ServoTester2 Build Instructions (rev B1)

Image: PCB control panel side

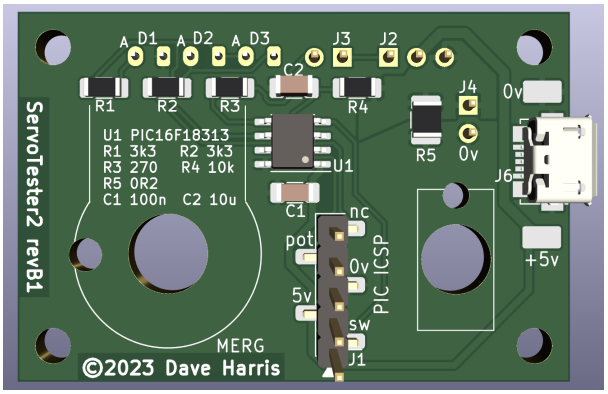
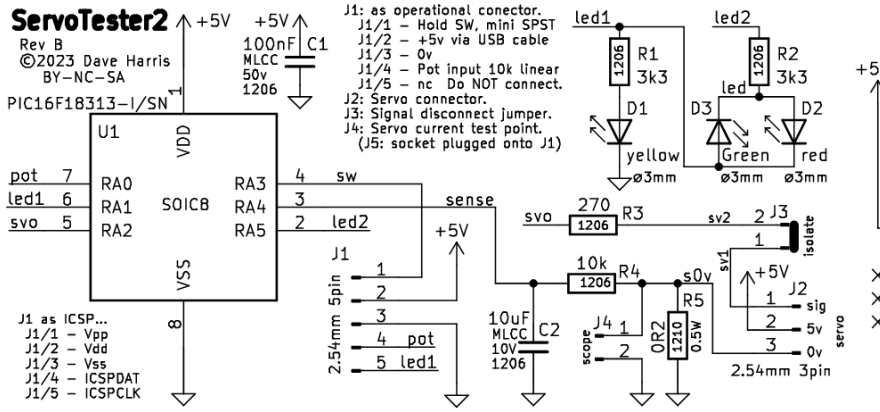


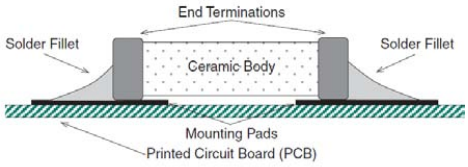
Image: PCB Component side



The rev B1 schematic is the same as the rev B shown here.

The Printed Circuit Board (PCB) is a 2-layer, 50 mm x 33.3 mm, dual sided with the control panel being one side and most components on the other side. Half the components are Surface Mount Device (SMD) and the rest are Through Hole (TH).

These build instructions are for SMD hand soldering. The parts will be fitted in an order that ensures nothing impedes the fitting of any other part. The TH headers and Light Emitting Diodes (LED) are fitted **after** the SMD parts and lastly the Potentiometer (pot) and the toggle switch (sw) are fitted, along with their wiring.



For hand soldering SMD (the way I do it), put jelly flux on the mounting pads, place the part and carry solder on the soldering iron tip, to the pad and component. The flux will cause the solder to flow around the pad and component pin to form a solder fillet joint.

There are several ways to solder SMDs and each way has pros and cons.
If this is your first SMD project, check a few YouTube videos to get an idea on how it's done.
An alternative to using solder and jelly flux is to use solder paste, check it out.

Required tools and materials

Temperature controlled soldering iron with a fine tip and fine solder.	SMD rework jelly flux, hypodermic. EG. Rapid 85-6648 (comes with fine solder)
Fine point tweezers	Fine wire side cutter
Long nose plier	Wire stripper
Magnifier or eyeglass, about x10	Headtorch or desk lamp
Isopropyl Alcohol (IPA) cleaning solution	Mounting or adhesive putty AKA Blue Tack
An old tooth brush for scrubbing PCB clean	A shallow tray/dish for cleaning PCB in
Toothpicks	LED tester … or Make your own, based on a PP3 9V battery and a 22k resistor.
Digital Multimeter	
solder pump and solder wick	USB power source, capable of > 2A
USB 'micro' to USB 'A' cable, charger rated	A known good working servo
PICKIT-4 and PC software (IPE or IDE). Optional as PIC in the kit may be preprogrammed	

Parts in the kit

Those shown in gray are on parts sheet.

