This is the Revision J version of the Servo4 module. The status of this project is finished.

Servo4 Module (Revision J)

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This document is also available as a PDF document.

1. Introduction

The Servo4 module allows for the control of up to 4 hobby grade servos. It can be configured as follows:

Pure Servo Mode
: In pure servo mode, it is expected that up to 4 unmodified servos are attached to the board. The four servos can be independently controlled. There is current feedback on all four servos.

Differential Steering Mode
: In differential steering mode, the module can control up to 4 servos. The first two servos are expected to be servos that have modified been for continuous rotation. The second two servos are regular unmodified servos. The first two servos have current feedback and the second two servos do not. There are two trim pots that are used to set the no rotation condition for the first two servos.

As you can see, this board is quite flexible. Please see the section on Hardware Configuration to see how the jumpers are set for each configuration.

2. Hardware Configuration

Up to four RC servos are connected to connectors N2 (servo 0) through N5 (servo3). Each connector has the following pin definitions:

Pin	Location	Description
1	Right	Servo control signal (varies between 0 and 5 volts)
2	Center	5 Volts
3	Left	Ground (0 Volts)

On many servos, the black wire is the ground wire. You will have to check you servo documentation to be absolutely sure though.

The connection to the controlling module occurs via N1 in the upper left corner.

Power for the servos comes from N9, the blue two terminal connector in the upper right corner. Connect a power source of 6−9 volts to connector N9, where the upper terminal is the positive terminal ('+') and the the lower terminal is negative ('−').

The hardware configuration for each mode is summarized in the table below:

Mode	**Jumpers**			**Trim Pots**		**LED**
	N7	**N8**	**N10**	**R4**	**R5**	**D1**
Pure Servo Mode	Right (2−3)	Right (2−3)	Down (2−3)	Unused	Unused	Off
Differential Steering Mode	Left (1−2)	Left (1−2)	Down (2−3)	Servo 0 Stop	Servo 1 Stop	Off
Differential Steering Calibration Mode	Left (1−2)	Left (1−2)	Up (1−2)	Servo 0 Stop	Servo 1 Stop	On

In differential steering calibration mode, N10 is jumpered upward and it causes yellow LED D1 to light. It causes both servos 0 and 1 to be enabled. The value of trim pot R5 to be sent to servo 0 and trim pot R6 to be sent to servo 1. The purpose of calibration mode is to allow you to adjust the two modified servos that are connected to servo 0 and servo 1 and adjust them until they stop rotating. This frees the programmer from having to experiment to find the `position' number for each servo that corresponds to each servo being motionless. The values of the stop value are read out using the Read Current Draw command for servo 2 and 3.

3. Programming

The Servo4 module can independently control up to 4 servos. Servo position is strictly a function of pulse width. The user can configure the Servo4 emit a wide range of pulse widths from 1µS to 4095µS. Most servos run up against a mechanical limit on the low end around 400S and the other mechanical limit around 2600µS. Each servo has computes width of its output pulse using following formula:

$$W = (BH * 256) + BL + P * S/16 + F$$

where

BH (0−255)
: BH is the high 8−bits of the base (i.e. minimum) pulse width.

BL (0−255)
: BL is the low 8−bits of the base (i.e. minumum) pulse width

P (0−255)
: P is the servo position represented as 8−bit number between 0 and 255.

S (0−255)
: S is the scale factor represented as an 8−bit number that is divided by 16. Thus the scale can be 0 to 15−15/16.

F (0−255)
: F is a final fine positioning number that is added to pulse width.

In addition, each servo has an enable bit. Since so many people use modified servos for robot drive gear motors, the servos are initialized to the *off* position.

