The Pocket Programmer

Last Updated 09 05 01

Circuit Description.

The circuit is designed to program microcontrollers with a voltage supply that can be varied between 2V and 6V. It also has EEPROM memory which is used to store the HEX file and system information.

The circuit is powered by a 18VDC supply. This is connected to the circuit by the power switch SW5. This switch also allows two external 9V batteries to be used in series to power the circuit in case the programmer needs to be used in a remote location.

Diodes D3, D4 and D5 provide reverse battery protection for the circuit. R33 helps to dissipate some of the 18VDC power that is fed to the 7805 regulator U5.

U5 provides a 5V supply for the programmer circuitry. U6 is an 8 volt regulator and when connected in series with the 5 volt regulator, provides a 13V rail for the microcontroller programming voltage.

The 13V programming voltage is controlled by transistors TR1 and TR2. When these are turned on, 13 volts appears at the correct pin on the programming socket. These transistors are controlled by inverters U10B and U10A which are in turn controlled by the PIC16F873 processor.

A variable supply voltage for the programming socket is generated by a Pulse Width Modulated (PWM) signal that comes from pin 13 (RC2) of the PICmicro. This is filtered by R2 and C1 and then voltage divided by R6 and R7. The resultant DC voltage is buffered by op amp U11B, U11A. TR4 provides a stronger output stage than the op amp can provide and is fed by the 13V power rail.

The output voltage from TR4 is dependant on the duty cycle of the PWM signal and varies from about 1.7 volts to 6.5 volts.

R29 and R22 provide a voltage divider circuit and the voltage at the junction of these two resistors is monitored by an analog to digital converter in the PIC.

Programming requires clock pulses synchronised with data pulses and are controlled by the PIC. The data comes from pin 28 (RB7) and the clock comes from pin 27 (RB6).

This information is fed to U9B and U9A via resistors R31 and R31. These resistors provide a voltage buffer for the inputs to U9 and limit the input current when this chip is operating at different voltages to the PIC.

U9 is a hex non-inverting buffer chip which has outputs that can be Hi, Lo or Tri-stated. This chip passes on the program information from the PIC to the target processor in the programming socket SKT1. This chip can operate over the range 2 volt to 6V which is the range of the variable programming power supply described earlier, and in fact, this chip is powered by that variable supply and is only turned on when TR3 is turned on.

This means that although the PIC is operating from a standard 5 volt supply, it has the ability to program a device at higher or lower voltages. In this application, the target chips are not programmed at voltages other than 5 volts, which is in accordance to the programming specs. However, the chips are verified at different voltages after the program cycle has been completed.

The data pin (RB6) on the target chip inputs data when programming takes place, but it also becomes an output pin when data is read from the device. The gates on U9 are not bi-directional so they cannot pass this data in both directions.

When reading is required, the output of U9B is tri-stated by the PIC via R34. The data coming from the target device is routed through U9C and buffered by transistor TR5. This buffering is required because of the voltage difference that may exist on the programmed chip's power supply. The output from TR5 is a square wave with an amplitude between 0 and 5 volts. The data signal is inverted, but the software in the PIC compensates for this.

U10D provides an open collector signal which can be used as a signal on the ISCP port during programming. Whenever the programming supply is turned on, the output of U10D is pulled low.

Switches 1 to 4 are used to control the programmer functions. There are connected as voltage dividers and produce 1 of 4 different voltage levels when each one is pressed individually. This voltage appears on pin 2 (RA0) of the PIC chip which is configured as an analog input. The PIC samples the voltage in set intervals and can determine which key is pressed.

U8 provides an RS232 interface from a host PC and the PIC processor.

LED1 serves as a power indicator and LED 2 gives an indication when the programming voltage is turned on.

<u>Construction</u>

First inspect the PCB for shorts or broken tracks. If all is well, you can begin to install the components. Use the component overlay shown elsewhere in this file as a guide to construction. Please read through this before commencing.

There are a number surface mount resistors and capacitors supplied with this kit and these should be mounted first.

The capacitors have a dull brown body, and the resistors have a green body colour with white markings on top. The markings on top of the resistors are the ohmic values. For example, the 10K resistors are marked as 103 and the 5K6 resistors are marked with 562. These markings mean 10 followed by 3 zero's which means 10,000 ohms, and 56 followed by 2 zero's which means 5600 ohms.

