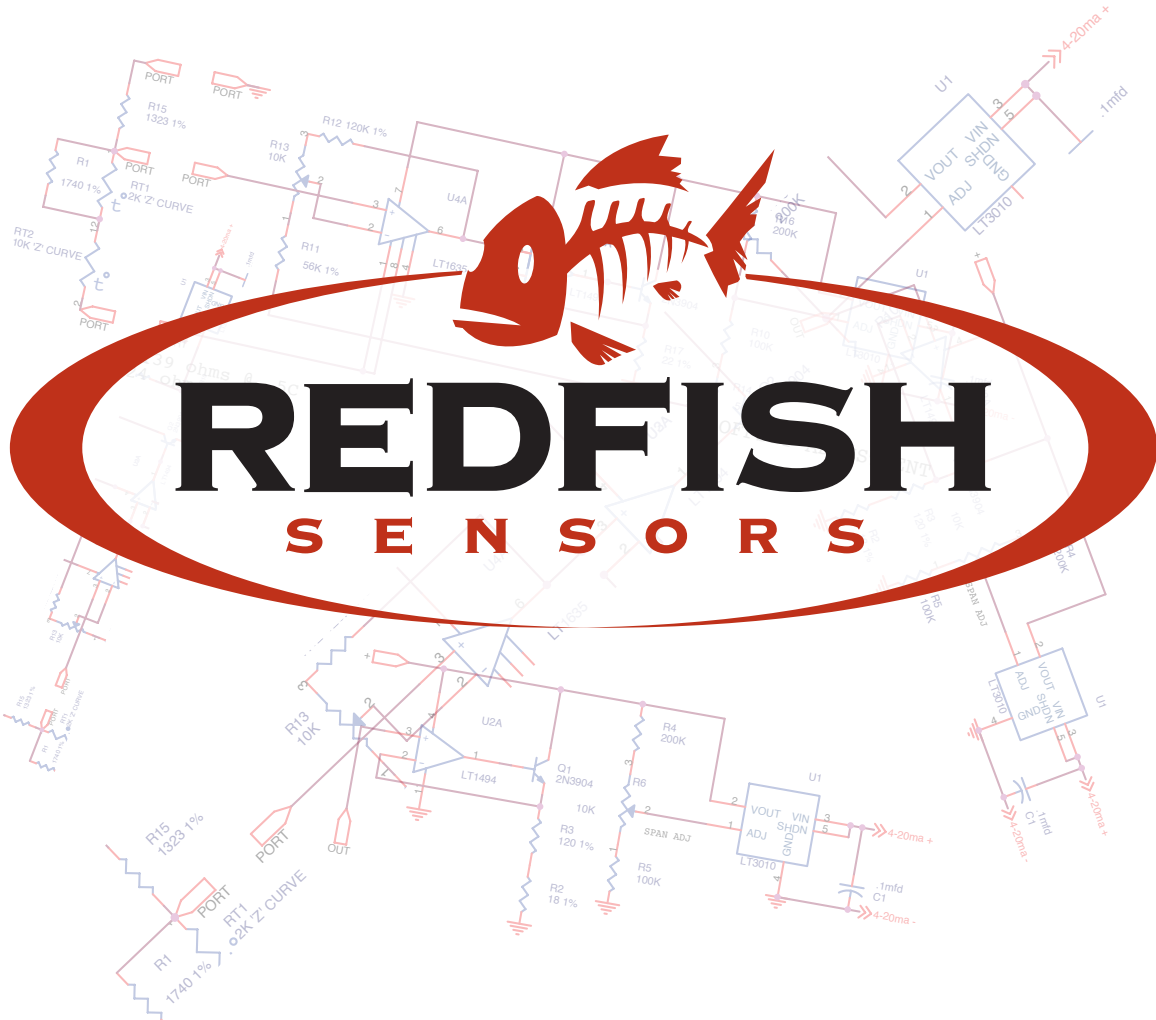


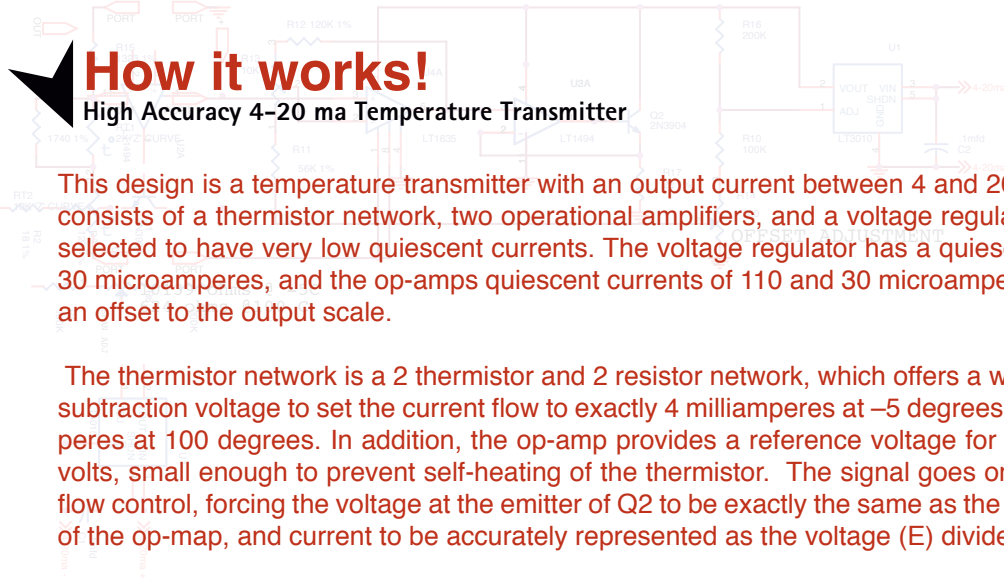
4-20 ma Temperature Transmitter





How it works!

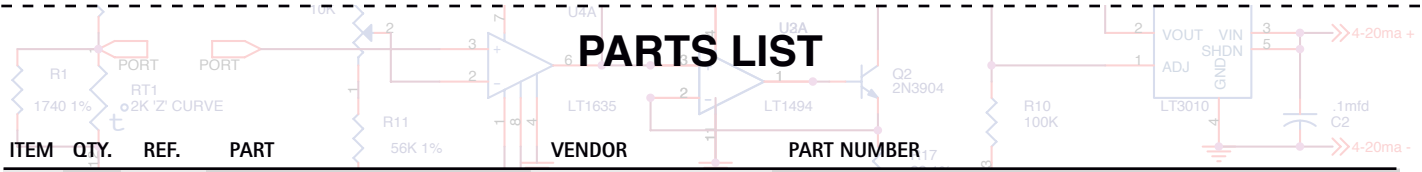
High Accuracy 4-20 ma Temperature Transmitter



This design is a temperature transmitter with an output current between 4 and 20 milliamperes. The system consists of a thermistor network, two operational amplifiers, and a voltage regulator. These components are selected to have very low quiescent currents. The voltage regulator has a quiescent current (idle current) of 30 microamperes, and the op-amps quiescent currents of 110 and 30 microamperes. These idle currents are an offset to the output scale.

The thermistor network is a 2 thermistor and 2 resistor network, which offers a wide network, and provides a subtraction voltage to set the current flow to exactly 4 milliamperes at -5 degrees Centigrade, and 20 milliamperes at 100 degrees. In addition, the op-amp provides a reference voltage for the thermistor network of .2 volts, small enough to prevent self-heating of the thermistor. The signal goes on to op-amp (U3) for current flow control, forcing the voltage at the emitter of Q2 to be exactly the same as the voltage on the positive input of the op-map, and current to be accurately represented as the voltage (E) divided by the 22 ohm resistor (R).