R1 3k3, SMD 1206	R2 3k3, SMD 1206	R3 270R, SMD 1206
C2 10uF 10v, SMD 1206	R4 10k, SMD 1206	R5 0R2 0.5w, SMD 1210
U1 PIC16F18313, SMD SOIC8	C1 0.1uF 50v, SMD 1206	D1 yellow LED 3mm, TH
D2 red LED 3mm, TH	D3 green LED 3mm, TH	C3 0.1uF 50v radial 0.1", TH
J1 5 way 0.1" header, SMD	J2/3/4 7 way 0.1" header, TH	22k axial resistor (LED tester)
J5 5 way 0.1" socket, TH	J6 USB micro socket, SMD	Shunt strap 0.1"
10k linear pot, panel mount	Knob for the pot	Strip board piece, 5x2 holes
Wire 7x0.2 - white, red, black	Toggle sw SPST, panel mount	PCB ServoTester2 revB1

*An SMD **1206** indicates its plan size and equates to 0.0**12**" x 0.0**06**" in size.*

Build Steps

1 Start

Read these instructions twice.
Check all the components are present.

Only detach a component from the parts sheet, WHEN it is needed. *The LEDs and capacitors have NO markings!* Capacitor values can be identified using a good digital meter, although in this kit, the 10uF is taller than the 0.1uF. LEDs will need use of an LED tester. The resistors and chip have markings but will require the use of a magnifier to see.

2 LED Tester

If you already have a tester, goto step 3, or make yourself a simple LED tester…
Solder the 22k axial resistor to a PP3 9v battery plus terminal. Solder a length of red wire to the free end of the resistor. Solder a length of black wire to the minus terminal of the battery. On the free ends of the wires, strip 3 mm of insulation and 'tin' them to ensure the wire strands stay together.
In use, the LED to be tested is temporarily connected to the red and black wires. Dab the wires on the LED while still on the parts sheet, the anode, longer leg, is red wire and the cathode, the shorter leg, the black wire. An LED can be tested while in circuit.

3 Prepare PCB

In a shallow tub give the PCB a scrub clean using IPA and an old toothbrush.
Give the PCB a good shake to remove excess IPA and allow it to air dry.
Place the PCB, component side up, on the worktop, affixing it with BlueTack.

4 Generic SMD part fitting procedure

Remove selected part (as given in step 5) from the parts sheet and place on its PCB pads, and with a magnifier ensure it is on the pads equally.
Hold part in place with downwards pressure from a toothpick.
Solder one pad only.
Recheck the part is still in the right place.
If not, reflow the one solder joint and gently turn/push the part to where it should be. Tweezers help here.
If the position is good, solder the other pad(s).
With the magnifier check the solder flow is good around the pads.

5 Fit SMDs in order

Using the procedure in step **4**, fit R1, R2, R3, C2, R4, R5, U1, C1, J6 and lastly J1.
For U1 ensure its corner dimple on the top of its case is adjacent to the 'U1' silk screen text.

J1 and J6 can only physically go one way round. USB J6 is difficult to test, so take care with its visual inspection. J6 case is metal and is soldered on a ground plane (AKA heatsink), so you will need to turn up the iron heat there. *Do NOT get flux inside the USB socket, as solder will be drawn in!* All other components are orientation and polarity insensitive.

6 Release the PCB from the worktop

7 Fit LEDs

Solder in the 3 LEDs, on the panel side of the PCB. Since the LEDs are clear plastic and have no ident, check each with a simple LED tester to confirm their colour. The longer LED leg is the anode pin (shown as 'A' on silk screen).

8 Fit TH headers

Cut the 7 way header strip 3 ways, 3 pins, 2 pins and 2 pins.
Fit, on the panel side, the pin headers J2 (3 way), J3 (2 way) and J4 (2 way).
Solder one pin first, if not vertical or raised from PCB, apply toothpick pressure while reflowing the joint until it is. Then solder the other pin(s).

9 Basic inspection and test

Scrub clean using IPA and an old toothbrush. Let it air dry.
Visually check your work with the magnifier, looking for missing or incomplete joints or solder bridges between pads. If you see any, fix by adding flux and reflowing the affected joint. Solder bridges can normally be cleared by adding flux and with no solder on the iron tip, drag iron tip across the joints.

Do NOT plug in the USB cable.
Ensure the Shunt Strap is on J3 "signal isolate" and there is no servo connected.

Using a multimeter, check the resistance readings between the points shown below…
One purpose of the tests is looking to find defective solder joints, the probe should be on the chip pins or component wire and NOT on the solder pads. Another purpose is to ensure the right component is in the right place. Choose the right range on the meter for the test, as looking to find zero Ω on the MΩ range may show 0.0 MΩ when it's actual is 500 Ω !

Measure resistance with meter probe + to -	
Test 1. U1/1 pin to J1/2 pin '5v' = less than 1 Ω	Test 2. U1/2 to D2 anode = 3.3 kΩ ±5%
Test 3. U1/3 pin to J2/3 '0' = 10 kΩ ±5%	Test 4. U1/4 pin to J1/1 'sw' = less than 1 Ω
Test 5. U1/5 to J2/1 'S' = 270 Ω ±5%	Test 6. U1/6 pin to D1 anode = 3.3 kΩ ±5%
Test 7. U1/7 to J1/4 'pot' = less than 1 Ω	Test 8. U1/8 pin to J1/3 '0v' = less than 1 Ω
Test 9. J1/2 to J2/2 '5v' = less than 1 Ω	Test 10. J1/3 to J2/3 '0v' = less than 1 Ω
Test 11. D1 anode to J1/5 'nc' = 3.3 kΩ ±5%	Test 12. +5v pad to 0v pad = greater than 1 MΩ

Using the LED tester check each LED lights with its correct colour, with plus wire on anode and minus wire on cathode. If incorrect, fix it now & redo the LED test.