The capacitors have no values marked, so be careful not to mix them up. They are in 3 separate packages and correspond to the amount of each required.

You need a fine tipped soldering iron and something like a heavy needle to mount these parts in position. This is the way that I use, but you may have your own method.

Make sure the PCB is on a flat surface. Place the a component in it's position making sure that they are placed as central as possible on their mounting pads.

Place your solder so that the end of it is suspended above the PCB but without getting in the way of the component.

Press a pin or the tip of a small flat bladed screw driver onto the top of a component to hold it in place. (It would be a lot easier if someone else does this part with you.)

Now get the soldering iron and place a bit of new solder on it and immediately dab it onto the end of the surface mount part and the PCB pad. When the solder cools, the component will be held in place.
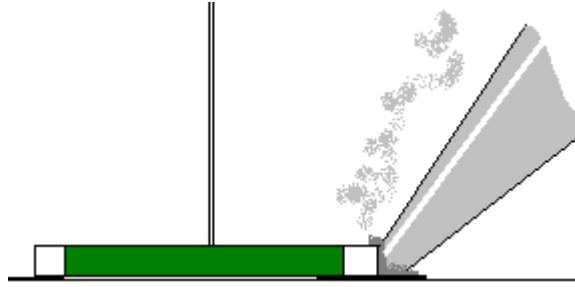
PLEASE do not leave the soldering iron on these parts for more than a couple of seconds or they will be damaged by the excess heat.

Do the same procedure for each of the other surface mount resistors and capacitors. Please note that you are only soldering _one end_ of these components at this stage, just to hold them in place.

The reason is that while you are soldering one end of each of the other components, the previous ones have time to cool down before soldering the other end.

If you have someone to help hold each component, solder the ends by placing the tip of the solder at the connection point and dabbing the soldering iron onto the solder end and the component/PCB junction. This should provide a neat joint.

Once you have soldered one end of the components in place, solder the other ends of each component to complete their connections to the PCB.

If you are doing this by yourself, you may need to quickly dab a fresh bit of solder on each of the first joints that you did just to make sure they are good connections.

The main thing to remember is _not to apply too much heat_.

Once you are satisfied that these components are in place, turn the PCB over and solder the remaining resistors and capacitors in place using the same procedure as outlined above.

Now you can solder the diodes D3 to D4 in place observing their orientation. The cathode is the end with the line marked on the component.

Mount resistor R33 next but leave it raised off the PCB surface by a few millimeters so that air can circulate around it.

Mount the crystal next. You need to take care that the crystal case does not short the tracks beneath it after it is mounted on the PCB. To avoid this use one of the diode pigtails (offcuts) and place it under the crystal before placing the crystal in it's mounting holes. Solder the crystal in place, avoiding excess heat, and then remove the pigtail. There should now be a small air gap under the crystal.

After soldering them check the connections under a strong light and make sure there are no shorts between the pins. Bear in mind that some pins may be shorted on the PCB design which is OK.

Solder in the IC sockets for U7 and U8 next.

Now solder the electrolytic capacitors C7, C8, C11, C12, C13 and C14 making sure you observe the polarity of each component. The 1uF caps near U8 may need to be bent slightly forward before soldering to make sure they fit under the LCD. Damage will be caused if these components are mounted the wrong way around. The negative pin has a stripe marked on the side of the component case. The PCB overlay highlights which pin is positive with a small plus (+) sign. Capacitor C1 is a tantallum type and it must be inserted correctly or it will probably fail very quickly. The positive terminal will be marked with a small (+) sign.

Next you can mount the 4 transistors but make sure they are inserted correctly. They all look the same, but they are different devices. These can be followed by the 2 LEDs. The anodes are the longer of the two connection leads and the cathode is marked with a flat surface on the LED body.
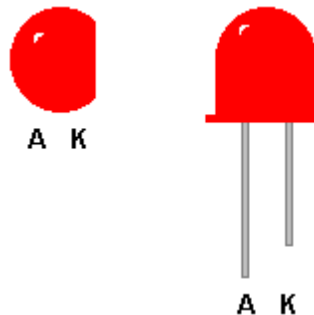
Mount the power socket next. You may need to trim the rear connector to fit in the PCB hole properly.

