QUASAR ELECTRONICS KIT No 1076
ELECTRONIC TEMPERATURE SWITCH (-45 °C TO +145 °C).

General Description

A unit that is ideal for use in applications where the continuous control of the temperature is required. It is also suitable for use in the cases that a temperature switch is necessary for the operation of a device.
Some possible applications include the continuous control of temperature in systems like air conditioning, central heating, refrigeration, etc.
The continuous monitoring of temperature within audio amplifiers, radio transmitters, or internal combustion engines, is also possible.

Technical Specifications - Characteristics

- Supply voltage: ....7V DC.
- Current consumption: ....50 mA max.
- Ability to adjust the relay activation point within a temperature range from -45 °C to +145 °C.
- Ability to adjust the relay activation hysterisis within a range from 1 °C to 7 °C.

How it Works

Integrated circuit IC1 (LM311) and IC2 (LM35) form the heart of the unit. IC2 (LM35) is the temperature sensor of the unit, while IC1 (LM311) forms the switching control circuit of the unit.
The functioning of each one of the two integrated circuits will now be examined.
IC2 (LM35) is an integrated circuit whose output is directly proportional to its temperature. LM35 requires no external adjustment. It provides an accuracy of +/- 1/4 °C at room temperature and +/- 3/4 °C within the range between -55 °C and +150 °C. Such an accuracy is possible thanks to the very low power consumption of the integrated circuit. A mere 60 uA current is required for the IC to operate. This renders the self-heating effect of the IC, negligible. The output voltage changes by 10mV for each degree °C of temperature change, throughout the temperature range of interest.
IC1 (LM311) is a voltage comparator integrated circuit. It compares the voltages present at its inputs and drives the relay driver circuit accordingly.
These two integrated circuits are used in order to form the temperature switch circuit. As specified above, the switch is required to operate within a range from -45 °C to +140 °C, approximately. IC2 provides an output voltage of about 10 mV for each degree °C. This results to an output voltage of 1V at 100 C. The output voltage becomes very small though for temperatures below 0 °C. This is mainly due to the voltage supply provided to IC2.
Diodes D1 and D2 are used in order to raise the voltage of the ground pin of IC2. Thus, the ground voltage of IC2 becomes about 0.9 V to 1.1 V and enables the IC to provide an output voltage that remains within the operating range of the comparator, IC1, even at temperatures below 0 °C. In this way, the operating range of the switch is extended to a very low

temperature level.
Zener diode D3 is used in order to form a constant voltage source. The voltage of this source is 2.5V and the special characteristics of the zener diode ensure a temperature stability of 1% throughout the temperature range under consideration. Resistor R4 is used to bias the zener diode.
The voltage generated in this way is fed to the voltage divider formed by trimmers P3 and P4, resistor P1 and resistor R12. Trimmers P3 and P4 set the upper and lower range limits of the switch. Variable resistor P1 is adjusted by the user so as to set the point at which the switch relay will be activated. In effect, P1 sets the voltage fed to the non-inverting input of the comparator IC1.
Resistors R2 and R5 are connected at the inputs of comparator IC1 so as to adjust the load seen by the integrated circuit. Since the two resistors have equal values, the IC is provided with two signals of equal load. Resistors R13 and zener diode D5 ensure a constant 5V supply to IC1. Variable resistor P2 may be set to adjust the hysterisis of the switch within a range of 1 °C to 7 °C.
Any abrupt changes in temperature will be reflected by abrupt changes in the output of IC2. Capacitor C6 is used to prevent such changes in the input signal level, from reaching IC1. The output of IC1 is used in order to drive the low pass filter formed by R7, R8, C4 and C5. This filter is used in order to suppress any high frequency transitions that might occur at the output of IC1, due to some abrupt temperature changes whose effect has not been reduced by C6. The output of the filter is then used to drive transistor TR1 and, therefore, switch the relay on and off. Diode D4 protects the circuit from the reverse voltage pulses that occur during the switching of the relay coil.
Additionally, the output of IC1 is also used to drive the transistor TR2. This is done through resistor R9. As a result, LED D6 lights up whenever the unit's relay is activated.
Finally, a small power supply unit is also included. it is formed by transformer T1, capacitors C1, C2 and C3, resistor R11 and LED D7. The latter lights up to indicate the operation of the unit whenever the power supply provides 7V DC to the circuit.
NOTE: resistor R14 and capacitor C8 are required in the case that IC2 is situated at a distance greater than 1m away from the main unit. The RC network that they form is used in order to decouple the load imposed on the circuit by the cable connecting the sensor to the main unit.

