Background

The Hall effect (HE) device in the existing current sensors has become obsolete, resulting in a mandate for the development of a replacement current sensor. These HE devices are susceptible to the following: offset errors, temperature sensitivities, mechanical stresses, aging and drifting outside of the normal output range.

To address this problem, Westinghouse has designed a new current sensor for the Control Element Drive Mechanism Control System (CEDMCS) automatic control element drive mechanism timing module (ACTM). This new current sensor is a form, fit and functional direct replacement for existing current sensors, and offers improved current sensor accuracy and stability.

Description

The original DC current sensor suffered from accuracy problems with respect to absolute accuracy as well as temperature issues. The new current sensor is a form, fit and functional replacement for the original. New features include improvements with the brass bracket hinge and the extension on the sides of the brass bracket for placement of the current carrying conductor through the center of the ferrite toroid ring on the current sensor.

The DC current sensor is designed to operate with a ferrite toroid with two HE sensor chips inserted in a gap within the toroid. The main current carrying conductor passes through the center of the toroid, generating a magnetic field. The HE sensor senses this field in the gap of the toroid. A sensor has been selected that offers advanced features, including temperature compensation and precision offset cancellation. The new current sensor has a programmable chip that provides calibration for offset, span and temperature compensation. The output signal is tailored to duplicate the original mV output levels based on the relationship of the DC current sensed through the main conductor. The unit operates from the original DC supply being delivered in the cable from the ACTM card. There is a precision regulator with the new design that allows the unit to provide accurate results even if the input voltage varies.
The linear range for offset correction, desired span and temperature compensation is specified by Westinghouse as 0 to 275 mV over the operational range of 0 to 25A. The programming is accomplished by utilizing programming and test equipment purchased from the Hall effect sensor manufacturer. This programming and testing is controlled in accordance with the Westinghouse quality management system.

Benefits

The new design of ACTM current sensor:

- Utilizes a new programmable linear HE device that provides temperature compensation and precision offset cancellation.
- Utilizes a voltage regulator mounted on the current sensor circuit board to provide a precise voltage reference.
- Utilizes an operational amplifier mounted on the current sensor circuit board to provide added voltage stability.
- Acceptable current sensor offset at zero current is -6 mV to +6 mV for all temperature ranges.
- At ambient, acceptable current sensor output at 4.5 +/- 0.04A is 50 +/- 0.5 mV.
- Acceptable mV output over elevated temperatures up to 104 F is equal to (+/- 6 mV) +/- (0.4 mV per Ampere).

[Graph of existing ACTM C/S & redesigned ACTM C/S operating range]

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