Handy Dandy Little Circuits

Temperature Controlled Soldering Station

Circuitry | Construction | Parts List

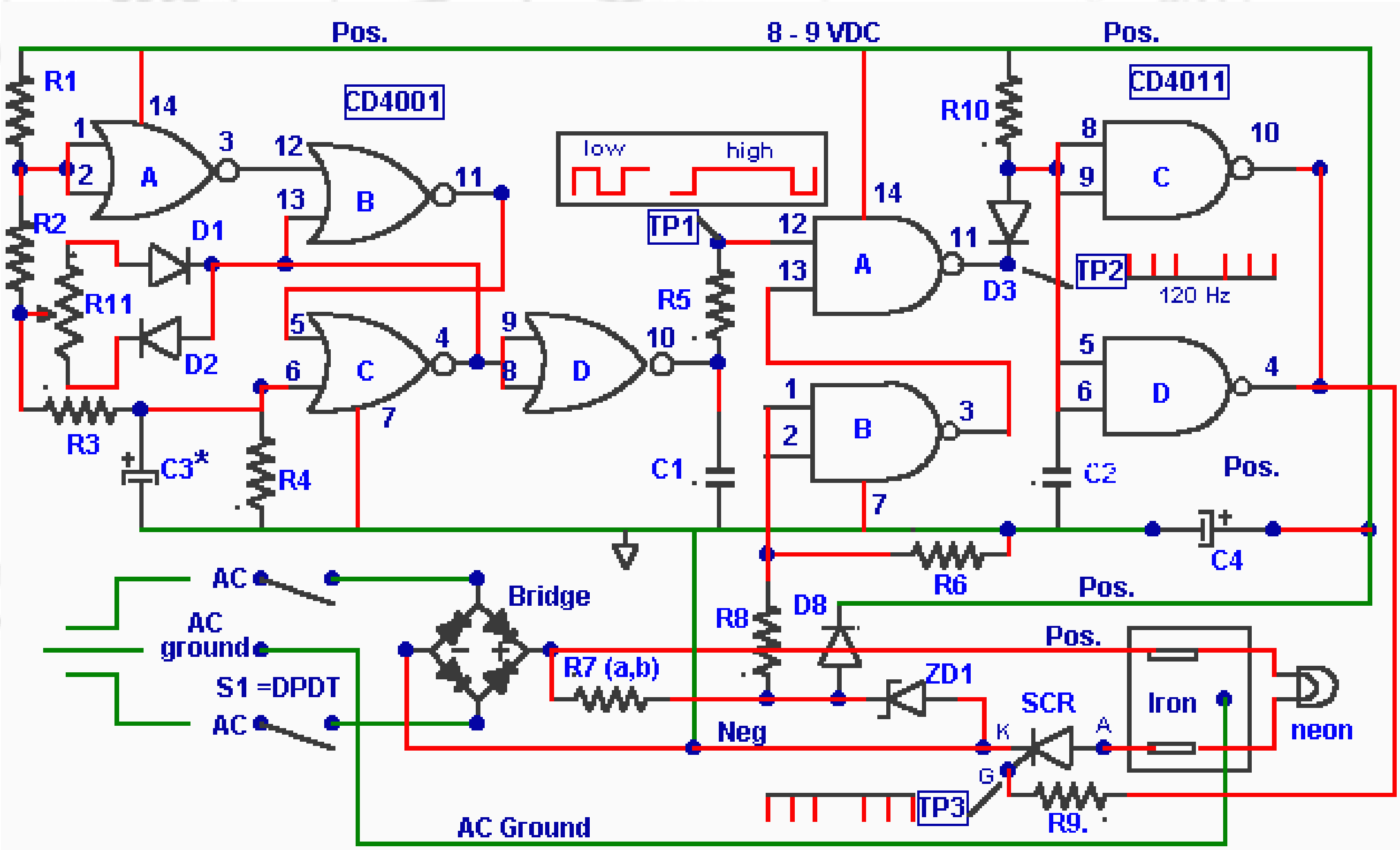
EVER WISHED YOU COULD CONTROL THE TEMPERATURE OF YOUR SOLDERING IRON? When you switch to a fine solder are you also having to switch to another iron? Sometimes it's just too hot for those delicate jobs. Or maybe you've just been struggling with a high-temp iron when doing your small stuff.

