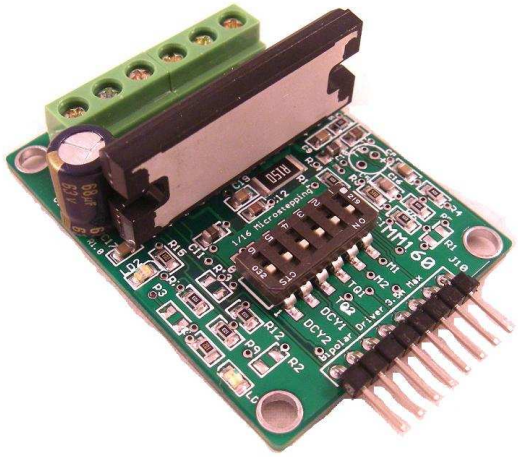
MM160 Single Axis Stepper Motor Driver

1/16th Microstepping 3.5A Bipolar Driver

Technical Reference Manual

PCB Rev 1.0



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1935A–08/00/5M

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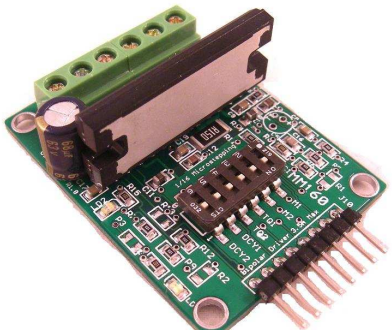
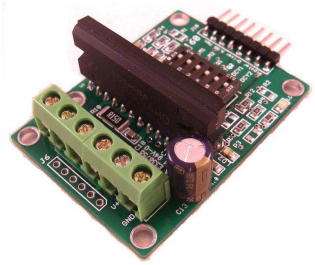
1.0 Introduction





Features:

- Bipolar 3.5A Stepper Motor Driver
- Maximum motor drive voltage 37V
- Full, half, eighth and sixteenth microstepping
- Maximum 3.5 A per phase
- DIP switch setting for step mode, decay and torque
- Green Power On LED
- Red thermal overload LED
- TB6560 Bipolar Driver chip
- Transient Voltage Suppression Diodes on Motor Signals
- Small form factor (2.10x1.56 in)
- 5VDC @ 12ma Power input for logic
- Motor drive input 10-37VDC at 3.5A

Hardware

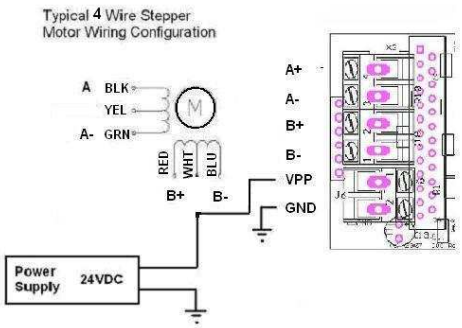
The MM160 is a 1/16th Microstepping Bipolar 3.5A per phase stepper motor driver that converts step and direction signals to the appropriate high voltage stepper motor drive signals. The board logic is designed to operate at 5VDC. Motor voltage can vary from 10-37VDC. A DIP switch sets step mode (full, half, 1/8th and 1/16th), torque level (100%, 75%, 50% and 20%) and decay mode (0%, 25%, 50% 100%). Optional resistors can be installed that route signals from the logic drive connector to allow step mode and driver chip reset and enable to be controlled by an external controller.

The MM160 consumes about 12ma in active state not including motor drive current.

Stepper Motor Connection

Motor Drive voltage should be between 10-37VDC. Average drive current (torque) is set using a DIP switch from 20% to 100%. The motor drive chip TB6560 has a 0.7ohm RDSon which means that the chip requires forced air cooling under most operating conditions. The diagram below shows stepper motor connections for the SOC Robotics SM2006 and SM3006 stepper motors – wire color for other stepper motors may vary although most coil phase diagrams are similar. It is good practice to wire a fuse between the motor power supply and the MM160. Do not turn motor power on if the logic side of the MM160 is not powered – damage to the TB6560 driver chip may result. If the motor will not turn then check your wiring. Never attach or detach stepper motor wires with power supply power turned on.

