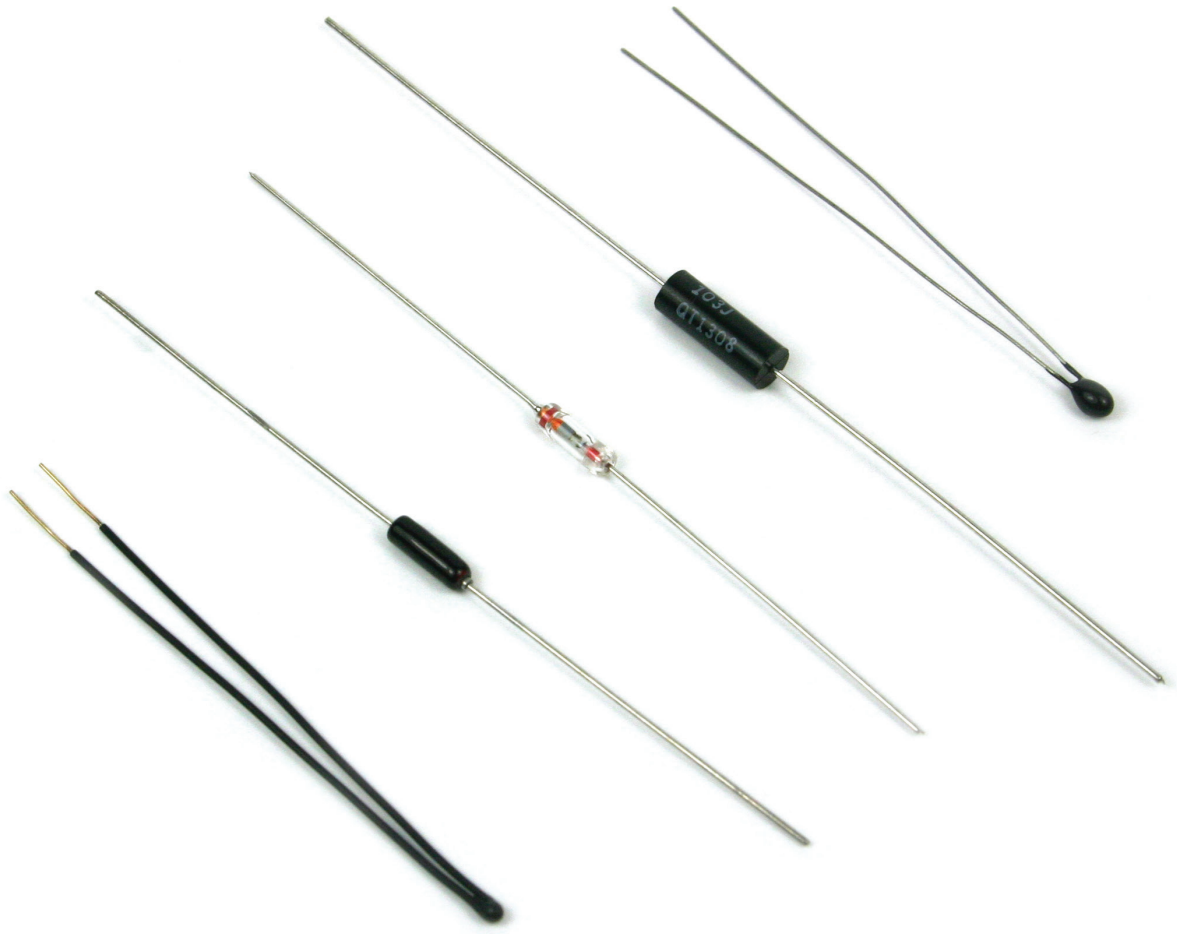
Qti
Sensing Solutions

HOW-TO GUIDE

TEMPERATURE CONTROLLER

QTI Engineering Department



HOW IT WORKS

Resistors R1 and R2 form a voltage divider, presenting ½ the power supply voltage to the positive input of the operational amplifier. The thermistor and the resistor form another voltage divider, to the negative input of the amplifier. The exact value of this divider depends on the resistance of the thermistor, which varies with temperature. In this way, the voltage to the negative input to the operational amplifier varies, and the amplifier changes its output depending on which of the two inputs is more positive. If the temperature is too low, the thermistor resistance is high, and the voltage to the negative input terminal is lower than the positive input. The operational amplifier amplifies this difference and forces the operational amplifier output high, turning on the relay. The value of R4 should be selected to be equal to the thermistor resistance at the temperature to be controlled. Looking at the QTI website (www.thermistor.com) you may select a 10K thermistor. Looking at the R/T curve we can see that at 32 degrees Fahrenheit (0˚C) the resistance is 34,903 ohms. Choosing a 33K would get us very close to the proper value. Using the two resistor/potentiometer combination would allow you to adjust the voltage divider to exactly 32 degrees. The results of this effort would be that the relay would be energized if the temperature were too low. If you were trying to heat, you would choose the COMMON and NORMALLY OPEN terminal of the relay to turn on a heater. If you were trying to cool, you would choose the COMMON and NORMALLY CLOSED terminals. We have added a transistor to the output of the amplifier, since the amplifier by itself cannot generate enough current to close the relay. The transistor amplifies the current of the amplifier, and delivers it to the relay.

For the math oriented…
The output of a voltage divider is equal to
Vout = Vin * R1/(R1+R2)
For a thermistor
Vout = Vin * Rthermistor/(Rthermistor+R2)

