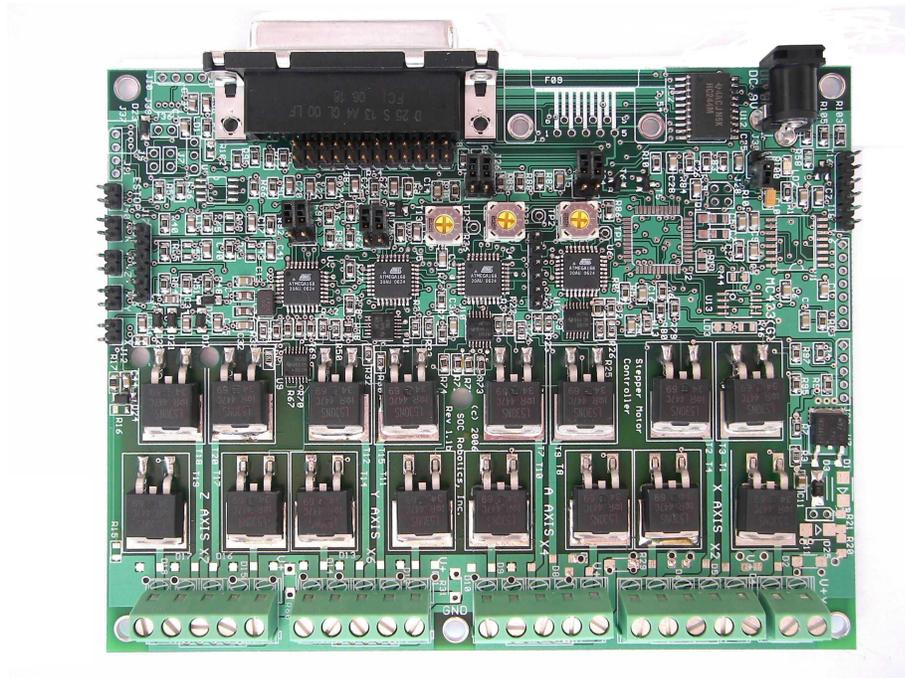


# MC433 Stepper Motor Controller

## 4 Axis, 10A PWM

### Hardware Reference Guide

PCB Rev 1.1,1.1b  
Motor Control Software Version 0.95



[www.soc-robotics.com](http://www.soc-robotics.com)

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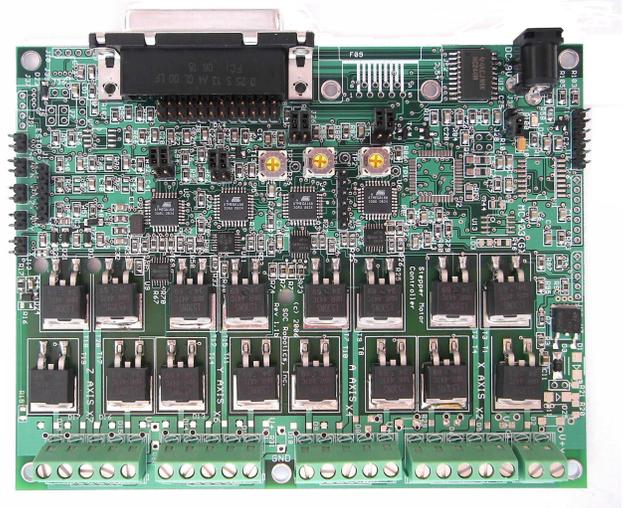
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## 1.0 Introduction

### Features:

- Unipolar Stepper Motor Controller
- 8A continuous, 33A peak (with cooling kit)
- 4 Axis - X, Y, Z and A
- Wave, Half and Full (High Torque) step
- Variable on time, chop duty cycle and duty cycle slew
- Dedicated 8bit RISC microprocessor for each axis
- Limit switch inputs routed to parallel port
- Stepper motor input voltage from 7-35V
- Noise reduction filter on each input step/dir
- 4 Open NPN outputs
- PC Parallel Port interface
- Logic supply from motor or separate supply
- Optional features:
  - Separate G Code interpreter
  - RS-232 and RS-485 port
  - External Serial Flash for program storage
  - Software controlled step mode selection
  - Joystick interface
  - 3 Analog input channels
- Relay daughter card interface
- I2C TWI Communication port
- Onboard programming interface via Parallel Port
- Works with most Windows based G Code programs
- 9-12VDC power input (5VDC board)
- Small form factor (3.85x3.00 in)



### Hardware

The MC433 is a 4-Axis unipolar stepper motor controller that converts step/direction inputs to jumper selectable wave, full or half step 4-phase power control. Each of the four phase coils of a unipolar stepper motor is connected to an IRF540 Power MOSFET switch. The IRF540 is capable of 8A continuous current load with the ability to peak at 33A. Each phase is pulse width modulated (PWM) to allow operation over a 7 to 35 volt range. PWM adjusts average current delivered to the stepper motor to better match the resistance/inductance of the motor without the need for load resistors. This ensures maximum power is delivered to the motor over a range of load conditions and motor types. PWM parameters are adjusted using three potentiometers - initial on time, chop rate duty cycle and duty cycle slew rate verse step rate. Chop rate is fixed at 12KHz. On time is the amount of time a switch remains on before PWM operation takes over - this allows the current to build to a maximum level as quickly as possible. Duty cycle is the percentage of on-time to off-time at a given chop frequency. Duty cycle is used to set the average current delivered to the motor. Duty cycle slew rate adjusts the duty cycle based on the duration of a step. As the step rate slows down (motor turns slower) the duty cycle is adjusted to deliver less power to the motor thereby maintaining constant current. The PWM potentiometer settings are described in more detail in section 3.2. Each motor can be individually set to wave, full, half step mode or be disabled by setting two jumpers on a four pin header. An onboard programming interface allows new Motor Controller programs to be loaded into Flash

A dedicated 8bit 20MHz RISC microprocessor (ATmega168) controls each axis. The microprocessor monitors step/direction inputs, limit switch input and PWM settings to generate the appropriate step sequence (wave, full or half) based on jumper settings. Three potentiometers set PWM operation for all four axis. The control processor automatically reduces current to the motor after 1.5 seconds by reducing the duty cycle and turns the motor off after 20 seconds - these parameters can be adjusted.

The MC433 is controlled via a PC compatible DB25 parallel port interface connector. The Parallel port interface has four Step/Direction inputs, four auxiliary outputs and four limit switch inputs. The four auxiliary outputs are connected to a Relay Adapter connector and an open NPN control connector. Limit switch inputs are connected to four 0.1" pin headers with pull up resistors - pulling the limit switch input to ground deactivates a stepper motor.

An I2C TWI communicate port allows an external TWI controller to communicate with each motor control processor individually to set step mode, step, PWM parameters and turn off conditions.

The MC433 has a 24pin header connector (J38) for attaching an optional G Code control processor. The optional high performance G Code processor supports USB 2.0.

## Host Software Applications

The MC433 is designed to work with a variety of third party G Code software programs. Step input for each axis requires an active high pulse lasting at least 2useconds - step inputs are edge triggered. A high level on the Direction input will turn the stepper clockwise or counterclockwise depending on how the motor is connected to the drive port. The direction signal is sampled after the step trigger so it must remain stable for at least 4useconds after the step trigger.

## Control Processor Reprogramming

New programs can be loaded into each control processors on chip Flash using the onboard programming interface. The programming interface is enabled by installing jumper J30. Once the programming jumper is installed all subsequent signals sent to the MC433 via the parallel port are interpreted as programming commands. Host programming program MC433Prog.exe is used to load new programs into the MC433. See the section on control processor programming for more information.

## Expansion Options

The MC433 has two expansion options: Relay Adapter and G Code Processing Adapter - MA48/SAM48.

The Relay Adapter provides four isolated contact closures for control of external devices. Power can be optionally supplied by the adapter if isolation is not required using a jumper. The relay board supports low voltage DC switching relays capable of handling 2A at 24volts.

The MA48/SAM48 is an ARM7 processor based daughter card that attaches to the expansion header on the board and converts G Code commands transmitted to it on a USB 2.0 connection into step/direction commands. The MA48/SAM48 is described by a separate document.

## Differences Between Rev 1.1 and Rev 1.1b

The MC433 was upgraded to PCB Revision 1.1 and then 1.1b.

Summary of Revision 1.1 changes:

1. On board programming interface added - separate ISP10 programming adapter is no longer required. Use MC433Prog.exe to program each processor
2. 74HC08 added to each motor control processor step output to lower chop load in the processor

4. Emergency Stop (EStop) interface added – an external panic stop button can be used to stop all
5. four motor controllers. EStop is routed to the parallel port interface.
6. A few routing detected on Rev 1.0 were corrected.
7. Filter circuit and 5V Zener added to each Limit Switch/EStop input to protect these inputs from
8. spurious voltage levels inducing in switch wiring.
9. Circuit allowing each motor controller to measure motor voltage added
10. 20MHz crystal added to allow the motor controllers to run at 20MHz rather than 8MHz

Summary of Revision 1.1b changes (in addition to Rev 1.1):

- External Serial Flash pad added to allow G Code Program storage on board.
- 74HC08 QFN replace with TSSOP package for increased manufacturing yield.
- A few routing errors were corrected.

Revision 1.1b PCB is now the current release.

## 2.0 MC433 Quick Start Guide

### 2.1 Introduction

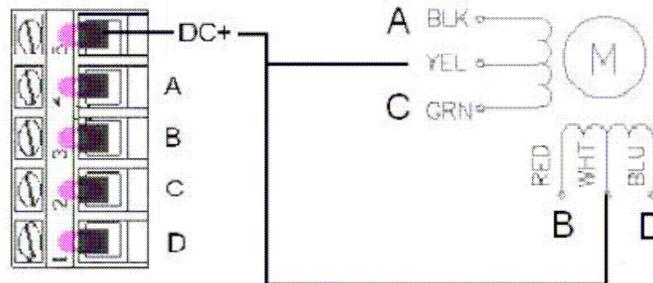
Before using the MC433 please read this quick start guide.

**WARNING: Before connecting Motor DC Power make sure the stepper motors are wired correctly. A Unipolar stepper motor has two sets of windings each with a common lead. The common leads should be connected to DC+ and each motor coil connected to a MOSFET power switch A,B,C or D. Depending on how the windings are connected the motor will turn clockwise or counterclockwise. Ensure the motor leads are securely attached – intermittent or loose connections can generate a several KiloVolt back EMF spike in the motor possibly damaging the motor and/or MC433.**

### 2.2 Wiring the Stepper Motor

The wiring of a Unipolar Stepper motor to the MC433 is shown in the diagram below. The color code used in the diagram is for a SOC Robotics SM2006A 2.5A Unipolar Stepper Motor and may not match the color code of your particular stepper motor – check the phase (coil) configuration diagram for your stepper to determine the correct lead connection to A,B,C and D before attaching the stepper to the MC433. Do not connect or disconnect stepper motor leads while the MC433 is generating a step pattern – always turn the DC Motor Power Supply Off first. The inductive kickback of the motor coils during disconnection can generate several kilovolts, which may cause an arc failure in the motor or personal injury. Also never touch the open leads of the stepper motor while they are in operation.

Typical 6 Wire Stepper  
Motor Wiring Configuration  
(Color codes may vary)



Never run the steppers without an inline fuse between the DC Motor Power supply and the MC433 – Power MOSFETs can fail and when they do they typically fail in a shorted state. Ensure there is a good ground between the DC Motor Controller, Board Logic Power and the controlling PC – the MC433 is a non-isolated design. All attached equipment must be at a common ground potential. Do not defeat the ground lug of all AC cords.

