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# Parallax Servo Controller (#28023) – Rev B

## 16-Channel Servo Control with Ramping

### Introduction

Robots, robots, robots; and, the bigger they get, the more servos and I/O are required to enable them to fulfill their duties. The Parallax Servo Controller, PSC, controls up to 16 servos, and may be networked together so that two PSCs can control 32 servos using a single I/O line.

The PSC manages all of the servo pulses so your host controller doesn't have to. Additionally, the ramping function allows you to individually set the speed of each servo. With ramping, you can tell the servo where to go, and just how fast to get there. The result is true, "set-it and forget-it" functionality.

### Packing List

Verify that your Parallax Servo Controller is complete in accordance with the list below:

- Parallax Servo Controller
- Shunt-Jumper
- 3-Conductor Cable
- Documentation

### Features

- Runtime Selectable Baud rate. A serial message switches the baud rate from: 2400 to 38k4.
- 16 Servos. Servos driven simultaneously, continuously, 0-180° of rotation, 2uS resolution.
- Servo Ramping. Choose one of 63 ramp rates for each servo.
- Position Reporting. User may request position of an individual servo at any time.
- Network Ready. Two modules may be linked together to drive 32 servos at the same time.

### Before You Begin

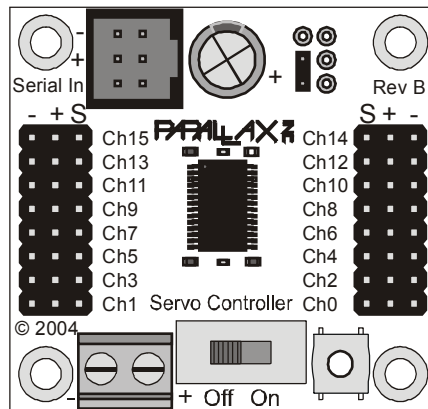


**The processor used on the PSC requires a supply 5 VDC. Use a separate power supply for your servos. In general, servos require 4-7.5 VDC. Be sure that the servo power source can supply ample current at the proper voltage and will not damage the servos.**

## Getting Started

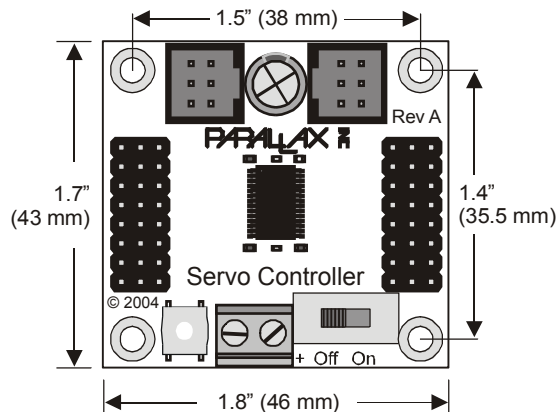
Locate and remove the Parallax Servo Controller from its protective anti-static bag. It should closely resemble the image shown in **Figure 1**.

