OMEGA ENGINEERING, INC.
One Omega Drive, Box 4047
Stamford, CT 06907-0047 (203) 359-1660

Model TX57 Two-Wire Temperature Transmitter

FEATURES

Compatible with Standard 4-20 mA Loops
Low Span Drift: ±0.005%/°C max.
Low Nonlinearity: ±0.05% max.
RFI Immunity

APPLICATIONS

Temperature Monitoring and Control
Remote Temperature Sensing
Process Control Systems
Energy Management Systems

GENERAL DESCRIPTION

The OMEGA® Model TX57 is a low cost, two-wire temperature transmitter designed to interface with AD590 temperature transducers and produce a standard 4-20 mA output current proportional to the measured temperature. The TX57 features a low span drift of ±0.005%/°C max., a high linearity (±0.05% max.) and high noise immunity to assure measurement accuracy in harsh industrial environments.

The transmitter accommodates the AD590 temperature measurement range of −55°C to +150°C. Both zero and span adjustments are provided to trim the range for input measurement spans between 20°C and 205°C. The transmitter output of 4 to 20 mA and a wide range of power supply voltages make the TX57 compatible with standard two-wire control loops.

The basic package is a versatile metal case.

APPLICATIONS

The TX57 has been specifically designed to provide accurate and reliable temperature measurement in any application below +150°C in which conventional electrical temperature sensors and transmitters are currently employed.

Industrial applications in process control and monitoring systems include chemical, petroleum, food processing, power generation and a wide variety of other industries.

In multipoint energy management applications, low cost and small size combine to make the AD590 and the TX57 ideal for mounting in standard utility or thermostat boxes for remote temperature sensing.

DESIGN FEATURES AND USER BENEFITS

RFI Noise Immunity: The transmitter incorporates RFI filtering circuitry to assure protection against radio frequency interference.

Low Cost: The low cost of the TX57 transmitter and two-wire operation reduce total system installation cost.

Linear Output: The transmitter output is linear with temperature, thus eliminating the need for linearizing circuitry.

Standard Loop Compatibility: The two-wire output structure conforms to the Instrument Society of America Standard ISA-S50.1 "Compatibility of Analog Signals for Electronic Industrial Process Instruments."

FUNCTIONAL DESCRIPTION

The TX57 transmitter converts the output of an AD 590 temperature transducer to a current output within a span of 4 to 20mA. The transmitter includes input protection and filtering circuitry, an amplifier, voltage regulator, precision voltage reference and an output current generator.

A precision voltage reference, resistor network, and span and zero adjusts are used in conjunction with a low current drain amplifier to scale output signal of the AD590. The amplifier drives a current generator which controls output current (Figure 1).

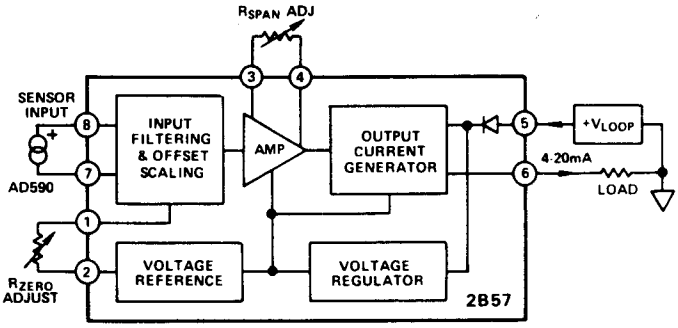

Figure 1. Model TX57 Functional Block Diagram

Input power and output signal are transmitted over the same two leads. The load resistance is connected in series with a dc power supply, and the current drawn from the supply is the 4 to 20mA output signal. The maximum series load resistance depends on the supply voltage and is given by $R_{LMAX} = (+V_S - 12V)/20mA$. A wide range of power supply voltages may be used (see Figure 2).

