

This is the Revision B version of the [Stepper1 RoboBrick](#). The status of this project is [work in progress](#).

Stepper1 Robobrick (Revision B)

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1. Introduction

The Stepper1 RoboBrick allows for the control of 1 small bipolar or unipolar stepper motor.

2. Programming

The Stepper1 RoboBrick is used to control a single bipolar or unipolar stepper motor. There are a number of variables inside the Stepper1 RoboBrick:

There are three wave tables:

Wave Drive					
LSB's					
	A	B	C	D	
1	0				
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Wave drive is the easiest to understand since it only activates one coil at a time.

Two Phase					
LSB's					
	A	B	C	D	
1	0				
0	0	1	1	0	0
0	1	0	1	1	0
1	0	0	0	1	1
1	1	1	0	0	1

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Two phase drive provides double the torque over Wave Drive (at double the power consumption.) This is accomplished by always having two coils activated at the same time.

Half Step								
LSB's			A	B	C	D		
2	1	0						
0	0	0	1	0	0	0	0	0
0	0	1	1	1	0	0	0	0
0	1	0	0	1	0	0	0	0
0	1	1	0	1	1	0	0	0
1	0	0	0	0	1	0	0	0
1	0	1	0	0	1	1	0	0
1	1	0	0	0	0	0	1	0
1	1	1	1	0	0	0	1	0

Half step mode provides twice the resolution by alternating between activating only one coil and activating two coils. When both coils are on, the power consumption (and torque) is twice that of when only one coil is on.

The simplest usage of the Stepper1 RoboBrick is to set the wave table and the slow rate. All rates are measured in units of ticks which are .139 milliseconds ($= 1/(3 \times 2400)$) long. The slow rate specifies the number of ticks between each step. The desired position can be increased to cause stepping to occur in a clockwise direction and decreased to cause counter-clockwise stepping.

In order to improve slew rates, the user can specify some additional variables to support speed ramp up and ramp down. This involves specifying a maximum step rate, a ramp rate, and ramp amount. The maximum step rate and the ramp amount are measured in ticks (.139ms) and the ramp rate is measured in steps.

For example, suppose a stepper motor has a slow step rate of 100 ticks (= 13.9ms) and a fast step rate of 50 ticks (6.9ms). If it can accelerate by 2 ticks every third step, the ramp rate is set to 3 and the ramp amount is set to 4.

There is a complement mask that is used to invert specific bits of the output value. A power down bit is used to power down the stepper coils when the stepper motor is not moving.

The Stepper1 RoboBrick implements the [RoboBrick Interrupt Protocol](#). The interrupt pending bit is set whenever the stepper motor is not being moved. {This may change.}

The Stepper1 RoboBrick commands are summarized in the table below:

Command	Send/ Receive	Byte Value								Discussion
		7	6	5	4	3	2	1	0	
Increment Desired	Send	0	0	0	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	Increment Desired Counter by <i>iiii</i> .
Decrement Desired	Send	0	0	1	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	Increment Desired Counter by <i>dddd</i> .
Set Desired High	Send	0	1	0	0	0	0	0	0	Set high order 8-bits of desired

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	Send	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	counter to <i>hhhhhhhh</i>
Set Desired Low	Send	0	1	0	0	0	0	0	1	Set high order 8–bits of desired counter to <i>lllllll</i> and start stepping.
	Send	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Set Current High	Send	0	1	0	0	0	0	1	0	Set high order 8–bits of current counter to <i>hhhhhhhh</i>
	Send	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	
Set Current Low	Send	0	1	0	0	0	0	1	1	Set high order 8–bits of current counter to <i>lllllll</i>
	Send	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Set Slow Rate	Send	0	1	0	0	0	1	0	0	Set slow step rate to <i>ssssssss</i> .
	Send	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	
Set Fast Rate	Send	0	1	0	0	0	1	0	1	Set fast step rate to <i>ffffffff</i> .
	Send	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	
Set Ramp Rate	Send	0	1	0	0	0	1	1	0	Set ramp step rate to <i>ffffffff</i> .
	Send	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	
Set Ramp Amount	Send	0	1	0	0	0	1	1	1	Set ramp amount to <i>aaaaaaaa</i> .
	Send	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	
Read Desired High	Send	0	1	0	0	1	0	0	0	Read high order 8–bits of desired counter <i>hhhhhhhh</i> .
	Receive	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	
Read Desired Low	Send	0	1	0	0	1	0	0	1	Read low order 8–bits of desired counter to <i>lllllll</i> .
	Receive	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Read Current High	Send	0	1	0	0	1	0	1	0	Read high order 8–bits of current counter <i>hhhhhhhh</i>
	Receive	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	
Read Current Low	Send	0	1	0	0	1	0	1	1	Read high order 8–bits of current counter to <i>lllllll</i>
	Receive	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Read Slow Rate	Send	0	1	0	0	1	1	0	0	Read slow step rate <i>ssssssss</i> .
	Receive	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	
Read Fast Rate	Send	0	1	0	0	1	1	0	1	Read fast step rate <i>ffffffff</i> .
	Receive	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	
Read Ramp Rate	Send	0	1	0	0	1	1	1	0	Read ramp rate <i>rrrrrrrr</i> .
	Receive	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>	
Read Ramp Amount	Send	0	1	0	0	1	1	1	1	Read ramp amount <i>aaaaaaaa</i> .
	Receive	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	
Set Complement Mask	Send	0	1	0	1	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	Set complement mask to <i>cccc</i> .
Set Wave Table	Send	0	1	1	0	0	0	<i>w</i>	<i>w</i>	Set wave table to <i>ww</i> .
Set Deneergize Bit	Send	0	1	1	0	0	1	0	<i>e</i>	Set the deneergize bit to <i>e</i> .
Read Deneergize Bit	Send	0	1	1	0	0	1	1	0	Read the deneergize bit to <i>e</i> .
	Receive	0	0	0	0	0	0	0	<i>e</i>	
Read Wave Table	Send	0	1	1	0	0	1	1	1	Read wave table <i>ww</i> .
	Receive	0	0	0	0	0	0	<i>w</i>	<i>w</i>	
Set Desired	Send	0	1	1	0	1	0	0	0	Set desired counter to <i>hhhhhhhh</i> <i>lllllll</i> and start stepping.
	Send	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	