**Figure 1: Parallax Servo Controller – Rev B**



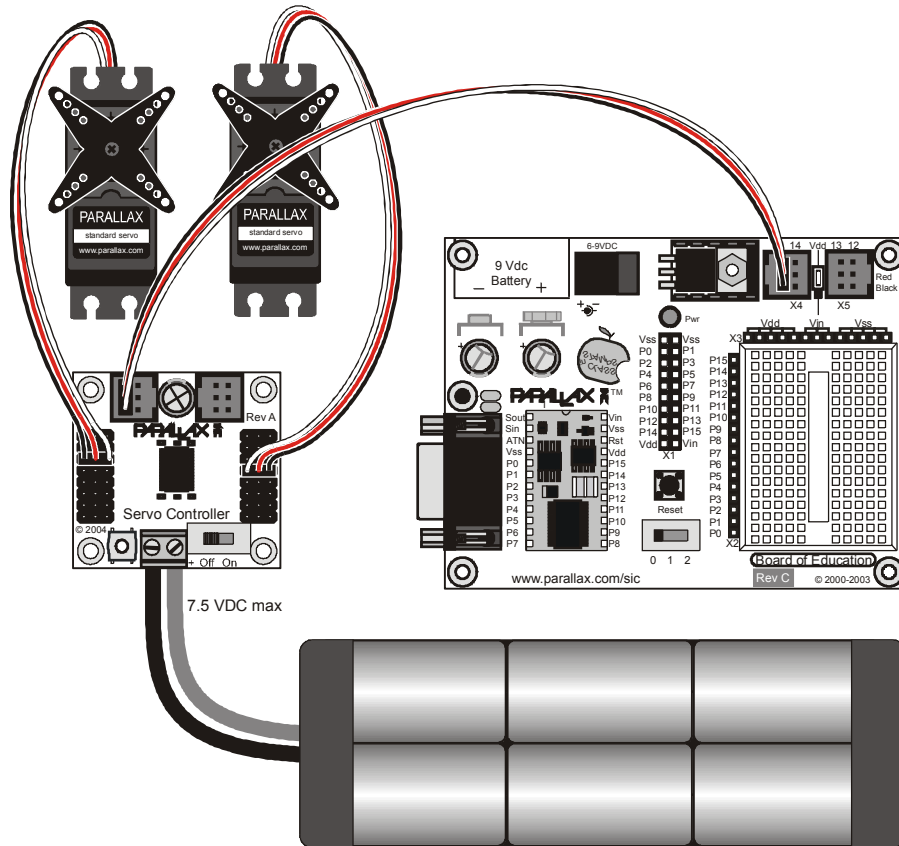
Mount the Parallax Servo Controller using 4-40 screws (or equivalent). **Figure 2** details the mounting-hole spacing and other dimensions of the PSC Rev A, which are the same for the Rev B board as well.

**Figure 2: Parallax Servo Controller Mounting Holes**



Ensure the servo power switch on the Parallax Servo Controller is off, and then connect the power source for the servos to the screw terminals observing proper polarity. **The power source for the servos must be a separate power source from that of the Board of Education Rev C.** This document assumes the host system is a BS2 module plugged into a Board of Education Rev C from Parallax, though those items are not required for proper operation. A three-conductor cable (included) connects the Ground, +5VDC, and serial I/O line to the host system. If you are not using the Rev C BOE, connect the wires of the three-conductor cable to VSS (black), +5VDC (red), and the I/O pin of your choice on your host system. Note the I/O pin number on the BOE that is connected as the serial I/O line on the PSC. This document assumes you have connected this cable into X4, slot 15. Ensure that the Vservo jumper selector, (between X4 and X5 on the BOE Rev C), is set to the VDD position. Connect your servos to the 3 pin terminals provided. Figure 3 is an example showing the Parallax Servo Controller connected to two servos and the Board of Education.

**Figure 3: Parallax Servo Controller, typical Connections.**



Follow the instructions in this document when making connections to the PSC. To power up your PSC, slide the power switch on the BOE to the "2" position. You should see the red LED illuminate on the PSC as well as the green LED light on the BOE.

### Serial Command Format

The PSC supports several commands that are sent to it via RS-232 serial protocol. The voltage swing of this serial line is 0-5 VDC (TTL level). Each serial command must be preceded with an exclamation point, "!", and the pair of letters, "SC".

When your PSC starts up, the default baudrate is 2400 N 8 2, (no parity, eight data bits, two stop bits) true data, open-drain (driven low, pulled high). The exclamation point is used in some AppMods to determine the incoming baudrate, thereby supporting a feature called Auto-Baud. The PSC does not support Auto-Baud. The "SC" portion is an identifier that pertains to the PSC. Together, the "!" and the "SC" form a preamble, "!SC". The preamble serves to distinguish commands for the PSC from other messages on the serial I/O line, and allow different types of AppMods to use the same serial line.

After the preamble is sent, the command and associated parameters are sent. The eighth and final character sent is a \$0D, (CR), used to terminate the string. If the command causes the PSC to reply, a three-byte reply is sent after a 1.5 mS delay.

## VER? Command – Identify Firmware Version Number

Syntax: "!SCVER?" \$0D

Reply: "1.3"

The VER? command causes the PSC to reply with its firmware version number. A string terminator, \$0D, must follow each command; note that you may use the constant CR instead. The version number divulged pertains to the version of firmware contained within the IC. The following code snippet can be used to find and identify your PSC.

```
'{$PBASIC 2.5}
Sdat          PIN      15          ' Serial Data I/O pin
Baud          CON      396         ' Constant for 2400 baud
buff          VAR      Byte(3)     ' temporary variable

FindPSC:      ' Find and get the version
  DEBUG "Finding PSC", CR          ' number of the PSC.
  SEROUT Sdat, Baud+$8000, ["!SCVER?",CR]
  SERIN  Sdat, Baud, 500, FindPSC, [STR buff\3]
  DEBUG "PSC ver: ", buff(0), buff(1), buff(2), CR
  STOP
```