The Servo4 commands are summarized in the table below:

Command	Send/ Receive	Byte Value								Discussion
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Set Base Low	Send	0	0	0	0	0	0	*s*	*s*	Set the low 8−bits of the minimum pulse width time (measured in µS) to *llll llll*.
	Send	*l*	*l*	*l*	*l*	*l*	*l*	*l*	*l*	
Set Base High	Send	0	0	0	0	0	1	*s*	*s*	Set the high 8−bits of the minimum pulse width time (measured in µS) for servo *ss* to *hhhh hhhh*.
	Send	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	
Set Position	Send	0	0	0	0	1	0	*s*	*s*	Set the position for servo *ss* to *pppp pppp*.
	Send	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	
Set Scale	Send	0	0	0	0	1	1	*s*	*s*	Set the scale for servo *ss* to *iiii*.ffff (i.e. *iiii + ffff/16.)*
	Send	*i*	*i*	*i*	*i*	*f*	*f*	*f*	*f*	
Read Base Low	Send	0	0	0	1	0	0	*s*	*s*	Read the low 8−bits of the minimum pulse width time (measured in µS) as *llll llll*.
	Send	*l*	*l*	*l*	*l*	*l*	*l*	*l*	*l*	
Read Base High	Send	0	0	0	1	0	1	*s*	*s*	Read the high 8−bits of of the minimum pulse width (measured in µS) for servo *ss* as *hhhh hhhh*.
	Send	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	
Read Position	Send	0	0	0	1	1	0	*s*	*s*	Read the position for servo *ss* as *pppp pppp*.
	Send	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	
Read Scale	Send	0	0	0	1	1	1	*s*	*s*	Read scale for servo *ss* as *iiii*.ffff (i.e. *iiii + ffff/16.)*
	Send	*i*	*i*	*i*	*i*	*f*	*f*	*f*	*f*	
Set High	Send	0	1	*h*	*h*	*h*	*h*	*s*	*s*	Set high order 4 bits of servo *ss* to *hhhh* and set the remaining 4 low order bits to zero.
Set Low	Send	1	0	*l*	*l*	*l*	*l*	*s*	*s*	Set the low order 4 bits of servo *ss* position to *llll*.
Set Enable and Position	Send	1	1	0	0	0	*e*	*s*	*s*	Select servo *ss* and set its position to *ppppppp* and enable flag to *e*.
	Send	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	
Set Enable Flag Only	Send	1	1	0	0	1	*e*	*s*	*s*	Select servo *ss* and set its enable flag to *e*.
Read Position	Send	1	1	0	1	0	0	*s*	*s*	Return the current position *pppppppp* for servo *ss*.
	Receive	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	
Read Enable	Send	1	1	0	1	0	1	*s*	*s*	Return the enable bit *e* for servo *ss*.
	Receive	0	0	0	0	0	0	0	*e*	
Read Enables	Send	1	1	0	1	1	0	0	0	Return the enable flags *eeee* for all four servos.
	Receive	0	0	0	0	*e*	*e*	*e*	*e*	
Set Enables	Send	1	1	0	1	1	0	0	1	Set enable flags for all four servos to *eeee*.
	Send	0	0	0	0	*e*	*e*	*e*	*e*	
Read Current Draw	Send	1	1	0	1	1	1	*s*	*s*	Return the *aaaaaaaa* current draw for servo *ss*.
	Receive	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	
Shared Commands	Send	1	1	1	1	1	*c*	*c*	*c*	Execute shared command *ccc*.