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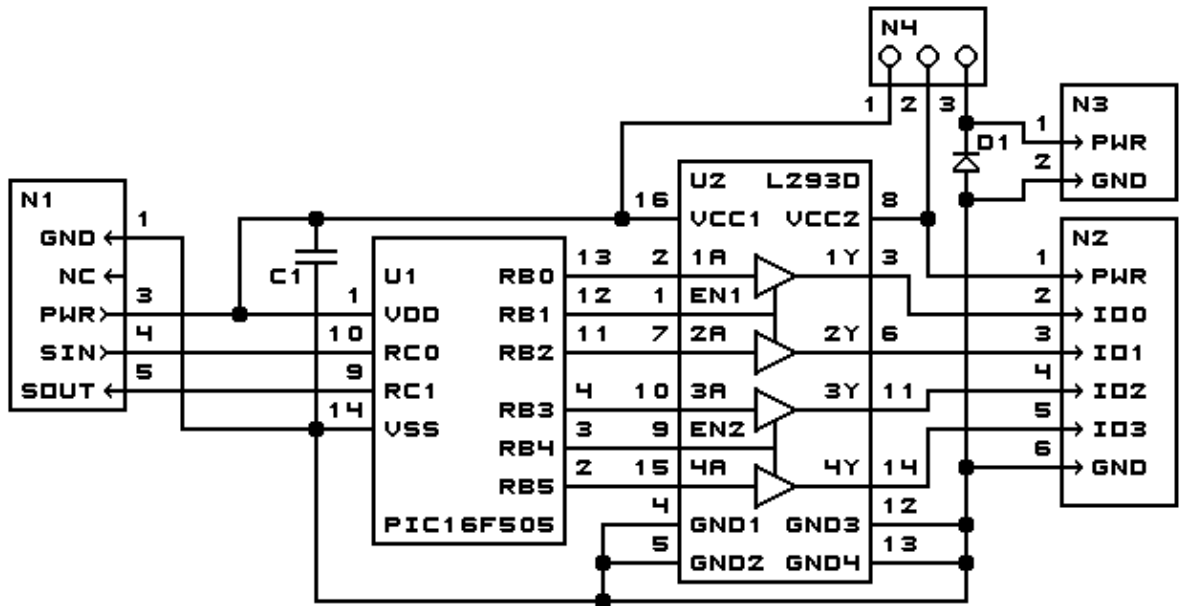
	Send	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Set Current	Send	0	1	1	0	1	0	0	1	Set current counter to <i>hhhhhhhh</i> <i>lllllll</i> .
	Send	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	
	Send	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Read Desired	Send	0	1	1	0	1	0	1	0	Read desired counter <i>hhhhhhhh</i> <i>lllllll</i> .
	Receive	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	
	Receive	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Read Current	Send	0	1	1	0	1	0	1	1	Read current counter <i>hhhhhhhh</i> <i>lllllll</i> .
	Receive	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	
	Receive	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Read Complement Mask	Send	0	1	1	0	1	1	0	0	Read complement mask <i>ccccccc</i>
	Receive	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	
Reset	Send	0	1	1	0	1	1	0	1	Emergency Reset
Stop	Send	0	1	1	0	1	1	1	0	Immediately ramp the stepper motor to a stop.
Read Interrupt Bits	Send	1	1	1	0	1	1	1	1	Return the interrupt pending bit <i>p</i> and the interrupt enable bit <i>e</i> .
	Receive	0	0	0	0	0	0	<i>e</i>	<i>p</i>	
Set Interrupt Commands	Send	1	1	1	1	0	<i>c</i>	<i>c</i>	<i>c</i>	Set Interrupt Command <i>ccc</i> .
Shared Commands	Send	1	1	1	1	1	<i>c</i>	<i>c</i>	<i>c</i>	Execute common shared command <i>ccc</i>

3. Hardware

The hardware consists of a circuit schematic and a printed circuit board.