THIS SOLDERING IRON TEMPERATURE CONTOLLER will make you a pro at a fraction of the cost of what you would pay for a professional soldering station. Sure to become a useful part of your toolkit it will help to increase productivity as well as the quality of your work. It offers a wide range of temperature settings, from less than 20 watts to near maximum temperature when using a 40-watt soldering iron with a grounded option. And by changing different capacitors a dual or even triple temperature range can be had.

Circuit Description

Through the on/off switch AC voltage is applied to the rectifier bridge.

- The rectified *negative* voltage is then applied directly to the cathode (K) of the SCR. The controlled trigger of the gate (G) allows the SCR to deliver bursts of DC pulses from the SCR anode (A) to one side of the iron connection.
- The rectified *positive* DC voltage from the bridge is processed in three ways:
  - From the bridge it is connected directly to the other side of the iron connection allowing the current to flow through the iron to the SCR cathode (K) thus completing the circuit.
  - From the bridge the positive DC, approx. 105 volts, is dropped down through R7 and clamped to 8vdc by a ZD1 regulating diode. It then passes through D8 and is filtered by C4. This voltage is used as the positive supply for the electronic circuitry.
  - From the junction of R7 and ZD1 pulses from the full-wave rippling, unfiltered DC voltage are fed through a voltage divider consisting of R8 and R9. This, in turn, is connected to gate A of CD4011.



Circuit Analysis

Note that without the controlling function of CD4001 the output of gates C&D of CD4011 would be a constant and uninterrupted stream of pulses, that is, the rectified rippling voltage of 120 pulses per second (PPS). As these pulses are used to trigger the SCR gate (G) through R9 the iron would maintain its full temperature.

The controlling element in this unit is R11. It allows for settings of short pulses for low heat as well as longer firing periods for those jobs requiring a higher temperature. As the potentiometer is adjusted, by moving it clockwise toward D1, the ON duration is increased. Turned toward D2 the timing is decreased. Note that C3 controls the range of CD4001 oscillation and therefore the minimum and maximum range of temperature control. Accordingly a *dual* or even *triple* range can be obtained by switching different capacitors in the circuit.

Test point 1 (TP1) shows the result of the oscillator output. This is applied to gate A of the CD4011. The substracting funtion of this trigger pulses at TP2 via gate B of CD4011. The resulting firing pulses to the gate of the SCR at TP3 . The neon connected across the iron connections gives a visual indication of the SCR on/off SCR firing periods .

For DC application see Modified Circuit

Circuitry	Construction	Parts List

A good project for a valuable tool to be used for many years to come . If you have any questions

or comments feel free to email me at roma60@home.com.

[Home](#)

