This is the Revision A version of the Stepper1 RoboBrick. The status of this project is that it has been replaced by the revision B version.

Stepper1 Robobrick (Revision A)

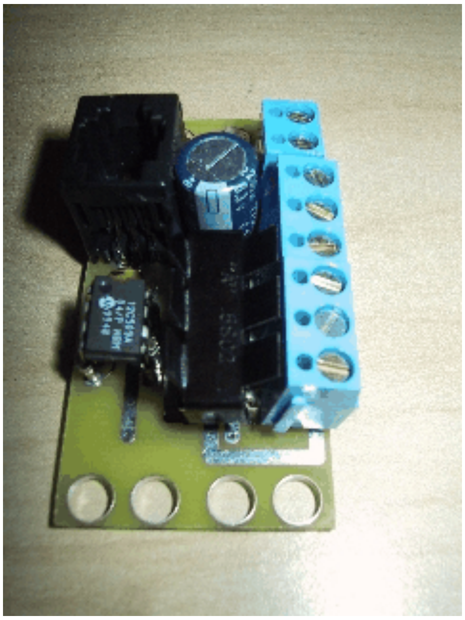
Table of Contents

This document is also available as a PDF document.

1. Introduction

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

A picture of a Stepper1−A RoboBrick is shown below:



2. Programming

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

Current Position (16−bits)
: The current position of the stepper motor.

Desired Position (16−bits)
The desired position of the steppper motor.

Wave Table (2−bits)
The wave table variable selects between Wave Drive, Two Phase, and Half Step modes.

Slow Rate (8−bits)
The number of ticks between steps when the motor is stepping at its slowest.

Fast Rate (8−bits)
The number of ticks between steps when the motor is stepping at its fastest. Fast rate is always less or equal to slow rate.

Ramp Rate (8−bits)
The number of steps between changes in the current rate (i.e. during ramping.)

Ramp Amount (8−bits)
The number of ticks to adjust the current rate by at each ramp adjustment point.

Complement Mask (4−bits)
The complement mask can toggle individule bits of the output.

Power Down Mode (1−bit)
When stepper motor is not being moved, deenergize the coils.

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

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	1	1	1	0	0

0	1	0	0	1	0	0
0	1	1	0	1	1	0
1	0	0	0	0	1	0
1	0	1	0	0	1	1
1	1	0	0	0	0	1
1	1	1	1	0	0	1

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 × 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 accellerate 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*	Increment Desired Counter by *iiiii*.
Decrement Desired	Send	0	0	1	*d*	*d*	*d*	*d*	*d*	Increment Desired Counter by *ddddd*.
Set Desired High	Send	0	1	0	0	0	0	0	0	Set high order 8−bits of desired counter to *hhhhhhhh*
	Send	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	
Set Desired Low	Send	0	1	0	0	0	0	0	1	Set high order 8−bits of desired counter to *llllllll* and start stepping.
	Send	*l*	*l*	*l*	*l*	*l*	*l*	*l*	*l*	
Set Current High	Send	0	1	0	0	0	0	1	0	Set high order 8−bits of current counter to *hhhhhhhh*
	Send	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	
Set Current Low	Send	0	1	0	0	0	0	1	1	Set high order 8−bits of current counter to *llllllll*
	Send	*l*	*l*	*l*	*l*	*l*	*l*	*l*	*l*	