3.1 Circuit Schematic

The schematic for the Stepper1 RoboBrick is shown below:



STEPPER1 ROBOBRICK MODULE (REV. B)
 COPYRIGHT (C) 2000-2001 -- WAYNE C. GRAMLICH

The parts list kept in a separate file -- [stepper1.ptl](#).

3.2 Printed Circuit Board

[stepper1_back.png](#)

The solder side layer.

[stepper1_front.png](#)

The component side layer.

[stepper1_artwork.png](#)

The artwork layer.

[stepper1.gbl](#)

The RS-274X "Gerber" back (solder side) layer.

[stepper1.gtl](#)

The RS-274X "Gerber" top (component side) layer.

[stepper1.gal](#)

The RS-274X "Gerber" artwork layer.

[stepper1.drl](#)

The "Excellon" NC drill file.

[stepper1.tol](#)

The "Excellon" NC drill rack file.

4. Software

There is no software yet.

5. Issues

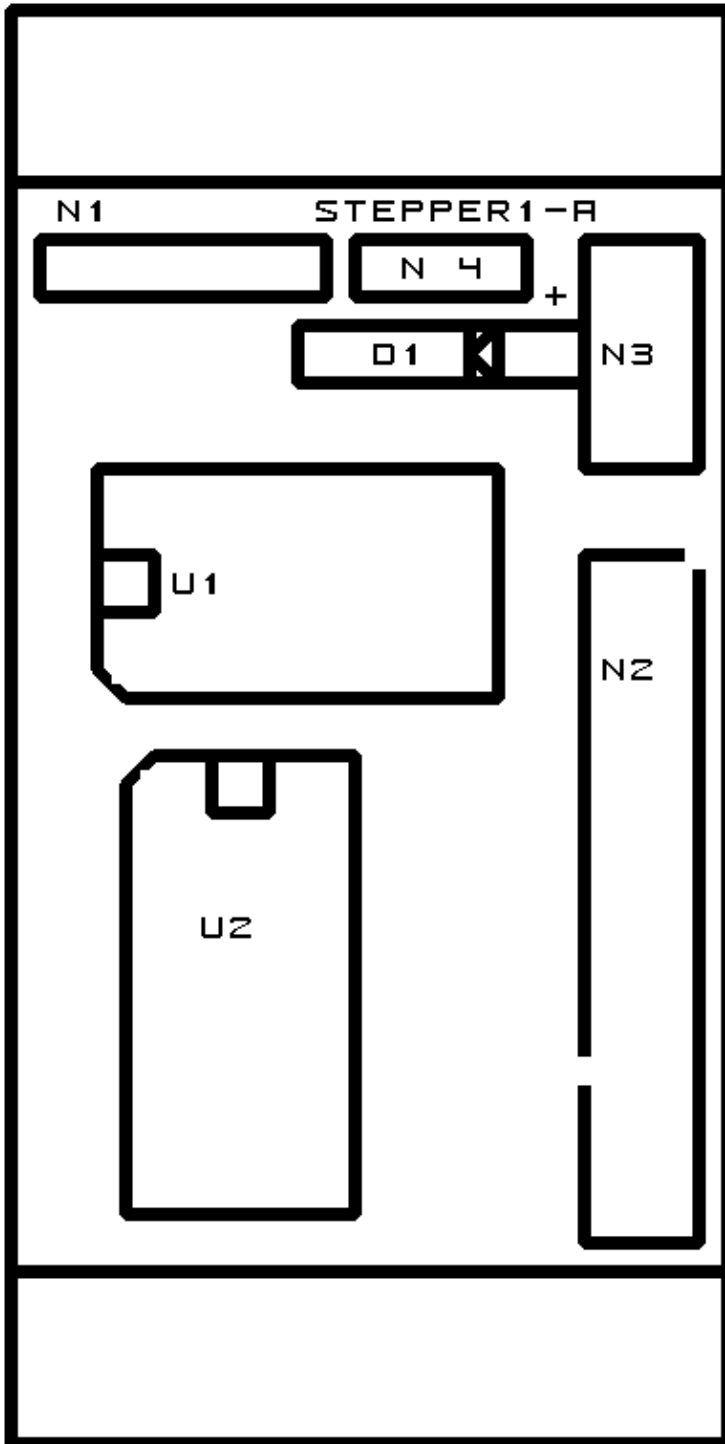
Any fabrication problems are listed here.