MM160 Motor Connection for SM2006/SM3006

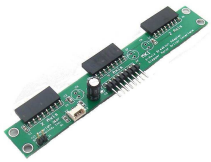


Adjusting Motor Drive Current

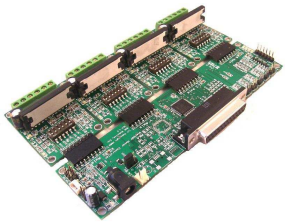
The MM160 motor drive current is set by a DIP switch in four increments. Default setting is 3.5A – the maximum setting. It is possible to set the motor current in such a way that the control chip delivers too much current to the motor resulting in motor overheating. If the motor missteps at high step rates then the motor maybe undersized for your application and can not develop enough torque – in this case use a bigger motor. The stepper motor may also misstep if the rate of change of speed (acceleration) is too high exceeding the motors pull-in/pull-out torque. Increasing drive voltage will increase maximum step rate. The maximum step rate of a stepper motor is determined by drive voltage, coil inductance and step mode. Changing step mode from full step to half step can reduce effective drive torque by 40% so when selecting microstepping modes remember that effective torque is reduced accordingly and may result in miss stepping.

MM160 Controllers

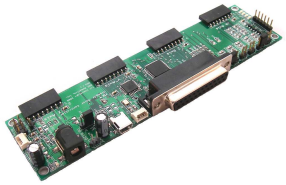
SOC Robotics has several controllers compatible with the MM160 - USB10M, MK1, MK4, MK5, MK14, MK54 and MK200. Each controller supports increasing levels of sophistication and control flexibility. The MK1 is a simple breakout board that allows three MM160's to be attached and controlled. The MK4 is a four axis breakout board with four auxiliary output ports, four limit switch inputs and one Estop input. The MK14 is a special version of the MK4 with a USB 2.0 interface. The MK54 is a high performance G Code processor with 10/100BaseT, CAN and USB 2.0. The MK200 is an ultra high performance G Code processor with onboard vision processing. For more information on our line of controllers and to help determine which one is best for your application go to our web site or contact the firm.



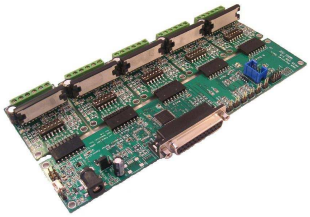
MK1



MK4 + 4 MM160

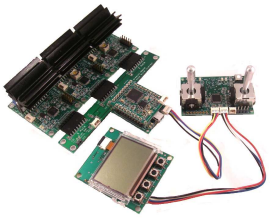


MK14 USB

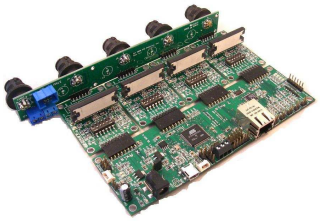


MK5 + 5 MM160

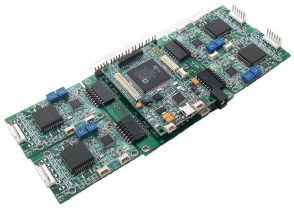
SOC Robotics has a family of embedded G Code controllers. The G Code controllers allow DRO and Joystick attachment for standalone operation. The G Code controllers support linear interpolation on four axis and circular interpolation on any two axis.



Wasp G Code controller



MK54 G Code controller



MK200 G Code controller

Heat Sink Option and Mounting Plate

A 4-axis heat sink with integrated fan is under development along with a mounting plate that accepts a MK4 and four MM160's or MK5. Both products should be available in late March 2011.