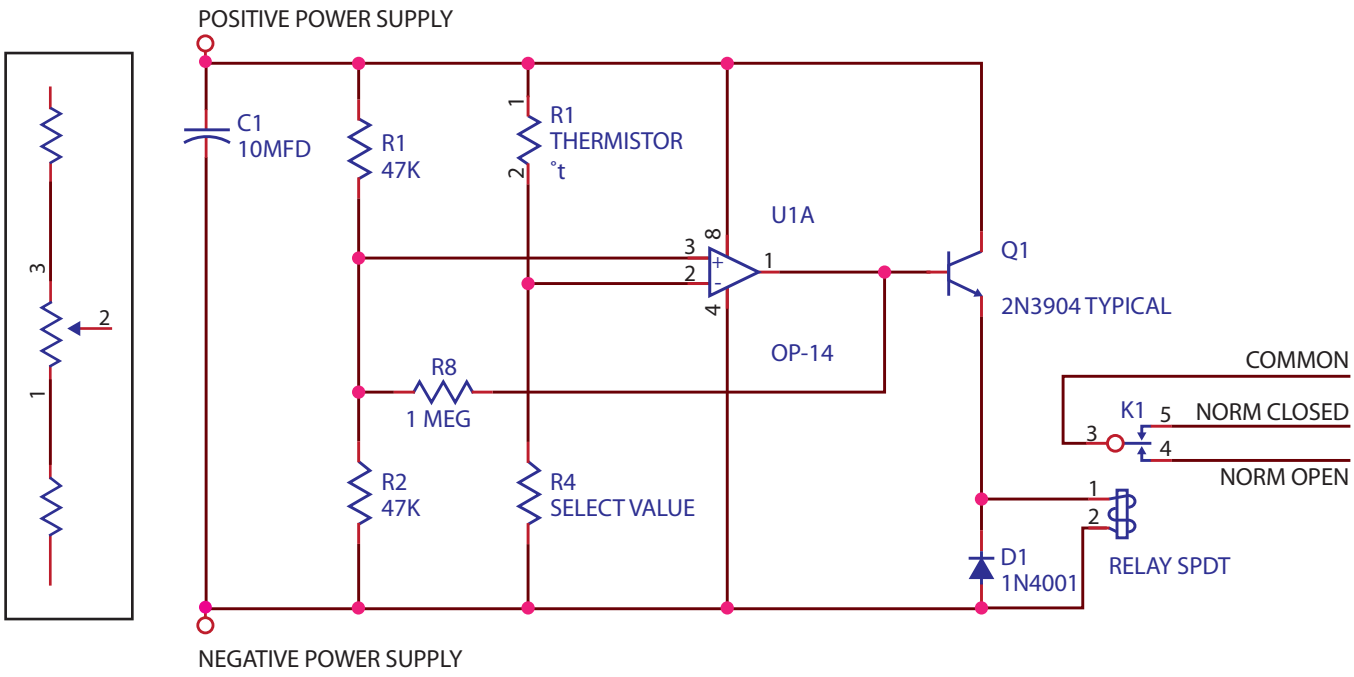
PARTS LIST

Name	Designator	Part Number	Vendor Number
Operational Amplifier	U1L	M741CN	276-007
Resistor	R1, R2	47k ohms	271-1342
Resistor	R8	1 Meg ohms	271-1356
Transistor NPN	Q1	2N3904	276-2016
Diode	D1	1N	4001276-1101
8 Pin Socket	none	none	276-1995
PC Board	none	none	276-150
Relay	K1	none	275-217
Capacitor	C1		

ALTERNATE PARTS

Name	Part Number	Vendor Number
Potentiometer	100k ohm trimmer	271-284
	10k ohm trimmer	271-282
	1k ohm trimmer	271-280

PARTS DIAGRAM



NOTES

R1 and R2 should be equal in value.

RT1 is the thermistor selected.

R4 is equal in value to the thermistor resistance at the control temperature selected.

Select a power supply (such as a 'wall supply') equal to the relay voltage. If you have a 12 volt relay (or 6 volt) , select a 12 volt supply (or 6 volt). Do not exceed 12 volts!

The resistors and potentiometer in the dashed lines may substitute for R1 and R2, if you would like a variable temperature control. Select a potentiometer equal to R1 and R2 for a wide range of control, and a smaller value (5K) for a narrow range.

The relay will be energized when the thermistor resistance is higher (temperature lower) than the set point resistor (R4). Use the relay COMMON wire and the relay NORMALLY OPEN wire to energize your heater. Use COMMON and NORMALLY CLOSED to energize your cooler.

Be sure to select a relay whose contacts are able to handle the voltage and amperage of heater/cooler assembly.

Q1 is any NPN transistor, such as a 2N3904. U1 is any operational amplifier such as an LM741CN.

R8 is added to eliminate any relay 'chatter'. It will determine the difference between the on and off temperatures of the controller. Make it larger in value for smaller differences in control.