Mount the four push button switches next. The switches are single pole normally open types. Use an ohmmeter to verify the connections and make sure the two shorted pins mate with the shorted pin connections on the PCB. If the switches are inserted incorrectly, the PIC will think they are pressed all the time.
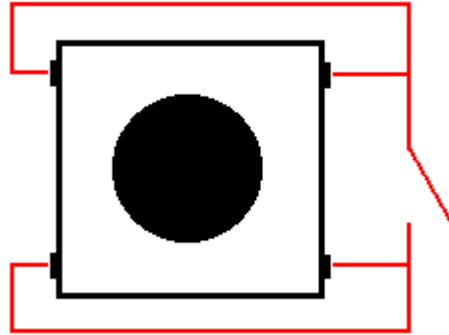
Mount the 10 header pins for the LCD next.

Solder the 3 battery terminals next by using a 3 way pin connector. Then use the remaining 8 pins for the Parallax connector. Solder the 2 power test connectors next, TM1 and TM2.

Now insert the power switch, power jack, RS232 socket and the ICSP socket followed by the LCD contrast pot. Note that the power switch should be raised slightly off the PCB to avoid a short on the tracks beneath it.

The two regulators can be soldered in now.

Make sure there are <u>no</u> chips inserted into their sockets and the circuit board can have 18VDC power applied to it for testing. LED 1 should light up. Make sure the output of U5 is 5 volts and the output of U6 is 13V. Pin number 20 in the socket where U7 is to go should have 5 volts.

If these checks are OK and the regulators a staying cool, then proceed with the construction. If there was a problem, try to track it down before proceeding. Usually it will be a component in the wrong position or a PCB short.

Mount ICs U10 and U11 next, but observe pin 1 and make sure they are positioned correctly. Apply a dab of solder to one of the corner pins and when it is cool, make sure the chip is still aligned. Then solder the pin on the adjacent corner. Usually, these first pins are the ground and power pins. When you are satisfied with the chip's position, solder the remaining pins using a minimum of solder. Be patient and wait a small amount of time before soldering each pin so that the chip does not over heat.

Solder the 40 pin ZIF socket into position next.

Now turn the PCB over and solder in the remaining chips. These chips have been purposely left until last as they are sensitive to static damage. Be as careful as you can not to touch the pins with your fingers.

Start with U9 (74HC126) and solder the power pins first. Pins 7 and 14. Then solder each of the remaining pins.

Now position one of the 24LC256 chip and solder the power pins 4 and 8 first. Do the same for the other 2 chips and then solder the remaining pins on all the devices.

Solder the header socket onto the LCD PCB as shown below.

PCB TOP

Insert he PIC16F876 and the ICP232 chips into their respective sockets. Make sure that pin 1 lines up correctly.

Insert the LCD into it's header socket and secure the opposite end to the PCB with the two spacer screws and nuts. Turn the LCD contrast pot so that it is about half way.

That completes construction.

Do another check of the parts for correct orientation and give the PCB another look over and check for possible shorts and joints that have not been soldered.

If you are satisfied that all is well, apply power and switch it on. The LCD is probably still blank, so turn the contrast pot away from the RS232 socket to make the display visible.

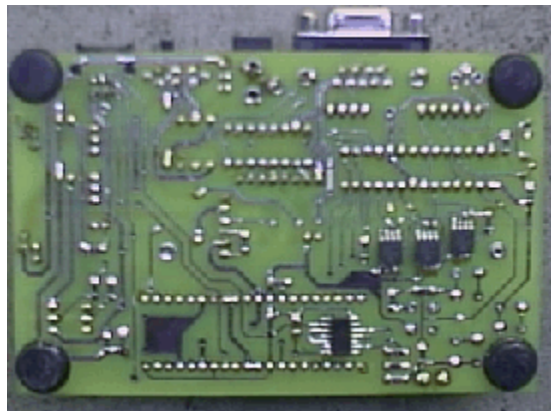When turned on without operational data available, the Pocket will display this message.

```
RUN POCKET.EXE
PRESS ANY KEY
```

