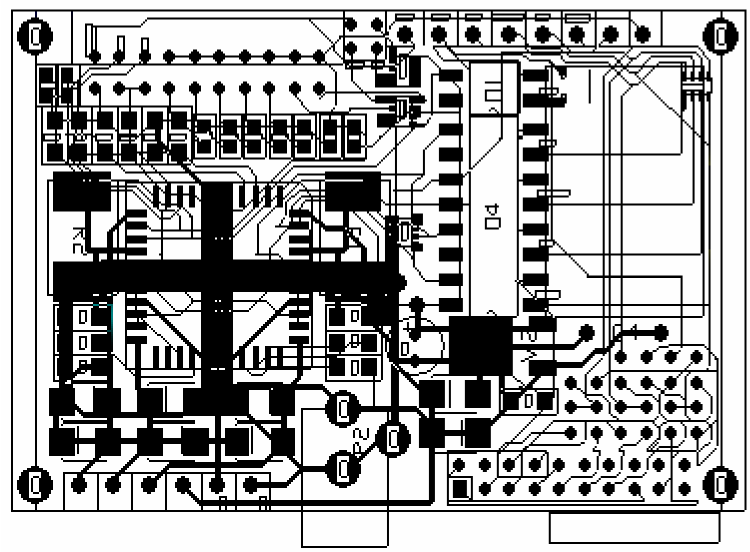
# SC125MS

## Stepper Motor Driver

# Data Sheet and Instruction Manual



## Salem Controls Inc.

**www.salemcontrols.com**

Last Updated 12/14/2004

| ! Warning ! | Stepper motors and drivers use high current and voltages capable of causing severe injury. Do not operate this product without reading and following the instructions contained in this document and on our web site at http://www.salemcontrols.com/ |
|---|---|

## Table of Contents

## Introduction

The SC125MS Stepper Motor Driver is a combination translator and driver built around the Allegro A3977SED (http://www.allegromicro.com/). The SC125MS can operate 2-phase bipolar motors up to 2.5A per channel. The SC125MS comes with an aluminum enclosure and cooling fan, and the SC125MSX version is the driver board only. In this document the specifications and connections apply to both the SC125MS and the SC125MSX.

The SC125MS receives logic input signals from a PC, PLC, microcontroller, or other device and translates these signals into the signals needed to drive a stepper motor. You can supply the TTL-level signals from the parallel port of a PC, as with CNC software, or from a PLC or microcontroller, such as may be used in machine automation applications. The logic input signals control the step, direction, motor enable, and microstepping level of the stepper motor.

The SC125MS uses PWM/chopper technology to limit current in the motors and improve torque at high speeds, and is capable of microstepping motors at up to 8 microsteps per full step. It also operates on a common step + direction (with optional enable) interface that allows it to easily interface with a PC and software (through the parallel port) or other devices capable of producing TTL-level signals.

All of the components on the SC125MS that are powered by external power supplies are optically isolated from the logic inputs from the PC or controlling device. This means that backwards EMF from stepper motors running at high current and voltage levels cannot damage connected equipment.

The enclosure of the SC125MS is anodized aluminum, with plastic end panels. The fan is 40 mm x 40 mm x 10 mm, and provides active cooling to the board through an integrated heat sink. The screw terminal connectors on the board are plug-type and can be removed, to allow for easy switching between motors, power supplies, or controlling devices.

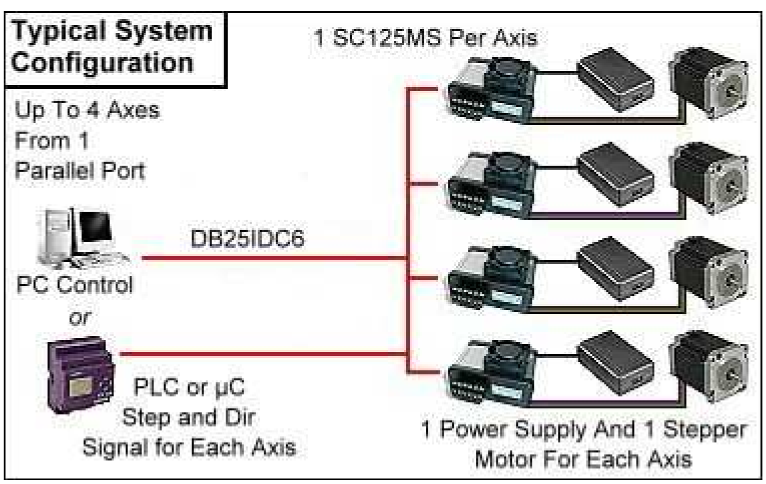



Figure 1

Figure 1 shows the typical system configuration, consisting of a controlling device, a connection between the controlling device and the SC125MS, a power supply and a stepper motor. Setup for the SC125MS consists of:

- Connecting the SC125MS to a PC, PLC, microcontroller, or other logic device
- Connecting the stepper motor to the SC125MS
- Connecting the power supply to the SC125MS

More information on each of these steps can be found in the Setup section.

Setup normally takes only a few minutes to complete. There is also free software available for download from http://www.salemcontrols.com/ that can be used to control the SC125MS from a PC. This document also contains the communications and pinout information that will allow the SC125MS to be controlled by TTL-level signals coming from any device.

