The integration advantage

Choosing between discrete and integrated solutions for sensor conditioning. By **Debbie Brandenburg.**

Our world is filled with intelligent products and technologies that make our lives more efficient, convenient, connected and informed.

We come into contact with smart devices every day. Cities are employing smart traffic lights that adjust to real time traffic conditions. Smart street lights and office lighting systems dim or turn off when no one is around in order to conserve energy. High efficiency washing machines determine the appropriate water level for each load, based on the weight of clothing. The latest smart cars respond to adverse conditions and now boast such features as parking assist. Meanwhile, mobile phones not only respond to your touch, but also to the force of your touch.

Many of these systems incorporate multiple analogue sensors that detect such variables as pressure, temperature, force, position, light, flow, sound, speed and heat.

An important electronic interface lies between the analogue sensor and the digital signal processing in the host. This block conditions the electrical signal to ensure it lies within the input range of the downstream A/D converter. Analogue sensors produce an electrical signal that is usually very small and surrounded by noise. In many cases, no two sensors are alike – each sensor has its own noise signature, introduces its own offset into the signal path and requires a different gain to meet the requirements of the downstream A/D converter. Calibrating the system, differentiating signal from noise and then amplifying that signal are steps crucial to system performance.

Today's system designer is faced with a choice between developing a sensor conditioning circuit based on discrete components or making use of a more integrated sensor interface analogue front end (AFE). Unfortunately, there is never a clear choice for every application. There are many factors to consider – such as footprint, ease of use, flexibility, performance, price and functionality. This article will describe some benefits and shortcomings of each.

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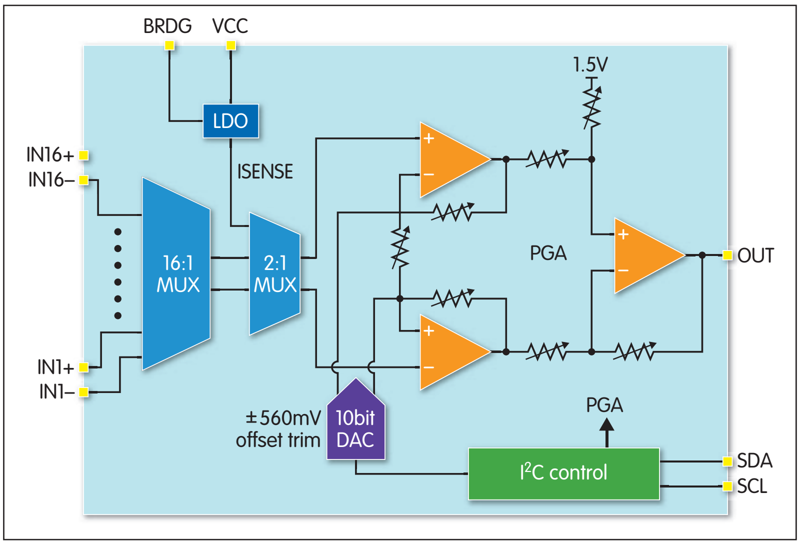

Fig 1: Block diagram of Exar's XR10910 analogue front end

Footprint comparison

If real estate is a concern, then a more integrated solution is usually more desirable. Exar's XR10910 is a 16:1 sensor interface AFE with a footprint of 6 x 6mm. It integrates a 16:1 differential multiplexer, a programmable gain instrumentation amplifier, a 10bit offset correction D/A converter and a low dropout regulator (see fig 1).

Take, for example, a system that uses 16 Hall Effect sensors to monitor current in a solar panel application (see fig 2). The XR10910 AFE allows each Hall Effect sensor to have its own amplification and offset correction path. This function could be handled with a discrete design, but that would require approximately twice the footprint and consume four times the power (see table).

There are many ways to implement a discrete solution for this function and the table takes only one into account but, in most cases, an AFE will have a total footprint advantage over its discrete counterpart.

Performance comparison

When it comes to performance, the end application plays a crucial role when deciding between a discrete and a more integrated solution. There are thousands of precision amplifiers available on the market, each with its own price/performance tradeoffs. But there are only a handful of integrated AFEs. When manufacturers develop an AFE, they typically have particular applications in mind and this dictates the overall performance specifications of the device.