Handy Dandy Little Circuits

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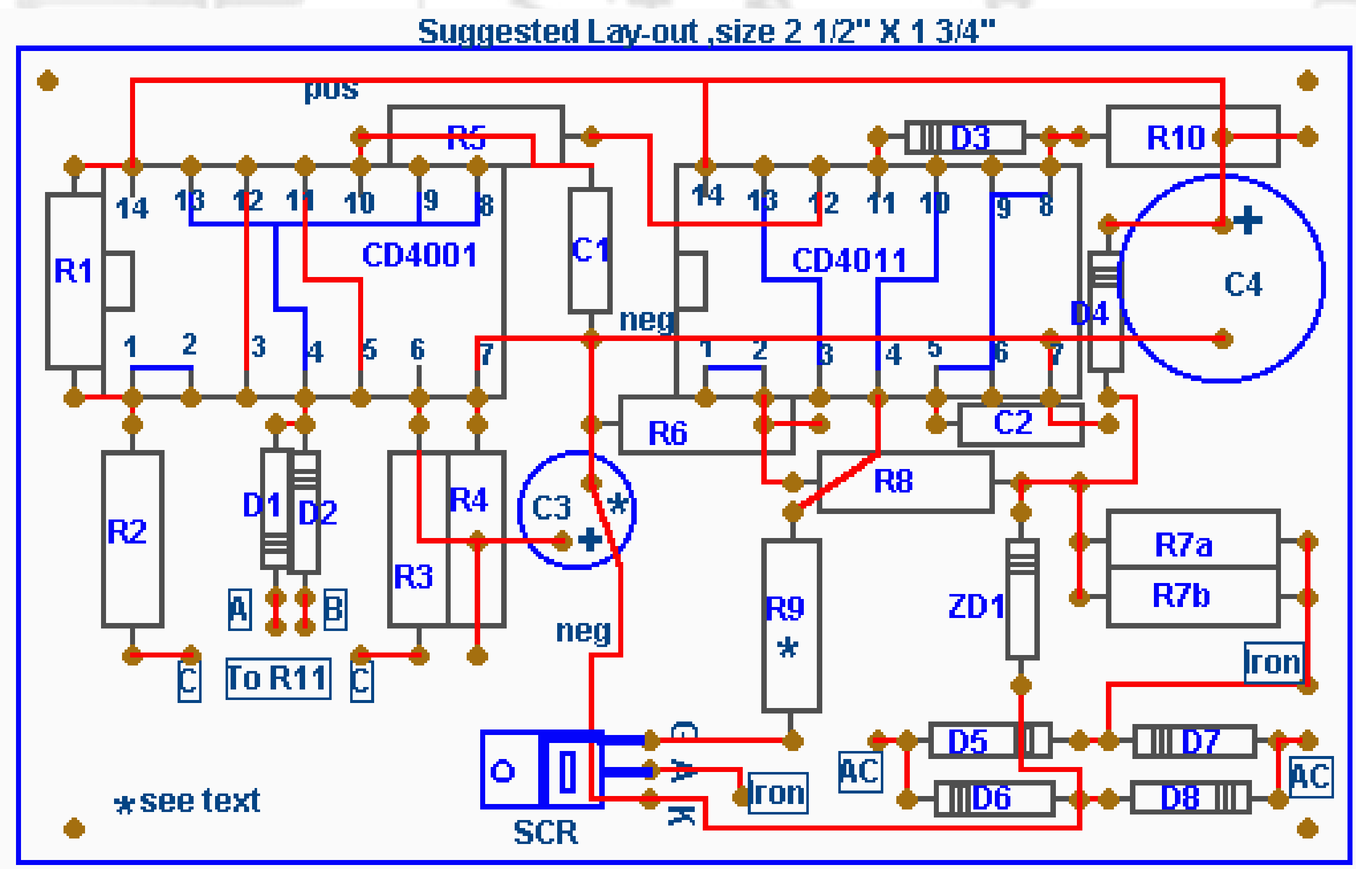
Circuitry | Construction | Parts List

Assembly and Construction

As a reference you may wish to print out the page containing the circuit diagram or open up a new window.

ASSEMBLY

A small perforated board was used approx. 2 ½" by 1¾". Components were layed out as per the diagram below. For ease of wiring, and good practical design, sockets are used for the two 14 pins IC's .



Use a slightly larger board to start your work. Study the lay-out and notice that some of the wire connecting the pins of each IC are in black and others in red. On the face of the board mark the areas where the two IC's are to be located as well as the number of each IC pin to be connected by jumper- wire, marked in black on the lay-out. This can easily be done by inserting small wire size #22 or smaller into each pin holes before inserting the sockets .

Double check your jumpers insertion then gently press the sockets into the holes firmly on top of the jumpers . If you cannot insert the sockets on top of the jumpers enlarge the holes until you can fit the sockets. When this is accomplished , use a testmeter and check that connections are good on the socket connectors. Then turn the board over and solder the pins with the jumper wire connections. Check and double check before soldering -- one mistake and you may have to rip the socket out and redo the set-up with a new socket .