If the display has not responded with that message then you have done something wrong. Please go over you work again and make sure that 5 volts appears on the correct power pins on each chip.
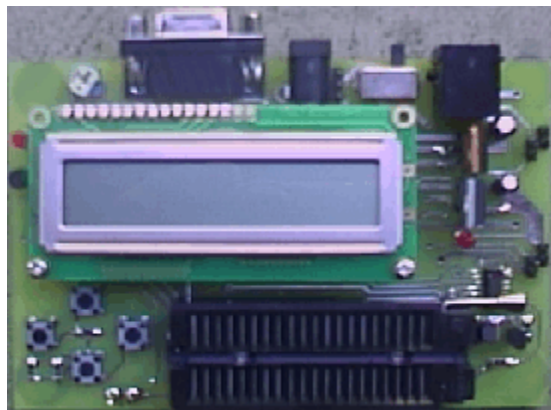
Turn off the power and run `pocket.exe` from your installation directory and open the help file. Read through it to discover how to set up and calibrate the programmer and then how to use it. See the end of this file to see how to wire up a suitable serial connection for the PC.
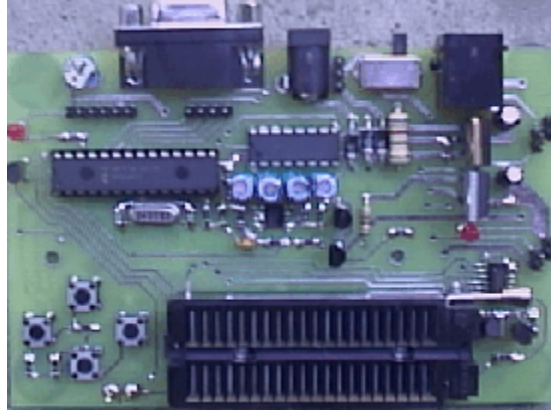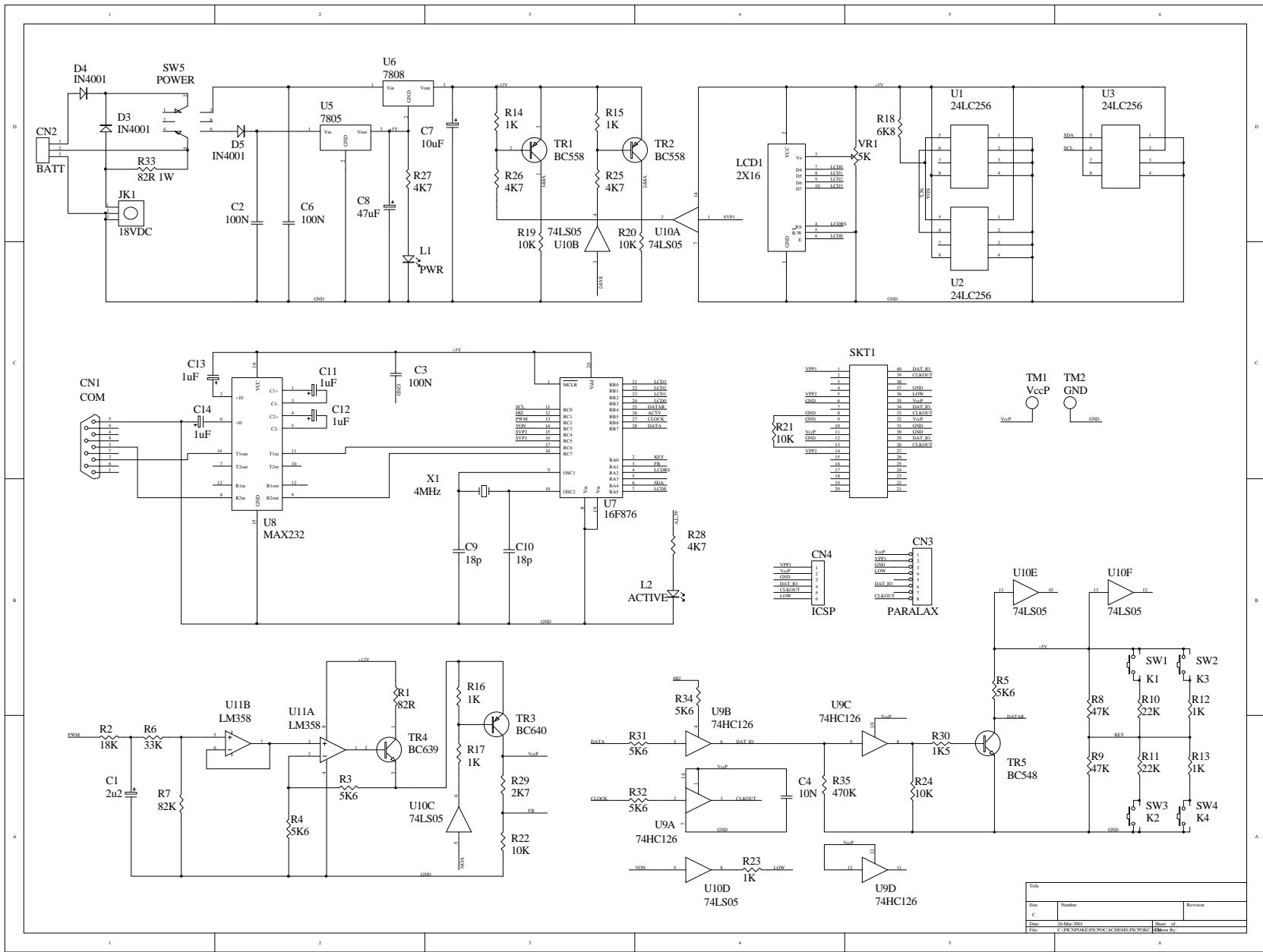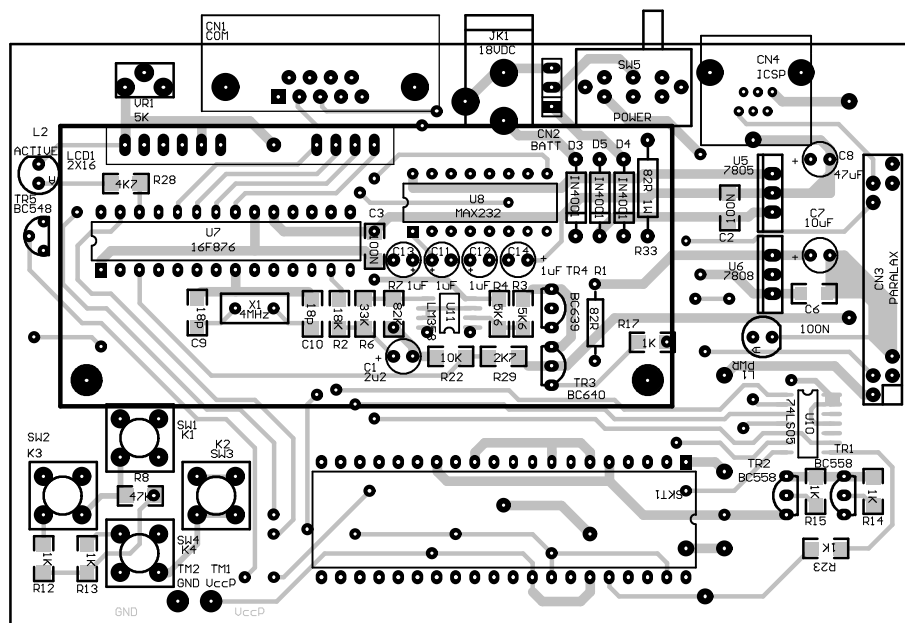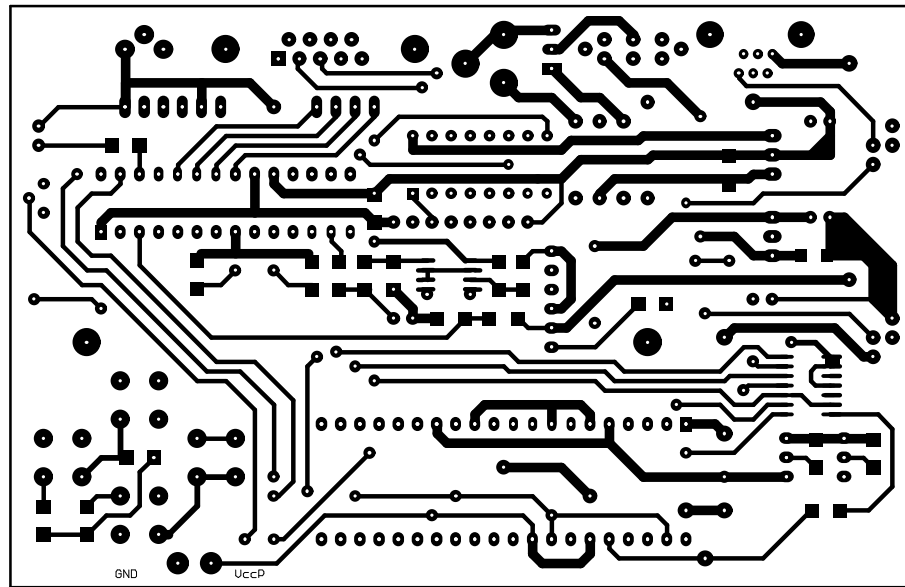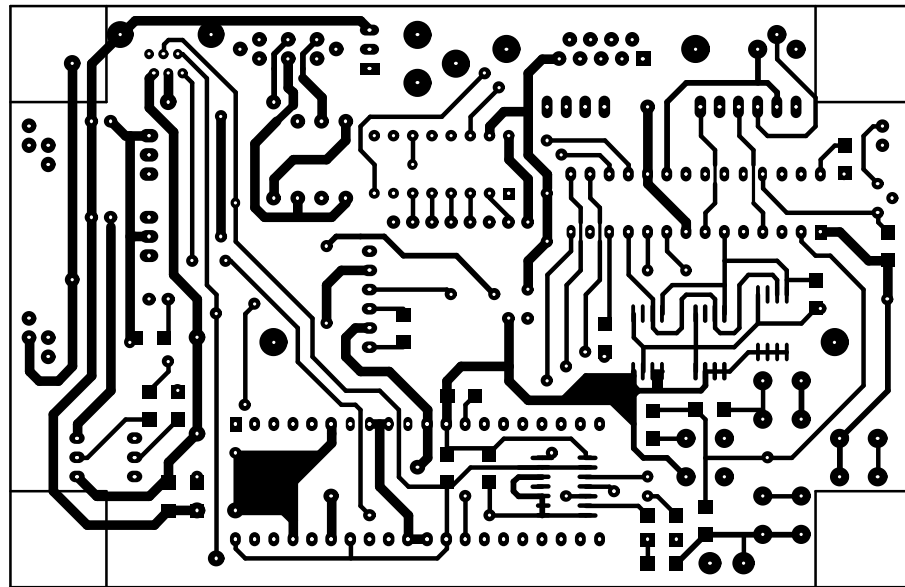

