Data Sheet

Semiconductor temperature sensor

RS stock number 308-809

The RS590 semiconductor temperature sensor is functionally a two terminal IC which produces an output current proportional to absolute temperature. For supply voltages between +4V and +30Vdc the device acts as a high impedance constant current regulator passing 1μA per degree Kelvin. Linearisation circuitry, precision voltage amplifiers, resistance measuring circuitry or cold junction compensation are not required for basic temperature measurement.

The RS590 is ideal in remote sensing applications. The device is virtually insensitive to voltage drops over long lines due to its high impedance current output provided the connection cable used is a twisted pair and well insulated.

Specification

Typical at +25°C (298.2K) and V_S = 5V unless otherwise stated.

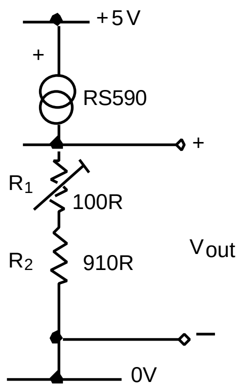
Absolute maximum ratings

Forward voltage (+ to -)	+44V
Reverse voltage (+ to -)	-20V
Breakdown voltage (Case to + or -)	±200V
Rated performance temp. range	-55°C to +150°C
Storage temperature range	-65°C to +175°C
Lead temperature (soldering, 10 sec)	+300°C

Power supply

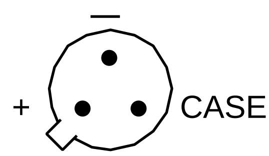
Operating voltage range	+4V to +30V

Figure 1 **Calibration error trim at single point temperature**



To trim the above circuit, the temperature of the RS590 is measured by a reference temperature sensor and R_1 is trimmed so that V_{out} = 1mV/K at that temperature.

PIN CONNECTIONS



TO 52 Package

PIN VIEW

Output

Nominal current output	298.2μA
Nominal temperature coefficient	1μA/°C
Calibration error	±2.5°C max.
Absolute error[2] (over rated performance temperature range)	
Without external calibration adjustment	±5.5°C max.
With +25°C calibration error set to zero	±2.0°C max
Non-linearity	±0.8°C max.
Repeatability	±0.1°C max.
Long term drift[1]	±0.1°C max.
Current noise	40pA/√Hz
Power supply rejection	
+4V < VS < +5V	0.5μA/V
+5V < VS < +15V	0.2μA/V
+15V < VS < +30V	0.1μA/V
Case isolation to either lead	1010Ω
Effective shunt capacitance	100pF
Electrical turn-on time[2]	20μs
Reverse bias leakage current[3] (Reverse voltage = 10V)	10pA

Notes:

1 Conditions: constant +5V, constant +125°C
2 Does not include self heating effects
3 Leakage current doubles every 10°C.

Operation

As previously stated the output of the RS590 is basically a proportional to absolute temperature (PTAT) current regulator ie. the output is equal to a scale factor multiplied by the temperature of the sensor in degrees Kelvin.

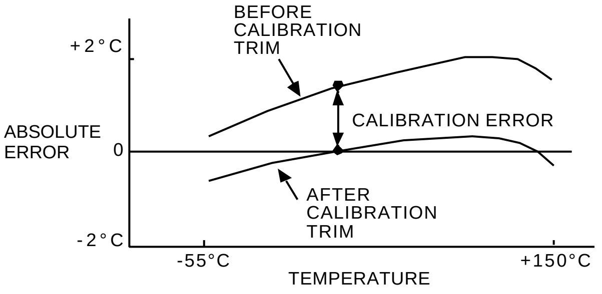
Calibration error

The difference between the indicated temperature and actual temperature is called the calibration error. Since this is a scale factor error, it is relatively simple to trim out. Figure 1 shows the most elementary way of accomplishing this.

Each RS590 is tested for error over the temperature range with calibration error trimmed out.

This error consists of a slope error and some curvature, mostly at the temperature extremes. Figure 2 shows a typical temperature curve before and after calibration error trimming.

Figure 2 **Effect of calibration error trim on accuracy at single point temperature**



Non-linearity

Non-linearity as it applies to the RS590 is the maximum deviation of current over the entire temperature range from a best fit straight line. Figure 3 shows the non-linearity of the typical RS590 from Figure.2.