Construction

It is easy to assemble this kit, provided that the basic rules of circuit assembly work, are followed. All components must lie flat on the printed circuit board. It is best to start by installing the lowest height components first (resistors, diodes, etc.) then solder them. Work through the various height components in stages. Check orientation of diodes, electrolytic capacitors, ICs and transistors matches the polarity shown at the schematic layout diagram of the PCB. Use sockets provide for the ICs. Jumper J1 should not be omitted.
Use a 25 watt soldering iron and the solder provided or a rosin cored solder. Do not use additional soldering flux. Make sure that both the component lead and the PCB pad are heated at the same time. The solder that is applied to the pad must just sufficient to make a good joint. After the removal of the iron, the solder must be shiny, with a metal-like look, and must cover the whole of the pad. Transformer T1 is installed on the PCB last. Insert IC1 into it's socket checking orientation against schematic layout diagram of the PCB Take a good

look at the PCB in order to spot any mistakes, any omissions, solder bridges, etc.
NOTE: Resistor R14 and capacitor C8 must be soldered close to IC2, only in the case that the sensor - IC2 - is installed at a distance greater than 1m away from the rest of the circuit. In this case, the pins of IC2, resistor R14 and capacitor C8 should be insulated with the use of silicone grease and a heat shrinking tube. Take care not to cover the body of IC2, otherwise, the temperature readings provided by the IC will be inaccurate and will cause a great deal of problems later on.
In the case that IC2 is installed at a distance from the main PCB, a two wire, coaxial cable should be used in order to connect it to the rest of the circuit.

Adjustments

As far as the circuit's adjustment is concerned, an effort was made in order to minimise any adjustment requirements while obtaining a maximum performance out of the circuit. Two possible adjustment procedures are presented below:

Adjustment procedure No 1.
A good quality (preferably digital) multimeter is required during this adjustment procedure. Variable resistors P1 and P2 are mounted onto the front panel of the kit, where two suitably marked scales have been printed. The front panel is provided together with the kit and is essential to use it during the adjustment procedure of the circuit.
Power is provided to the circuit and LED D7 lights up to indicate the circuit's operation.
Select the multimeter's 0-20 V scale.
1. Connect the positive lead of the multimeter onto point TP3 on the PCB Also connect the negative lead of the multimeter onto the jumper J1. Take a note of the multimeter's reading (the reading will be used later on).
2. Connect the positive lead of the multimeter onto point TP2 on the PCB Also connect the negative lead of the multimeter onto the jumper J1. Take a note of the multimeter's reading. Set the variable resistor P1 (mounted on the front panel of the unit) so as to point at the 0 °C reading. Use a small screwdriver so as to adjust trimmer P4 and, thus, obtain a multimeter reading that will be equal to the one recorded during step 1, above.
3. Connect the positive lead of the multimeter onto point TP2 on the PCB Also connect the negative lead of the multimeter onto the jumper J1. Take a note of the multimeter's reading. Set the variable resistor P1 (mounted on the front panel of the unit) so as to point at the 100 °C reading. Use a small screwdriver so as to adjust trimmer P3 and, thus, obtain a multimeter reading that will be exceeding the one recorded during step 1, above, by 1 Volt. In this way, in the case that the recorded reading was 0.97 Volts during step 1, the required reading should be 0.97 V + 1 V : ....1.97 V.

Since both trimmers P3 and P4 alter the circuit's adjustment, the three steps described above should be repeated until the unit establishes the greatest possible accuracy. The temperature switch will be able to offer its reliable services as soon as these steps have been completed.

Adjustment procedure No 2.
Like in the adjustment procedure described above, a good quality multimeter will be required in this case, too. Additionally, a bowl full of ice and a bowl full of boiling water will also be required.

1. Place the sensor IC into the bowl containing the ice. Allow a few minutes to elapse. Adjust the variable resistor P1 so as to point at the 0 °C reading at the unit's front panel. Adjust the variable resistor P2 so as to point at the 1 °C hysterisis. Use a small screwdriver so as to adjust trimmer P4 until the multimeter's reading between TP1 and TP3, is equal to zero.
2. Place the sensor IC into the bowl containing the boiling water. Allow a few minutes to elapse. Adjust the variable resistor P1 so as to point at the 100 °C reading at the unit's front panel. Adjust the variable resistor P2 so as to point at the 1 °C hysterisis. Use a small screwdriver so as to adjust trimmer P3 until the multimeter's reading between TP1 and TP3, is equal to 1 volt exactly.

Both steps 1 and 2 should be repeated until the accuracy of the adjustments reaches an acceptable level.

Warning

Quasar Electronics kits are sold as stand alone training kits.
If they are used as part of a larger assembly and any damage is caused, our company bears no responsibility.

While using electrical parts, handle power supply and equipment with great care, following safety standards as described by international specs and regulations.