Unipolar Stepper motors can be attached to the MC433 one of two ways:

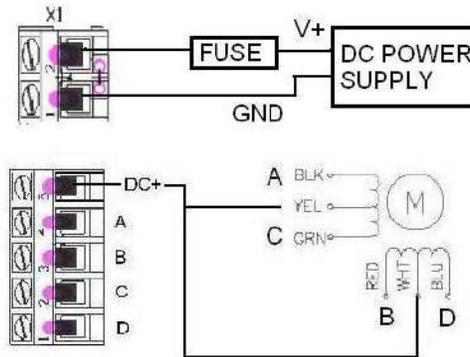
- Common Motor DC Connection – Configuration A.
- Independent Motor DC Connection – Configuration B.

**Common Motor DC Connection**

For low amperage steppers (<2-3amps) the Common Motor DC connection configuration can be used. For this configuration DC Motor Power is connected to screw top terminal X1 where it is then routed to the DC+ terminal of each stepper motor connector (see the diagram below).

Configuration A - Common DC Motor Power with inline fuse for 6 Lead Stepper Motor.

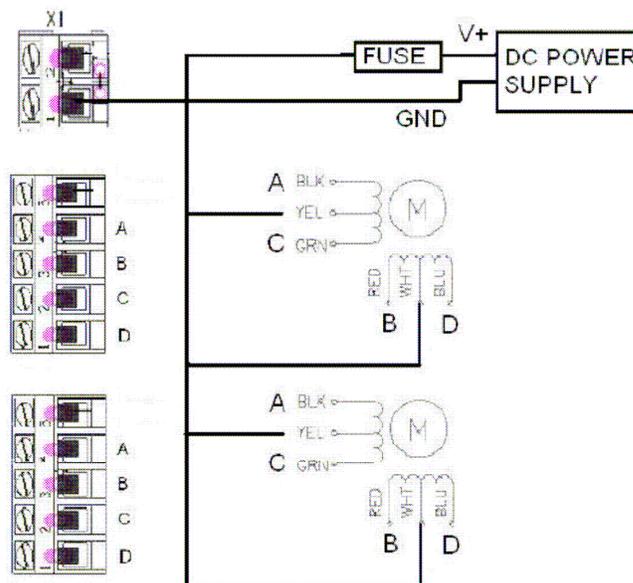
(Color codes may vary)



**Independent Motor DC Connection**

High amperage steppers should be wired using Configuration B shown below. The screw terminal connectors used on the MC433 are rated at 8A and are not designed to handle higher current. The Rev 1.1b PCB has a common ground hole located between the A and Y Axis connectors – a lead should be run from this hole to earth ground. Never run the MC433 without an inline fuse.

Configuration B - Recommended wiring diagram for high amperage Stepper Motor attachment.



## 2.3 Hardware Setup

The following procedure will guide you through the setup of the MC433 – start with the board unpowered:

1. Set the step sequence for each motor – wave, full or half step by installing jumpers on connectors J24, J25, J26, J27. The unit is shipped with Wave step selected (no jumpers installed). Wave turns one phase on at a time, full turns two phases on and half turns one or two phases. It may be best to leave the default setting to ensure the motors are wired correctly.
2. Connect a DC power adapter to the Board Logic input (9-12VDC – center positive – reverse polarity protected). The initial turn on state of the MC433 is all motors off.
3. Turn potentiometer R27 (on time) fully counterclockwise (zero on time). Turn potentiometer R28 (duty cycle) fully counterclockwise then turn clockwise half a turn (50% duty cycle). Turn potentiometer R36 (duty cycle slew rate) fully counter clockwise. This sets on time and duty cycle slew rate to the minimum setting and duty cycle to 50%.
4. Make sure jumper J30 (programming enable) is not installed.
5. Attach a PC parallel port cable.
6. Connect the DC Motor Main power to X1. The DC Motor Power connector is located at the top of the board with DC+ near the board top. If 5V is available this can be used for initial testing before connecting 12 or 24V.
7. Connect a unipolar stepper motor to the Motor X Axis connector. This is the first connector next to the DC Motor Power connector on the top right of the board if the DB25 connector is on the left. An easy way to verify correct motor connection is to send a one step per second pulse to the motor and connect motor leads in different configurations until the motor steps reliably in one direction (see SOC Machines web site for setup software).
8. Try sending a continuous step command to the controller at a 200pps rate (if you don't have an application that can generate this pulse sequence download the **MC433Test.exe** program from the SOC Robotics web site).
9. Disconnect motor.
10. Repeat steps 6 to 8 for the other three axis.
11. If 5V was used in the steps above connect 10-35 volts to Motor Main power connector.
12. Attach a motor to the X Axis.
13. Send a continuous step command to the controller. Adjust initial on time, duty cycle and duty cycle slew rate for the most reliable step operation over the full step range. Final adjustment should be done under typical load conditions.
14. If the step sequence is changed then the potentiometers may need to be adjusted again for reliable operation.
15. Once the potentiometers have been adjusted they shouldn't need adjusting again.

## 2.3 Host Software Setup

Application software controls four step/direction output pairs, four auxiliary control outputs and monitors four limit switch inputs. The correct pin assignment and polarity must be configured in the host application software for correct operation of the MC433.

The MC433 expects a low to high transition on the Step input to generate a step. The Direction input causes a clockwise step or counterclockwise step depending on how the motor is wired to the drive. The direction input is sampled after the step is activated so it must remain unchanged for at least 5useconds after the step low to high transition. Step and direction inputs can be changed at the same time. Host software must the set the Direction line high or low and cause a low to high transition on a step line to cause a step. The Direction and Step inputs are pulled high

with a 10K resistor. Noise reduction logic in the motor processor eliminates false steps due to noise.

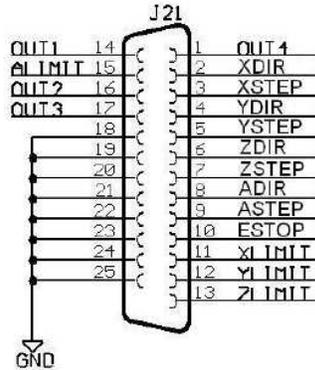


Figure 2-1. Parallel port signal function assignment.

Limit switch inputs are pulled high with 10K resistors – an external contact closure will pull the limit switch input low indicating a limit has been reached. Each motor processor monitors the limit switch input pertaining to its stepper motor and automatically stops the motor without requiring input from the host. Host software should interpret a low level on a limit pin as an indication that a limit has been reached.

Four Auxiliary outputs are available for host software to control. Each Auxiliary output is routed to two different connectors: Relay adapter connector J17 and open NPN transistor output connector J18. A high level on an OUTX pin sends a high level to the relay port and causes the appropriate transistor to conduct pulling the output lead to ground on J18. Host software must be configured accordingly to control external devices.

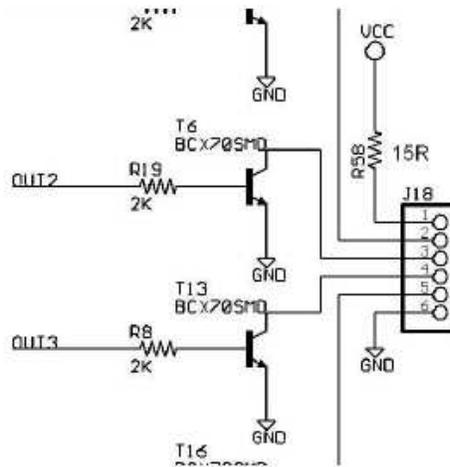


Figure 2-2. Typical open NPN Auxiliary Output circuit on J18.

### 3.0 Detailed Description

#### 3.1 Introduction

The MC433 Stepper Motor Controller is a 4-Axis unipolar stepper motor controller that uses four high performance 8bit 20MHz RISC processors to regulate the power delivered to each stepper using Pulse Width Modulation (PWM). Wave, Full and Half step operation is selected on an individual motor basis using two jumpers. PWM initial on time duration, duty cycle and duty cycle slew rate is controlled by three potentiometers eliminating the need for load resistors. The processors monitor step and direction inputs, step sequence jumpers and limit switch input to determine how and when to control the Power MOSFETs controlling power delivery to each motor phase. After 1.5 seconds of step inactivity the duty cycle is automatically adjusted to reduce unnecessary power consumption and motors are turned off completely after 20 seconds. Although PWM operation can be changed to delivery significant power to the motors it can not be turned off completely at slow step rates in order to protect the motors and drive circuit from overheating. Four auxiliary outputs are available to control external devices - both 5V TTL levels and open NPN transistor outputs are available. Limit switch inputs are routed to the Parallel Port interface and each motor processor.

The MC433 accepts two optional expansion adapters: High Performance G Code Processor MA48/SAM48 and Relay adapters. The Relay Adapter is controlled by the four auxiliary outputs and provides isolated relay closure for external 12 or 24 volt devices. The G Code processor port allows connection of a 55MHz ARM7 G Code processor for high performance applications.

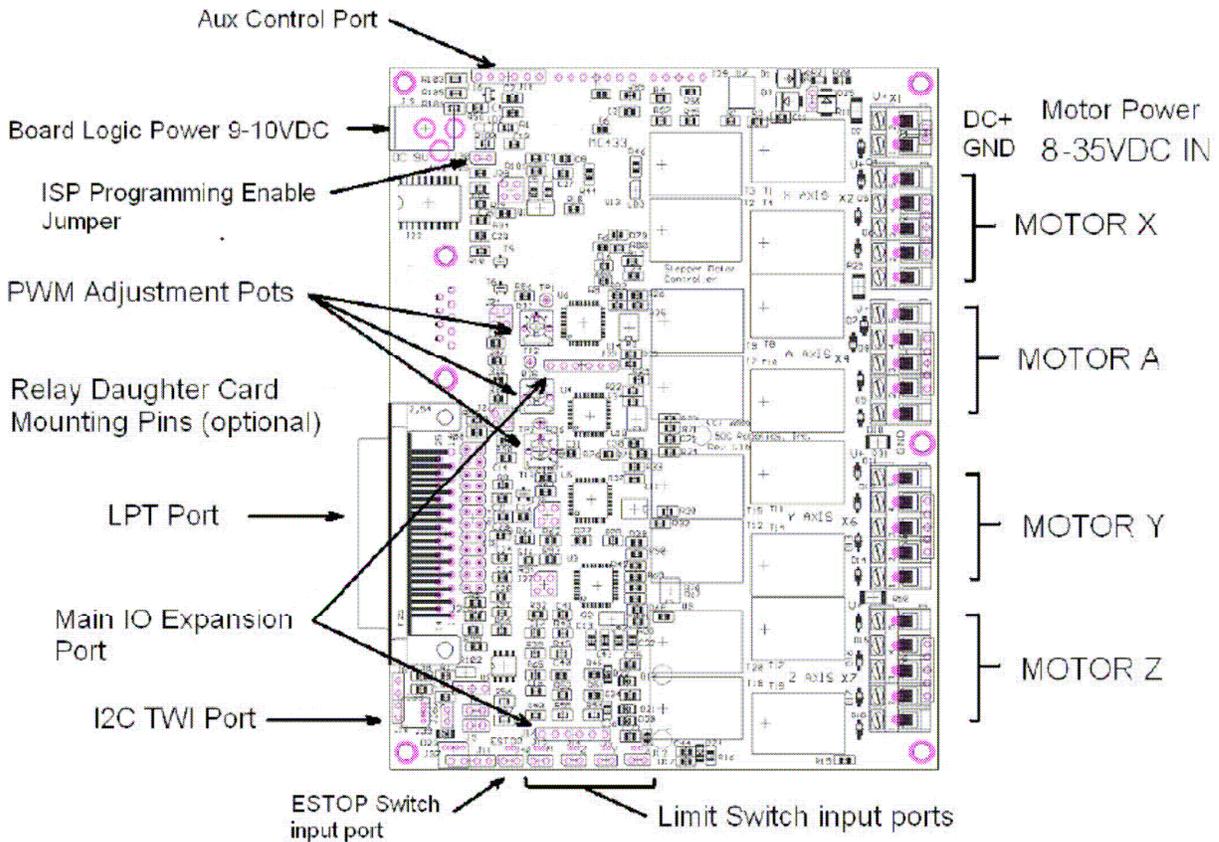


Figure 3.1. MC433 Top Side Connector Layout.

