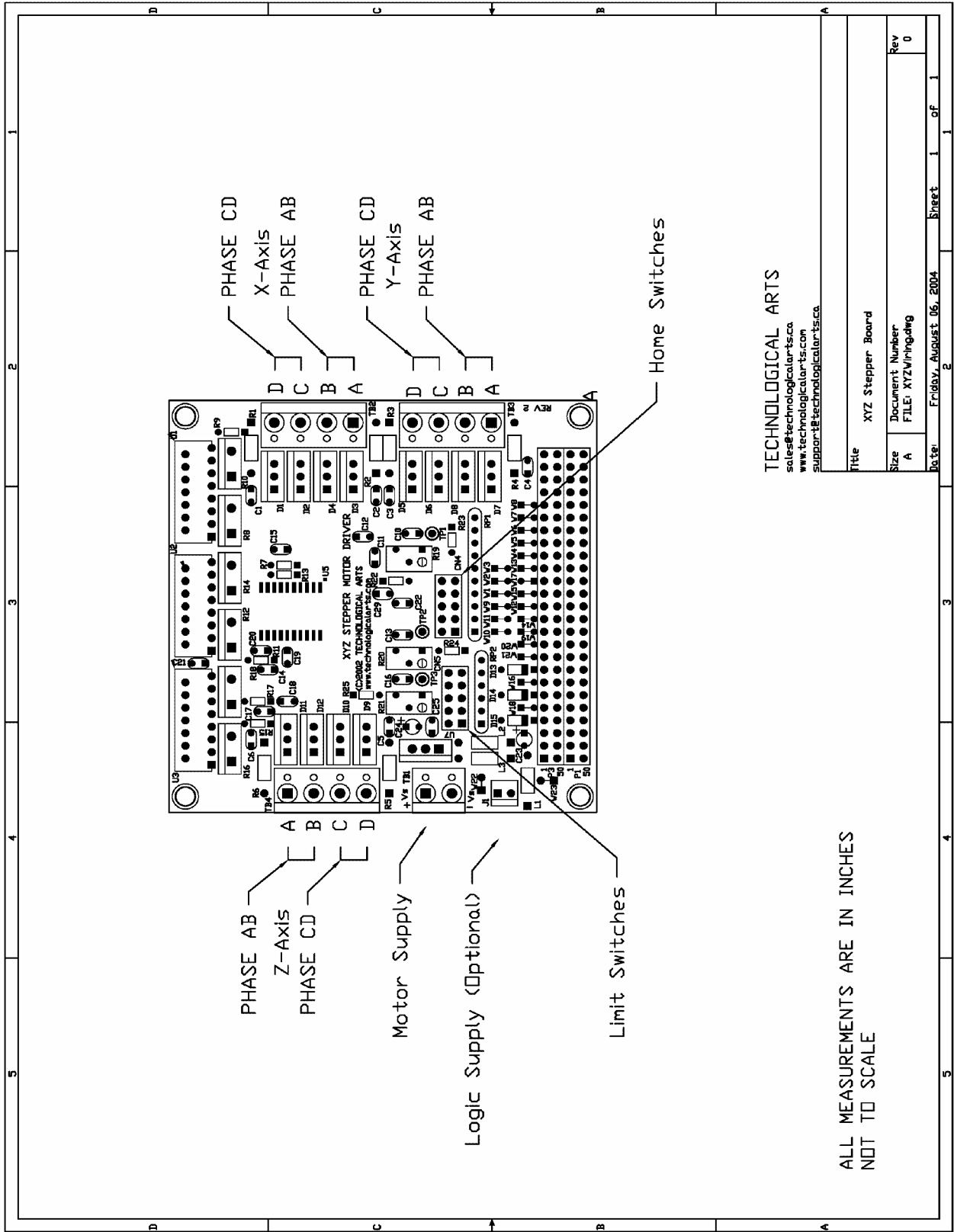
AN460 Stepper Motor Driver Considerations: Common Problems & Solutions