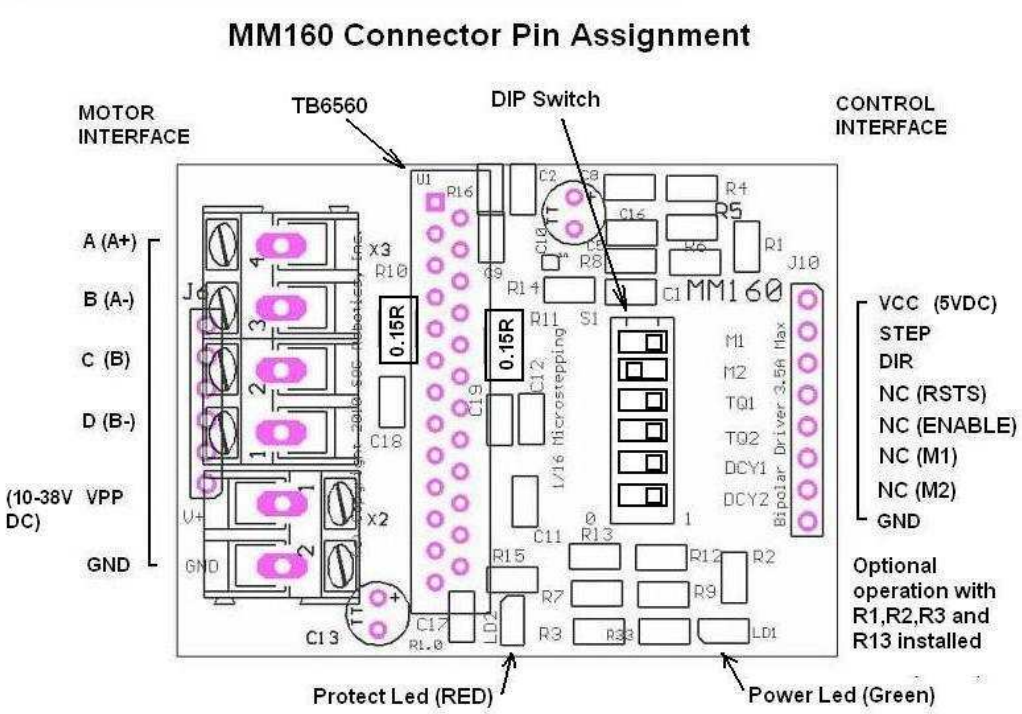
2.0 MM160 Detailed Description

2.1 Introduction

The MM160 is a compact single axis bipolar 3.5A/phase stepper motor microstepping driver with step and direction inputs, DIP switch settable step mode (full, half, eight and sixteenth), torque (100%, 75%, 50%, 20%) and decay mode (0%, 25%, 50% and 100%). The stepper motor driver IC is a TB6560 manufactured by Toshiba. The TB6560 converts step and direction signals to Pulse Width Modulated high voltage drive signals that send the appropriate current to the four coils of a bipolar stepper motor.

The MM160 has two I/O ports: a motor control port and motor drive port shown in the connector layout diagram below. The motor control port accepts step and direction inputs which are routed to the TB6560 driver chip. The motor drive port is connected to the stepper motor coils and motor power. Note that motor power should not be turned on unless logic power (VCC, GND) is also turned on. A Green Power LED and Red Thermal Overload LED indicate Power status and thermal shutdown state. Optional resistors connect TB6560 RSTS, ENABLE, M1 and M2 to the motor control port.

Optional 0 ohm resistors R1, R2, R3 and R13 connect port J10 pins to the TB6560 Reset, Enable and M1,M2 signals. Reset when pull low forces the TB6560 microstep state machine to a know state. Enable when pulled low turns all Power MOSFET coils drivers off. M1 and M2 select the microstep mode.



2.2 Motor Control Port

Motor control port is routed to connector J10. Step and direction signals are fed to the board on this port along with main power (5V DC) and ground and optional control signals (see description of optional control signals in section 2.5).

The 5V DC power must be applied to the MM160 before or at the same time that motor power is applied and the ground between the logic and motor ground must be common. If motor power is applied before 5V power the MM160 maybe damaged.

A positive going pulse on the Step input activates a step operation. The pulse must remain high for at least 10useconds before going low. Pulse durations less than 10useconds may yield unpredictable results. The direction signal is sampled when the Step pulse goes high so it should be set and stable before activating the step pulse. Direction of rotation depends on how the stepper motor has been wired. The polarity of step and direction is typically set by desktop software. If using Mach3 then select Sherline mode to ensure pulse duration is long enough.

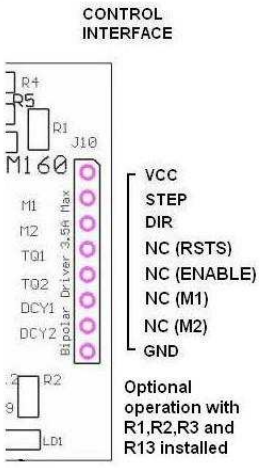


Figure 2-2. Step/Direction **Control Port Pin Assignment J10.**

2.3 DIP Switch Settings

A DIP switch is used to set step mode (full, half, eight and sixteenth), torque (100%, 75%, 50%, 20%) and decay mode (0%, 25%, 50% and 100%). The diagram below shows the various settings, default setting is half step, 100% torque and no decay. When a DIP switch is set to "ON" the respective signal is pulled to ground. DIP switch changes should be made with power off so the correct selection is active at power up.