### 3.2 Theory of Operation

The MC433 is designed to control unipolar stepper motors. A unipolar stepper motor is usually supplied with six wires having two center tap leads. A typical wiring configuration is to connect the center leads (YEL and WHT in the picture below) to the DC+ supply and the remaining four leads to four power transistors (MOSFETS in the MC433) that are in turn connected to ground. By turning the power transistors on and off in the correct sequence the motor steps in the clockwise or counterclockwise direction.

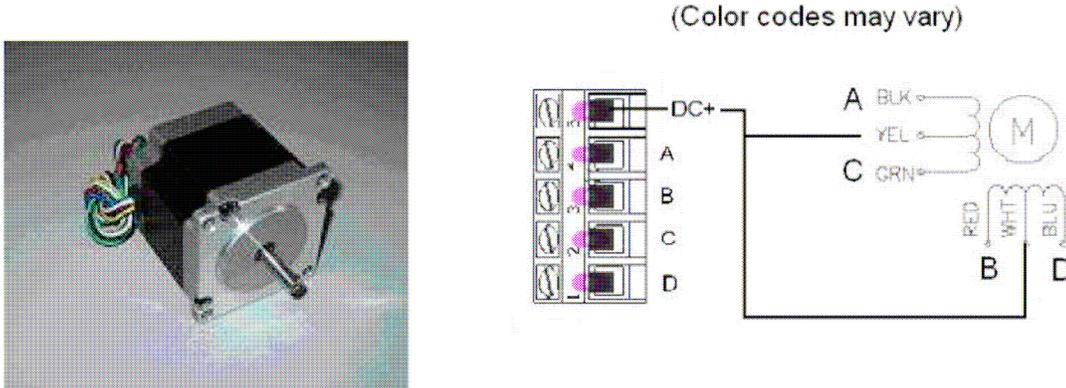


Figure 3-2. Typical Unipolar Stepper Motor and winding diagram.

The MC433 implements three different step sequences: Wave, Full and Half step. In Wave stepping each winding or phase is turned on one at a time in sequence while the other phases are turned off. In Full step two phases are turned on at the same time in the correct sequence. Full step operation develops more torque while consuming more power. Half step operation turns one or two phases on at a time generating a half step with a drop in torque. By varying the current to each phase it is possible to microstep a unipolar stepper motor while trading off even more torque. The MC433 does not support microstepping.

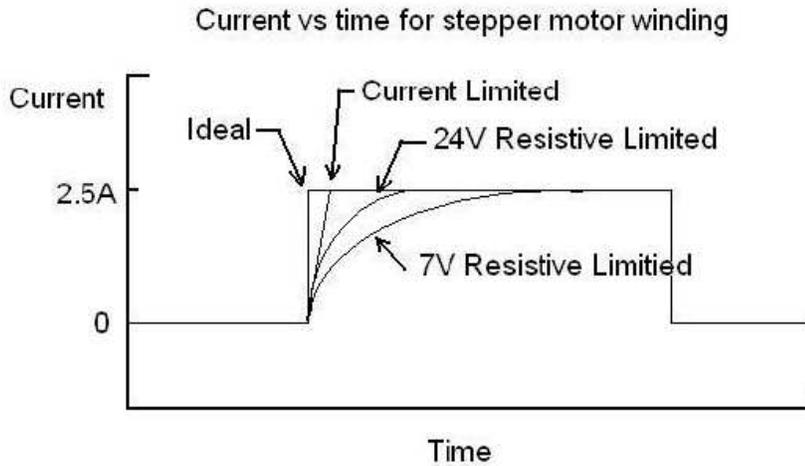
The MC433 generates the following step sequences for Wave, Full and Half stepping.

WAVE STEP				FULL STEP				HALF STEP			
A	B	C	D	A	B	C	D	A	B	C	D
1	0	0	0	1	1	0	0	1	0	0	0
0	1	0	0	0	1	1	0	1	1	0	0
0	0	1	0	0	0	1	1	0	1	0	0
0	0	0	1	1	0	0	1	0	0	1	0
								0	0	1	0
								0	0	1	1
								0	0	0	1
								1	0	0	1

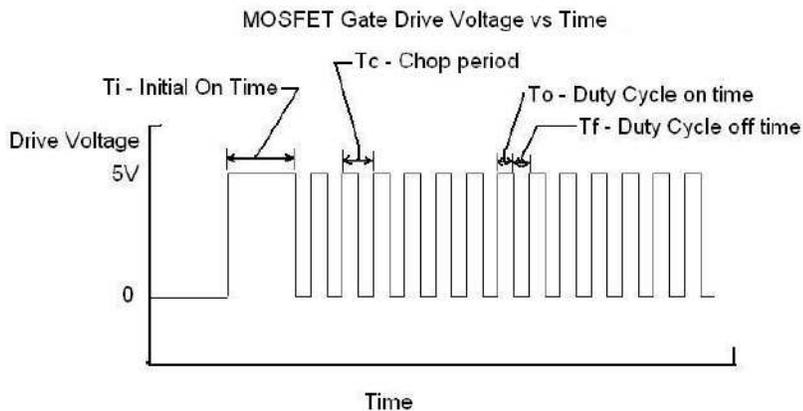
1 - Motor Phase Powered - MOSFET ON  
 0 - Motor Phase Not Powered - MOSFET OFF

Unipolar stepper motors are available in various step resolutions (with 1.8 or 0.9 degree per step being the most popular) and torque/step speed ratings. High speed steppers usually have lower winding resistance and inductance so they reach maximum current (and hence torque) quickly. Winding inductance determines how quickly the stepper reaches maximum current - the higher the voltage across the windings the faster this current level is reached. Voltage can only be

increased so much, however, before the current rating of the motor is exceeded. One way to limit current is to use series resistors but this also increases the time constant of the motor counteracting to some extent the benefit gained from increasing the voltage. Once the motor reaches maximum rated current if some form of current limiting could be applied an ideal trade off between operating voltage and maximum performance is reached. This is accomplished by turning the voltage on and off rapidly at a rate sufficient to keep the motor at a constant current state - Pulse Width Modulation accomplishes this. The figure below shows the trade off between the different approaches.



The MC433 is designed to operate in a constant current mode by regulated the power delivered to the stepper using PWM. The MC433 uses an open loop PWM approach. The user is responsible for adjusting the PWM parameters for best performance. PWM parameters are changed by adjusting three potentiometers. The potentiometers adjust initial on time, chop duty cycle and duty cycle slew rate. The chop frequency is fixed at 12KHz - duty cycle ranges from 5% to 95% or off at high step rates. Initial on time  $T_i$  ensures each winding reaches maximum current in the least time. Chop Duty cycle sets the current while chop slew rate changes the duty cycle as step rate slows down to reduce current to the motor at low step rates.



## 4.0 MC433 Hardware Expansion Port Summary

### 4.1 Introduction

The MC433 has a PC Parallel Port interface for step/direction input for of the four stepper motor axis, four Limit switch inputs and four Auxiliary control outputs. Expansion connectors for an optional Relay Adapter, G Code IO processor and I2C TWI communication port are also on the MC433.

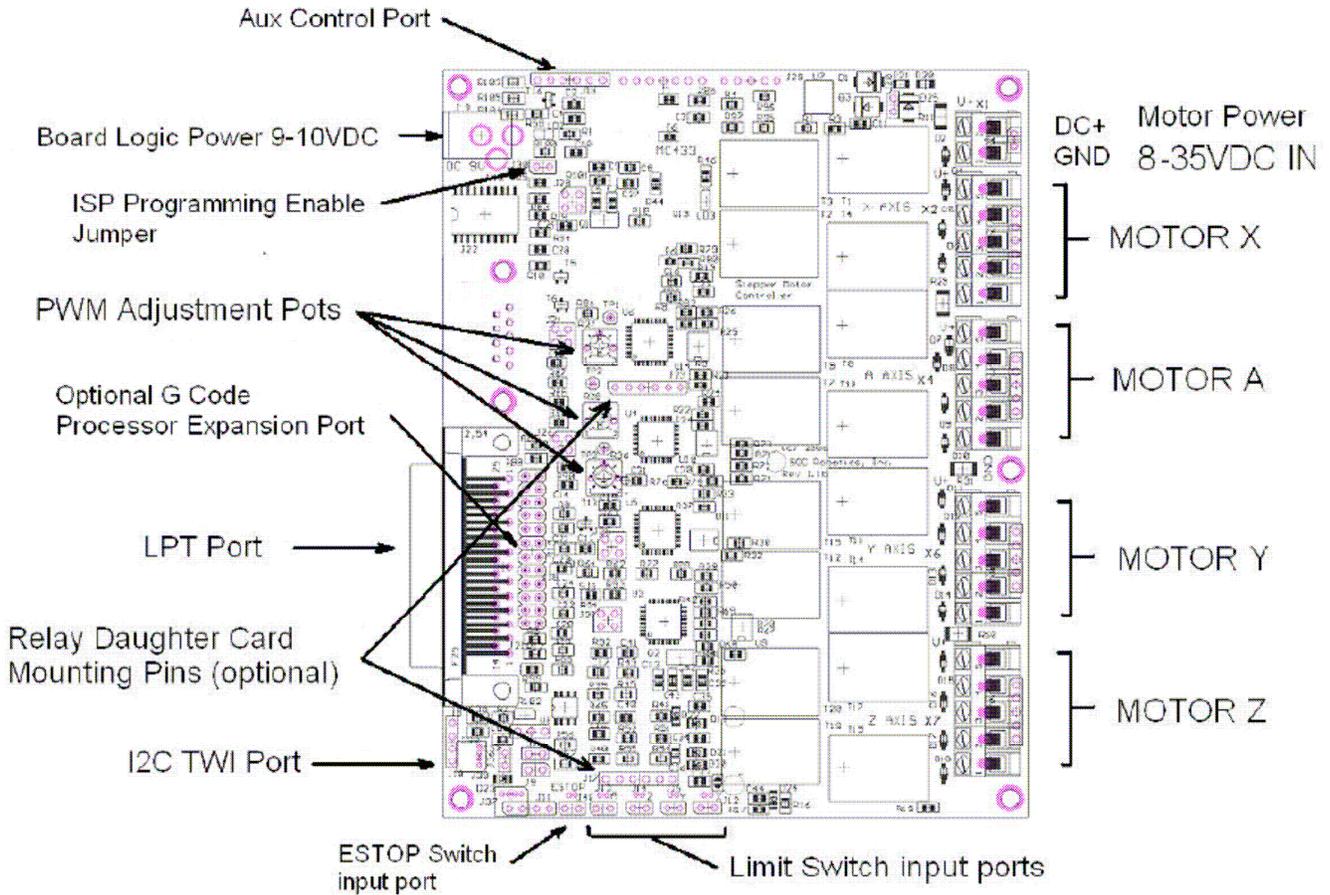


Figure 4-1. MC433 Expansion Connector Locations.

### 4.2 Parallel Communication Port DB25

The MC433 Parallel Communication port (J21-DB25) is the main interface for step/direction input, limit switch detection and aux output control. J21 is compatible with the standard PC parallel port.