## Specifications

| | |
|---|---|
| Part # | SC125MS |
| Type of Stepper Motors | 2-Phase Bipolar |
| Maximum Motor Current | 2.5A Per Phase |
| Current Level Selection | 7-Position DIP Switch or Resistor/Potentiometer |
| Supply Voltage | 7V – 30V |
| Step Sizes | Full, 1/2, 1/4, and 1/8 Step Microsteps |
| PWM Chopping Frequency | 20 kHz |
| Maximum Step Frequency | 500 kHz* |
| Terminal Blocks | Removable Screw Terminal Plugs |
| Optoisolated Logic Inputs | Step, Direction, Enable, Microstep 1 and 2, GND |
| Power Input | 2.1 mm x 5.5 mm Center Positive Plug or 2 Screw Terminal Positions |
| Dimensions | Board Only: 2.94” x 2.00”<br>Enclosure and Fan: 3.19” x 2.24” x 1.52” |
| Case | Anodized Aluminum with Plastic End Caps |
| Indicator LEDs | Power On and Motor Enable |

*Maximum step frequency is subject to several system characteristics and is not guaranteed.

## Schematic

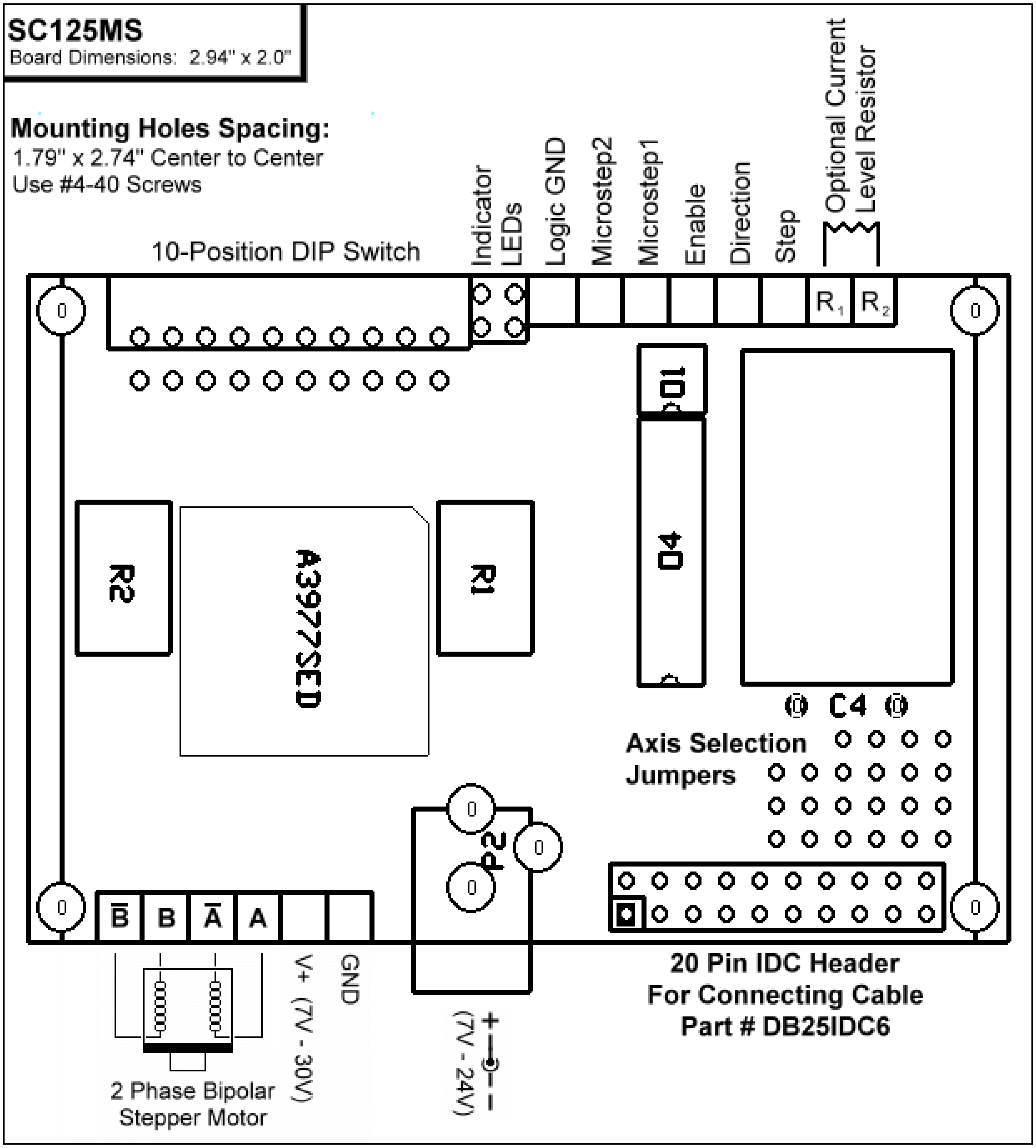



Figure 2

## Pinout Information

There are a total of 14 screw terminal positions and one 20-pin IDC header on the SC125MS. 6 of the screw terminal positions and 6 of the pins of the IDC header are connected to each other on the board and serve the same exact purpose. These 6 connections are for logic inputs from a controlling device, whether it be a PC, PLC, microcontroller, etc. For more information on which screw terminal positions or which IDC header pins connect to which logic inputs, please see the schematic, Figure 2, and the section that follows on Logic Inputs.