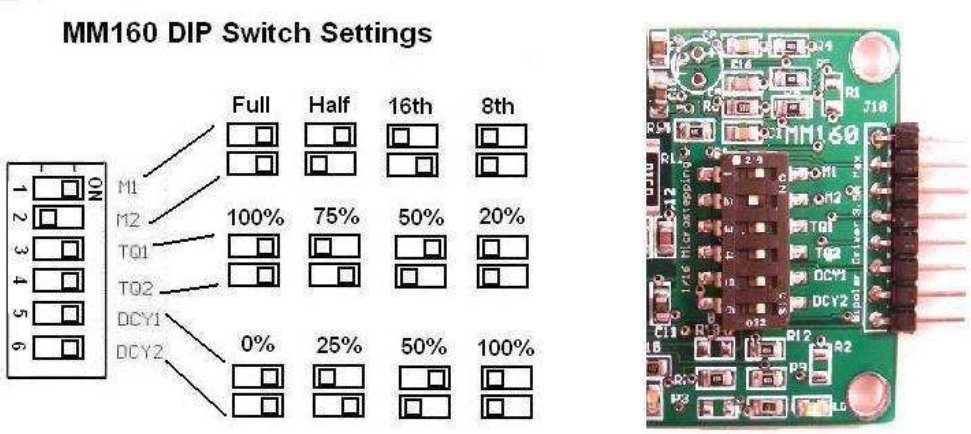


Figure 2-3. **DIP Switch setting and location.**

The MM160 supports four different step modes set by DIP switch 1 and 2 shown in the diagram above.

The MM160 has four torque modes. The maximum torque is 3.5A set by two 0.150 ohm sense resistors. Lower torque settings are selected by setting DIP switch 3 and 4.

The MM160 supports four decay modes. Decay modes determine how fast residual current is discharged by the TB6560. As the TB6560 drives a stepping motor at faster step rates a back emf is produced by the rotation of the rotor. In order to discharge this back emf quickly fast decay is required. The MM160 is shipped with no decay selected. According to the TB6560 data sheet the appropriate setting for the decay is best determined by observing the current signal on an oscilloscope. In the absence of an oscilloscope the best decay setting is determined experimentally. As a rule of thumb if you don't plan to run the stepper at its maximum rated step rate then leave decay at 0%.

2.4 Thermal Considerations

The MM160 uses 0.150 ohm sense resistors – these resistors ensure the maximum current rating of 3.5A is reached. When using a stepper motor with a lower current rating set the torque DIP switches to a lower setting to prevent the TB6560 and stepper motor from overheating.

At the maximum torque setting 3.5A a 3.5A stepper motor will cause the TB6560 to overheat in a few minutes and shut down unless forced air cooling is used. A RED led on the board turns on when the TB6560 enters thermal shutdown which occurs when the die temperature reaches 170deg C +- 20deg C and all outputs shutoff. The RED led goes out once the temperature falls to a safe operating level.

The TB6560 typically runs hot so forced air cooling is mandatory under most operating conditions. For example, with a 3.0A NEMA23 stepper motor attached to the MM160, no heat sink and no forced air the TB6560 will reach maximum operating temperature and shut down in just over two minutes. A small brushless DC 24V 0.1A 2.5" diameter fan blowing air across the TB6560 keeps the package at a constant operating temperature of 75C which is 60C less than without forced air cooling. Adding a heat sink lowers the operating temperature by another 15C to 60C.

Consult the factory for a recommend heat sink or the obtain specifications on the SOC heat sink kit for the MM160.

2.5 Transient Voltage Suppressor (TVS)

Three bidirectional TVS 600W diodes are installed across A+, A-, B+, B- and VPP, GND. These diodes conduct when the voltage across them exceeds 37 volts and have a turn on time of less the 1 picosecond. They are designed to protect the driver chip from excessive inductive voltage spikes. The TVS diodes used on the MM160 are made by Littlefuse part number P6SMB39CA.

2.6 Optional Resistors

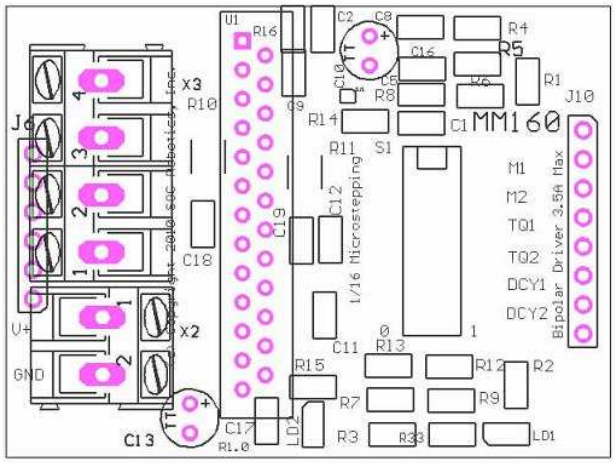
Optional 0R resistors can be installed to map M1,M2, RSTS and Enable signals from the TB6560 driver to connector J10. RSTS is the TB6560 Reset input, ENABLE turns the driver MOSFETS on or off and M1/M2 set step mode. If R3 and R13 are installed then the Step mode DIP switch should be set to 1/8th step mode so the external controller can control these lines.