Figure 3 **Non-linearity**

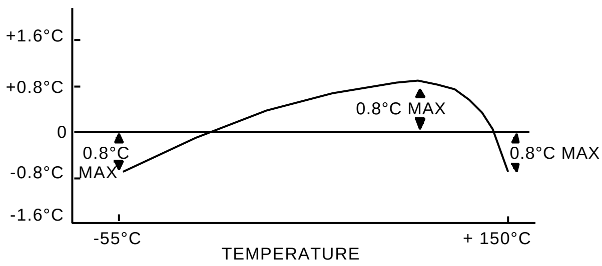
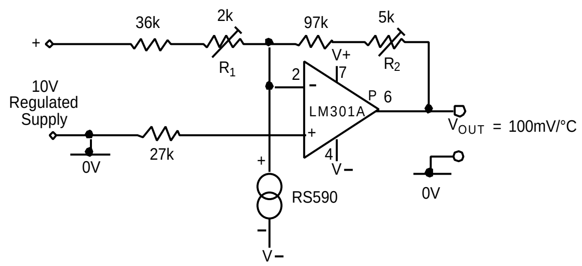


Figure 4A. shows a circuit in which non-linearity is the major contribution to error over temperature. The circuit is trimmed by adjusting R_1 for a 0V output with RS590 at 0°C. R_2 is then adjusted for 10V out with the sensor at 100°C. Other pairs of temperatures may be used with this procedure as long as they are measured accurately by a reference sensor. Note that for +15V output (150°C) the V+ supply to the op-amp must be greater than 17V. Also note that V- should be at least -4V: if V- is ground there is no voltage applied across the device.

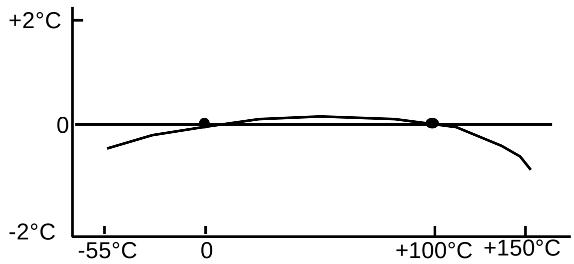
Note: Resistor values are typical and may need alteration depending upon magnitude of V-.

Figure 4A **Two point temperature trim**



LM301AP **RS** stock no. 307-244

Figure 4B **Typical two-trim accuracy**



Series/Parallel connection

Several RS590 devices may be connected in series as shown in Figure 5. This configuration allows the minimum of all the sensed temperatures to be indicated. Connecting the sensors in parallel (Figure 6) indicates the average of the sensed temperatures.

Figure 5 **Series connection**

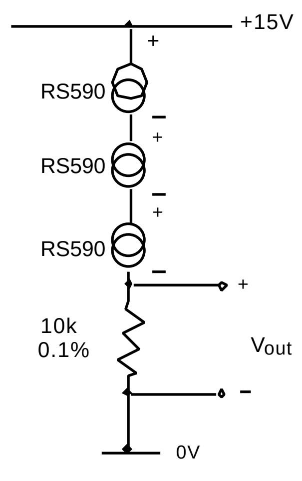
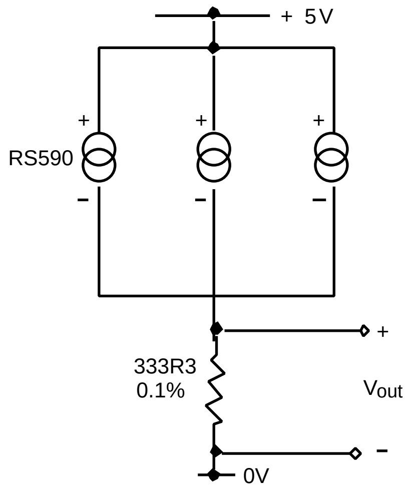


Figure 6 **Parallel connection**

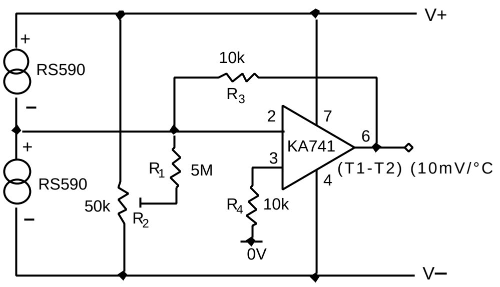


Differential temperature measurement

Figure 7 illustrates one method by which differential temperature measurements can be made.

R_1 and R_2 may be used to trim the output of the op-amp to indicate a desired temperature difference.

Figure 7 **Differential temperature measurement**

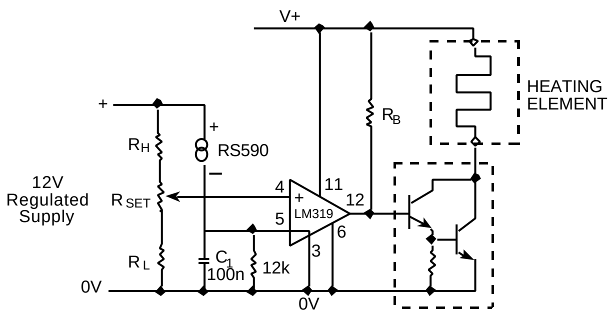


KA741 RS stock no. 298-7606

Temperature control

The RS590 may also be used in temperature control circuits (Figure 8). R_H and R_L are selected to set the high and low limits for R_{SET}. The RS590 is powered from a 12V stabilised source which isolates it from supply variations while maintaining a reasonable voltage across it. C1 may be needed to filter extraneous noise. The value of R_B is determined by the ß of the transistor and the current requirements of the load.

Figure 8 **Temperature control**



LM319 RS stock no. 306-128

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