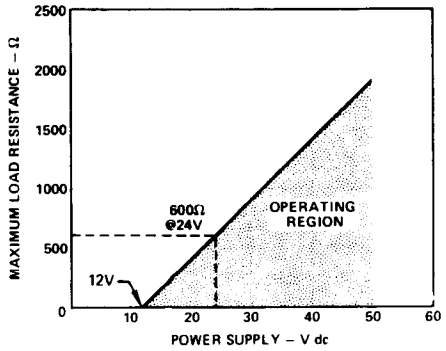

Figure 2. Maximum Load Resistance vs. Power Supply

SPECIFICATIONS (typical @ +25°C and V_S = +24V dc, unless otherwise noted)

INPUT SPECIFICATIONS	
Sensor Type[1]	AD590
Maximum Temperature Measurement Range	−55°C to +150°C
Minimum Input Span (for a 4-20mA Output)	20°C
Zero Adjustment Range	−55°C to +60°C
Input Protection[2]	+50V dc
Open Input Detection	Upscale
OUTPUT SPECIFICATIONS	
Output Span	4 to 20mA
Minimum Output Current	2.5mA
Maximum Output Current	26mA
Load Resistance Range	
Equation	$R_{LMAX} = (V_{SUPPLY} - 12V)/20mA$
@ +24V Supply	0 to 600Ω max
Output Protection[2]	+50V dc
NONLINEARITY (% of Span)	±0.02% typ (±0.05% max)
ACCURACY	
Warm-Up Time to Rated Performance	1 min
Total Output Error, without External Trims[3]	
Zero	±0.2% typ (±0.5% max)
vs. Ambient Temperature (−30°C to +85°C)	±0.005%/°C typ (±0.01%/°C max)
Span	±0.2% typ (±0.5% max)
vs. Ambient Temperature (−30°C to +85°C)	±0.001%/°C typ (±0.005%/°C max)
RESPONSE TIME, to 90% of Span	0.15 sec
POWER SUPPLY	
Voltage, Rated Performance	+24V dc
Voltage, Operating	+12V to +50V dc
Supply Change Effect, % of Span	
on Zero	±0.005%/V
on Span	±0.001%/V
ENVIRONMENTAL	
Temperature Range, Rated Performance	−30°C to +85°C
Storage Temperature Range	−55°C to +100°C
Relative Humidity, to +40°C	0 to 90%
RFI Effect (5W @ 420MHz @ 3 ft)	
Error, % of Span	±0.5% max

NOTES

[1] AD590 produces an output current proportional to absolute temperature (1μA/°K).

[2] Protected for any combination of input and output pins.

[3] Accuracy is specified as a percent of output span (16mA) for an input range of −55°C to +150°C. Accuracy spec includes combined effects of transmitter repeatability, hysteresis, and linearity. Does not include sensor error.

Specifications subject to change without notice.

THE SENSOR

The AD590 is a calibrated two terminal temperature sensor producing a current in microamperes ($1\mu A/^{\circ}K$) that is linearly proportional to absolute temperature for temperatures from $-55^{\circ}C$ to $+150^{\circ}C$. The AD590 sensor is available in a hermetically sealed TO-52 transistor package, and a miniature ceramic flat pack. The sensor construction assures reliable isolation from ground.

The AD590 is available in several accuracy grades, as shown in Table 1. The grade selection will depend on whether the device is used uncalibrated or with calibration at a single value. For greater accuracy (in any grade), the device may be calibrated at two points.

TABLE 1. AD590 ACCURACY SPECIFICATIONS (MAX ERROR)

Conditions	Max Error (±°C)				
Grade	I	J	K	L	M
Error at 25°C, as delivered	10.0	5.0	2.5	1.0	0.5
Errors over the -55°C to +150°C range:					
Without external calibration	20.0	10.0	5.5	3.0	1.7
With error nulled at 25°C only	5.8	3.0	2.0	1.6	1.0
Nonlinearity	3.0	1.5	0.8	0.4	0.3

OPERATING INSTRUCTIONS

Model TX57 is factory calibrated to ±0.5% accuracy for a maximum sensor measurement range of $-55^{\circ}C$ to $+150^{\circ}C$ ($205^{\circ}C$ span) with R_{SPAN} and R_{ZERO} resistor values as shown in Figure 3. For this input range 4mA output corresponds to an AD590 temperature of $-55^{\circ}C$ and 20mA to $+150^{\circ}C$. The span and zero adjustments can be used to accommodate other input ranges.