On the wiring side of the board solder the two jumper wiring connections under the CD4001 as indicated in red on the lay-out. Now you are ready to assemble all the components as they appear on the lay-out. Resistors lead wires should be formed to fit the four holes distance except for R7 which occupies more space. Capacitors and diodes use three holes. Feel free to modifiy as required .

R7 values required for proper voltage drop and zener current limit is 16.8K/ 2W. I subsituted two resistors on hand each of 33k/1W connected in parrallel. These large resistors should be installed away from the board as they will dissipate some heat.

For the rectifier bridge I used four rectifier diodes (1N4005) from my junk box. But you may use a rectifier brige module of equivalent specifications if you wish . Before installing the SCR make sure you have enought room for R9 , which incidentally may not be required after testing and substituted with a jumper connection to the gate .

Make sure that all the diodes are properly oriented with the end band being positive and laid out as shown.

As you can see on the lay-out most connections are made with the component leads cut at the connection points except for the positive and negative busses which can be made with a bare wire #20 from point to point. Holes must be made larger for connecting the AC wires at the bridge and SCR connections .

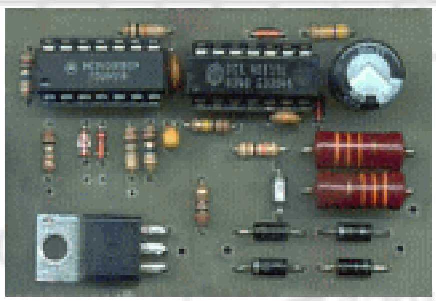
DO NOT INSTALL THE IC'S UNTIL A COMPLETE VOLTAGE CHECK IS DONE

TESTING

Satisfied that the board has been checked for errors, use a 9 volt source connected at the negative end of C4 and the positive at the junction of D8 and ZD1. Check for proper voltage minus the diode voltage drop (.5V) at pin #14 of each IC 's socket. If ok then disconnect the power source and install the ICs.

Then using 3 to 4 inches of wire make connections to the R11 potentiometer. With the shaft toward you, the wiper left connection is made to point A (D1)and the right to point B (D2). The center connection is made to points C (jumper R2 and R3). Then reconnect the power supply and with a scope connected from ground (neg.) to TP1 you should see a slow oscillation that you can vary with the rotation of R11. If no scope is available a voltmeter can be used to monitor a voltage deflection from zero to about 4.5 volts. In either case this is an indicatation that CD4001 is functioning properly. Until all connections are completed this is all we can test for.

The finished board actual size



Continued Construction and PART LIST

Circuitry	Construction	Parts List

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Home

Handy Dandy Little Circuits

Temperature Controlled Soldering Station

Circuitry | Construction | Parts List

Continued Construction

As you already have noticed no transformer is used for isolation in this circuit. It is *strongly* recommended that a plastic enclosure be used for safety in avoiding accidental shorts and shock from the AC line voltage. If a metal enclosure is used make sure that a ground line is used and the case is connected (grounded) to it as well as the AC outlet.

On the face of your enclosure, install the switch , neon and make your hole for the potentiometer. On the back of the case drill a hole for your line cord allowing enought wire length to reach the switch and secure the cord. As well cut the square hole to accept the AC input plug and then snap it in.

Before installing the PC board connections must made for the AC wiring. Use 4 to five inch lengths of AC wire soldered to the bridge and SCR connection on the board. Make sure no bare, high-voltage wire is accessible to the touch on top of the board.

Insert the PC board in the enclosure. Keep in mind where you'll be making external connections. As noted above, if you're using a metal cabinet see that it is well isolated. Solder the AC (black & white) input wires to the switch and the bridge AC wires from the board to the centre of the switch. Twist connect the positive wire from the bridge to one side of the AC outlet plug wire and the SCR output wire to the other side. Then twist connect the neon wires on each side and use the plastic screw caps to secure the two connections. Finally twist or solder the green wire from the AC cord to the ground connection of the AC outlet.