The MK4C controller allows OUT3 and OUT4 to control RSTS and ENABLE via the host PC.

3.0 Electrical and Mechanical Description

3.1 Component Layout

Components are mounted on the top side of the board. Not all components may be mounted. See the section on optional components for more information.



3.2 Electrical Specifications

Electrical

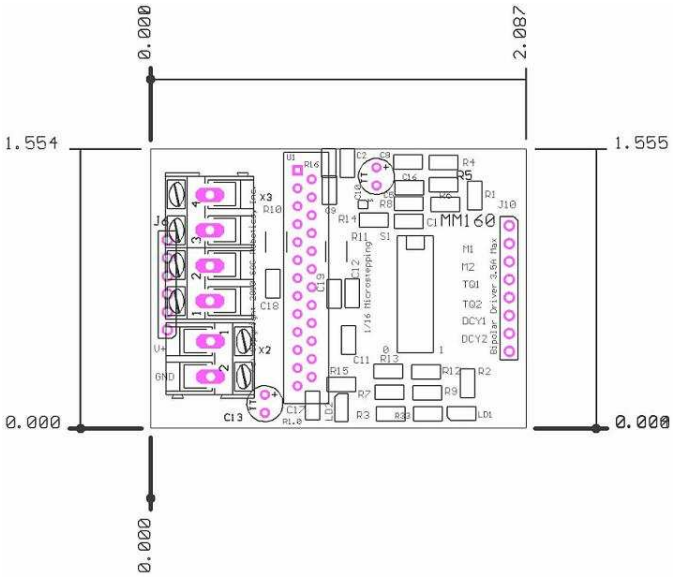
Input power: 5VDC @ 12ma

Mechanical

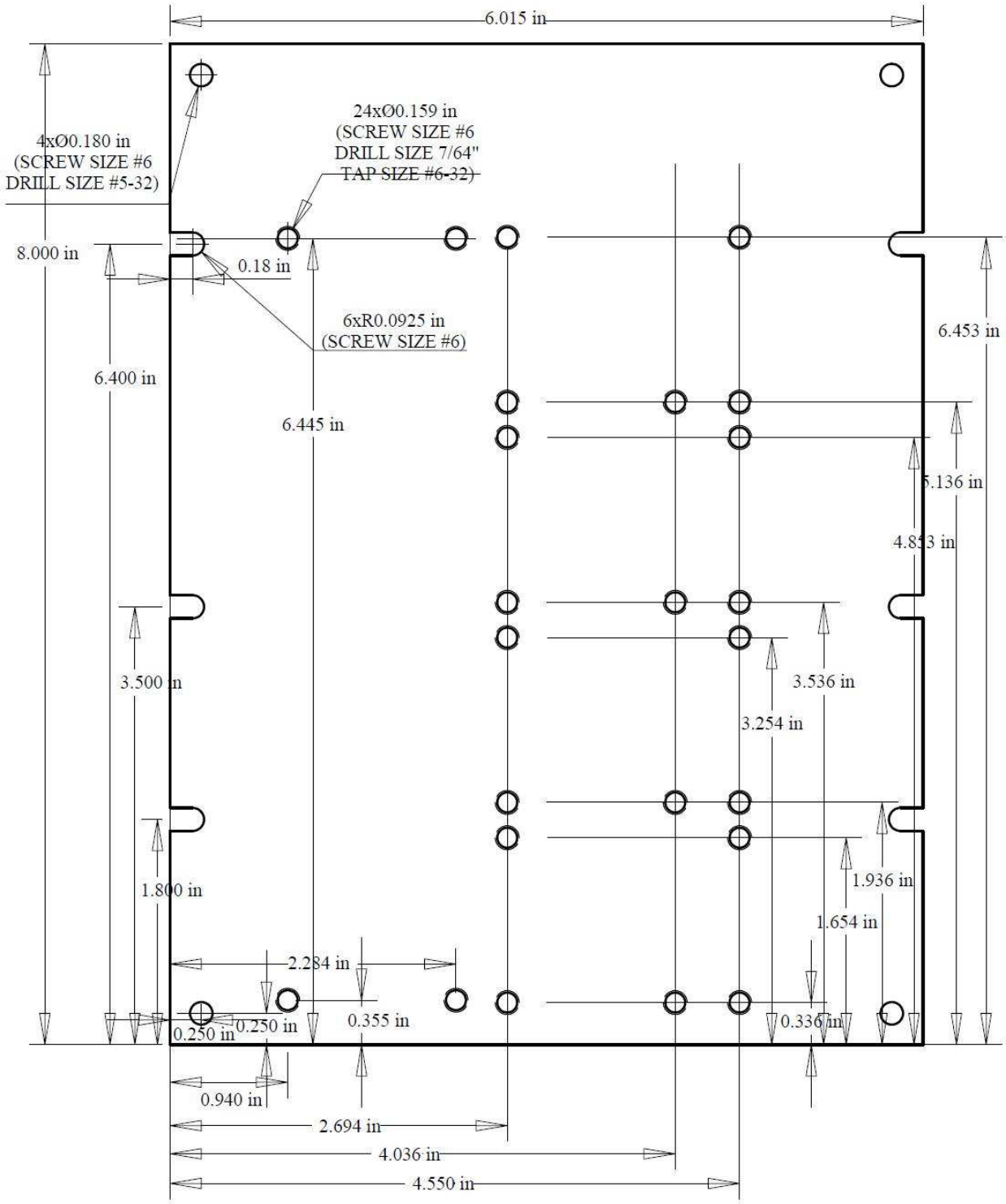
Dimensions: 2.1x1.56 in (one mounting hole)
Weight: 38 grams