Top PCB view

Bottom PCB view

Completed PCB view
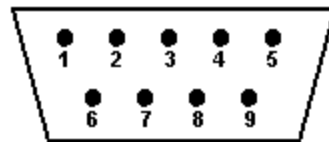
GND   UccP

MALE

```
   ●    ●    ●    ●    ●
   1    2    3    4    5
      ●    ●    ●    ●
      6    7    8    9
```

FEMALE

```
   ●    ●    ●    ●    ●
   5    4    3    2    1
      ●    ●    ●    ●
      9    8    7    6
```
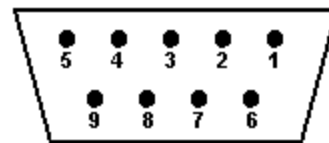
LOOKING INTO MATING CONTACTS

WIRING CONNECTIONS

1 - 1
2 - 2
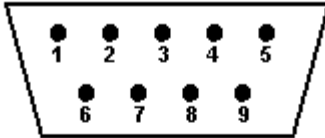- - -

9 - 9

RS232 CONNECTOR WIRING

DO NOT USE A NULL MODEM CABLE FOR RS232
COMMS OR IT MAY CAUSE DAMAGE TO THE PCB.

MALE


```
1   2   3   4   5
  6   7   8   9
```
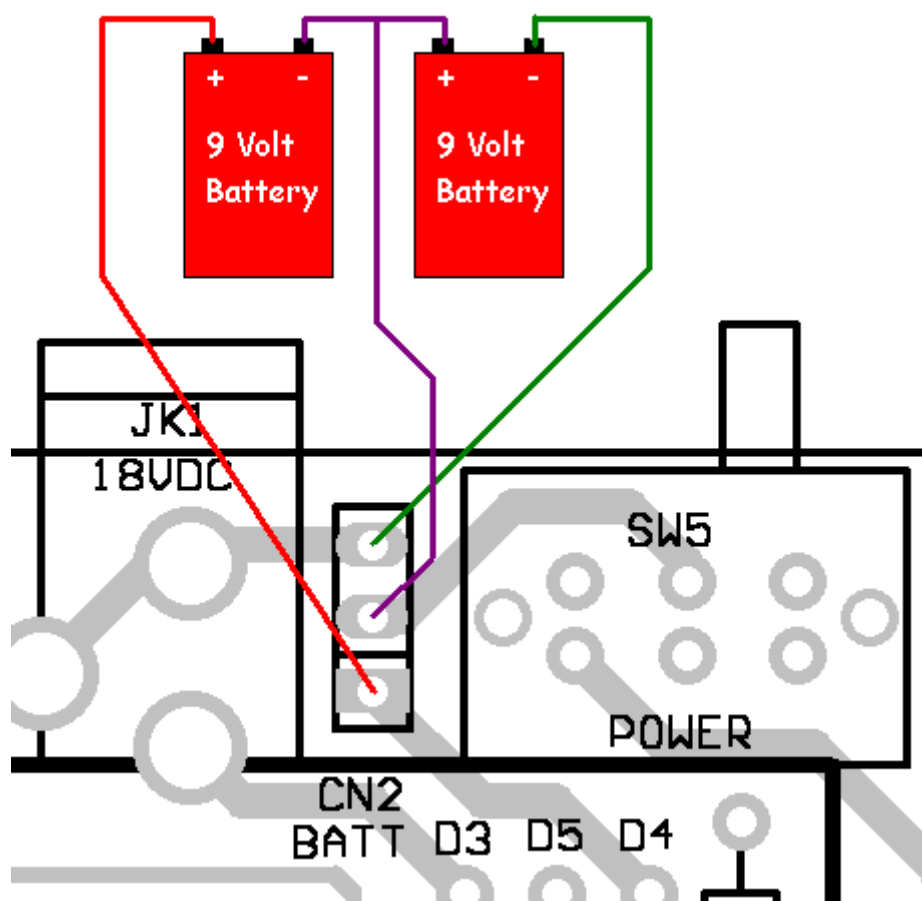
MALE


```
1   2   3   4   5
  6   7   8   9
```
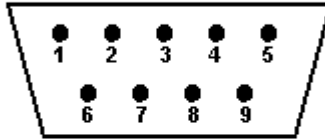
LOOKING INTO MATING CONTACTS

WIRING CONNECTIONS

2 - 3
3 - 2
5 - 5

BOOT CABLE WIRING

9 Volt
Battery

9 Volt
Battery

JK1
18VDC

SW5

POWER

CN2
BATT D3 D5 D4

Parts List

Part	Used	Part Type	Marking	Designators
1	2	18p Ceramic		C9, C10
2	1	2u2 Tantalum		C1
3	1	10N Ceramic		C4
4	3	100N Ceramic		C2, C3, C6
5	1	10uF Electro		C7
6	4	1uF Electro		C11, C12, C13, C14
7	1	47uF		C8
8	1	82R Resistor 1W		R33
9	1	82R Resistor 1/4 W		R1
10	7	1K Resistor	102	R12,R13,R14,R15,R16,R17,R23
11	1	1K5 Resistor	152	R30
12	1	2K7 Resistor	272	R29
13	4	4K7 Resistor	472	R25,R26,R27,R28
14	6	5K6 Resistor	562	R3,R4,R5,R31,R32,R34
15	1	6K8 Resistor	682	R18
16	5	10K Resistor	103	R19,R20,R21,R22,R24
17	1	18K Resistor	183	R2
18	2	22K Resistor	223	R10, R11
19	1	33K Resistor	333	R6
20	2	47K Resistor	473	R8, R9
21	1	82K Resistor	823	R7
22	1	470K Resistor	474	R35
23	2	BC558		TR1,TR2
24	1	BC640		TR3
25	1	BC639		TR4
26	1	BC548		TR5
27	3	24LC256 EEPROM		U1,U2,U3
28	1	7805 5V Regulator		U5
29	1	7808 8V Regulator		U6
30	1	PIC16F876-04P		U7
31	1	ICP232		U8
32	1	74HC126		U9
33	1	74LS05		U10
34	1	LM358 Op Amp		U11
35	1	4MHz Crystal		X1
36	3	IN4002 Diode		D3, D4, D5
37	2	LED		L1, L2
38	1	2 X 16 LCD		LCD1
39	1	5K Trimpot		VR1
40	4	Push Button Switch		SW1,SW2,SW3,SW4

41	1	Slide Switch	SW5
42	2	Calibration Connector	TM1, TM2
43	1	DB9 RA PCB Connector	CN1
44	1	3 Pin Battery Connector	CN2
45	1	8 Pin Parallax Connector	CN3
46	1	6 Way PCB Mount Connector	CN4
47	1	Power Jack	JK1
48	1	40 Pin ZIF Socket	SKT1