PARTS LIST



ITEM	QTY.	REF.	PART	VENDOR	PART NUMBER
1	1	Q2	Transistor, NPN, 2N3904	Digikey	2N3904FS-ND
2	1	RT1	Thermistor, 2K 'Z' Curve	Quality Thermistor	QTMC-6F
3	2	RT2	Thermistor, 10K 'Z' Curve	Quality Thermistor	QTMC-14F
4	1	R1a	Resistor, 1500 1%	Digikey	P1.50KCACT-ND (in series with R1b, see note below)
5	1	R1b	Resistor, 240 1%	Digikey	P240CACT-ND (in series with R1a, see note below)
6	1	R17	Resistor, 22 1%	Digikey	P22.0CACT-ND
7	1	R16	Resistor, 200K 5%	Digikey	P200KCACT-ND
8	2	R10	Resistor, 100K 5%	Digikey	P100KCACTG-ND
9	2	R13	Trim Pot, 10K	Digikey	490-2094-ND
10	1	R7a	Resistor, 1000 1%	Digikey	P1.00KCACT-ND (in series with R7b, see note below)
11	1	R7b	Resistor, 330 1%	Digikey	P330CACT-ND (in series with R7a, see note below)
12	1	R11	Resistor, 56K 1%	Digikey	P56.0KCACT-ND
13	1	R12	Resistor, 120K 1%	Digikey	P120KCACT-ND
14	1	R14	Trim Pot, 500	Digikey	490-2756-ND
15	1	U1	Regulator, LT3010	Digikey	LT3010CN8-ND
16	1	U2	Op Amp, LT1494	Digikey	LT1494CN8-ND
17	1	U4	Op Amp, LT1635	Digikey	LT1635CN8-ND
18	1	C3	Capacitor, 1MFD	Digikey	P824-ND
19	1	C2	Capacitor, 0.1MFD	Digikey	BC1154CT-ND
20	1		Case	Digikey	SRA21
21	1		PCB, Prototype Board	Radio Shack	276-150

Note: R1a+R1b = 1740 1% and R7a+R7b = 1323 1% resistors must be as close as possible to the nominal values. Any error detracts slightly from the linearity.



How it works!

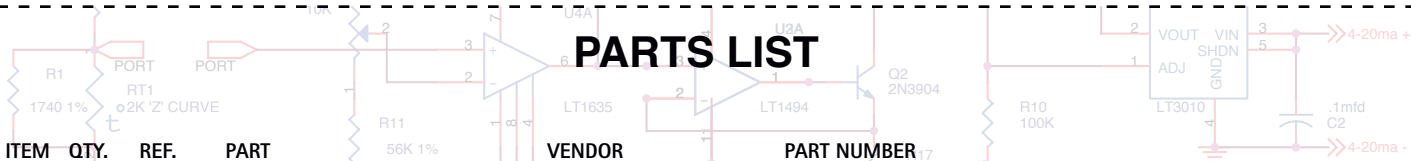
Low Cost 4-20 ma Temperature Transmitter

This design is a temperature transmitter with an output current between 4 and 20 milliamperes. The system consists of a thermistor network, an operational amplifier, and a voltage regulator. These components are selected to have very low quiescent currents. The voltage regulator has a quiescent current (idle current) of 30 microamperes, and the op-amp quiescent currents of 30 microamperes. This idle current is an offset to the output scale.

The user has a choice between a simple network of a resistor and thermistor, with an accuracy of ± 0.2 degrees (see Quality thermistor bridges) over a temperature range of 0 to 70 degrees Centigrade, or a thermistor network of 2 thermistors and 2 resistors, which offers a -5 to 100 degrees Centigrade range of temperature and excellent linearity (± 0.75 degrees) and accuracy.

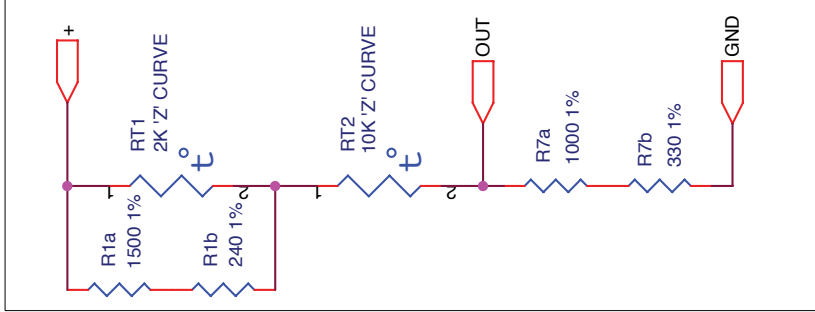
In the diagram the op-amp (U2) amplifies the voltage from the thermistor and resistor network, forcing the voltage at the emitter of Q2 to be exactly the same as the voltage on the positive input of the op-amp, and current to be accurately represented as the voltage (E) divided by the R3/R2 resistors (R).

Note that this system supplies a 'span' control (the ratio of low to high output) in R6, but requires the 4 to 20 milliamp current receiver to be capable of adjustment of both offset and span for best accuracy.