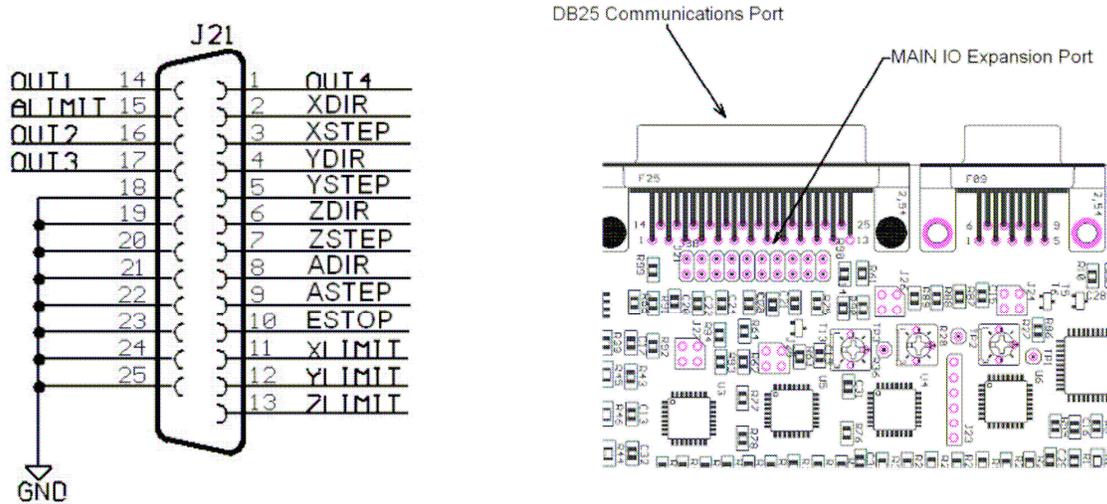


Figure 4-2. Parallel Port DB25 Connector J21

### 4.3 Main IO Expansion Port

The Main IO expansion port (J38 - 24pin 0.1" pin header) provides a connection point for the addition of a high performance G Code processor that can drive the step inputs directly without host support. The optional G Code processor accepts G Code command via RS-232, RS-485 or USB.

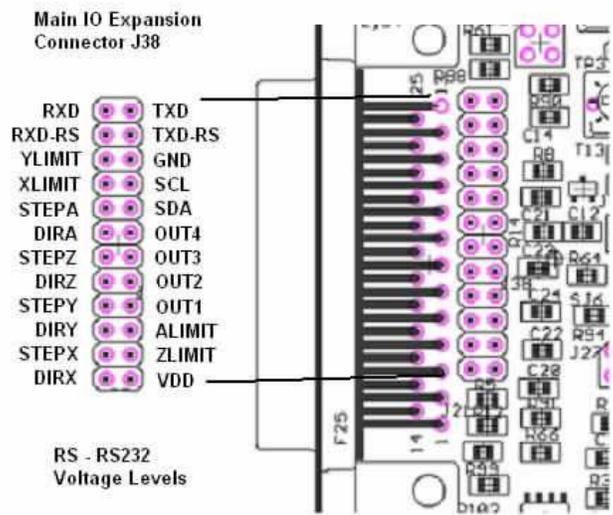


Figure 4-3. Main IO pin assignment.

### 4.4 Stepper Motor Drive Ports

The MC433 has four stepper motor drive ports. Each motor is connected to a five terminal screw top connector. The top connector of each motor port provides DC+ to the motor. The other four connectors connect to each phase of the motor. DC+ is connected to the common center lead of each phase pair (see diagram below). A,B,C,D leads are controlled by four 33A Power MOSFETs. By pulling each of these inputs low a motor phase is energized.

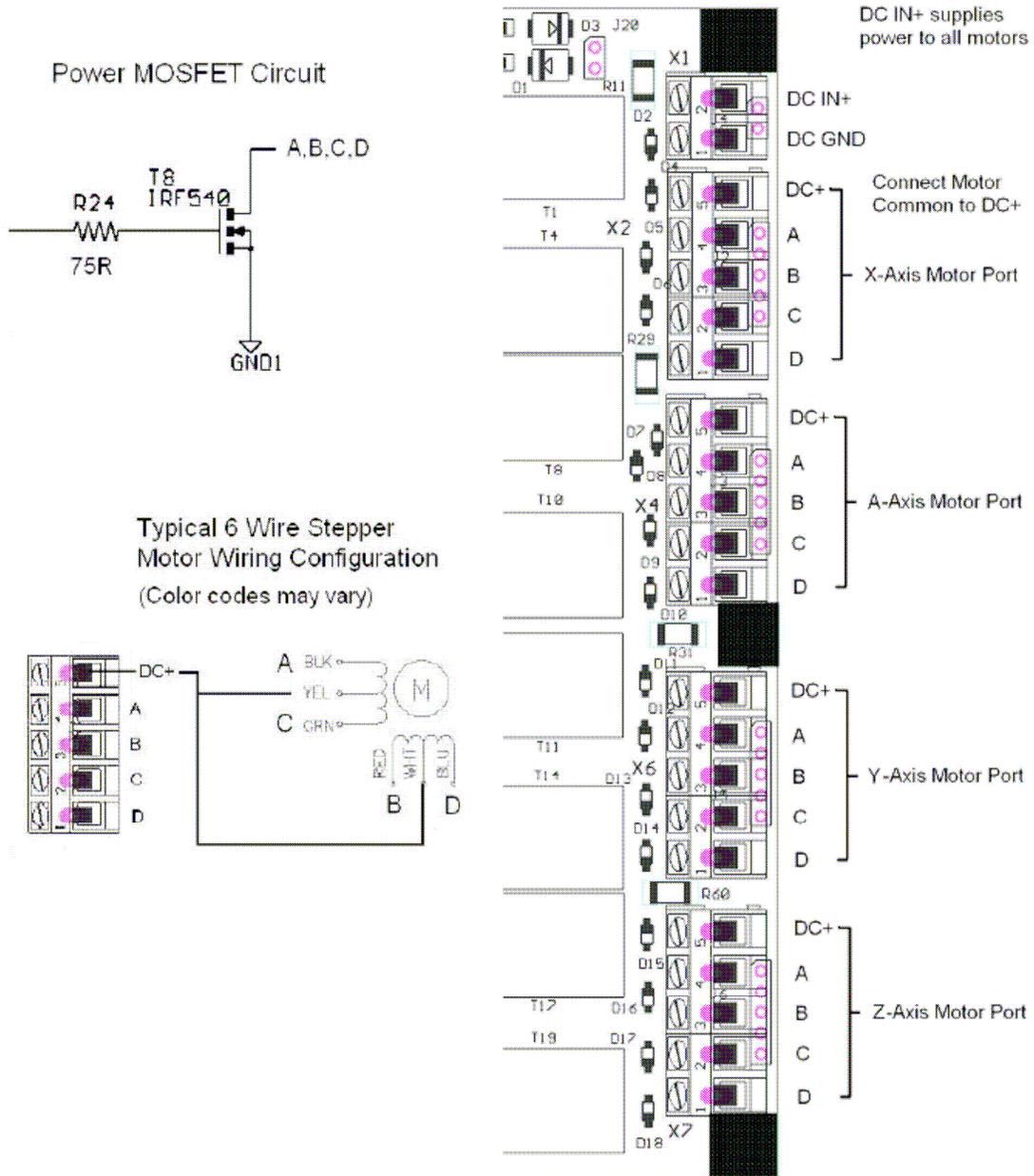


Figure 4-4. Stepper motor output drive ports and Motor Power In.

### 4.5 Step Sequence Selection Ports

The MC433 Step Sequence Selection Headers allow the step sequence for each motor axis to be set individually. PWM potentiometers set on time, duty cycle and duty cycle slew rate.

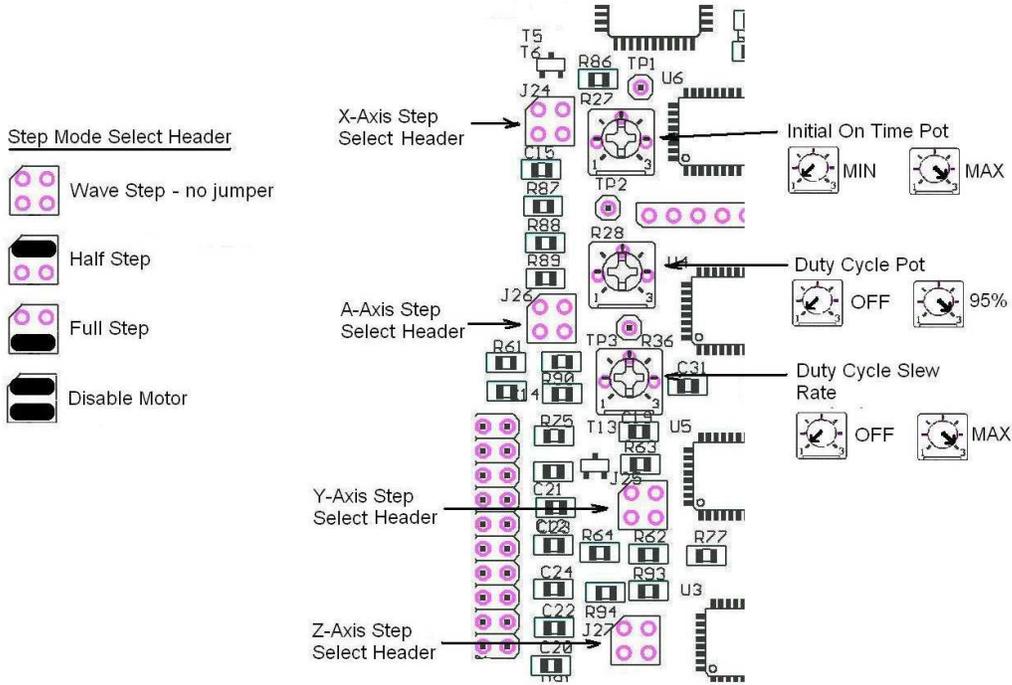


Figure 4.5. Step Sequence Selection and PWM Potentiometer settings.

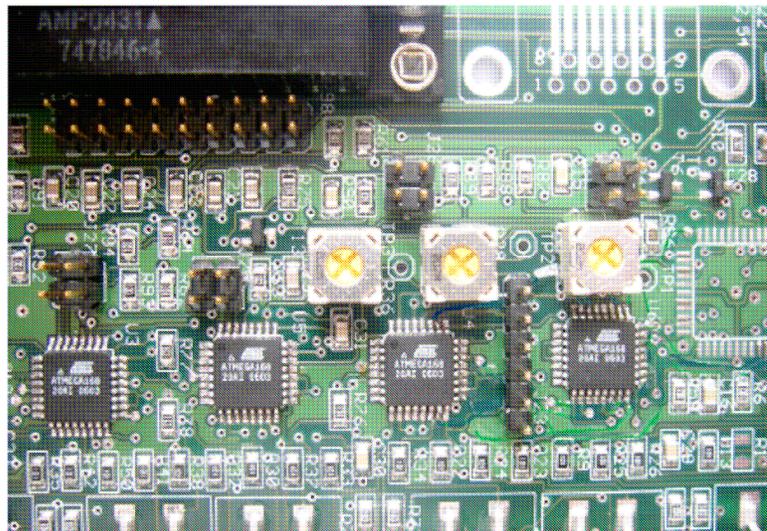


Figure 4.6. Step Sequence and PWM Potentiometers.

### 4.6 DC Motor Power Connector and Board Logic Power Connector

The MC433 Logic requires an unregulated DC input source between 9-12V DC. A wall mount DC power adapter is recommended. Power Jack should be center tap positive. A reverse polarity protection diode protects the on board voltage regulator from damage if the polarity is reversed. Although the board has provision (jumpers) to source logic power from the DC Motor Power source this is not recommended as inductive voltage spikes from the stepper motors may damage the on board 5V Logic.

The DC Motor power connector is a screw top connector. The DC Motor does not have reverse polarity protection.