Within the DEBUG window, you will see a series of "Finding PSC" messages. The Stamp should find the unit immediately. This is evidenced by the PSC replying with a number like "1.3", which is its firmware version number. If after 3 or 4 messages the PSC has not been found, you should check that all the connections are proper and that power is applied. If the PSC fails to respond, you may momentarily push the Reset button on the PSC. If the PSC fails to respond, contact Parallax Technical Support at (916) 624-8333.

## SBR Command – Set the Baudrate (to either 2400 or 38K4 Baud)

Syntax: "!SCSBR" x \$0D

Reply: "BR" x (where x is either 0 for 2400, or 1 for 38K4)

After establishing communications with the PSC you may wish to elevate the baudrate to 38K4 baud. To do this, you may follow the example in the following code snippet.

```
'{$PBASIC 2.5}
Sdat          PIN      15          ' Serial Data I/O pin
Baud          CON      396         ' Constant for 2400 baud
buff          VAR      Byte(3)     ' temporary variable

SetBaud:
  DEBUG "Setting Baudrate", CR
  SEROUT Sdat, Baud+$8000, ["!SCSBR",1,CR]
  SERIN  Sdat, 6,500, SetBaud, [STR buff\3]
  DEBUG "Baud reply: ", buff(0), buff(1), DEC1 buff(2), CR
  STOP
```

Note that the SERIN command's baudmode is set to 6 (38K4). That's because the PSC will reply to the command with the new baudrate to confirm the command has been executed. If you wished to set the

baudrate back to 2400, you must either reset the controller or send it a SBR, \$0 command at 38K4 baudrate. Once the baud rate has been changed, it would be wise to "ping" the servo controller from time to time. If either the BASIC Stamp or the PSC reset without the other resetting, they could be left in the state of different baud rates. When "pinging" the PSC with an VER? command, the BASIC Stamp's SERIN function should employ its timeout feature. At this timeout label, you can then attempt to VER? the PSC at the other baudrate. Once identified, the baudrate can again be set, and the program can resume.

## Position Command – Set the Position of a Servo Channel

Syntax: "!SC" C R pw.LOWBYTE, pw.HIGHBYTE, \$0D

Reply: none

To control a servo, you must write a position command to the PSC. Each position command is comprised of a header, three parameters: C, R, and PW, and a command terminator.

The Header: "!SC" is the header. The header signifies to all devices on the same wire that this is a command for a Servo Controller.

The C parameter is a binary number 0-31 corresponding to the servo channel number. The servo channel number should be 0-15 with no jumper present on the PSC, or 16-31 with the jumper present. With a jumper present on the PSC, servo channel 0 become channel 16, channel 1 becomes 17, etc.

The R parameter is a binary number 0 – 63 that controls the ramp function for each channel. If the ramp parameter is set to 0, ramping is disabled and the pulse width will be set to the P parameter sent immediately. Ramp values of 1-63 correspond to speeds from  $\frac{3}{4}$  of a second up to 60 seconds for a full 500uSec to 2.50 mSec excursion for standard servos. This correlation is rather linear though no equation presently exists.

The P parameter is a 16-bit Word that corresponds to the desired servo position. The range, (250-1250), corresponds to 0 to 180 degrees of servo rotation with each step equaling 2 uSec.

The command terminator, \$0D, (CR), must not be omitted.

The following code snippet demonstrates the Position Command by ramping a servo channel 11 from 0 to 255 at ramp rate 7.

```
'{$PBASIC 2.5}
ch  VAR Byte
pw  VAR Word
ra  VAR Byte
Sdat CON 15
baud CON 396

  ra = 7
  ch = 11
DO
  pw = 1250
  SEROUT Sdat, Baud+$8000, ["!SC", ch, ra, pw.LOWBYTE, pw.HIGHBYTE, CR]
  PAUSE 1000
  pw = 250
  SEROUT Sdat, Baud+$8000, ["!SC", ch, ra, pw.LOWBYTE, pw.HIGHBYTE, CR]
  PAUSE 1000
LOOP
```

**Note: Not all servos are exactly alike. If your servos appear to strain when commanded to position 250, you should increase the**