The 2 positions $R_1$ and $R_2$ in the schematic, Figure 2, can be joined by a resistor to set the current limit in the motor. Please see the section on Using a Resistor to Set the Maximum Motor Current for more information.

The 4 positions labeled A and B are for connecting 4 leads of the stepper motor to the SC125MS. Please see the section on Motor Connection Information for more about these connections.

The 2 connections closest to the DC power jack are for connecting the positive and GND leads of a power supply to the SC125MS. You can use either the DC power jack or these two screw terminal positions to connect your power supply to the board. The position directly beside the DC power jack is for the power supply ground, and the next position to the left is for V+ from the power supply. See the section on Connecting the Power Supply to the SC125MS for more information.

## Logic Inputs

The SC125MS schematic, Figure 2, shows the various connections available on the board. These include connections for logic inputs, motor leads, current level resistor, and the power supply. A description of the logic inputs follows.

There are 6 logic inputs on the SC125MS. These 6 inputs are Step, Direction, Enable, Microstepping 1, Microstepping 2, and GND.

### Step

When the STEP pin of the A3977SED is transitioned from GND to +5V the motor advances one step. The Step logic input on the SC125MS is connected through an optoisolated channel to this STEP pin on the A3977SED. A logic high on the Step input of the SC125MS causes the STEP pin of the A3977SED to go to +5V, and a logic low on the Step input of the SC125MS causes the STEP pin of the A3977SED to go to GND.

The motor advances one step on the rising edge of the transition from GND to +5V on the STEP pin. The Step logic input must remain high for at least 1 microsecond, and must remain low for at least 1 microsecond between steps (see the A3977SED for more information at http://www.allegromicro.com/datafile/3977.pdf). The motor will advance one step for each logic transition from low to high, but this step may be a full step, 1/2 step, 1/4 step or 1/8 step, depending on the microstepping level of the SC125MS at the time the signal is received. See below for more information on microstepping levels.

### Direction

This logic input causes the motor to rotate clockwise or counterclockwise. When the Direction logic input is high the motor will rotate one direction, and when the Direction logic input is low the motor will rotate the opposite direction. The actual direction for a low or high signal varies depending on the order in which the motor leads are connected to the board.

**Enable**

Before the motor will rotate, the SC125MS must enable the windings of the motor. The A3977SED chip has an ENABLE pin that is active low. The logic input to the SC125MS is reversed, in the sense that a logic High on the Enable input will enable the motor, and a logic low on the Enable input will disable the motor. When the motor is disabled there is no current flowing through the windings of the motor, and the motor shaft will not be held in place.

It is not necessary to always supply the Enable logic input for motor operation. You can set DIP Switch position 10 to ON to cause the ENABLE pin on the A3977SED to always be low, thereby making the motor always enabled whenever power is applied to the board. When position 10 is ON the motor will be enabled regardless of the status of the Enable logic input. When position 10 if OFF the motor will only be enabled when the Enable input is High.

**Microstepping 1 and Microstepping 2**

These two logic inputs determine the level of microstepping that the motor is operating at. There are 4 levels available, Full Step, Half Step, 1/4 Step, and 1/8 Step. In Full Step a 200 step per revolution motor will step 1.8 degrees each time the Step logic input transitions from low to high. The same motor would step 0.9 degrees if the SC125MS was in Half Step mode, 0.45 degrees if in 1/4 Step mode, and 0.225 degrees if in 1/8 Step mode.

To set the level of microstepping set the Microstepping 1 and Microstepping 2 logic inputs to Low or High according to the table below:

| | Microstepping 1 | Microstepping 2 |
|---|---|---|
| **Full Step** | Low | Low |
| **Half Step** | High | Low |
| **1/4 Step** | Low | High |
| **1/8 Step** | High | High |

You can also select the level of microstepping using DIP Switch positions 8 and 9. Position 8 corresponds to Microstepping 1 and position 9 corresponds to Microstepping 2. Turning a position “off” sets it to Low, and turning a position “on” sets it to High. If the DIP Position is “off” setting the logic input to High will cause the microstepping level to be high. If the DIP Position is “on” setting the logic input to low will not cause the microstepping level to be low. The DIP positions override the logic inputs, so be sure that they are both “off” if you would like to control the microstepping level through the logic inputs.

**GND**

This logic input must be connected to the GND of your logic device in order for the other logic signals to pass through the optoisolators and work properly. The optoisolators on the SC125MS are activated by the flow of a small amount of current (5mA or so) through a diode, and thus the logic inputs must have a GND present to sink this small current. The GND pins of the parallel port are pins 18-25.  Your logic device should have a GND available.

## Setup

To begin setup, remove the SC125MS from any packaging material and visually inspect it for damage or missing components. If the board appears to be damaged in any way please contact Salem Controls Inc. at http://www.salemcontrols.com/ for replacement.

