What is Effective Modulus Compensated (EMC) Strain Gauges

1. Span-Temperature-Drift and its Correction by EMC Strain Gauges

It is well known that the elasticity (i.e., Young's modulus, E) of sensor bodies decreases with the increase of temperatures. This is called temperature effect on Young's modulus of materials. For a given load on the sensor, the stress (δ) of the sensor body is constant and, according to Hooke's law (δ = E·ε), the decrease of Young's modulus (E) will result in the increase of strain (ε) when the temperature increases. The resultant increase of strain is shown by the curve I in Fig. 1. This resultant increase of strain is not due to the same source which causes the thermal output of the strain gauges as discussed in Technical Note of STC strain gauges, but due to the temperature effect on Young's modulus of the sensor body.

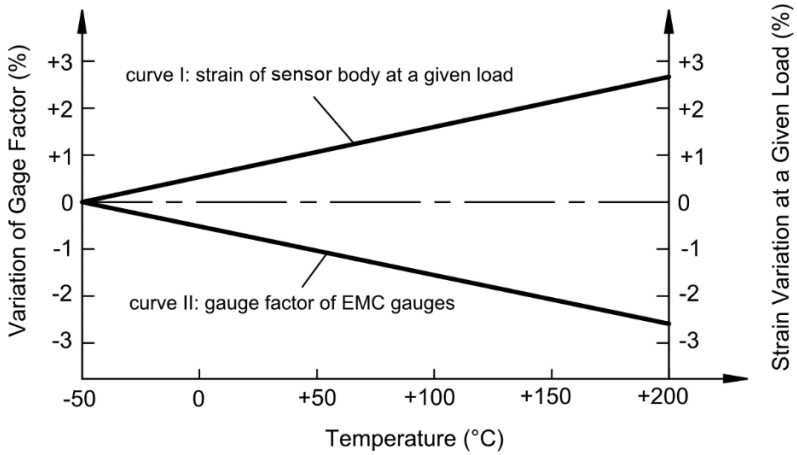

Fig. 1: Temperature Effect on Young's Modulus and Matched Gauge Factor of EMC Gauges

Because of the resultant increase of strain induced by the temperature effect of Young's modulus of the sensor body, the strain gauges bonded on it will probe more strain with elevated temperatures. As a result, the sensor output sensitivity (or span) will change with ambient temperatures. This change is called span-temperature-drift of sensors and, in general, is a positive value. In sensor applications, such drift has to be eliminated as much as possible.

Both the EN-series and EB-series bondable resistors from BCM SENSOR are designed to correct the span-temperature-drift of sensors in a certain temperature range. Nevertheless, when there is no space available on the sensor body to bond those resistors, one can make use of so-called EMC gauges for the same purpose.

Hereby is a short explanation how the EMC gauges can be used to correct the span-temperature-drift of sensors.

There are two factors which contribute to the output sensitivity of sensors: one is the Young's modulus of sensor bodies, and the other is the gauge factor of strain gauges which are bonded on the sensor body. Due to the temperature effect on Young's modulus, as mentioned above, the span-temperature-drift of sensors is a positive value. To eliminate this drift, one can make use of the strain gauge with a gauge factor of a negative temperature coefficient (see curve II in Fig. 1).

If the gauge factor of strain gauges varies with temperatures to the same extent as the resulting increase of strain, but in the opposite polarity (see curve II in Fig. 1), the variation with temperatures of superimposed output sensitivity of sensors will be consequently suppressed to and within a certain tolerance band (e.g., ±0.01%fs/°C), in a concerned temperature range.

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This technique is called Young's modulus compensation of sensors. The strain gauge with its gauge factor modulated to compensate the temperature effect of Young's modulus of sensor bodies is called the effective modulus compensated (EMC) strain gauge, i.e., the EMC gauge.

2. Availability of EMC Strain Gauges

It is found that the gauge factor of karma (and Evanohm) strain gauges can be modulated to have a negative temperature coefficient, as shown in Fig. 2.

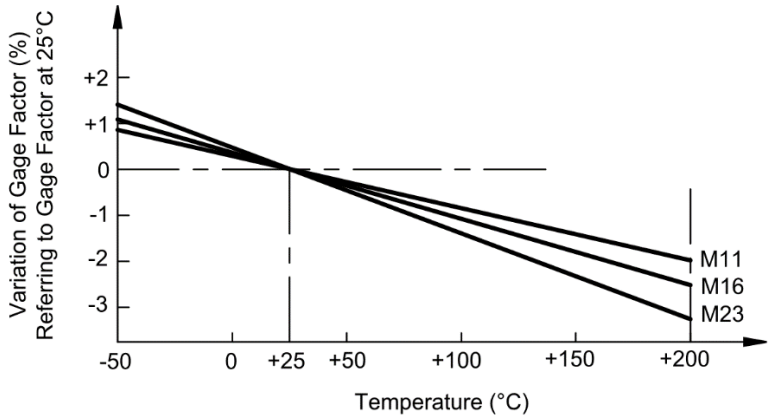

Fig. 2: Gage Factor Variation of EMC Gauge

Therefore, all the karma gauges from BCM SENSOR for sensor applications can be manufactured as the EMC gauges to correct the span-temperature-drift of sensors. Listed below in Tab. 1 are the commonly used sensor body materials and their associated EMC numbers of the EMC gauges as indicated in Ordering Information of each datasheet of strain gauge.

Tab. 1: EMC Number of Commonly Used Metals

Metals	EMC Numbers
mild steel	M11
martensitic stainless steel	M11
austenitic stainless steel	M16
coper	M16
beryllium copper	M16
aluminum	M23

Because the temperature effect of Young's modulus varies with materials, one needs to select the EMC gauges of the right EMC number matching to the sensor body material, so as to achieve the best compensation by the EMC gauges.

3. Application Notes

Although the EMC gauge is designed for correction of the span-temperature-drift of sensors, it also possesses partially the function to correct the zero-temperature-drift of sensors. Therefore, though the EMC gauge cannot correct the span-temperature-drift of sensors to the same extend as what both the EN-series and EB-series bondable resistors can do for 0.01%fs accuracy class sensors, the EMC gauges from BCM SENSOR are the ideal candidates to manufacture 0.1%fs accuracy class sensors without need for either the ON-series or OB-series bondable resistors for zero-temperature-drift compensation, and without need of either the EN-series or EB-series bondable resistors for span-temperature-drift compensation.

For detailed engineering advice, one can contact BCM SENSOR for the utilization the EMC gauges.

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