Keywords: digital signal conditioner, multi-channel signal conditioner, sensor, digital, signal conditioner, multi-channel, precision pressure sensor, compensation, calibration, PRT, thermocouple, RTD, thick film, thin film, strain gauge, linearization

APPLICATION NOTE 3911

Maximizing the MAX1464's ADC Range

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Abstract: The MAX1464 is a high-performance, multichannel, signal conditioner that uses an internal 16-bit analog-to-digital converter to convert an analog input signal to a digital value. To maximize the conversion resolution, offset must be stripped from the input signal and then amplified, without exceeding the linear range of the analog-to-digital converter. This application note describes the procedure, and presents a flowchart, for performing this task efficiently.

Maximizing the Conversion Resolution of the MAX1464

The MAX1464 is a high-performance, low-cost, low-power, multichannel, microprocessor-based digital-sensor signal conditioner with on-chip flash memory and a temperature sensor. In the heart of the signal path is a 16-bit analog-to-digital converter (ADC) that converts the analog input signal to a digital value to be processed by the internal microprocessor. To maximize the conversion resolution, the input signal must be stripped from its offset using the coarse-offset DAC (CO), and, then, it must be amplified by setting the programmable-gain-amplifier (PGA) index to the maximum possible value without exceeding the ADC's linear range. The coarse-offset index of the input signal must be set so that the digitized value, at mid-scale sensor excitation, is as close to 0x0000(hex) as possible. Then, the PGA index must be set so that the digitized value, at minimum and maximum excitation levels, is as close to ±85% of the ADC's range as possible.

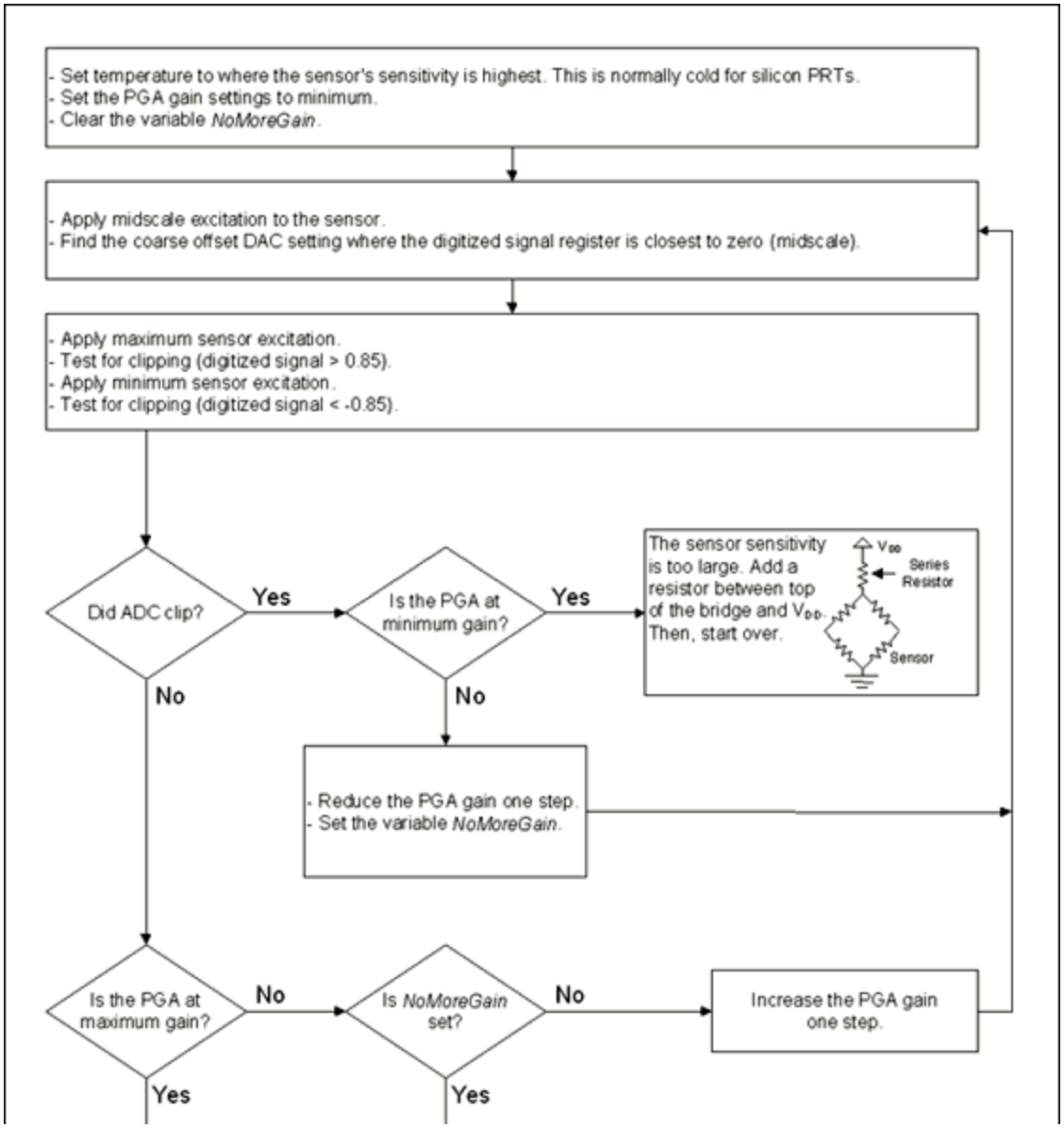
Because of the limited resolution of the CO and PGA settings, only coarse PGA and offset adjustment of the input signal is possible at this stage. The final and most accurate setting of the output signals is normally achieved during the final calibration process, when sensor errors, device-to-device variations, application-circuit component-to-component variations, and all other residual errors are consolidated and corrected by the compensation algorithm. Typically, the same CO and PGA settings can be used in a manufacturing line with sensors of reasonable consistency; consequently, it is not necessary to determine CO and PGA settings for each individual sensor.

