Single-Chip Bridge Sensor to Microcontroller Interface Using the ispPAC30

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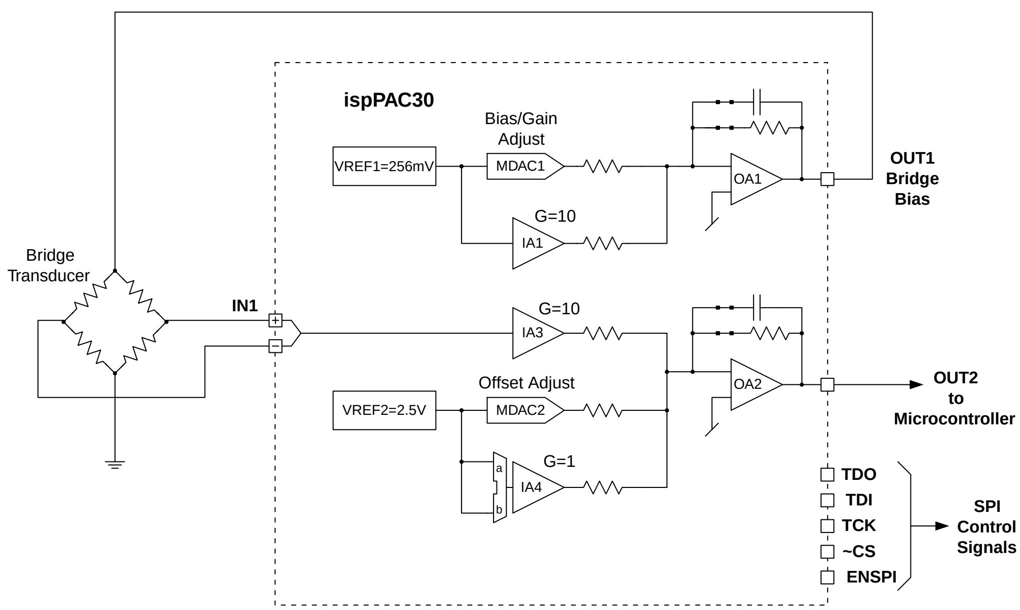
Because microcontrollers with integral Analog-to-Digital Converters (ADC's) have become very inexpensive in recent years, there are many applications to provide embedded 'intelligence'. One example is to turn 'dumb' transducers into 'smart sensors'. Many transducers in common use, however, require a significant amount of interface electronics both to provide excitation for the transducer, and an acceptable signal for the ADC on the microcontroller.

Some of the key requirements for a bridge-to-microcontroller interface are:

- Provide stable constant-voltage DC excitation to the transducer bridge.
- Provide a precise and stable gain.
- Provide differential to single-ended conversion.
- Be able to trim offset errors.

The ispPAC®30 can provide all of these functions when configured as shown in Figure 1.

Figure 1. ispPAC30 Bridge Interface Internal Configuration

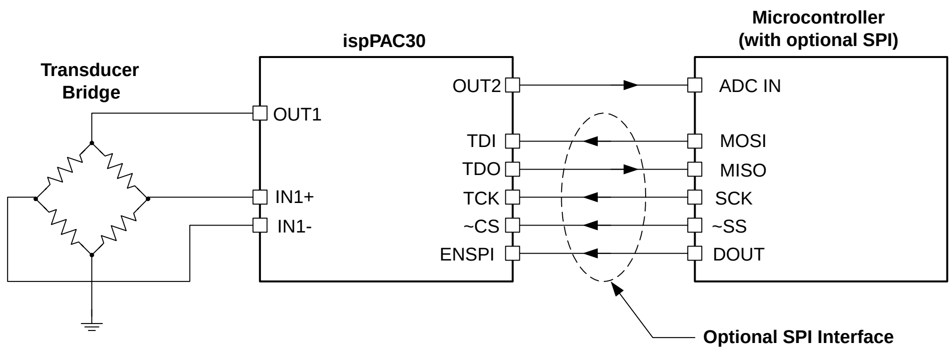


In this circuit, a combination of VREF1, multiplying DAC MDAC1, and instrumentation amplifier IA1 provide the bias voltage for the transducer. In this example, setting the reference to 256mV, and setting IA1's gain to 10 results in a nominal bridge excitation of 2.56V. MDAC1 allows an adjustment range of ±256 mV (±10%). Because a resistive bridge is ratiometric, meaning that the sensitivity is proportional to the excitation voltage, varying the excitation voltage is also a convenient way to perform a gain (span) adjustment. This technique provides a simple way to adjust the system gain while using a fixed gain amplifier. Because the ispPAC30 analog outputs are capable of driving up to 10mA, this circuit can directly drive transducers with bridge resistances down to approximately 300Ω.

The differential voltage output of the transducer is sensed by input pair IN1 of the ispPAC30. This signal is fed to IA3, which provides a fixed gain of 10. Because the input signal was sensed differentially, the value of the signal at this point will be zero for a balanced-bridge condition. To be able to represent a bipolar signal at OUT2, which is single-ended, the signal will need to be offset. For this purpose, VREF2 is set to 2.5V and summed into OA2. This has the effect of offsetting the signal appearing at OUT2 so that the balanced-bridge condition is represented by 2.5V. Additionally, MDAC2 is also connected to the VREF2 and summed into OA2. This makes it possible to adjust the offset of the output signal to compensate for imbalances in the transducer. The arrangement shown in Figure 1 provides a ±250mV offset adjust range with a resolution of 2mV (input referred).

All settings for gain and offset can be stored in the ispPAC30's internal E^2 memory, from which they will automatically be loaded when power is applied to the device. All configuration data are programmed into the chip serially through an integral JTAG port. This feature makes it straightforward to perform end-of-line test and calibration procedures for adjusting sensor assemblies on an individual basis.

Figure 2. Block Diagram



It is also possible for a microcontroller to change calibration factors in an ispPAC30 on-the-fly through the device's SPI interface. Figure 2 shows the necessary connections. When the ENSPI pin on the ispPAC30 is pulled high, the pins normally used for JTAG programming become an SPI port. The ability to program the ispPAC30 under SPI control can be valuable in several situations. The first is where multiple ispPAC30's are slaved to a single microcontroller, and the designer wants to store all calibration data centrally in the microcontroller. Another situation where SPI control might be desirable is when packaging makes it difficult or impossible to get access to the ispPAC30's JTAG pins. As an example, a packaged sensor assembly may have a communication interface to the microcontroller (e.g. RS-232, RS-485). In addition to being able to read the sensor data through this interface, it is also possible for a supervisory microcontroller to perform calibration operations by writing to the ispPAC30's on-chip E^2 memory.

Technical Support Assistance

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