Figure 2 shows the connections between the SC125MS and other components of the complete motion control system. In addition to the SC125MS you will need:

- PC or other controlling device
- Up to 2.5A per phase bipolar stepper motor
- A DC power supply 7V to 30V
- Cable DB25IDC6 to connect the SC125MS to the parallel port of the PC, or hookup wires to connect to other controlling device

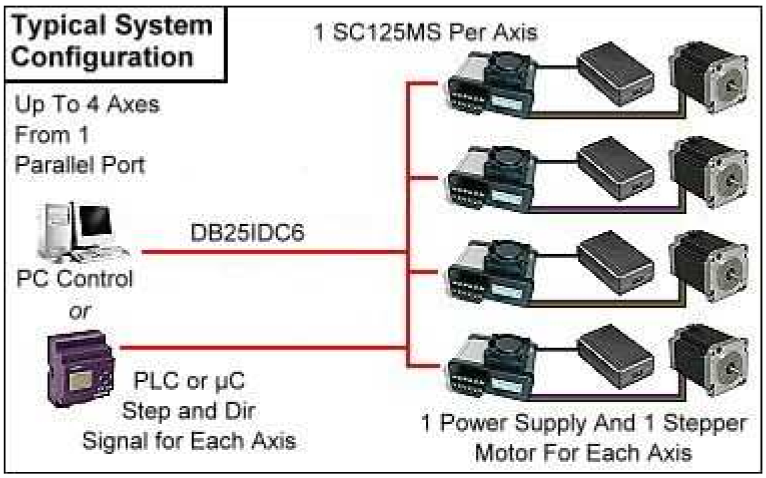



Figure 2

### Connecting the SC125MS to a PC

If you are using the DB25IDC6 cable to connect the SC125MS to a PC, first plug the male DB 25-pin end of the DB25IDC6 cable into the parallel port on the back of your PC. Then, plug one of the four 20-pin IDC connectors on the other end of the cable onto the 20-pin IDC header on the SC125MS.

### Connecting the SC125MS to Other Devices

You can use any device capable of producing TTL-level logic signals to control stepper motors through the SC125MS. Your controlling device will need to be able to produce enough current to drive the optoisolator chips on the SC125MS. More information on the signals needed to drive the SC125MS optoisolator chips can be found in the PS2501L datasheet at http://www.cel.com/pdf/datasheets/ps2501.pdf

There are 6 logic inputs on the SC125MS. These are accessible either through 6 screw terminal positions beside the indicator LEDs or through the 20-pin IDC header. These 6 logic inputs are Step, Direction, Enable, Microstepping 1, Microstepping 2, and GND. Please see the section on Logic Inputs for more information on these inputs.  The inputs that you will need to connect to depend on the amount of control that you need over the movement of the stepper motor.

To connect to the logic inputs of the SC125MS using the 6 screw terminal positions simply insert the wire connecting the logic output of your controlling device to the logic input of the SC125MS into the small opening of the screw terminal plug.  Tighten the screw in the screw terminal plug to secure the connecting wire in place.

To connect to the logic inputs of the SC125MS using the 20-pin IDC header you will need a cable that terminates in a 20-pin IDC socket.  The pinout for the 20-pin header on the SC125MS can be found in Appendix 1 – SC125MS and DB25IDC6 Pinouts.  Pin # 1 of 20-pin IDC header is in the lower left of the header when looking at the SC125MS.

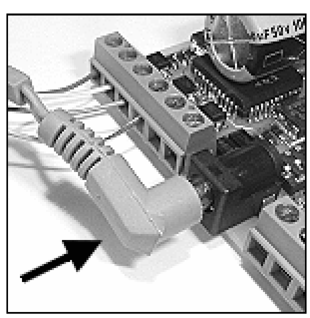
Regardless of how many logic inputs you supply to the SC125MS, for any of them to work properly the GND of your controlling device must be connected to the logic GND input of the SC125MS.  This can be done through either the screw terminals or the 20-Pin IDC connector.  The presence of the logic GND connection allows a small amount of current to flow through the optoisolator chips of the SC125MS, to transmit the signals optically to the power side of the board.

**Connecting the Stepper Motor to the SC125MS**

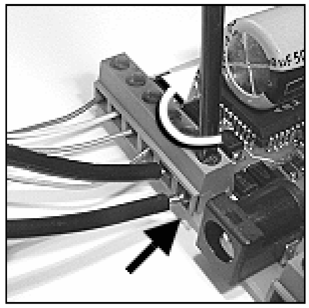
Next, connect the stepper motor to the SC125MS.  You will need a small screwdriver to connect the leads of the motor to the appropriate terminal block positions.  For more information on the connecting your motors to the SC125MS please see the schematic (Figure 2) and the section on Motor Connection Information.

**Connecting the Power Supply to the SC125MS**

Lastly, connect a power supply to the SC125MS for each motor.  Be sure that the power supply is not plugged in or turned on while it is being connected to the board.  If you are using a power supply with a barrel-plug type connector, the supply should be from 7V to 24V DC, and the barrel plug should be 2.1 mm x 5.5 mm and center positive.



If you are using a power supply with positive and negative leads the supply should be from 7V to 30V.  The positive and negative leads should be connected to the appropriate terminal block positions.  Be sure that the leads do not connect with each other or any other terminal block positions. Please see the schematic (Figure 2) for more information on the power supply connection positions.



At this point all of the equipment you need for your motion control system is in place, and you are ready to begin controlling your stepper motors with the SC125MS. You can now use the free software from our web site at http://www.salemcontrols.com/ or your own controlling device or software. For more information on our software and its installation please see our web site at http://www.salemcontrols.com/ For more information on using your own controlling device, please see the section on Pinout Information.