**250 up to 260 (or so) to prevent the servo from straining itself. Similarly, if your servo strains when commanded to go to position 1250, you should decrease the 1250 to 1240 or so to prevent the servo from straining itself.**

### RSP Command – Report the Position of a Servo Channel

Syntax: "!SCRSP" x \$0D

Reply: x y z(where x is the channel number, and z:y is the value reported)

Sometimes it is necessary to know the current servo position. The RSP command returns the value of the specified servo channel. If the servo is still moving as a result of a ramp command, the position may still be read. The following code snippet demonstrates how to use this command.

```
'{$PBASIC 2.5}
ch    VAR Byte
pw    VAR Word
ra    VAR Byte
x     VAR Byte
Buff  VAR Byte(3)
Sdat  CON 15
baud  CON 396

Init:
  ra = 15: ch = 0
DO
  pw = 1240: GOSUB WRservo
  pw = 240: GOSUB WRservo
LOOP

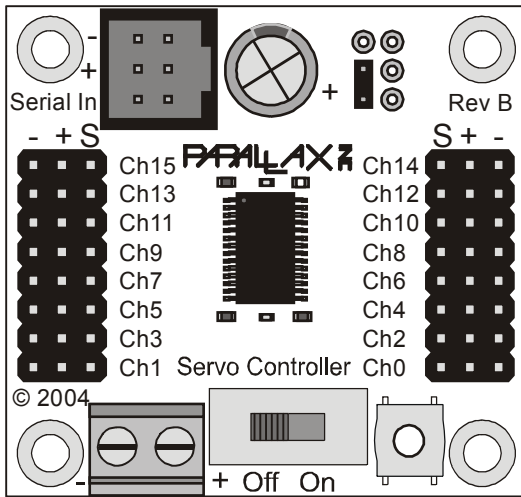
WRservo:
  SEROUT Sdat, Baud+$8000, ["!SC", ch, ra, pw.LOWBYTE, pw.HIGHBYTE, CR]
  FOR x = 0 TO 4
    PAUSE 1000
    SEROUT Sdat, Baud+$8000, ["!SCRSP", ch, CR]
    SERIN  Sdat, Baud, 1000, Init, [STR Buff\3]
    DEBUG "Servo ", DEC buff(0), " ", HEX2 buff(1), " :", HEX2 buff(2), CR
  NEXT
  RETURN
```

Within the DO-LOOP, this program sets the pulse width (pw) to one extreme or the other and writes this value to the PSC. The ramp value (ra) was set to give the program time to poll the servo position several times. Within the WRservo subroutine, the new pw is sent, and the position is polled five times, once each second. A DEBUG command is used to format the reply and post it to a window for your review.

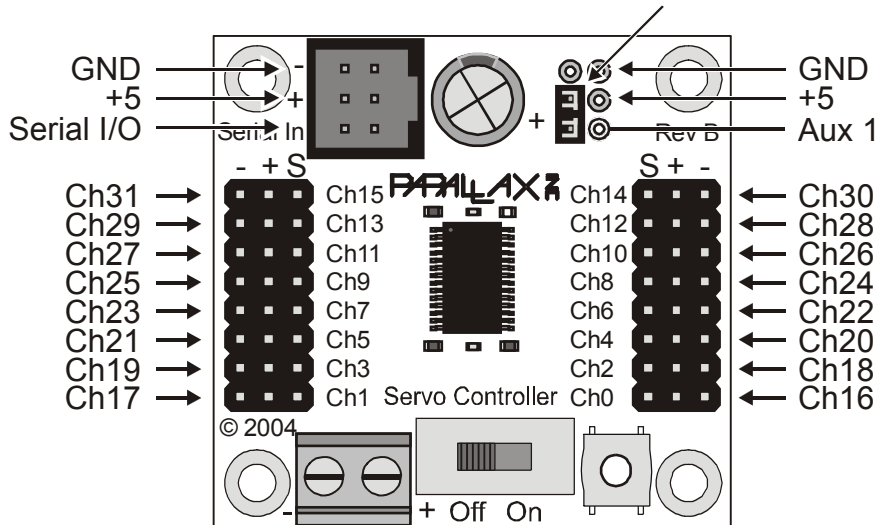
## Networking Two PSCs Together

It is possible to network two PSCs together to control up to 32 servos. Simply use a second 3-Conductor cable to daisy chain two PSCs together as shown in Figure 6. The presence of a shunt differentiates between Unit 0 (channels 0-15) and Unit 1 ( channels 16-31).