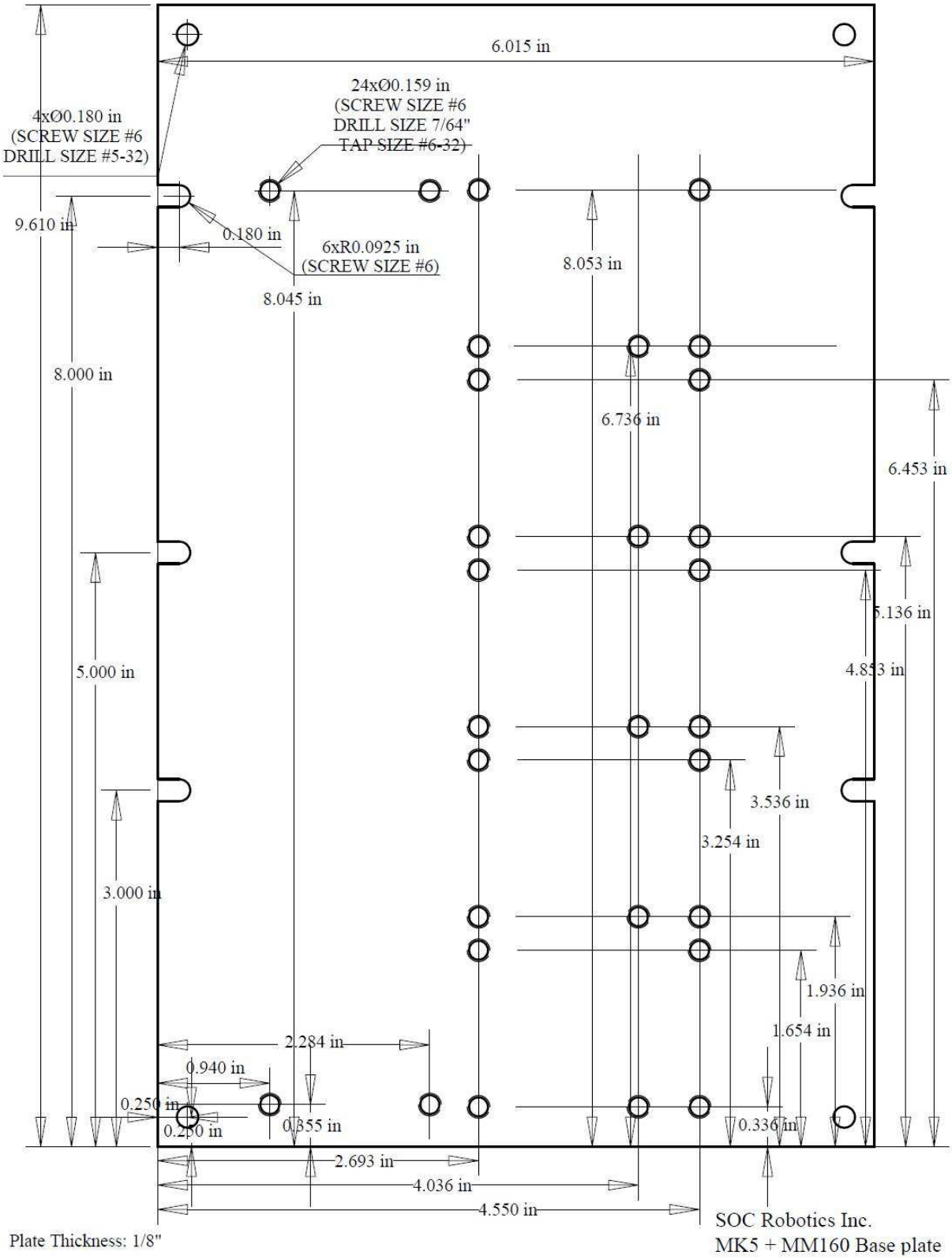
3.3 Mechanical Dimensions

Board dimensions are stated in inches.