If the SC125MS fails to operate correctly please see the Troubleshooting section below or our online Support area (http://www.salemcontrols.com/support/support.html) and Discussion Groups (http://www.salemcontrols.com/discussion/discussion.html) If you still have problems please contact us at http://www.salemcontrols.com/

## Current Level Selection

The SC125MS can limit the current level in the stepper motor from 330mA to 2.5A. You can select the maximum level of current in the windings of the stepper motor in 2 different ways on the SC125MS. One method is by manipulating DIP switch positions to select one of 128 current levels. The other method involves connecting a resistor between screw terminal positions $R_1$ and $R_2$ on the board. Each of these methods has some inherent error and the maximum current levels obtained in the formulas that follow are estimates and not exact. To know the exact current in the motor you must measure it directly.

Please note that the current level in the windings of the motor is also limited by the capability of the power supply for each axis, and the current limit level should not be set to a value greater than the rated current output of the power supply or the power supply may be damaged. Also, setting the current limit to a value higher than the rated value of the motor can cause the motor to overheat. Stepper motors may become warm during normal operation, but excessive heat can cause permanent damage to the motor. Please see the data sheet for your stepper motor for more information on heat dissipation and operating temperature.

### Using a Resistor to Set the Maximum Motor Current

To use a resistor to set the current level in the motor windings, connect a resistor between the two left-most positions of the 8-position screw terminal plug of the SC125MS, labeled $R_1$ and $R_2$ in the Schematic, Figure 2.

To find the resistor value required to set the current at a particular level, you first must calculate the total resistance formed by the combination of the DIP switch positions 1 – 7 and the resistor connected between screw terminal positions $R_1$ and $R_2$. This total resistance in kilo-ohms can be calculated as:

$$R_{tot} = 1 / (1/(1*D_1) + 1/(2*D_2) + 1/(4.02*D_3) + 1/(8.06*D_4) + 1/(16.2*D_5) + 1/(32.4*D_6) + 1/(64.9*D_7) + 1/R_c + 0.0617)$$

Where $R_c$ is the value of the resistor you are using in kilo-ohms and $D_x$ is the value of the DIP switch position x. For example, if DIP switch position 4 is "on", the value of $D_4$ is 1. If DIP switch position 4 is "off", the value of $D_4$ is 0.

When you have the value of $R_{tot}$, you can then calculate the reference voltage, $V_{ref}$ using the formula:

$$V_{ref} = 5*(R_{tot}/(R_{tot} + 4.12))$$

The reference voltage can also be measured directly between the two screw terminal positions $R_1$ and $R_2$. From this voltage the current level in the motor, $I_{motor}$, can be calculated by:

$$I_{motor} = V_{ref}* 0.625$$

As an example, if you have all of the DIP switch positions set to "off" and you use a resistor with a value of 4 kilo-ohms connected between $R_1$ and $R_2$, the value of $R_{tot}$ would be:

$$1/((1/4)+0.0617) = 3.21 \text{ kilo-ohms}$$

Therefore, $V_{ref}$ would be:

$$5*(3.21/(3.21 + 4.12)) = 2.19 \text{ V}$$

And the maximum current level in the motor, $I_{motor}$, would be:

$$2.19 * 0.625 = 1.37 \text{ Amps}$$

You can also use a potentiometer to vary the resistance between the $R_1$ and $R_2$ and therefore the maximum motor current. You can also measure the reference voltage, $V_{ref}$, with a multimeter at the two screw terminal positions for a more accurate reading. This $V_{ref}$ value can then be used to calculate $I_{motor}$.

### Using the DIP Switch Positions to Set the Maximum Motor Current

The SC125MS has a 10-position DIP switch. Positions 1 – 7 of this switch are used for selecting the current level limit in the windings of the stepper motor. The current level can be set from 330 mA to 2.5A by turning a combination of these 7 switches on or off.

Each switch position is turned on when the small tab is pushed to the "on" side of the switch, and the positions are turned off when the small tab is pushed to the side of the switch where the labeling #'s are located. See figure 3.

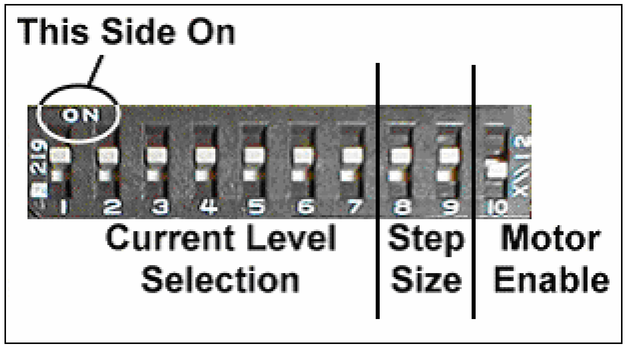


Figure 3

The table in Appendix 3 shows the setting for DIP switch positions 1 – 7 and the approximate current levels that will result in the motor windings for each setting. The actual current limit is determined by many factors, and current levels in the windings should be measured directly if precision is required. All of the values in this table were calculated based on an open circuit between screw terminal positions $R_1$ and $R_2$ (no resistor present). In the table, a “1” denotes the switch position being “ON” and a “0” denotes the switch position being “OFF”. The current limit in the motor windings for each group of switch settings is labeled “I (mA)”.