Final test

Remove the ICs and check your wiring connections. Then connect the AC and switch on the power. The neon should be off as the SCR is not firing. If the neon is on turn off the power and recheck everything.

If the first step checks out reinsert the IC's and turn on the power. The neon should be low but blinking, an indication all is well. Turn off the power. Connect a soldering iron to the AC plug on the back and reapply power. The neon should now be blinking brightly. Rotate the potentiometer and observe the change in the neon's cycling.

Troubleshooting

- With the soldering iron connected the neon light is weak or unstable.
  - The gate trigger signal may be too weak. Remove R9 and reconnect with a jumper wire to the gate.
- The neon stays on all the time and is not cycling.
  - With a scope or a voltmeter check TP2 for a pulse signal. If no signal is present go to the junction of R8, R6 and check for a steady stream of pulse from the negative line of the bridge. If all is well there the CD4011 IC may be defective. Improper insertion may have damaged the IC. Replace it.
  - Go to TP1 and check that CD4001 is oscillating if not check D1, D2 for open or short circuit.
  - With the power on check for proper voltage supply at pin#14 of the IC's and the pos. end of C4. The voltage should be fluctuating within .5V if the SCR is working. If supply voltage is not present check D4 as it may be open. If more or less than 5Vdc check the junction of ZD1 and R7. If the

voltage is too high or zero change the Zener diode.

- One or both of the ICs may be defective. Check all the diodes and rectifiers for an open-circuit state. One more final point, it is sad to say, is that the SCR you have installed may not be compatible or sensitive enough to the gate signal level.

Notes

After you have everything working and you may find that the iron's heat range is too high or too low. I'm sorry to declare that all parts are not made equal. Consequently the C3 value may be too high or too low. You would do well to have several values on hand. I'd suggest from 2.2uf to 6.uf to test for the best range acceptable to you. Alternately install a DPST switch to add another heat range between the Neg. bus and pin 6 of CD4001. Another option is to increase the value of R11 to 2M ohms and lower the value of C3 .

One more point, stick with high-quality parts -- you'll be rewarded with a first class tool that you'll be proud to own and work with for many years. Have fun.

Parts List

RESISTANCES (all 1/4 W / 10%) Except for R7 * See text

¤ R1,R4 100k
¤ R2, R3 1Meg
¤ R5,R8 10K
¤ R6 100K
¤ R7 16.8K/2W or 2 @ 33k/1W (R7a,R7b)
¤ R9 100 ohms
¤ R10 470K
¤ R11 1Meg potentiometer

CAPACITORS

¤ C1,C2 0.01uf disc.
¤ C3 3.3uf/15V electrolitic (see text)
¤ C4 200uf/25V electrolitic

ICs

¤ IC1 CD4001 Quad 2- input NOR Gate 14 pins Dip
¤ IC2 CD4011 Quad 2- input NOR gate 14 pins Dip

Diodes/Rectifiers

¤ D1 - D4 1N4148
¤ D5 - D8 1N4003 (200V/1A) or PC mount rectifier bridge with same rating or higher
¤ ZD1 8.2V/1W (1N4738, 1N3018) or 9.1V/1A (1N4739 , 1N3019)
¤ SCR MCR106 (400V/4A) or equivalent

Other Parts

¤ neon One colour capsule with resistor (Panel mounting type)
¤ Socket 14 pins DIP 2-ea
¤ Switch One DPDT toggle , small panel mount (120V/6A rated)
¤ AC Socket One square input plug for panel mounting "press to fit"
¤ Cabinet 3"x3"x4" sturdy plastic preferred for good isolation (see text)
¤ One control knob
¤ AC line cord 3ft with ground plug (see text)
¤ AC wire connectors 2-ea plastic screw type medium size.
¤ Stick on rubber or plastic foot buttons 4-ea.

Circuitry	Construction	Parts List

Modified SCR

Questions and comments to roma60@home.com

Home