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

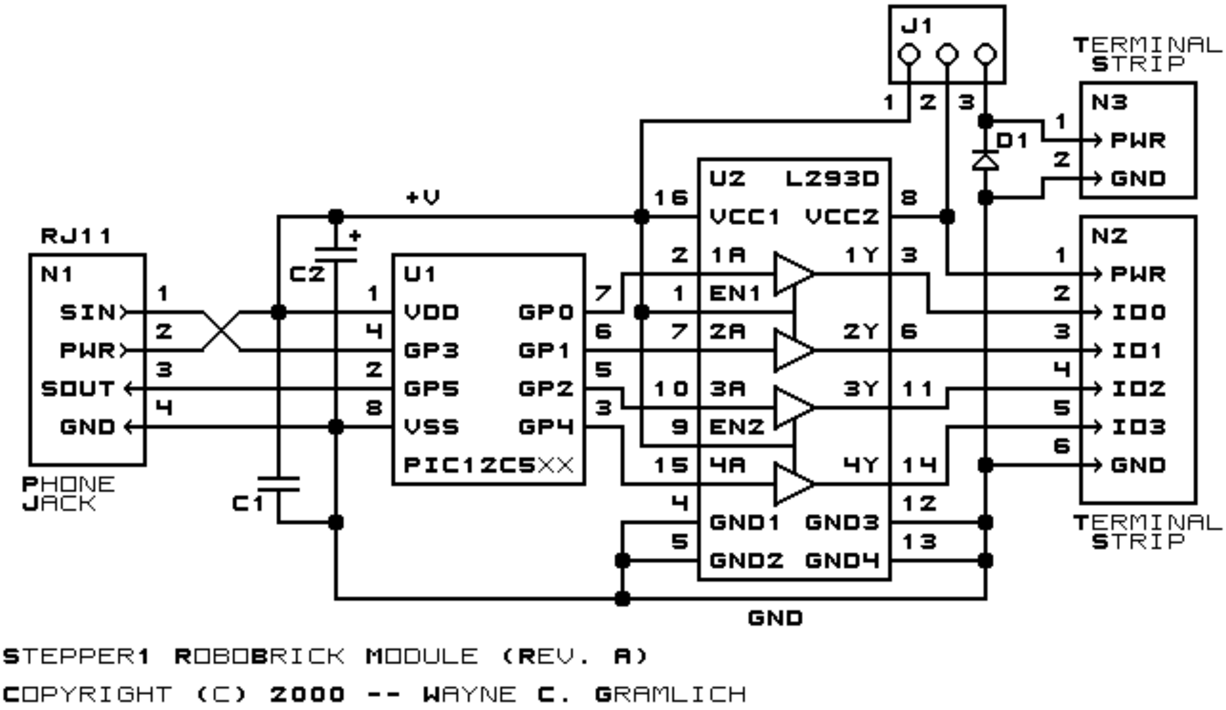
	Receive	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	Read current counter *hhhhhhhh llllllll*.
	Receive	*l*	*l*	*l*	*l*	*l*	*l*	*l*	*l*	
Read Complement Mask	Send	0	1	1	0	1	1	0	0	Read complement mask *cccccccc*
	Receive	*c*	*c*	*c*	*c*	*c*	*c*	*c*	*c*	
Reset	Send	0	1	1	0	1	1	0	1	Emergency Reset
Stop	Send	0	1	1	0	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 *p* and the interrupt enable bit *e*.
	Receive	0	0	0	0	0	0	*e*	*p*	
Set Interrupt Commands	Send	1	1	1	1	0	*c*	*c*	*c*	Set Interrupt Command *ccc*.
Shared Commands	Send	1	1	1	1	1	*c*	*c*	*c*	Execute common shared command *ccc*

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:



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

The Stepper1 software is available as one of:

stepper1.ucl
  The µCL source file.
stepper1.asm
  The resulting human readable PIC assembly file.
stepper1.lst
  The resulting human readable PIC listing file.
stepper1.hex
  The resulting Intel® Hex file that can be fed into a PIC12C5xx programmer.

5. Issues

The following issues have come up:

- The terminal strip holes are too small.
- Swap U1 and U2 so the heat sink on U2 does not interfer with N2.