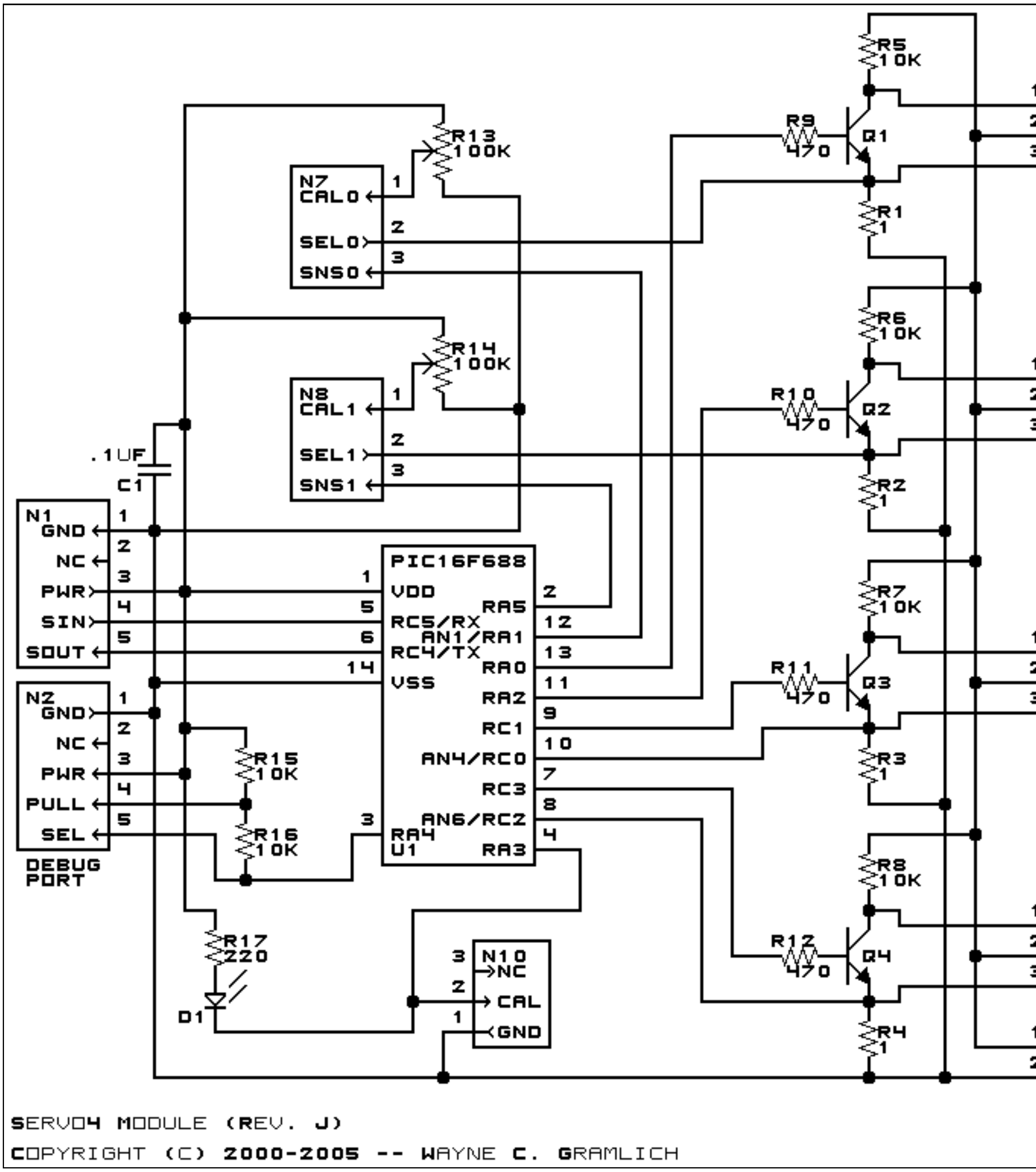
The Servo4 module does *not* know the minimum and maximum extent for each servo. This has to be determined by experimentation.

4. Hardware

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

4.1 Circuit Schematic

The schematic for the Servo4 module is shown below:



The parts list kept in a separate file −− servo4.ptl.

4.2 Printed Circuit Board

The printed circuit board files are listed below:

servo4_back.png
The solder side layer is shown below:

servo4_front.png
The component side layer is shown below:
servo4_artwork.png
The artwork layer is shown below
servo4.gbl
The RS−274X "Gerber" back (solder side) layer.
servo4.gtl
The RS−274X "Gerber" top (component side) layer.
servo4.gal
The RS−274X "Gerber" artwork layer.
servo4.drl
The "Excellon" NC drill file.
servo4.tol
The "Excellon" tool rack file.

5. Software

The Servo4 software is available as one of:

servo4.ucl
The µCL source file.
servo4.asm
The resulting human readable PIC assembly file.
servo4.lst
The resulting human readable PIC listing file.
servo4.hex
The resulting Intel® Hex file.

6. Issues

The following issues need to be dealt with:

- The feedback sensor for servo 1 is connected to U2 pin 2, which is not an A/D pin. Sheesh!
- Connectors N7 and N8 should have pin 2 running to the microcontroller (U1), not pin 3.
- The commands are not very regular any more. Think about rearranging the commands.