**CAUTION: DO NOT CONNECT THE DC MOTOR POWER INPUT INCORRECTLY OR THE BOARD MAYBE DAMAGED.**

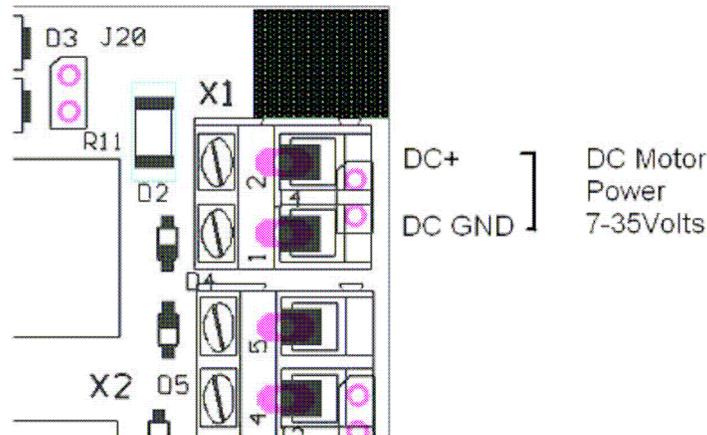


Figure 4-6. DC Motor Power Connector.

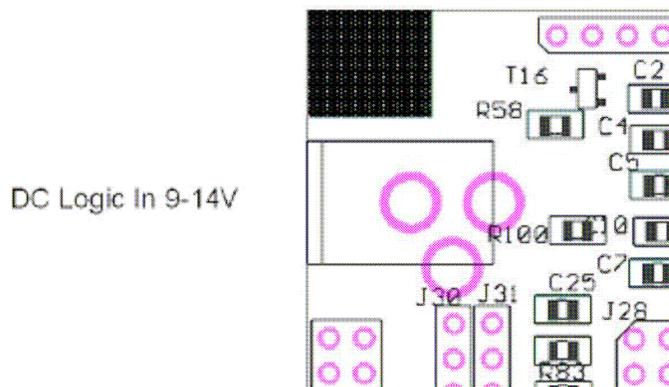


Figure 4-7. Board Logic Power Connector.

### 4.7 Limit Switch Input Ports

Each motor has a limit switch input circuit. The Limit detection logic input line is routed to the DB25 and each motor control processor. A Limit event is activated when an external switch pulls the level to ground through a contact closure. Each Limit Switch input is pulled high with a 10K resistor.

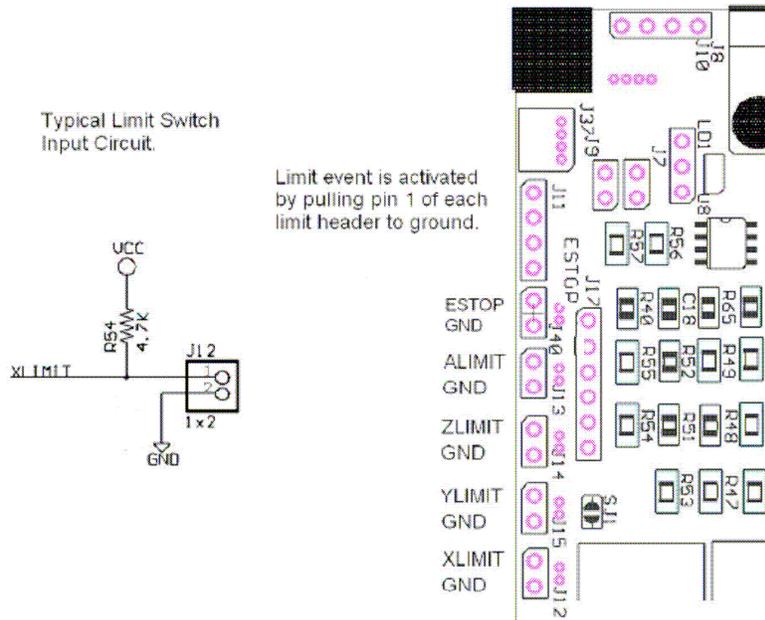


Figure 4-8. Limit Switch input ports.

### 4.8 Relay Adapter Port

The Relay Adapter port connectors J17 and J23 provide an attachment point for an optional Relay Adapter board. Connector J17 and J23 support the Auxiliary Output and Power/IO signals respectively. The Relay Adapter board pulls power from either VDD (Board Logic 5V supply) or DC IN (unregulated power supplying the Board Logic 7-14VDC). Signals SDA/SCL are the I2C communication lines connected to each motor control processor. Signals OUT1-4 are controlled via the Parallel Port connector.

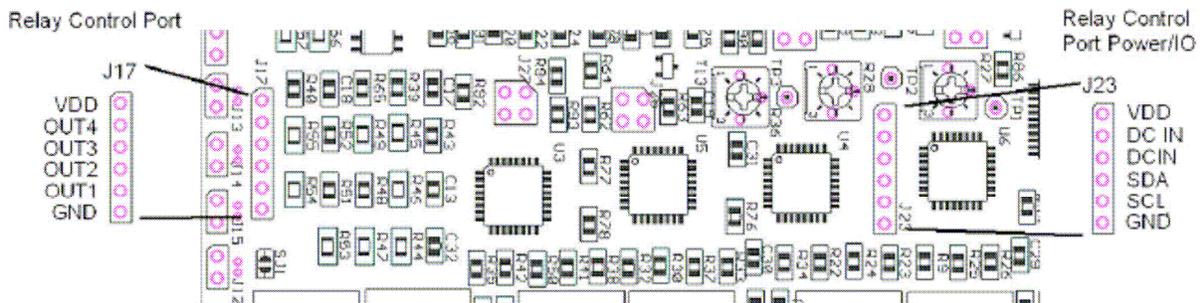


Figure 4-9. Relay Adapter connectors.

### 4.9 Auxiliary Output Port

The Auxiliary output port can be used to control external devices via open NPN transistor circuit. Setting AUX OUT X high causes the respective transistor to conduct pulling the external circuit to ground. A current limited DC output (5V with 10ohm series resistor) is provided on pin1 to power external devices. Maximum pull down current is limited to 100ma.

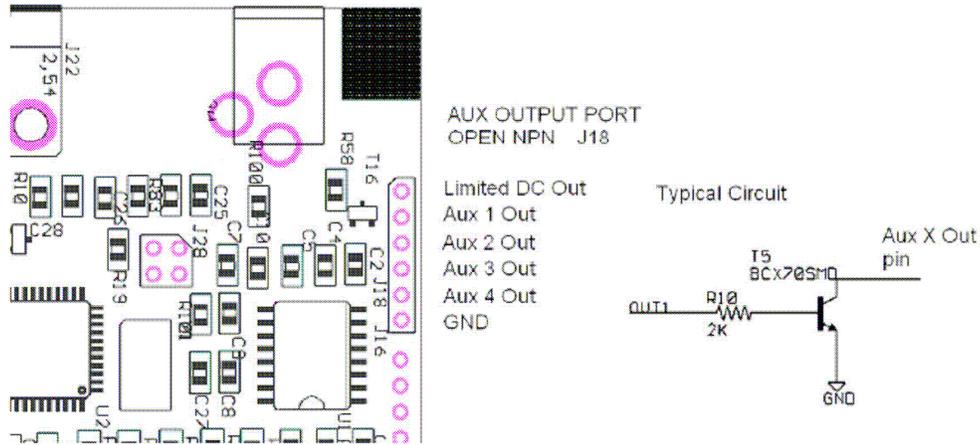
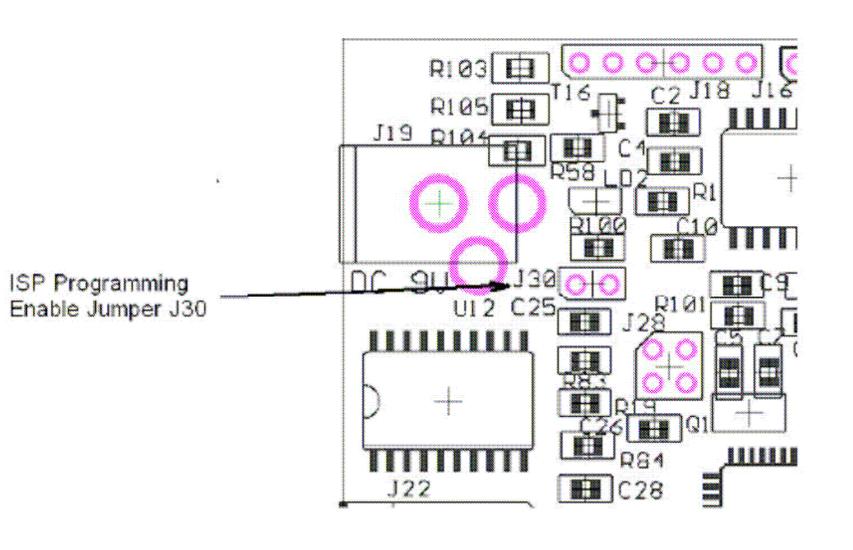


Figure 4-10. Auxiliary Output Port and drive circuit.

### 4.10 ISP Programming

An ISP programming circuit is now built onto the board. Installing a shorting Jumper on connector J30 enables ISP programming. New programs are loaded into Motor Controller Flash using programming utility MC433Prog.exe (available from the SOC Robotics web site).

**SHORTING JUMPER J30 MUST BE REMOVED BEFORE SENDING STEP/DIRECTION COMMANDS TO THE MC433 – FAILURE TO REMOVE THIS JUMPER WILL RESULT IN THE MOTOR CONTROLLERS BEING REPROGRAMMED TO AN UNKNOWN STATE AND POSSIBLY DAMAGED.**



### 4.11 I2C TWI Communications Port

The MC433 I2C TWI Communication port is connected to the I2C port of each for the four motor control processors. I2C (called Two Wire Interface TWI by Atmel) is a bidirectional communications protocol developed by Philips to allow embedded processors to communicate with each other at a 400KHz rate. Through the TWI port an external processor can communicate with each of the control processors to set PWM parameters, step the motors, change step sequence (wave, full or half step), change motor turn off conditions, change chop frequency and request status. The TWI port allows the characteristics of each motor controller to be tailored to the specific requirements of the stepper motor. The protocol used between the MC433 and an external TWI controller is described in a separate document.

Using the TWI port it is possible to step the motors, change from full step to half step and back on the fly and change PWM characteristics in real time to suite the specific needs of the application. The optional ISP-USB adapter **MC-USB** (sold separately) provides direct control of the MC433 via a PC's USB port.

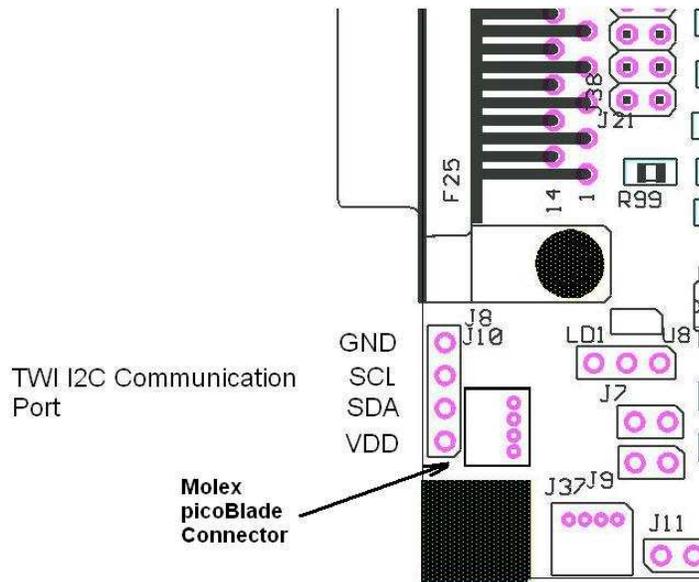


Figure 4-12. TWI I2C Communication Port.