In the MAX1464 signal conditioner, both CO and PGA indices are set independently for channel-1, channel-2, and channel-T (temperature sensor) inputs. For each channel, the PGA index is set using 5 bits (with 17 possible settings) and the CO index is set using 4 bits (including 1 sign bit, with 16 possible settings) in the configuration register. The flowchart in **Figure 1** shows a procedure for finding the optimum coarse-offset and gain settings for a sensor of unknown characteristics. Refer to the MAX1464 data sheet for detailed definitions and for how to set the Configuration Registers.

Example

In this example, the CO and PGA indices are determined based upon a desired compensated output of 0.5V to 4.5V when the supply voltage is 5V, using a sensor with a sensitivity of 10mV/V and an offset of -12mV/V. Therefore, the sensor offset is 5V * (-12mV/V) = - 60mV, and the sensor span is 50mV at full excitation. Similarly, -FSO (Full-Scale Output) = -85mV and +FSO = -35mV. Following through the flowchart, the PGA gain setting is **PGAn[4:0] = 10000b (gain = 123)** and the Coarse Offset Correction setting is **Con[3:0] = 1010b (+57mV RTI** - Referred to Input). The coarsely corrected -FS input to the ADC is (-85mV + 57mV) * 123 = -3.690V. The +FS input to the ADC is (-35mV + 57mV) * 123 = + 2.460V. The input range of the ADC is $\pm V_{DD}$. Thus, the digitized sensor signals become -FS = -3.690/5 = -0.738 and +FS = +2.460/5 = +0.492.

Notice that the bridge multiplies by V_{DD} and the ADC divides by V_{DD}. Hence, the system is ratiometric and insensitive to the DC value of V_{DD}. The ADC output clips to ±1.0 when input values exceed $\pm V_{DD}$.



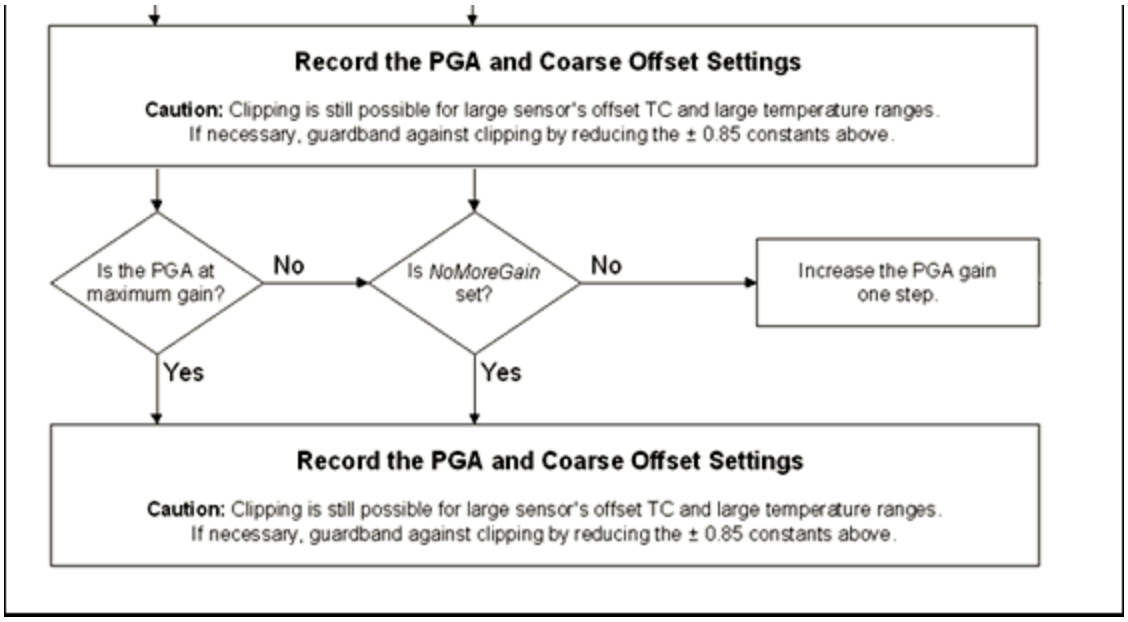


Figure 1. Procedure for determining the optimum Coarse Offset and PGA settings for compensating a sensor signal using the MAX1464 signal conditioner.

Related Parts		
MAX1464	Low-Power, Low-Noise Multichannel Sensor Signal Processor	Free Samples

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