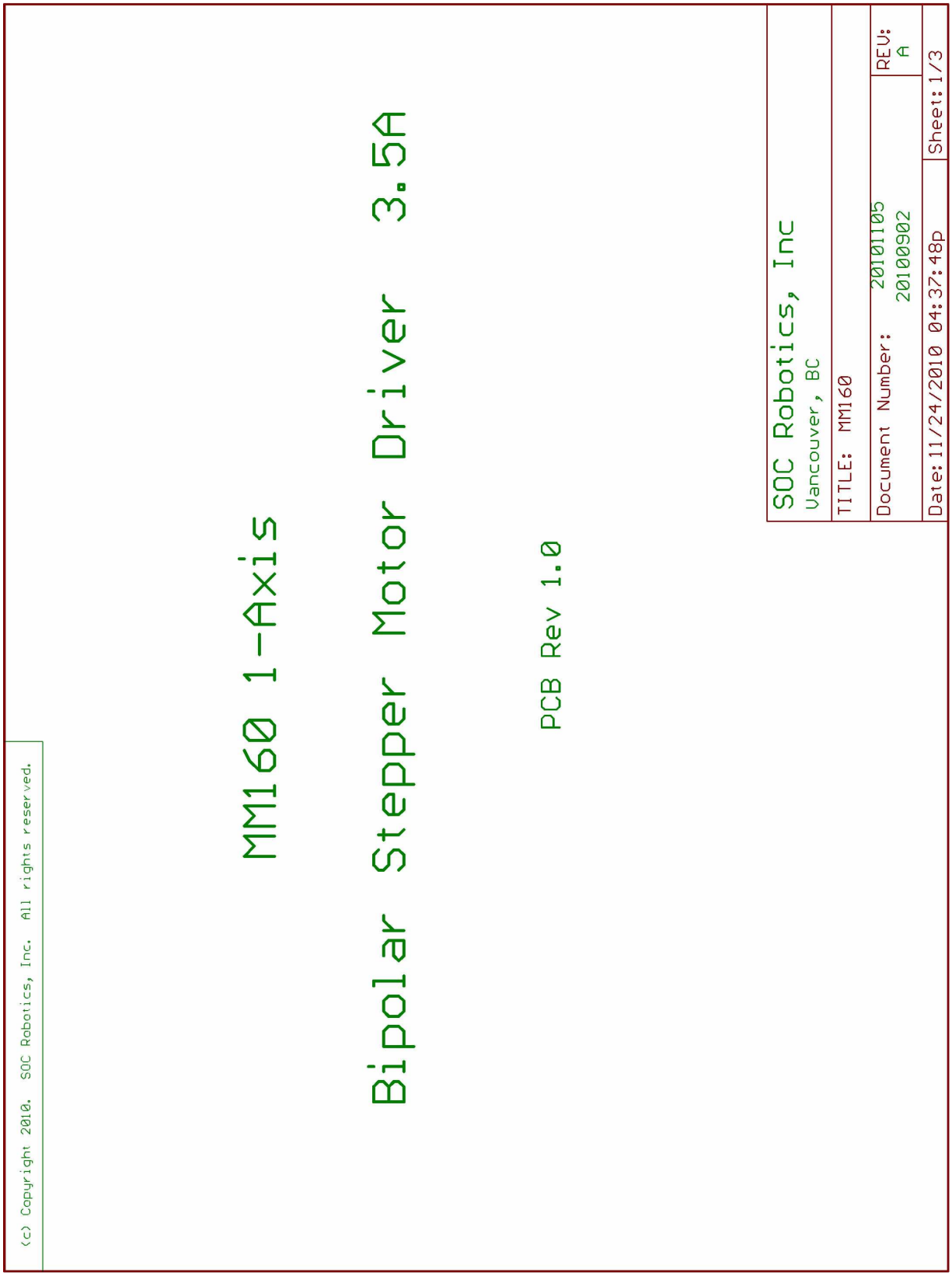


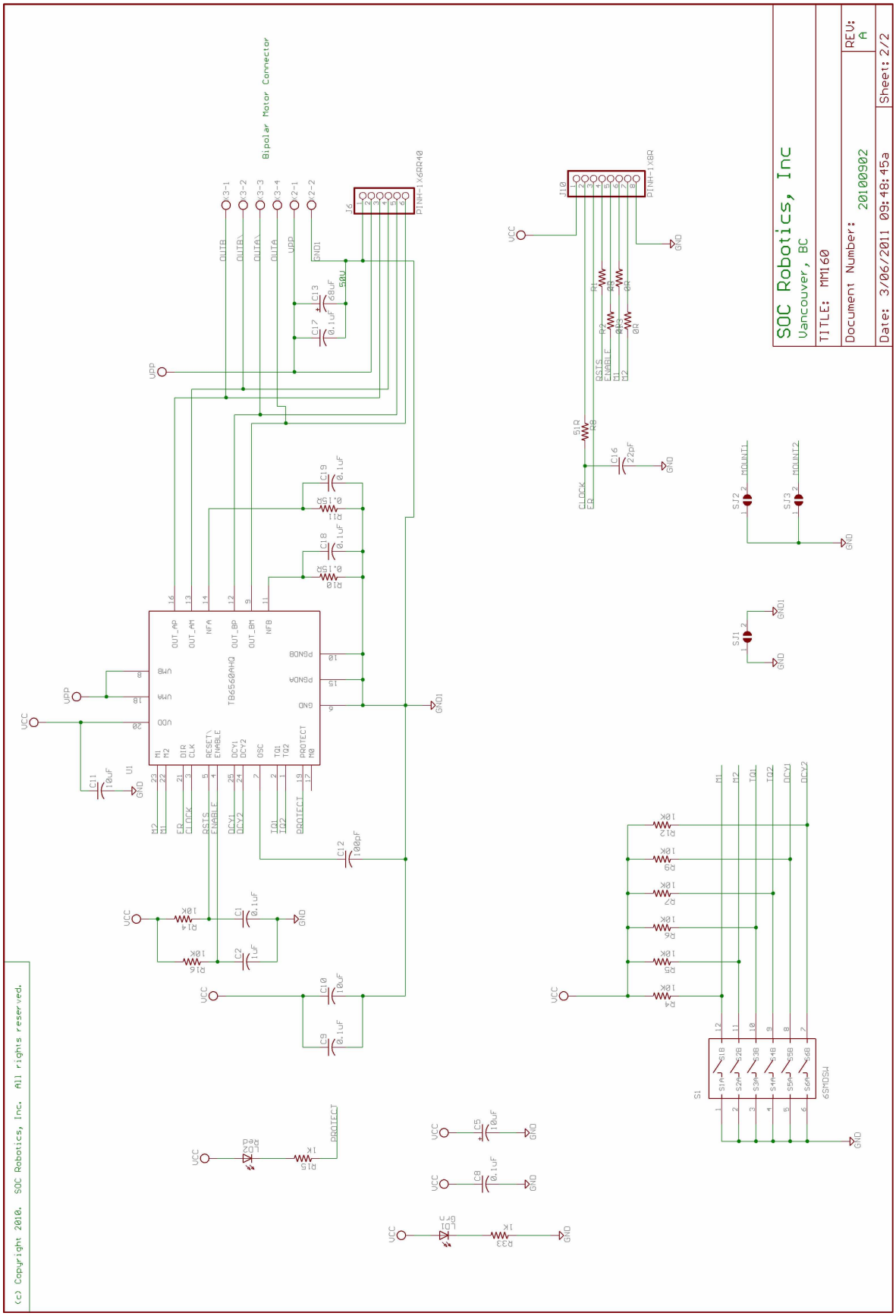
3.4 Mounting Plate for MK4 and MK5 with MM160's (not to scale).




6.015 in
24xØ0.159 in
(SCREW SIZE #6
DRILL SIZE 7/64"
TAP SIZE #6-32)
4xØ0.180 in
(SCREW SIZE #6
DRILL SIZE #5-32)
9.610 in
0.180 in
6xR0.0925 in
(SCREW SIZE #6)
8.045 in
8.053 in
8.000 in
6.736 in
6.453 in
5.136 in
5.000 in
4.853 in
3.536 in
3.254 in
3.000 in
1.936 in
1.654 in
2.284 in
0.940 in
0.250 in
0.250 in
0.355 in
0.336 in
2.693 in
4.036 in
4.550 in
Plate Thickness: 1/8"
SOC Robotics Inc.
MK5 + MM160 Base plate

4.0 MM160 Circuit Schematics

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Vancouver, BC
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Bipolar Motor Connector
TB6560AHQ
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