## 5.0 Programming the MC433

### 5.1 Overview

The MC433 can be programmed one of two ways:

- Re-Program Motor Controller Flash using MC433Prog.exe.
- Update EEPROM parameters using MC433Setup.exe.

Programming Motor Controller Flash overwrites the contents of the current Motor Controller Flash with a new program. A new program may add new features, fix bugs or update the main PWM control algorithm. Flash contents can only be changed by enabling Flash Programming Mode by installing a shorting jumper on connector J30 and downloading a new program using utility **MC433Prog.exe**. Changing Motor Controller contents must be done carefully to avoid damaging the AVR processors. Flashing the Motor Controller erases the content of EEPROM.

**CAUTION: Once programming is complete the programming enable jumper must be removed. If the jumper is left in place and step/dir commands are sent to the controller the motor controllers will be reprogrammed with incorrect information and possibly damaged.**

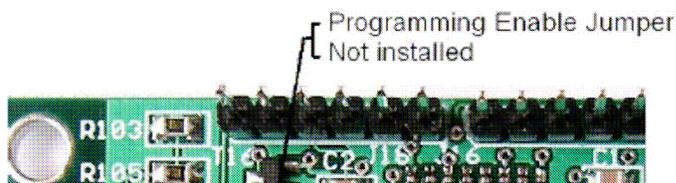
Updating EEPROM parameters such as chop rate, chop frequency, automatic shut off, etc is done by modifying the contents of Motor Controller EEPROM. Changing EEPROM contents does not require installation of the Flash Programming Mode shorting jumper. This mode is entered by installing both Step Mode Shorting Jumpers on each Motor Controller. **MC433Setup.exe** can be used to converse with each Motor Controller to change system settings on an individual Motor Controller basis. MC433Setup.exe will be released with V0.97 Motor Control Software.

Before attempting to Re-Flash the controllers or change EEPROM content turn motor power off. The programming procedure may turn on all Power MOSFETs - drawing significant power from the motor power supply.

### 5.2 Programming Motor Controller Flash

The MC433 Rev 1.1 and Rev 1.1b PCB's have a programming interface on the board. The Flash contents of the motor control processors and G Code processor can be re-programmed through the parallel port interface. Rev 1.1 and 1.1b are programmed the same way - there is no functional difference between Rev 1.1 and 1.1b PCBs except for the G Version - Rev 1.1b has an additional SPI Serial Flash device for on board G Code storage.

To enable Programming Mode the supplied shorting jumper must be installed on connector J30. J30 is located next to the DC Logic Power connector (see picture below). To download a new control program to the processors use programming utility **MC433Prog.exe** only - do not use any other programming utility. **MC433Prog.exe** is available on the SOC Machines web site on the MC433 product page. As soon programming mode is enabled all commands sent to the parallel port are interpreted, as programming commands - sending any other command such as step/dir sequences will probably damage the control processors. Utility **MC433prog.exe** implements the AVR ISP programming protocol. Use of any other program or programming utility may damage or lock the processors from further programming. Remove the program enable jumper immediately after programming is complete. Do not remove or attach the parallel port cable with the programming enable jumper installed.



**MC433Prog.exe** is a command line program running under Windows98, 2000 and XP. The program emulates the operation of **ISProg.exe** (an AVR ISP programming utility) and is used to download new Flash and/or EEPROM files to the Motor Controllers and G Code Processor. **MC433Prog.exe** can be used to program each of the four processors individually or (using a command file) perform a sequence of programming functions on all four motor controllers in one pass.

New motor control programs and G Code programs are provided as Intel Hex files. New code releases will always include a master program configuration text file. **MC433Prog.exe** has been tailored to program the MC433 and MC433G only - do not use this utility to program AVR processors with the ISP10 programming adapter - use **ISProg.exe** instead.

An MC433 has four AVR processors identified as X2, X3, X4 and X5. Each of these processors is either an ATmega168 or ATmega88. The key difference between an ATmega168 and ATmega88 is the amount of Flash, EEPROM and SRAM - the performance of each processor is the same. The correct code must be loaded into each processor. The relationship between X number and motor axis is as follows:

Processor ID	Motor Axis
X2	Z
X3	A
X4	Y
X5	X

To select a specific processor enter it's identifier at the command prompt -X2, X3, X4 or X5 - subsequent programming commands are then sent to the selected processor. Note these identification numbers do not correspond to the motor drive connector numbers.

Remove power from the MC433 DC Logic and Motor Power DCIN. Remove the Flash Programming Enable jumper (J30). Attach a parallel port cable to the controller and apply power. Now install the Flash Programming Enable jumper.

Start **MC433Prog.exe** by double clicking or starting it a cmd window – the first command to use is the “**xa**” command – this interrogates each processor to verify it’s type and fuse settings. Type “**h**” to show all commands – note that it is possible to send commands to the MC433 with **MC433Prog.exe** that will lock the board from further programming so please use the commands carefully. Contact the company If in doubt about how to proceed.

```
>MC433prog <CR>
MC433 Programming Utility V0.99
© Copyright 2006, SOC Robotics, Inc.
Type 'e' to exit or 'h' for help
-xa
Reset 1: Target not responding
Reset 2: Target ATmega168 responding - default fuses set
Reset 3: Target ATmega168 responding - default fuses set
Reset 4: Target ATmega168 responding - default fuses set
Reset 5: Target ATmega168 responding - default fuses set
-
```

Having confirmed all the processors are alive and talking new motor controller software can be downloaded to each motor controller by typing “**f**” followed by the name of the Program Configuration file.

```
-fMC433config_R95.txt<CR>
< contents of MC433config_R95.txt is executed >
```

The program will now program all four processors in turn loading the correct hex file from the MC433config\_R95.txt text file.

Below is an example of the contents of Program Configuration file **mc433config\_R95.txt**:

```
x2
dfmc433_motor_controller_R95z.hex
x3
dfmc433_motor_controller_R95.hex
x4
dfmc433_motor_controller_R95.hex
x5
dfmc433_motor_controller_R95.hex
xa
```

Exit **MC433Prog.exe** by entering the “**e**” command. Note processor X2 – Z Axis is loaded with a different program than the other three processors. X2 is unable to monitor ESTOP so must get this information from the other processors.

All Program Configuration files supplied by the company end with a Version Identification Number. In the example file above the VIN is R87 – Version 0.87.

After programming is complete **REMOVE** the programming enable jumper – the board does not need be powered down to remove the jumper. You are now ready to send new step/dir commands to the controller.

### 5.3 Updating EEPROM Contents

Update Motor Controller EEPROM contents using **MC433Setup.exe**. In order to use **MC433Setup.exe** Motor Controller Version 0.95 or later must be installed in motor controller Flash. To check the current motor controller Flash version run **MC433Setup.exe** with the EEPROM update jumpers installed – **MC433Setup.exe** interrogates all four motor controllers retrieving all setup information.

Check the [www.soc-robotics.com](http://www.soc-robotics.com) for the latest MC433 Motor Controller Software.

#### **5.4 Post Programming Procedure**

After completing the programming procedure it's good practice to interrogate the processors one more time with the "xa" command to ensure all Motor Controllers are responding. Motor controllers will only respond to **MC433Prog.exe** if the Flash Programming Enable jumper is installed.

One last thing:

**DO NOT FORGET TO REMOVE THE FLASH PROGRAMMING ENABLE JUMPER BEFORE SENDING STEP COMMANDS TO THE MC433.**



## 6.2 Electrical Specifications

### Electrical

Input power: 7-12VDC @ 80ma

Board power: 5V DC @ 50ma

### Mechanical

Dimensions: 4.42x5.61 in (four mounting holes)

Weight: 290grams

## 6.3 Mechanical Dimensions

Board dimensions stated in inches. Connector locations with respect to the lower left corner are annotated in the drawing. A sample schematic with connector library and board layout in Eagle CAD format is available at [www.soc-robotics.com/download/mc433layout.htm](http://www.soc-robotics.com/download/mc433layout.htm).

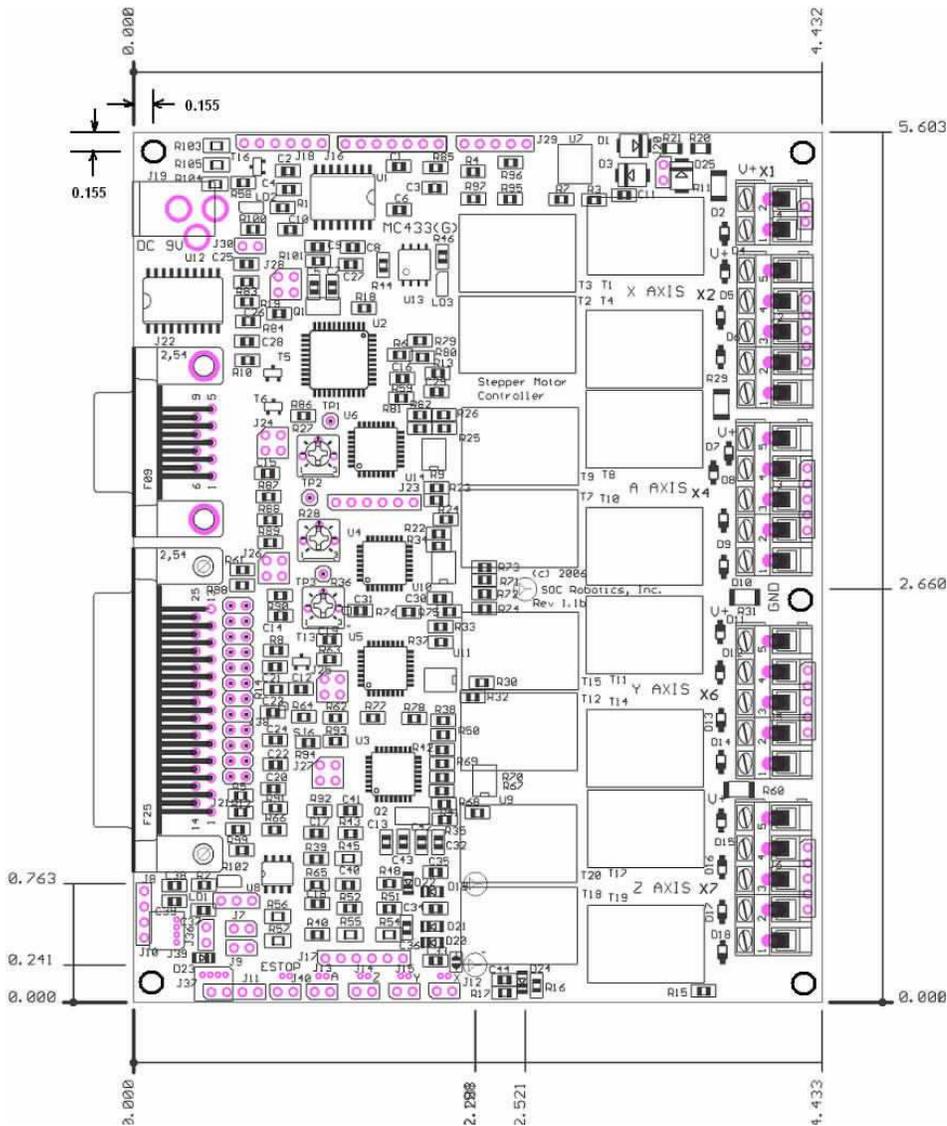
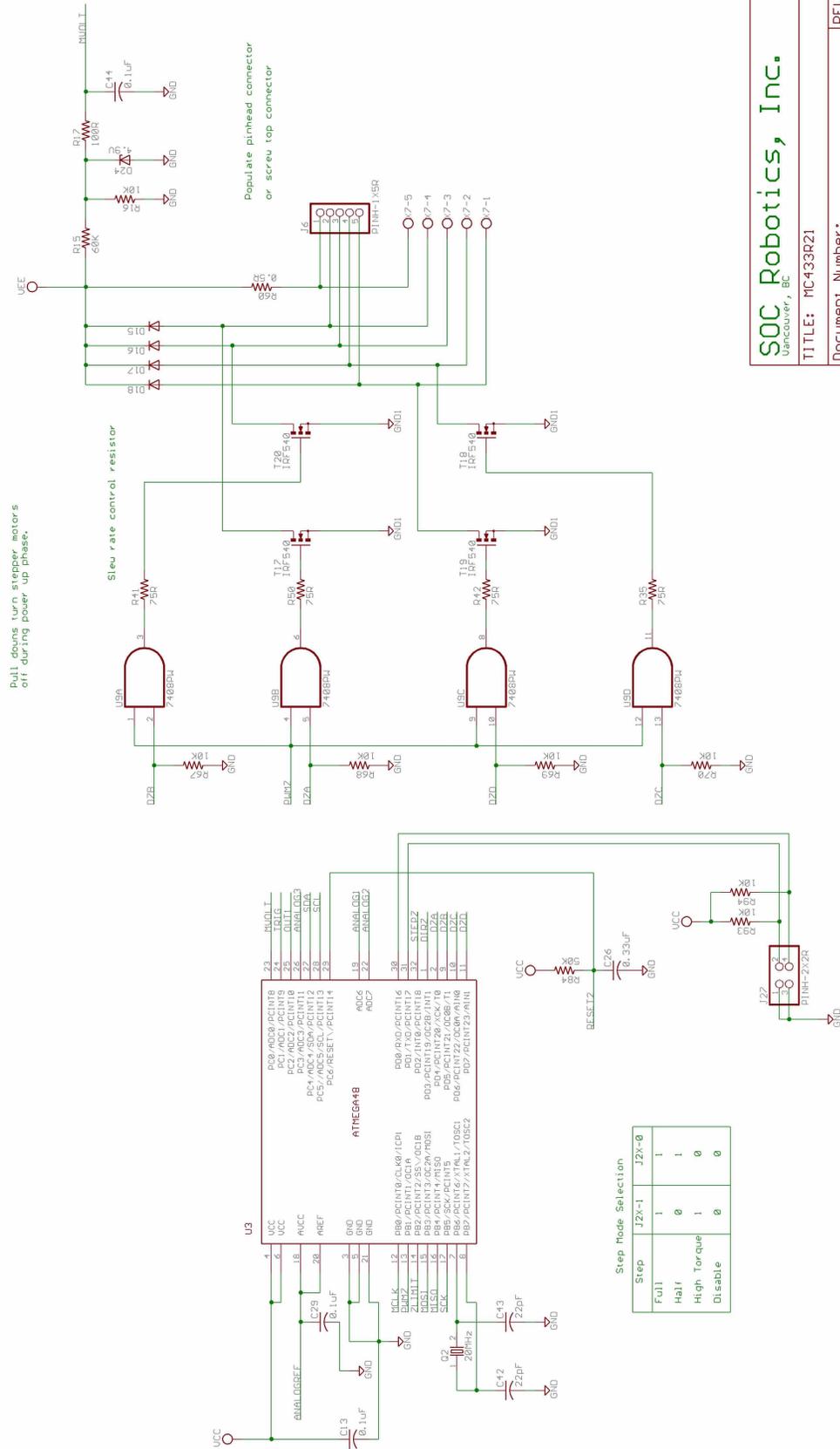


