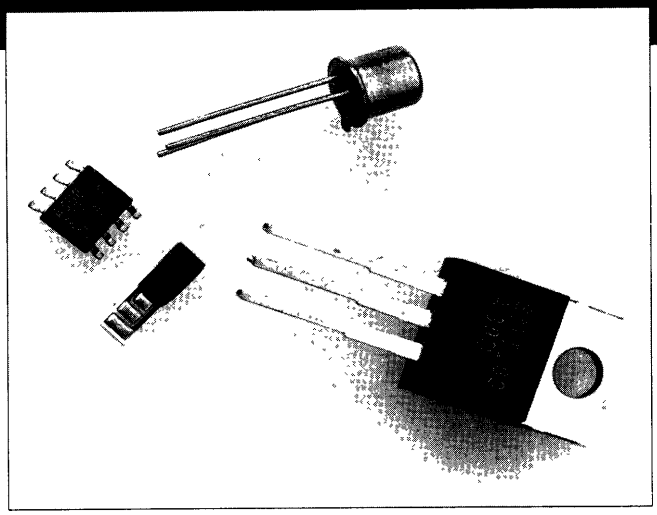
SENSORS

DIGITAL TEMPERATURE SENSOR



The SMARTEC sensor represents a significant development in transducer technology. Having a single wire digital output and being fully calibrated during manufacture means it can be directly connected to processor circuitry without A – D conversion circuitry.

FEATURES

- ▲ Range of package styles and mounting options
- ▲ Pre-calibrated
- ▲ Direct connection to processor
- ▲ Temperature range 175°C (-45 to +130°C)
- ▲ TTL/CMOS compatible
- ▲ Absolute accuracy ± 0.7°C
- ▲ Linear output within 0.2°C
- ▲ 200 microamp supply current max

DESCRIPTION

The sensor is a three terminal device with integrated sensor circuitry. A duty cycle modulated square wave is available from one terminal, the other two being power input and ground. At the heart of the product is a bipolar temperature sensor with precision circuitry calibrated during manufacture.

OUTPUT SIGNAL

As stated in the specifications the output is a square wave with a well defined temperature-dependent duty cycle. The duty cycle of the output signal is linearly related to the temperature according to the equation: D.C. = 0.320+0.00470*t
D.C. = duty cycle t = Temperature in °C
Easy calculation shows for instance that at 0°C the D.C. = 0.320 or 32.0% and at 130°C the D.C. = 0.931 or 93.1%.

TOTAL ACCURACY

The above mentioned equation is the nominal one. The maximum deviation from the nominal equation is defined as total accuracy. With temperatures above 100°C the accuracy decreases.

NOISE

The resolution found is better than 0.005°C. The standard deviation of the noise level (measured over a 20ms. period) is below this 0.005°C. Improvement of this noise can be easily obtained by lengthening the measurement time.

GENERAL OPERATION

An easy way of measuring a duty cycle is to use a microcontroller. It is only necessary to connect the sensors output to one of the microcontrollers inputs. With the help of a small programme it is possible to sense that input whether it is high or low. The speed of this sampling is limited due to the instruction time of the controller. So to achieve the wished accuracy, it is necessary to sample over more than one sensor period. This way of working has also the advantage to filter noise. From the theory of signal processing it can be derived that there is a fixed ratio between the sensors signal frequency, the sampling rate and the sampling noise. This sampling noise limits the accuracy and amounts to: $T^{error} = 200 * t^s/\mathrm{sqrt}(6*t^m*t^p)$

T^{error} = measurement error (= standard deviation of the sampling noise)
t^s = microcontrollers sampling rate
t^m = total measurement time
t^p = output signal periodicity of the sensor

Modern microcontrollers can sample at a high frequency so with a small program it is possible to measure the sensor's duty cycle within 50 ms and a resolution of .01°C.

Note: The above mentioned error has in principle nothing to do with the accuracy of the sensor. It gives only an impression of the accuracy of measuring duty cycles with microcontrollers.

NON-LINEARITY

Non -linearity as it applies to the SMT 160-30 is the deviation from the best fit straight line over the whole temperature range. For the temperature range of -30°C to +100°C the non-linearity is less than 0.2°C (TO18).

LONG TERM DRIFT

This drift strongly depends on the operating condition. At room temperature the drift is very low (<0.05°C is to be expected). However at higher temperatures the drift will be worse, mainly because of changes in mechanical stresses. This drift is partly irreversible and causes non-ideal repeatability and long-term effects. At temperatures above 100°C but in the operating range a long-term drift better than 0.1°C is to be expected.

TIME CONSTANTS

The time constants of the sensor is measured under different circumstances. To compare this with other types of sensors the same kind of measurements were done. The time constant is defined as the time required to reach 63% of an instantaneous temperature change.

Condition	Time constant (sec) TO18
Mounted in an alu block of a certain temperature	0.6
In a bath filled with oil that was stirred (mean value of different measurements)	1.4
Moving air with a speed of about 3 m/s	
– without heatsink	13.5
– with heatsink	5.0
Non moving air	
– without heatsink	60
– with heatsink	100

The above mentioned figures are difficult to measure, an accuracy of around 5% is a reasonable estimation. These figures are from test data on the sensor in a TO18 housing.

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SPECIFICATIONS

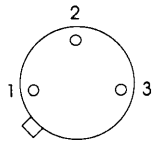
Supply voltage	4,75 – 7 V
Supply current	max 200 µA
Short Circuit protection	infinite (within supply voltage range)
Operating temperature range	-45 to +130°C
Storage temperature	-50 to + 150°C

Package style	TO18			TO92	TO220	HE	308L	
Characteristic	min	typ	max	max 1	max			units
Supply voltage[2]	4.75	5	7	*	*	*	*	V
Supply current	160		200	*	*	*	*	µa
Temperature Range[3]	-45	-	130	*	*	*	*	°C
Total accuracy[4]	-30 +100°C		0.7	1.2	1.7	1.5	1.7	°C
	-45 +130°C		1.2	2.0	1.7	1.5	1.7	°C
Non-linearity[5]			0.2	0.4	0.5	0.4	0.4	°C
Supply voltage sensitivity			0.1	*	*	0.1	0.1	C/V
Repeatability			0.1	0.2	0.2	0.2	0.2	°C
Long term drift			0.1	*	*	0.1	0.1	°C
Output:								
– duty cycle = 0.320 + 0.00470*t (t = temperature in °C)								
– frequency	1	-	4	*	*	*	*	Khz
– noise			0.005	*	*	*	*	°C
– impedance			200	*	*	*	*	Ohm

1 All not mentioned specifications are the same as TO18
2 Case connected to ground
3 The SMT 30-160-18 can be used from -65 to +160°C for short periods without physical damage to the device. The specified accuracy applies only to the rated performance temperature range.
4 Total accuracy includes all errors
5 Applicable from -30 to +100°C

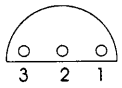
ORDERING INFORMATION

SMT 160-30-18



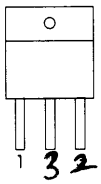
TO18

SMT 160-30-92



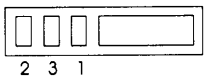
TO92

SMT 160-30-220



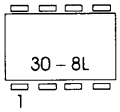
TO220

SMT 160-30-HE



Hybrid Alu. substrate

SMT 160-30-308LSMD



SMD
1 – + Vcc
7 – GND
8 – OUTPUT
all other pins N.C.

Connections: 1 – OUTPUT 2 – + Vcc 3 – GND

We reserve the right to make engineering, material and model changes on catalogue items without notice when such changes do not interfere with the general purpose for which such items are manufactured.

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