ABOUT QTI SENSING SOLUTIONS

QTI Sensing Solutions was founded in 1977 to meet the increasing demand for high quality electronic components for the aerospace industry. Since then, QTI has exceeded the requirements of some of the most stringent high cost of failure applications, changing the landscape of the supply chain for the entire industry.

Today, QTI continues to maintain its leadership position for mission-critical applications as well as for medical and industrial applications by supplying the world's top companies with innovative products and services. In fact, QTI developed the highest standard for surface mount thermistors with the introduction of qualified surface mount parts to MIL-PRF-32192; supplying design engineers with fully qualified Defense Logistics Agency options for two PTC and three NTC surface mount package styles. Additionally, QTI has partnered with the NASA Goddard Space Flight Center for surface mount thermistors qualified to S311-P827, an industry first!

In addition to QTI's accomplishments, our ISO:09001:2000 and AS9100 certified manufacturing and testing facilities in Idaho enhances our ability to meet the needs of today's challenging temperature measurement and control applications.

LEARN MORE

If you would like to learn more about how QTI can help you, please contact us today. We would be happy to discuss your project with you and help with the product selection process. Additionally, if you are unable to find the item you need, our engineers may be able to produce a custom component for your individual application.

Qti
Sensing Solutions

2108 Century Way Boise, Idaho 83709 USA
T: (208) 377-3373, 800-554-4784 | F: (208) 376-4754
qtisales@thermistor.com | www.thermistor.com