AN235 Stepper Motor Driving

AN470 The L297 Stepper Motor Controller

AN280 Controlling Voltage Transients in Full Bridge Driver Applications

AN468 Stepper Motor Performance: Constant Current Chopper Drive UPS

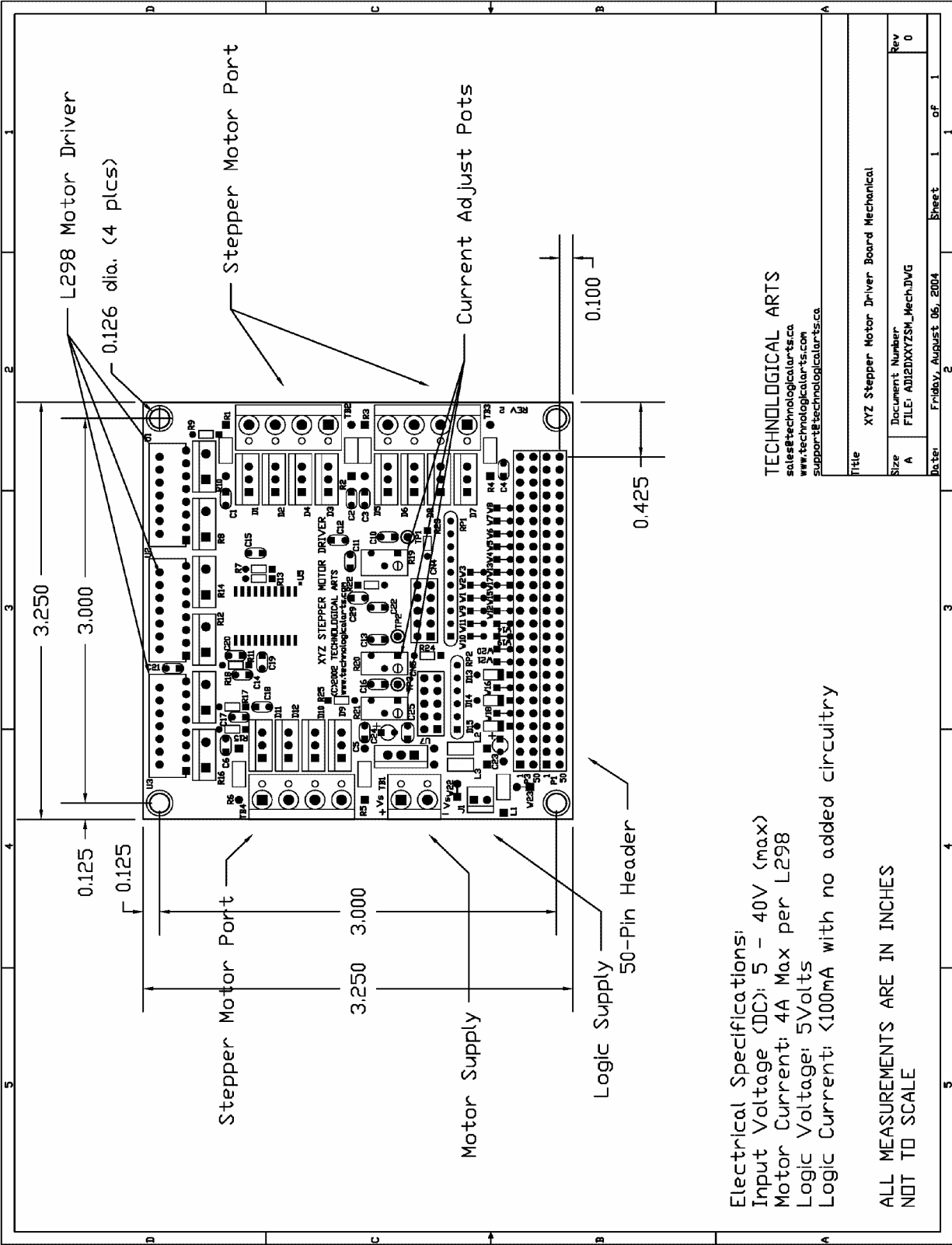


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Size	Document Number	FILE: XYZWiring.dwg
A	Rev	0
Date:	Friday, August 06, 2004	Sheet 1 of 1