You can also calculate the maximum motor current using the formulas found in the previous section on using a resistor to set the maximum motor current.

## Microstepping

Positions 8 and 9 of the DIP switch for each axis determine the step size. There are four possible settings, determined by the status of these two switches.

The table below shows the step size based on the status of the switches. Please see Figure 3 above and the previous section for an explanation of when a switch position is on or off.

| Position 8 | Position 9 | Step Size |
|---|---|---|
| OFF | OFF | Full |
| ON | OFF | 1/2 |
| OFF | ON | 1/4 |
| ON | ON | 1/8 |

For example, if a stepper motor with 1.8 degrees per step is connected to the board and DIP positions 8 and 9 are set to OFF and ON, respectively, the stepper motor will rotate 1/4 * 1.8 = 0.45 degrees for every step executed, and will require 800 steps to complete a full revolution. Please see the datasheet for the A3977SED Driver with Translator at http://www.allegromicro.com/sf/3977/ for more information on microstepping modes.

## Motor Enable Selection

The SC125MS has the ability to enable and disable the windings of the stepper motor. Being enabled means that the current from the power supply will be allowed to pass through the motor windings of that axis to energize the motor, either locking the shaft in place if no rotation is occurring, or rotating the shaft of the motor as the step sequence causes the motor to advance.

Without being enabled, the motor will not have any current passing through its windings, and the shaft will rotate relatively freely. For more information on enabling and disabling the motor please see the datasheet for the A3977SED Driver and Translator at http://www.allegromicro.com/sf/3977/.

The SC125MS allows you to determine when each axis and motor will be enabled, either all the time or only when the enable logic input on the board is HIGH. This means that the motor can be disabled when rotation is not needed so that it can cool and so that less power will be used.

It is not necessary to always supply the Enable logic input for motor operation. You can set DIP Switch position 10 to ON to cause the ENABLE pin on the A3977SED to always be low, thereby making the motor always enabled whenever power is applied to the board. When position 10 is ON the motor will be enabled regardless of the status of the Enable logic input. When position 10 if OFF the motor will only be enabled when the Enable input is High.

For more information on the ENABLE pin and functionality of the A3977SED, please refer to the A3977 data sheet which can be downloaded from http://www.allegromicro.com/sf/3977/. For more information on the Enable logic input please see the SC125MS schematic (Figure 2).

## Motor Connection Information

The SC125MS can drive bipolar stepper motors up to 2.5A per channel. There is a simple diagram showing the basic connection of the motor to the SC125MS in the Schematic (Figure 2).

Most stepper motor data sheets contain a diagram that shows the phases of the motor, labeled A and B. This diagram normally shows the leads that form the ends of these phases. In the case of 2-Phase stepper motors, which are the type that the SC125MS can control, there will be 4 phase end leads (2 for each phase) to connect to the control board. These leads are normally labeled A, $\overline{A}$, B and $\overline{B}$ in the motor datasheet. To connect your motor to the SC125MS, simply match up the four leads with the terminal positions on the SC125MS labeled A, $\overline{A}$, B and $\overline{B}$ in the schematic, Figure 2.

There are wiring diagrams for the stepper motors that we sell on our web site in our motors section at http://www.salemcontrols.com/products/motors.html

Some 2-phase motors may come with 5 or 6 leads instead of only 4. To connect these motors to the SC125MS determine the A, $\overline{A}$, B and $\overline{B}$ leads and connect them to the board, and leave the remaining leads unconnected. Be sure that the ends of the unconnected leads do not touch the board, and use electrical tape, heat shrink, a wire nut, or some other means of covering the exposed wire in the unconnected leads.

Some 2-phase motors have 8 leads. In this case you will need a diagram that shows how the leads coming out of the motor form the ends of the 4 half-phases of the motor. You have two options for operation. The first is to only connect two half phases to the SC125MS. The second option is to connect two sets of half-phases together by connecting some of the leads of the motor, and then connect the two full phases that were formed to the SC125MS. Using half-phases only will result in less torque, but also less power used. Just as with a 5 or 6 lead stepper motor, the leads of the 8 lead motor that are not connected to the SC125MS should be protected to prevent damage to the board or motor.

In most cases the stepper motors from one manufacturer all have the same internal wiring, and thus if you can find wiring information for one motor you can normally connect a motor with the same color of windings in the same way. If you cannot find the information you need to connect your motor to the SC125MS, please contact us.