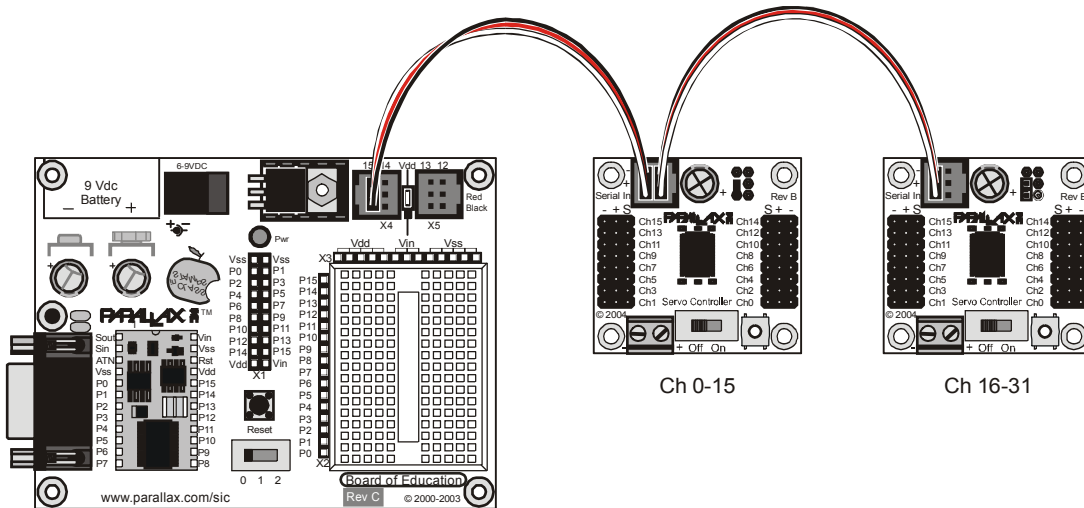
**Figure 4: PSC without jumper (Ch0-15).**



**Figure 5: PSC with jumper (Ch16-31).**



**Figure 6: Two PSCs daisy chained together.**



Please note that in this configuration when you send a serial command to one unit, you send it to both. Commands that set servo positions are the only commands ignored by the other unit. All other commands invoke a reply. Unit 0 replies first. Unit 1 replies approximately 3 mS later. Since all replies are fixed at 3 byte lengths, you would need to configure your SERIN command to receive six bytes.

## Revision List

Hardware      Firmware

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Rev A            1.0            (Only Beta units released)

90 degree rotation, 4 uSec resolution, 1-2 mS pulses, 8 bit PWM, 15 possible ramp values, position polling, and a serial interface at 38k4 Baud. You could daisy-chain this unit, but the fact that there was only one comm connection made it difficult. The bulk of the silkscreen was on the PCB bottom. Glitch (due to comms) on Ch0 and Ch8 removed.

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Rev B            1.1            released March 1<sup>st</sup>, 2004

The connectors were changed slightly to accommodate easier to implement daisy-chain scheme. The silkscreen was corrected so that pertinent info was on pcb top. The serial interface was expanded to support either 2400 Baud or 38k4 Baud.

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Rev B            1.2            released March 16<sup>th</sup>, 2004

The firmware was enhanced to support 16-bit pwm, 180 degree rotation, 2uSec resolution, and 63 ramp rates. Serial code was optimized to accept messages faster than the BS2 could send them.

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Rev B            1.3            released April 19<sup>th</sup>, 2004

Report position bug in the firmware was found and corrected. Specifically, when polling a servo position, the position of the last servo written to was reported regardless of the requested channel number.

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Rev B            1.4            released January 12<sup>th</sup>, 2005

Some conditions caused interrupt contention within the PSoC chip which in turn caused a small amount of glitch on some of the output channels. This glitch caused some servos to oscillate when they should have been still. The PWM channels were restructured such that interrupt contention no longer affects PWM performance. The output glitch has been reduced from +-2uS to less than +- 100 nS.

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Note: your PSC is re-programmable. If your PSC firmware is not current, you may send it in to Parallax for a free firmware upgrade. Your only cost is the shipping fee.

## Liability Disclaimer

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Figure 6: PSC Rev B Schematic