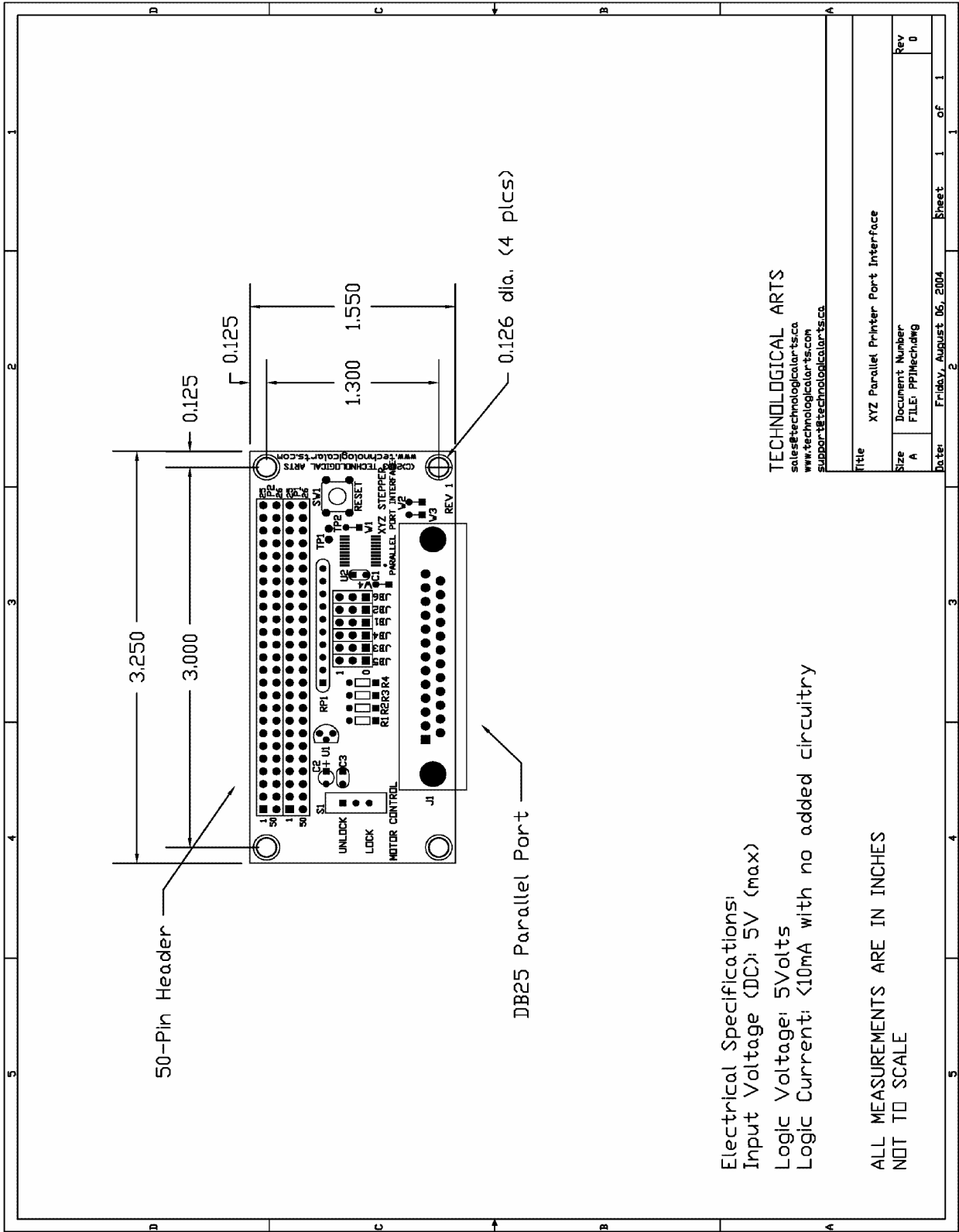
ALL MEASUREMENTS ARE IN INCHES  
 NOT TO SCALE

Drawing 3



Drawing 4





50-Pin Header

DB25 Parallel Port

0.126 dia. (4 plcs)

Electrical Specifications:  
 Input Voltage (DC): 5V (max)  
 Logic Voltage: 5Volts  
 Logic Current: <10mA with no added circuitry

ALL MEASUREMENTS ARE IN INCHES  
 NOT TO SCALE

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Title		XYZ Parallel Printer Port Interface
Size	Document Number	Rev
A	FILE: PPIMech.dwg	0
Date:	Friday, August 06, 2004	Sheet 1 of 1

Drawing 5

## **OPERATION INSTRUCTIONS**

**Follow this sequence every time you use STEP3PPI:**

- 1) Make sure the power to the stepper motor board is off.
- 2) Slide SW2 on the PPI to UNLOCK to isolate the port.
- 3) Connect the PPI to computer parallel port (if not already connected)
- 4) Launch your PC software (e.g. CNC program)
- 5) Apply logic power via J1 (if using Power Option 2, above).
- 6) Slide SW2 to the LOCK (ENGAGE) position to enable the motors.
- 7) Apply motor supply voltage via TB1.