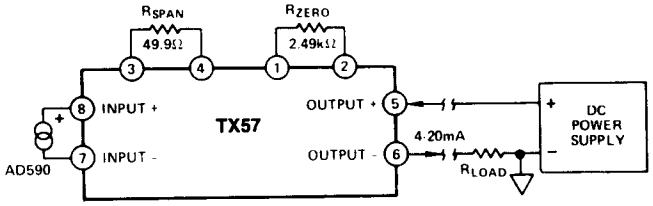

Figure 3. Model TX57 Basic Application

Span Adjustment: The value of the span setting resistor R_{SPAN} is determined by:

$$R_{SPAN}\ (\Omega) = \left(\frac{1.2V}{10^{-6}\ A \times SPAN}\right) - 5810\Omega$$

where SPAN is a desired measurement span in °C. For example, for a measurement span of 100°C R_{SPAN} = $\left(\frac{1.2V}{10^{-6}\ A \times 100}\right) - 5810\Omega = 6.19k\Omega$. If a span accuracy of ±0.5% if desired, the value of the R_{SPAN} resistor should be accurate to ±0.1%.

Zero Adjustment: Zero adjustment must be performed after installation of the R_{SPAN} resistor. To select R_{ZERO} an AD590 or a calibrated current source may be used as an input to the TX57. If an AD590 is used, it must be maintained at the desired reference temperature. A resistance decade box is inserted between pins 1 and 2 of the TX57. The decade box is adjusted to produce an output corresponding to the selected reference temperature. For example, for a sensor measurement range of 0 to 100°C and an AD590 at 0°C, the R_{ZERO} is adjusted for an output current of 4mA. If a current source is used, its output must equal the AD590 output at the selected reference temperature. For example, at 0°C the current source output must equal 273.2μA.

Sensor Calibration Trim: The sensor calibration error is the major contributor to maximum total error in all AD590 grades. To trim this error the temperature of the AD590 is measured by a reference temperature sensor and R_{ZERO} is trimmed to the calculated value of the TX57 output current at that temperature. A reference temperature at the midpoint in the span should be selected.

For best measurement accuracy over temperature, R_{ZERO} and R_{SPAN} should be trimmed with the AD590 at two known temperatures. For example, with the R_{SPAN} selected for a 100°C span and with the AD590 at 0°C R_{ZERO} is adjusted for a 4mA output. R_{SPAN} is then trimmed for a 20mA output with the sensor at 100°C. Figure 4 illustrates a typical two-trim system accuracy.

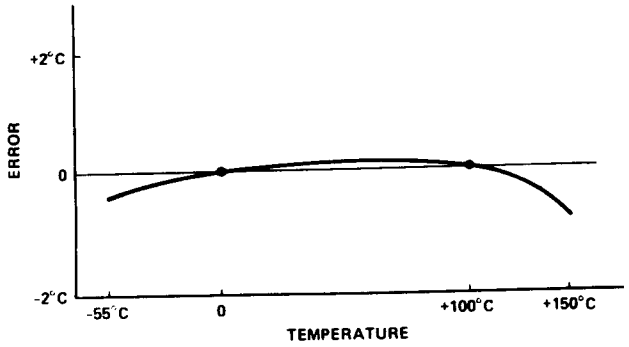

Figure 4. Typical Two-Trim Accuracy (AD590 and TX57)

PACKAGING CONFIGURATION

The TX57 is mounted in an aluminum case including screw terminals for connecting an external sensor and power. This versatile housing may be surface mounted in racks, cabinets, NEMA enclosures, etc., or snapped onto standard relay tracks. The TX57 in the metal housing is calibrated for a $-55^{\circ}C$ to $+150^{\circ}C$ measurement range.

TRANSMITTER HOUSING OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).