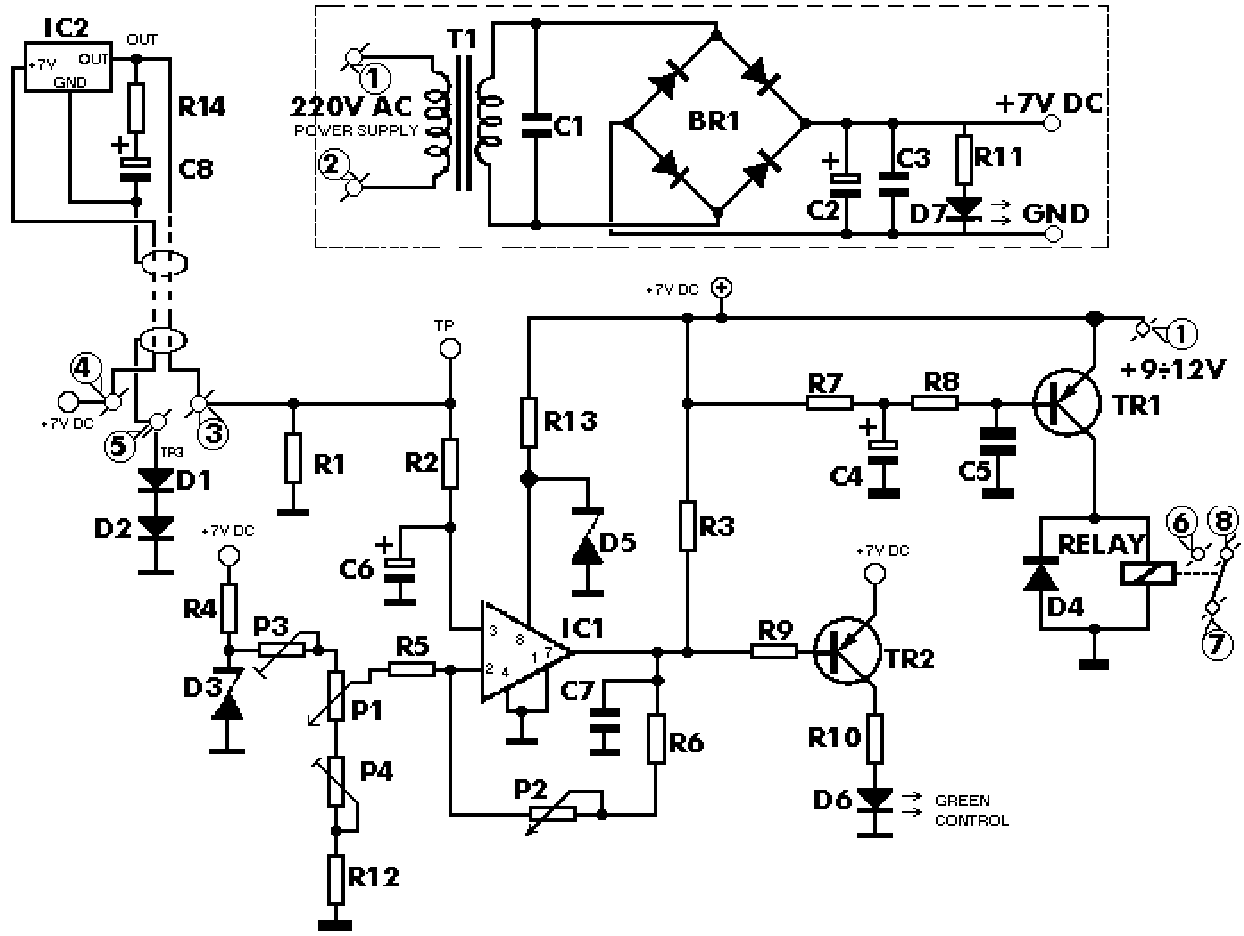
CAUTION
This circuit works from the mains and there are 220 VAC pre sent in some of its parts.
- Voltages above 50 V are DANGEROUS and could even be LETHAL.
- In order to avoid accidents that could be fatal to you or
- members of your family please observe the following rules:
- DO NOT work if you are tired or in a hurry, double check everything before connecting your circuit to the mains and be ready to disconnect it if something looks wrong.
- DO NOT touch any part of the circuit when it is under power.
- DO NOT leave mains leads exposed. All mains leads should be well insulated.
- DO NOT change the fuses with others of higher rating or replace them with wire o r aluminium foil.
- DO NOT work with wet hands.
- If you are wearing a chain, necklace or anything that may be hanging and touch an exposed part of the circuit BE CAREFUL.
- ALWAYS USE a correct mains lead with the correct plug and earth your circuit correctly.
- If the case of your project is made of metal make sure it is properly earthed.
- If it is possible use a mains transformer with a 1:1 ratio to isolate your circuit from the mains.
- When you are testing a circuit that works off the mains wear shoes with rubber soles, stand on dry non conductive floor and keep one hand in your pocket or behind your back.

- If you take all the above precautions you are reducing the risks you are taking to a minimum and this way you are protecting yourself and those a round you.
- A carefully built and well insulated device does not constitute any danger for its user.
BEWARE: ELECTRICITY CAN KILL IF YOU ARE NOT CAREFUL.

If it does not work

Check your work for possible dry joints, bridges across adjacent tracks or soldering flux residues that usually cause problems.
Check again all the external connections to and from the circuit to see if there is a mistake there.
- See that there are no components missing or inserted in the wrong places.
- Make sure that all the polarised components have been soldered the right way round. - Make sure the supply has the correct voltage and is connected the right way round to your circuit.
- Check your project for faulty or damaged components.
If your project still fails to work, please contact us for information about our Get-You-Going service.

Electronic Diagram



Parts List

All components including printed circuit board, assembly instructions including schematics and detailed parts list are supplied when you purchase the kit.

Ordering

For pricing info and online ordering please visit:

http://www.quasarelectronics.com/1076.htm

For further info please contact us by e-mail:

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