PARTS LIST

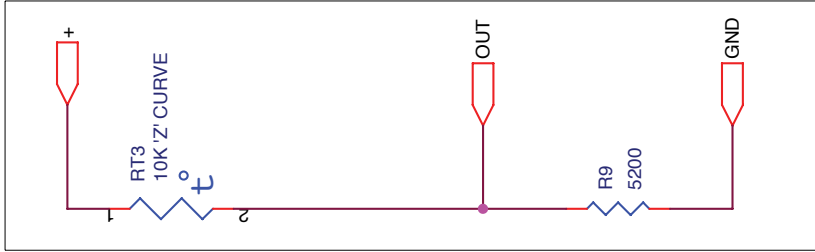
ITEM	QTY.	REF.	PART	VENDOR	PART NUMBER
1	1	Q2	Transistor, 2N3904	Digikey	2N3904FS-ND
2	1	R3	Resistor, 120 1%	Digikey	P120CACT-ND
3	1	R2	Resistor, 18 1%	Digikey	P18.0CACT-ND
4	1	R4	Resistor, 200K 5%	Digikey	P200KCACT-ND
5	2	R5	Resistor, 100K 5%	Digikey	P100KCACTG-ND
6	2	R6	Trim Pot, 10K	Digikey	490-2094-ND
7	1	U1	Regulator, LT3010	Digikey	LT3010CN8-ND
8	1	U2	Op Amp, LT1494	Digikey	LT1494CN8-ND
9	1	C4	Capacitor, 1MFD	Digikey	P824-ND
10	1	C1	Capacitor, 0.1MFD	Digikey	BC1154CT-ND
11	1		Case	Digikey	SRA21
12	1		PCB, Prototype Board	Radio Shack	276-150



WIDE RANGE NETWORK

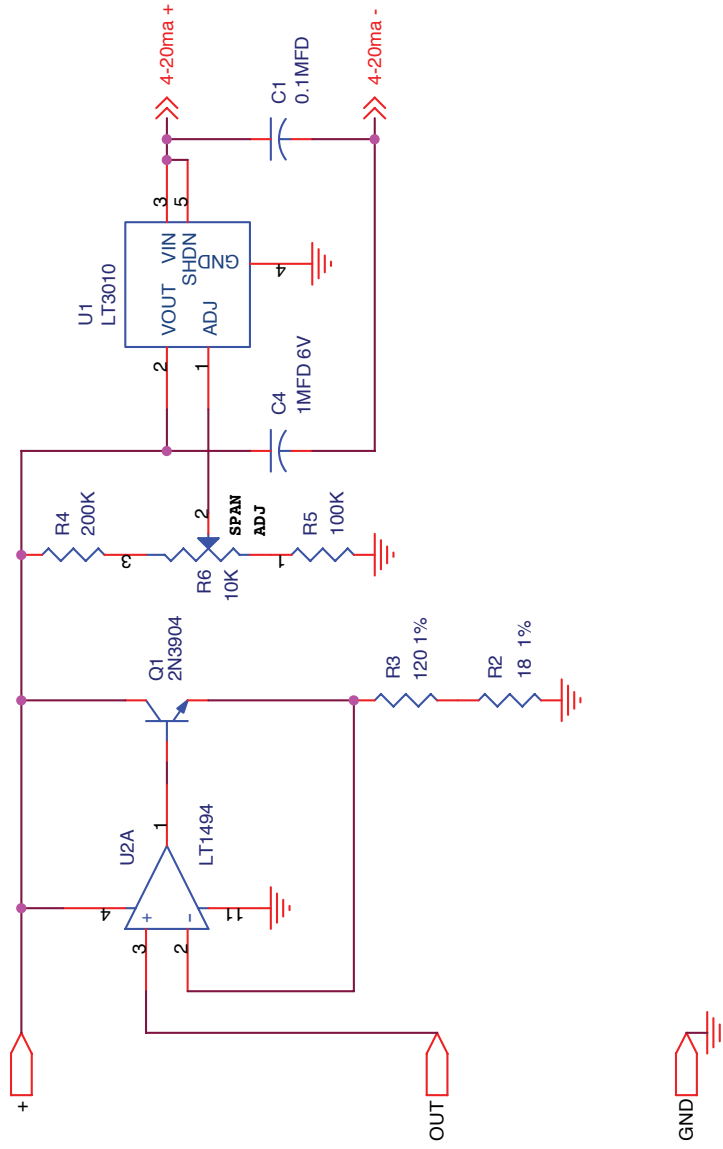
10139 @ -5C
624 @ 100C

For this network, remove R2!



LOW COST NETWORK

11160.9 @0 C
685 @100 C



Title		Richard Becker www.nanomeasure.net	
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