## Troubleshooting

Please refer to the table below for help in troubleshooting problems with the SC125MS. If your problem is not solved by the information found in this table, please consult our online support documentation and discussion groups at www.salemcontrols.com

| Behavior | Possible Solution |
|---|---|
| Motors Do Not Rotate | • Check that all cables are connected securely both to the SC125MS and to the PC or other controlling device.<br>• Be sure that the power supply is connected to the board properly, and the power supply is plugged in and/or turned on.<br>• Check that the power supply is the correct polarity or that the positive and negative leads are connected to the correct positions.<br>• Check the connection of the motors to the board to make sure the leads are in the correct terminal positions.<br>• If there is a significant load on the stepper motor the current limit in the motor may need to be increased. |
| Motors Vibrate Instead of Rotating, or Step or Rotate Erratically | • Excessive cable lengths over can cause signals to degrade between the controlling device and the SC125MS. Try using a shorter cable if possible.<br>• Check the order in which the leads of the motor are connected to the controller board.<br>• If there is a significant load on the stepper motor the current limit in the motor may need to be increased.<br>• Increasing the voltage of the power supply can also improve the performance of the stepper motors, especially at high step rates. |
| Motors Vibrate Instead of Rotating, Miss Steps or Stop Rotating at High Speeds | • If controlling from a PC, be sure that other software or processes running on the PC are not causing the timing of the signals from the control software to vary greatly.<br>• Increasing the voltage of the power supply can also improve the performance of the stepper motors, especially at high step rates.<br>• The stepper motor may not have enough torque to rotate the load. |

## Appendix 1
### DB25IDC6 Pinouts

Up to four SC125MS drivers can be connected to one parallel port using the DB25IDC6 cable. The signals for all 4 axes are transmitted through all 4 of the 20-position IDC sockets and the 26-position IDC socket on the DB25IDC6 cable. Each SC125MS connected to the same DB25IDC6 cable acts as axis 1, 2, 3, or 4 depending on the axis selection jumpers, as explained in Appendix 2. Below is a table showing the connection between the pins of the parallel port and the connectors on the DB25IDC6.

| Parallel Port Pin # | IDC Connector Position # | Parallel Port Pin # | IDC Connector Position # |
|---|---|---|---|
| 1 | 1 | 14 | 14 |
| 2 | 2 | 15 | 15 |
| 3 | 3 | 16 | 16 |
| 4 | 4 | 17 | 17 |
| 5 | 5 | 18 | 18 |
| 6 | 6 | 19 | 19 |
| 7 | 7 | 20 | 20 |
| 8 | 8 | 21 | 21 |
| 9 | 9 | 22 | 22 |
| 10 | 10 | 23 | 23 |
| 11 | 11* | 24 | 24* |
| 12 | 12* | 25 | 26* |
| 13 | 13* | | 26* |

*Only present on the 26-Position IDC socket

## Appendix 2
### Axis Selection Jumpers

The SC125MS can be configured to act as axis 1, 2, 3, or 4 when connected to a computer's parallel port using a DB25IDC6 cable. This configuration is changed by moving jumpers on the SC125MS board. These jumpers are located just behind the large capacitor on the SC125MS circuit board. If you need to modify the jumper positions and your board is inside of an enclosure, you will need to remove the enclosure to access the jumpers.

For the step, direction, and enable signals there are 4 different jumper positions that can be used—one for each of the 4 axes. The following diagram shows the positions for the jumpers on the SC125MS for operation as axis 1, 2, 3, and 4, when connected to a PC's parallel port using a DB25IDC6 cable.

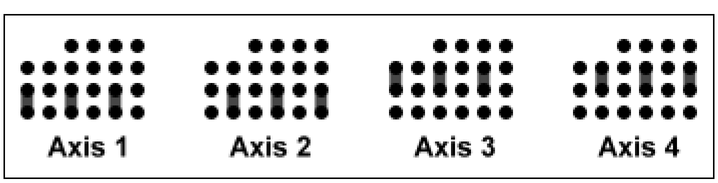



Figure 4: Axis Selection Jumper Positions

To operate up to 4 SC125MS boards from one parallel port using the DB25IDC6 cable, these jumper positions are all you need to know. However, if you would like to control the SC125MS from a device through the 20-pin IDC header with a custom configuration, the information below will show which pins of the header are connected to the various board functions for each of the jumper configurations.

There are 5 different logic inputs on the board that can be accessed through the 20-pin IDC header and axis selection jumpers. There are 4 pins in the IDC header that can connect to each of the three signals for step, direction, and enable. Also, a jumper can be used to connect pin 14 to Microstepping1, and pin 16 to Microstepping2. The following diagram shows the axis selection jumper area and the IDC header pins that can be connected to the various logic inputs using the jumpers.

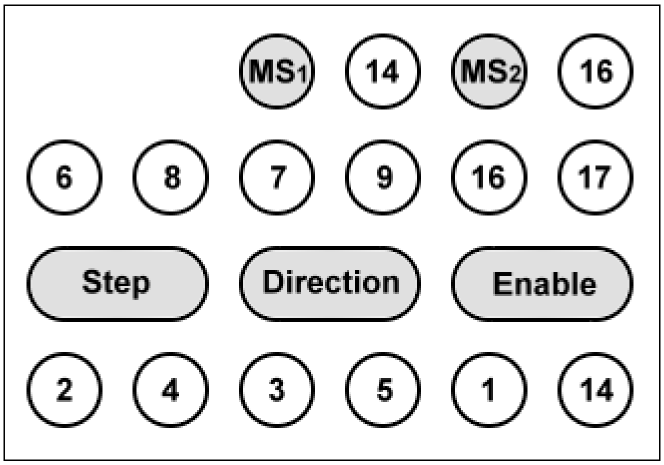



Figure 5: Axis Selection Jumper Area with 20-Pin IDC Header Pin Numbers

Also, pin 18 of the 20-pin IDC header is always connected to logic GND on the board, so the GND signal for your logic inputs must always be connected to pin 18 of your IDC connector. Pins 18-25 on a standard parallel port are GND, thus the selection of pin 18.