Figure 6-3. MC433 Rev 1.0 Mechanical mounting dimensions

## 7.0 Circuit Schematics PCB V1.1b

<p>(c) Copyright 2006, SOC Robotics, Inc. All rights reserved.</p> <p>Uni-Polar Stepper Motor Controller</p> <p>4-Axis</p> <p>10 Amp/Motor, Full, Half, High Torque</p> <p>PCB Rev 1.1b</p>		<p><b>SOC Robotics, Inc.</b> Vancouver, BC</p>	
		<p>TITLE: MC433R21</p>	<p>REU: A</p>
		<p>Document Number: 20050410</p>	
		<p>Date: 9/04/2006 08:57:29a</p>	<p>Sheet: 1/8</p>

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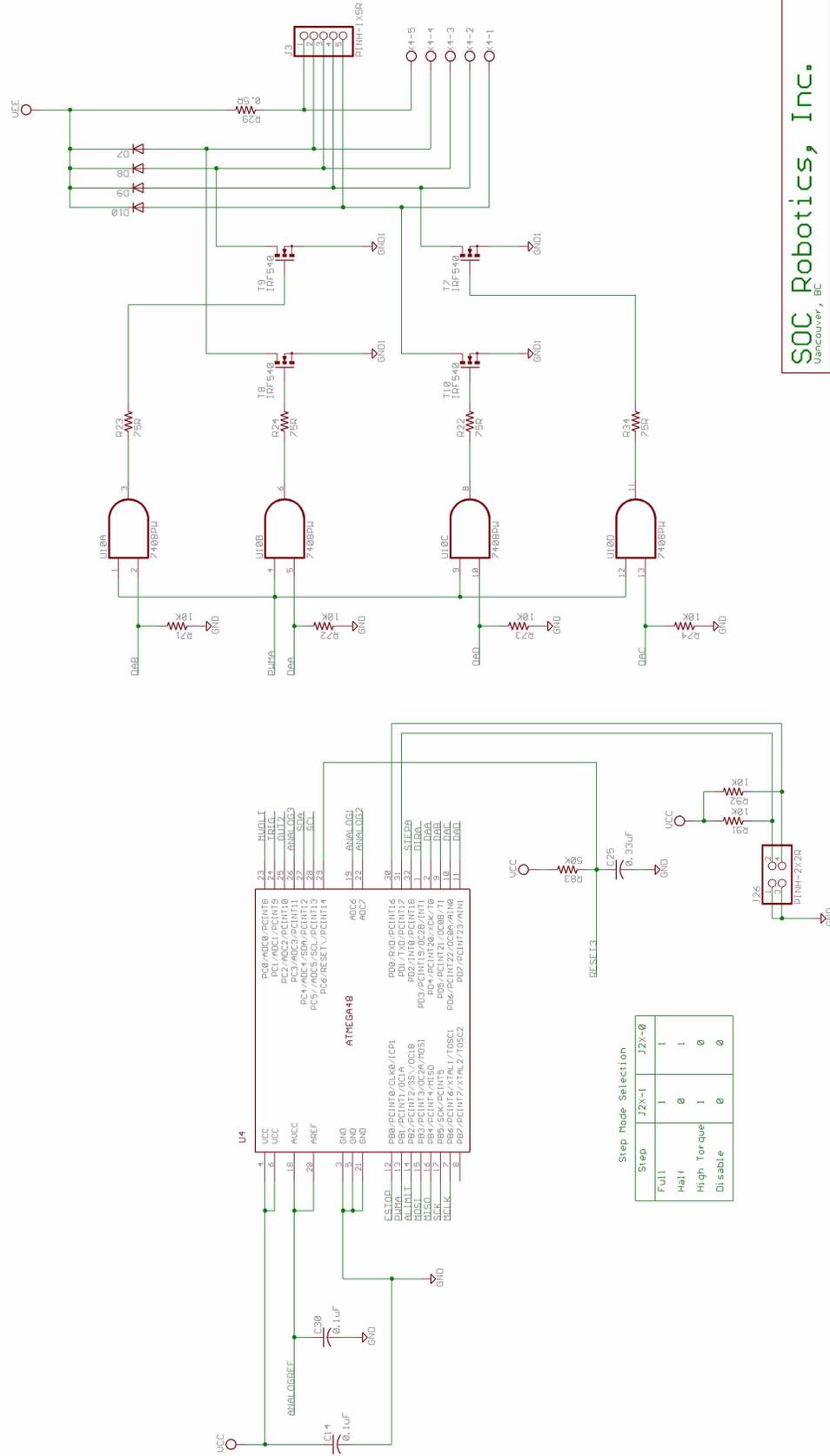