A. Appendix A: Parts List

```
# Parts list for Stepper1 RoboBrick (Rev. A)
#
C1: Capacitor10pF − 10 pF Ceramic Capacitor [Jameco: 15333]
C2: Capacitor2200uF − 2200 uF 6.3V Electrolytic Capacitor [Jameco: 133145]
D1: 1N5400 − 1N5400 Diode [Jameco: 77075]
J1: Header1x3.Stepper1 − 1x3 Male Header [3/40 Jameco: 160881]
N1: RJ11Female4_4.RBSlave − Female RJ11 (4−4) Phone Jack [Digikey: A9071−ND]
N2: TerminalStrip6.Stepper1 − 6 terminal terminal strip [2 Jameco: 189667]
N3: TerminalStrip2.Stepper1 − 2 terminal terminal strip [Jameco: 189675]
U1: PIC12C509.Stepper1 − Microchip PIC12C509 [Digikey: PIC12C509A−04/P−ND]
U2: L293D − Dual H−Bridge [Digikey: 296−9518−5−ND]
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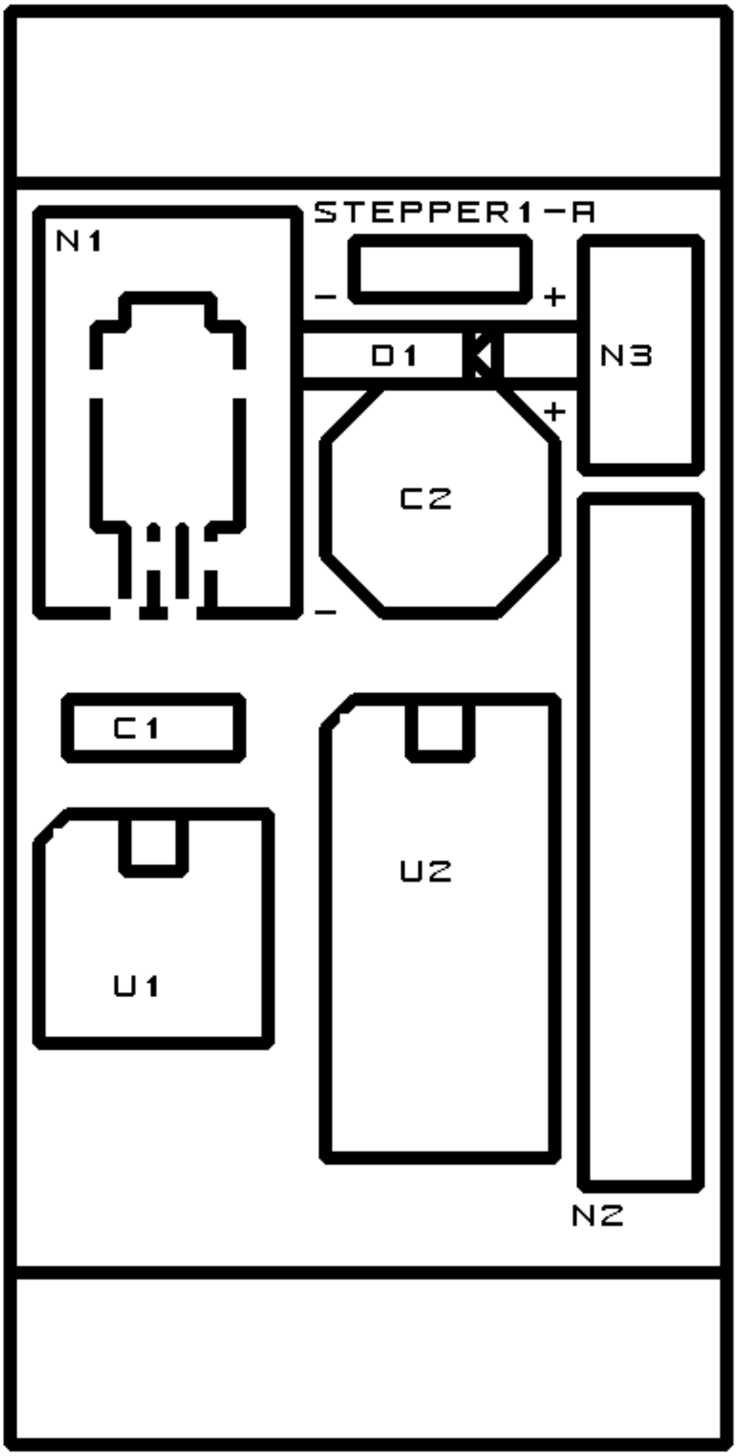
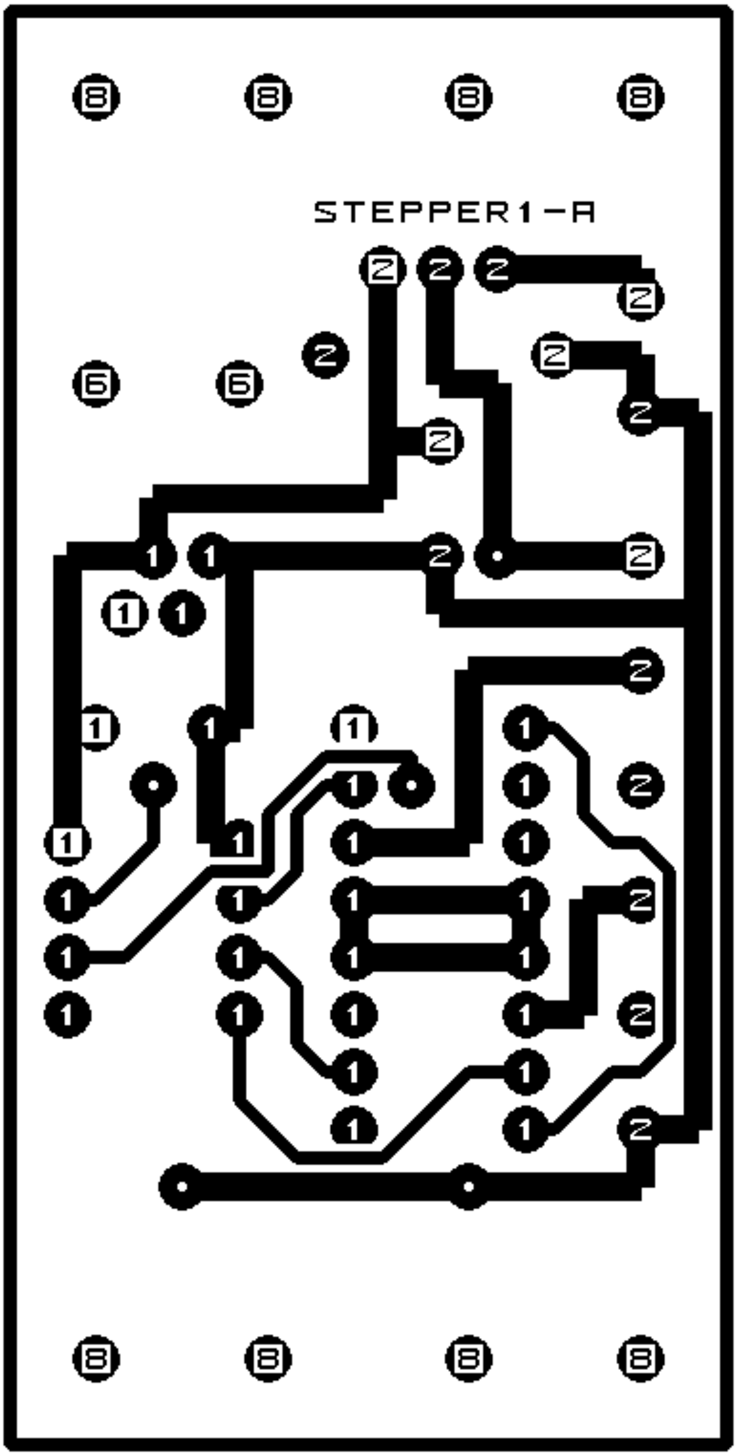
B. Appendix B: Artwork Layer



C. Appendix C: Back (Solder Side) Layer



D. Appendix D: Front (Component Side) Layer