With the jumpers in the standard axis selection positions shown in Figure 4, the following parallel port pins would be connected to the various logic inputs on the SC125MS boards:

| Parallel Port Pin # | SC125MS Logic Input | Parallel Port Pin # | SC125MS Logic Input |
|---|---|---|---|
| 1 | Axis 1 Enable | 10 | |
| 2 | Axis 1 Step | 11 | |
| 3 | Axis 1 Direction | 12 | |
| 4 | Axis 2 Step | 13 | |
| 5 | Axis 2 Direction | 14 | Axis 2 Enable |
| 6 | Axis 3 Step | 15 | |
| 7 | Axis 3 Direction | 16 | Axis 3 Enable |
| 8 | Axis 4 Step | 17 | Axis 4 Enable |
| 9 | Axis 4 Direction | 18 | All Axes Ground |

# Appendix 3
## Current Limits Values for DIP Switch Settings

The tables on the following pages show the values that the current in the motor windings will be limited to for all possible DIP switch settings for positions 1 – 7. The first table is ordered by increasing values of current limit, so that a setting corresponding to a desired current limit can be found. The second table is ordered by increasing DIP switch settings, so that the current associated with a given DIP switch setting can be found. All of these values are calculated based on the assumption that there is an open circuit between $R_1$ and $R_2$.

Please note that the actual current limit in the motor windings is affected by many factors, and the values found in these tables are only expected values, and are not guaranteed. For optimal performance the current limit should be monitored directly on the board and motor current and temperature should not be allowed to exceed rated values.

## Current Limit Values for DIP Switch Settings, Ordered by Current Limit (I)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | I (A) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | I (A) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | I (A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.33 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0.47 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0.80 |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0.33 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0.47 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0.82 |
| 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0.34 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0.48 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0.83 |
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.34 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0.48 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0.85 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0.34 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0.49 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0.86 |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0.34 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0.49 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0.88 |
| 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0.35 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0.50 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0.89 |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0.35 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0.50 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0.91 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0.35 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0.51 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.93 |
| 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0.35 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0.51 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0.94 |
| 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0.36 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0.52 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0.97 |
| 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0.36 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0.53 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0.99 |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0.36 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0.53 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1.01 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0.36 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0.54 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1.03 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.37 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0.54 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1.05 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0.37 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0.55 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1.07 |
| 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0.37 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0.56 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1.10 |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0.38 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0.56 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1.12 |
| 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0.38 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0.57 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1.15 |
| 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0.38 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0.57 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1.17 |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0.38 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.58 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1.20 |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0.39 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0.59 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1.23 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0.39 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0.60 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1.27 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0.39 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0.60 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1.30 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0.40 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0.61 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1.33 |
| 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0.40 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0.62 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1.37 |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0.40 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0.63 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1.41 |
| 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.41 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0.64 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1.46 |
| 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0.41 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0.64 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1.50 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0.41 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0.65 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1.55 |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0.42 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0.66 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1.60 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0.42 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0.67 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1.65 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0.42 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0.68 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1.71 |
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0.43 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0.69 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1.77 |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0.43 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0.70 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1.84 |
| 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0.44 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0.71 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1.91 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0.44 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0.72 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1.99 |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0.44 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0.73 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2.07 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0.45 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0.74 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2.16 |
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0.45 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0.75 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2.26 |
| 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0.46 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0.77 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.37 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0.46 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0.78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.49 |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0.47 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0.79 | | | | | | | | |

## Current Limit Values for DIP Switch Settings, Ordered by DIP Switch Settings

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | I (A) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | I (A) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | I (A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.49 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0.39 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0.67 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.58 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1.07 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0.36 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0.94 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0.44 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1.50 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0.42 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0.63 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0.50 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1.37 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0.34 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0.75 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0.49 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1.91 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0.38 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0.72 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0.54 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1.01 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0.37 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0.85 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0.43 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1.77 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0.40 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0.60 |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0.53 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1.17 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0.34 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0.82 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0.46 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2.16 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0.39 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0.66 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0.56 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1.12 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0.35 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0.89 |
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0.45 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1.46 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0.41 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0.64 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0.50 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1.27 |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0.35 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0.74 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0.47 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2.07 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0.38 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0.69 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0.56 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0.99 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0.36 |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0.88 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0.43 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1.60 |
| 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.41 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0.60 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0.51 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1.23 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0.33 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0.78 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0.47 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.37 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0.38 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0.68 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0.57 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1.05 |
| 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0.36 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.93 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0.44 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1.55 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0.42 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0.62 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0.51 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1.33 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0.34 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0.77 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0.48 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1.84 |
| 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0.38 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0.71 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0.54 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1.03 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.37 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0.83 |
| 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0.44 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1.71 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0.40 |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0.61 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0.53 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1.15 |
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.34 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0.80 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0.46 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2.26 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0.39 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0.65 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0.57 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1.10 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0.35 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0.91 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0.45 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1.41 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0.41 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0.64 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0.49 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1.30 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0.35 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0.73 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0.48 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1.99 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0.37 |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0.70 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0.55 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0.97 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0.36 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0.86 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0.42 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1.65 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0.40 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0.59 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0.52 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1.20 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.33 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0.79 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0.47 | | | | | | | | |