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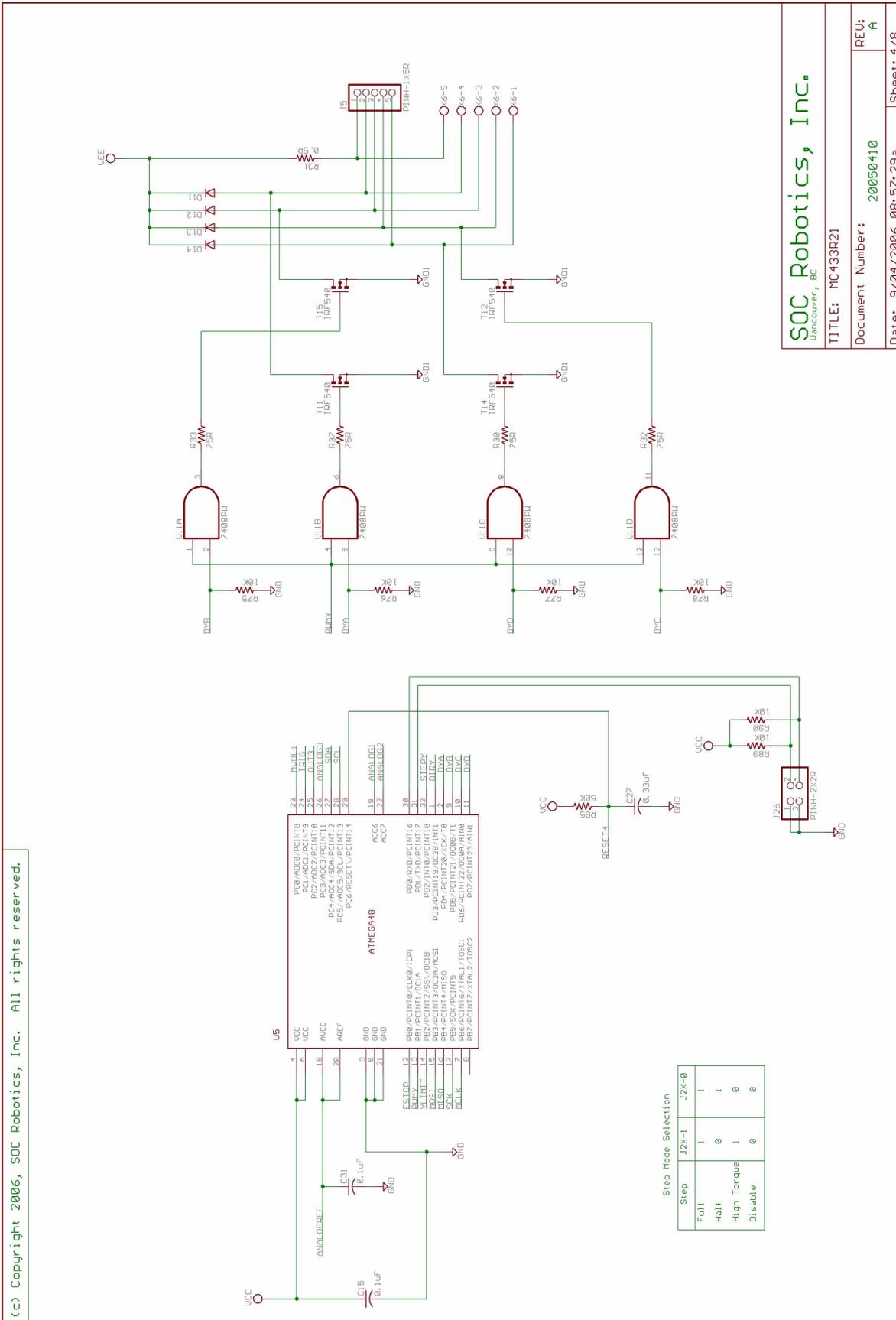
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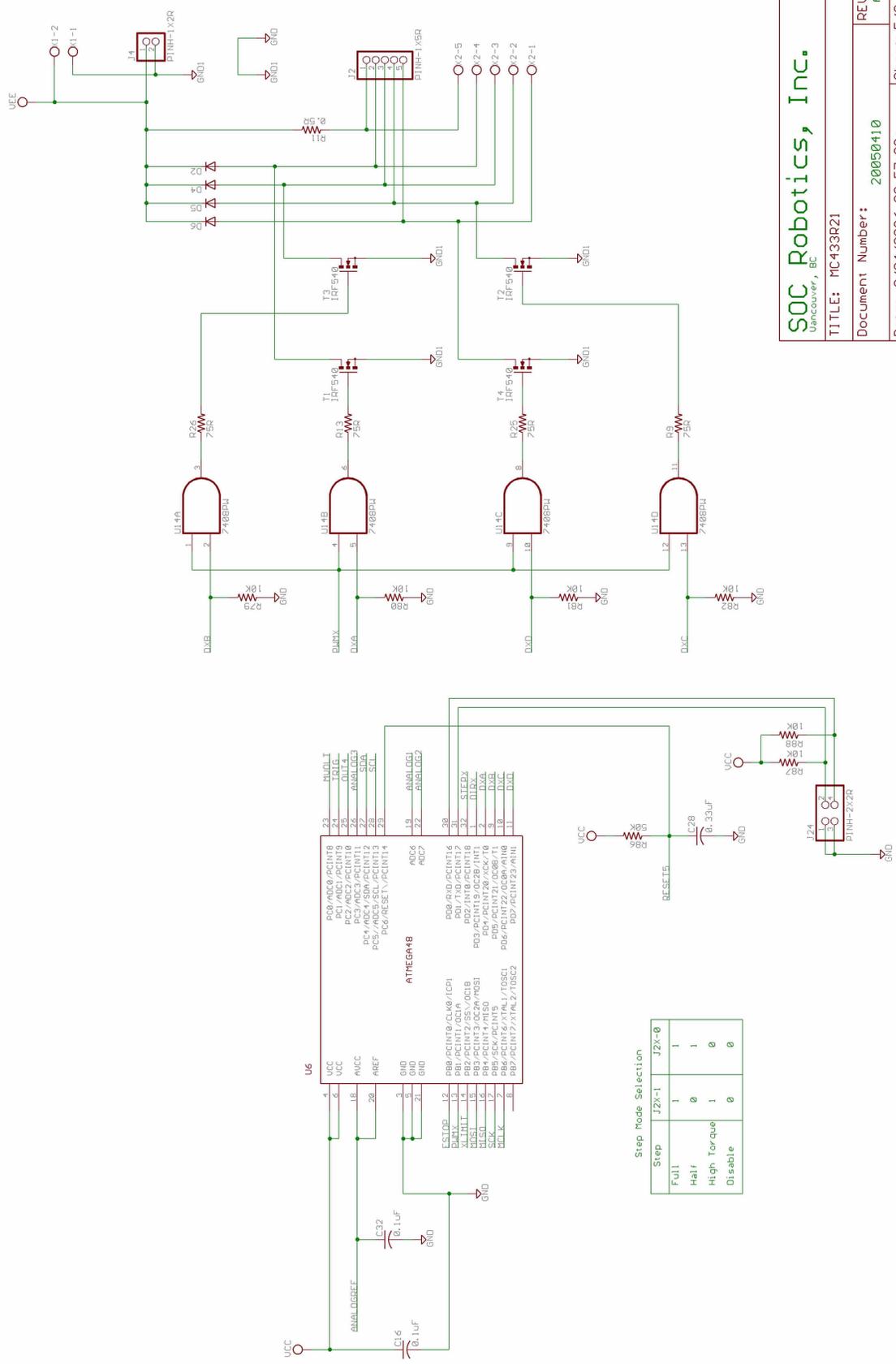
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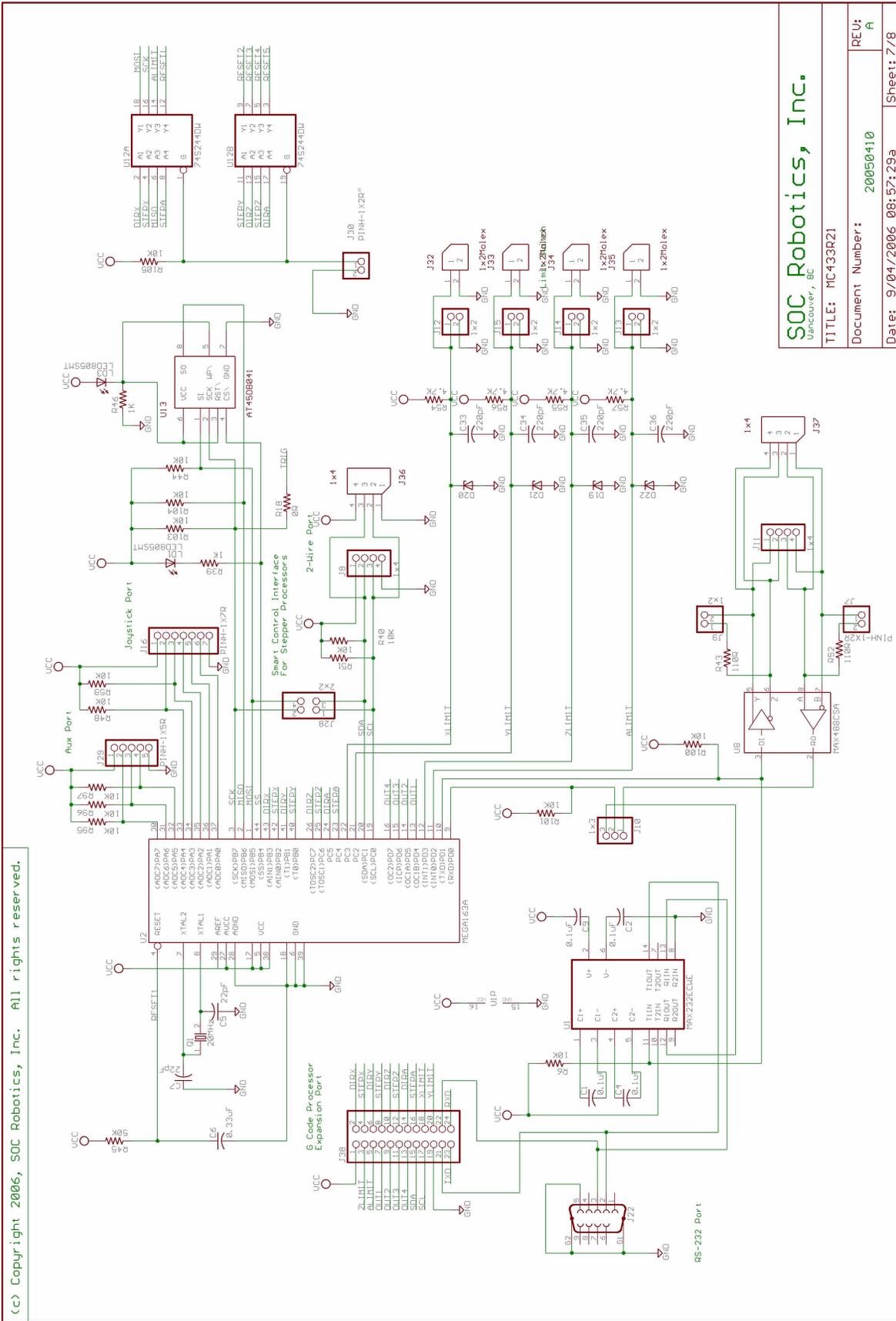
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Step Mode Selection

Step	J2X-1	J2X-8
Fu11	1	1
Hal1	0	1
High Torque	1	0
Disable	0	0



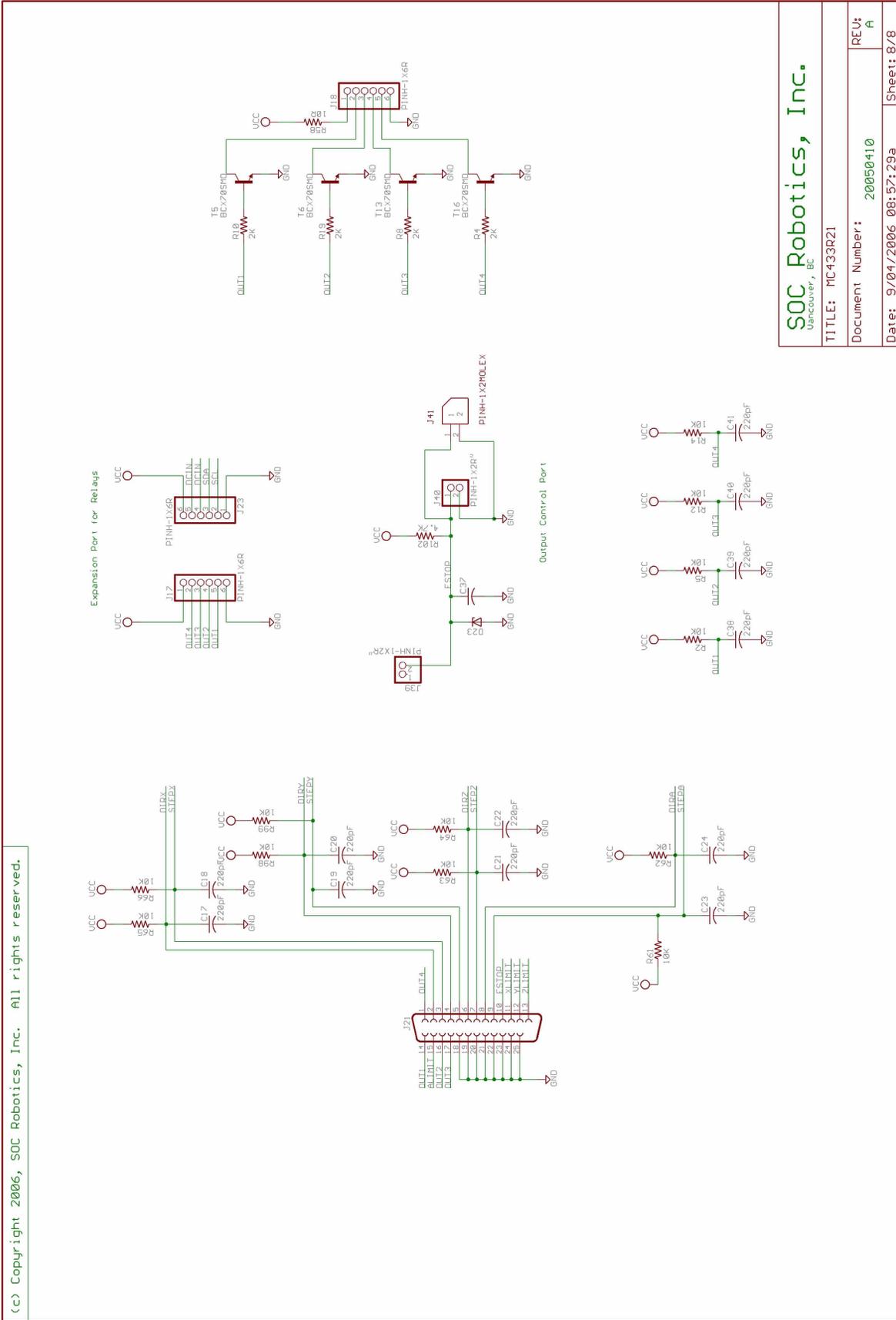


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