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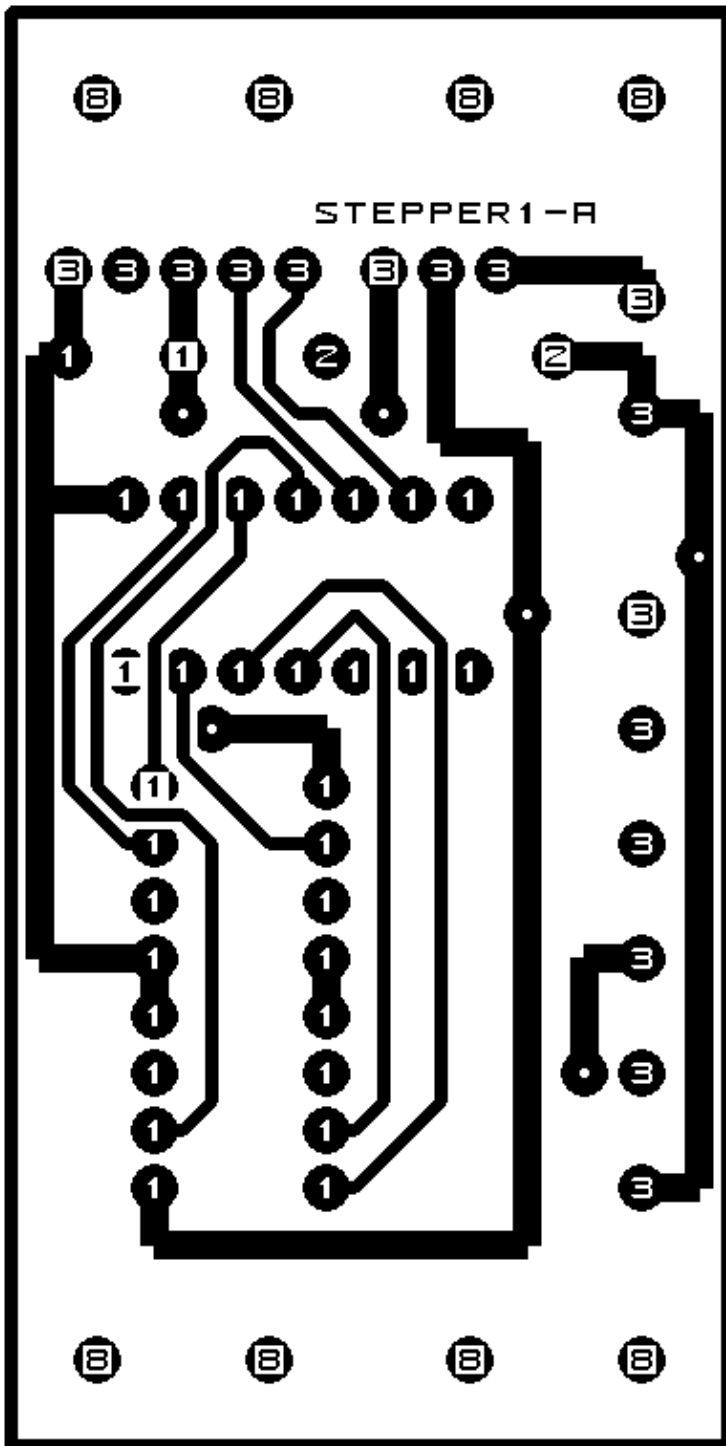
A. Appendix A: Parts List

```
# Parts list for Stepper1 RoboBrick (Rev. B)
#
C1: Capacitor10pF - 10 pF Ceramic Capacitor [Jameco: 15333]
C2: Capacitor2200uF - 2200 uF 6.3V Electrolytic Capacitor [Jameco: 133145]
D1: 1N5400 - 1N5400 Diode [Jameco: 77075]
N1: Header1x5.RBSlave - 1x5 Male Header[5/40 Jameco: 160881]
N2: TerminalStrip6.Stepper1 - 6 terminal terminal strip [2 Jameco: 189667]
N3: TerminalStrip2.Stepper1 - 2 terminal terminal strip [Jameco: 189675]
N4: Header1x3.Stepper1 - 1x3 Male Header [3/40 Jameco: 160881]
U1: PIC16C505.Stepper1 - Microchip PIC16C505 [Digikey: PIC16C505-04/P-ND]
U2: L293D - Dual H-Bridge [Digikey: 296-9518-5-ND]
```


B. Appendix B: Artwork Layer



C. Appendix C: Back (Solder Side) Layer



D. Appendix D: Front (Component Side) Layer