If any test fails, do NOT proceed further. Fix the fault and redo step 9.

10 Panel controls

Fit the toggle switch and the pot and knob. When both are straight and tightened, place a small drop of superglue on an edge of the nut where it meets the washer.

11 J5 connector

Solder the TH header socket into the piece of strip board (5x2 holes) to form J5.
Plug J5 onto J1 so that the empty row of holes is towards the pot.

12 Wiring

Solder the 0.1uF radial capacitor to the pot, across the left hand lug and center lug.
Solder short lengths of 7 strand 0.2 mm wire (7/0.2) to this plan. Only strip about 3 mm of insulation from each end.

White wire from switch upper terminal to J5/1 (sw) *(J5 pin 1 is next to the white arrow)*
Red wire from pot right hand terminal to J5/2 (5V)
Black wire from pot left hand terminal to J5/3 (0V)
Black wire from pot left hand terminal to switch center terminal
White wire from pot center terminal to J5/4 (pot) *Note, J5/5 marked "nc" has no wire connected to it.*

13 Programming the PIC

The kit may be provided with a pre programmed chip. If so, goto step 14.

In your web browser, goto https://github.com/daveharrisuk/ServoTester2 and download the ZIP file `HEX_ServoTester2_v11.zip` and extract the latest version of the rev B hex file. At time of writing, it's `ServoTester2_revB_v11_PIC16F18313.hex` .
Unplug J5 from J1 (*disconnects pot and switch, allowing J1 to be used as In Circuit Serial Program (ICSP) header for use of PICKIT*).
Plug PICKIT-4 onto J1. Pin 1 on each is shown by a white arrow. J5 will need to be pushed to one side, carefully.
Using the Microchip IDE or IPE send the .hex file to the PIC. See Microchip documentation on IPE/IDE for this process. Set the software to program a PIC16F18313.
The D1 yellow LED will flash while loading is in progress.

14 Operation Testing

Ensure…

- Pot knob is fully anti clockwise, 0 degrees (*No position offset from servo mid position*).
- switch is set to || 'pause' (*No servo position oscillate*).
- J5 is on J1 (*the pot and switch are connected to PIC*).

- Shunt Strap is on J3 'signal isolate' (*the servo signal is NOT isolated*).
- No servo is connected.

Plug in USB 'micro' cable. It should be 'charger' rated type since normal USB cables have higher resistance.
Plug the USB cable into a USB power source capable of supplying 2A.
The PICs power up code will flash all 3 LEDs.
After that the yellow LED should light and the green LED and red LED should be dark.
If no LEDs light, then…
Check the Voltage on the 0v and 5v pads, there should be between 4.9V to 5.2V.
Assuming all previous tests have passed, then suspect the PIC programming.

With a temperature probe, check for any hot components (*I use the tip of my little finger, if it's hot, it may burn*!). Everything should be cool.

For a short duration, place a short circuit across the J2 servo header '5' pin and '0' pin.
A longer duration short circuit will probably trip the USB power.
The yellow LED will go dark and the red LED will light (*greater than 250 mA*).
Remove the short circuit promptly.
If however all the LEDs go dark or the yellow LED flashes (*the USB 5V power drops below 4.75*V), then suspect the USB power source or the cable can not supply enough current.

*The red LED lights when there is more than 250 mA **average** current. However when the servo's internal Pulse Width Modulation turns on the servo motor, a repetitive **peak** current over an Amp can flow, in short durations. This peak can trip the USB power. For best operation results use a portable USB battery boost charger rated 3A or more.*

Check the component temperatures, everything should be cool, except maybe for R5 which will be warm after a short circuit or a period of operation with the red LED lit.

If all is well, then connect a known good servo to J2.
The signal wire (white, yellow or orange) goes to the pin marked 'S'. If connected the wrong way, no damage happens, but the servo won't function.
A servo horn mounted on the servo shaft will help movements to be seen.
The servo should, if not already, move to its center position.
The green LED may/will flash (*greater than 25 mA)* while the servo moves. *If the green is lit most of the time, then it is probably the servo at fault.*

Set the switch to 'Run' and gradually turn the knob clockwise. The servo should start a slow oscillating movement and the green LED (*greater than 25 mA*) will flash in time with the movement. *If the green is lit most of the time, then it is probably the servo at fault.*

Intermittent red light (greater than 250 mA) can occur with larger servos or with a servo with something impending the horn movement.

End of document.