The XR10910, for example, offers 14bit signal path linearity, a maximum offset voltage of 1mV, a peak to peak noise of 2μV and a gain ranging from 2V/V to 760V/V. It also features an input voltage noise of 35nV/√Hz at

Home automation systems mean we are coming into contact with a range of sensors on a daily basis and their output often needs to be conditioned for further processing

G=760. The low noise performance of the XR10910, combined with the low bias current capability (100pA maximum), allows the device to interface with a wide range of sensors and to pair nicely with 16bit A/D converters operating at 3 to 5V.

However, although these parameters may be adequate for some applications, they most certainly will not be suitable for every sensor interface application.

If performance is the designer's top priority and they cannot find an AFE on the market designed specifically for the application, then a discrete solution will usually be the preferred method. The designer can hand pick the components that best fit their needs, ultimately fine tuning the sensor conditioning block.

Comparing AFEs

The AFEs currently on the market offer different levels of integration. Some will include an A/D converter or processing power, while others –like the XR10910 – will not.

Most sensor interface AFEs are very application specific; thus their performance feature set and functional blocks are extremely useful for a particular target application. For example, several currently available AFEs were designed for medical instrumentation applications and integrate 16bit or 24bit delta-sigma A/D converters, PGAs and a host of features designed to reduce size, power and time to market, which is great if you happen to be designing medical diagnostic equipment.

But if you face the challenge of conditioning the system with multiple Hall Effect sensors described above, highly integrated AFEs are not the answer; less integration and more flexibility is needed.

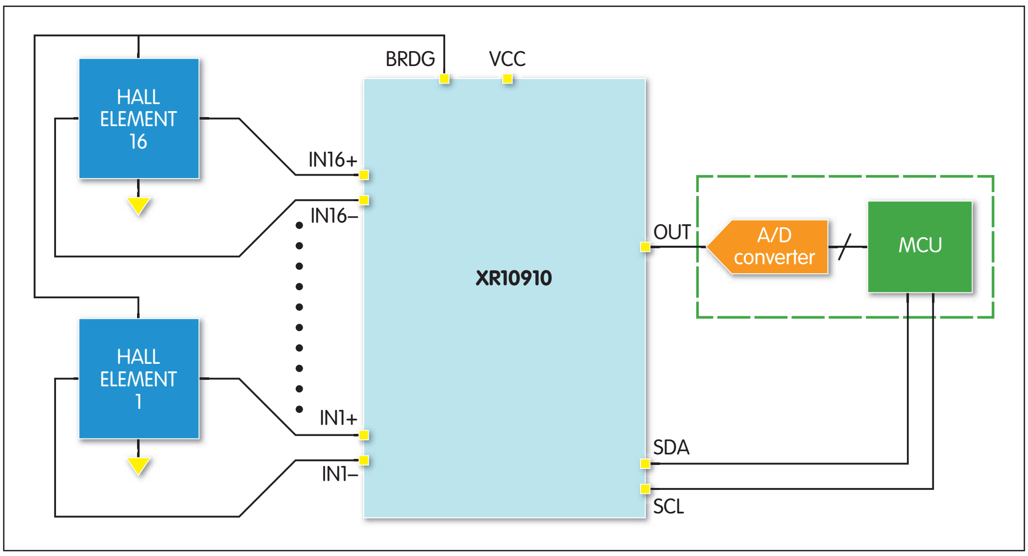

Fig 2: The XR10910 allows each Hall Effect sensor to have its own amplification and offset correction path

Conclusion

Sensor interface AFEs tend to offer faster time to market, higher ease of use, smaller footprint and – in many cases – lower power. But many are designed for certain applications and cannot support multiple sensors or multiple types of sensors.

Discrete solutions tend to be more flexible and can be tuned for specific applications, but require analogue design prowess, more real estate, more power and tend to lack many automated features, such as auto calibration to correct for sensor drift.

The XR10910's features place it in the gap between less feature rich discrete solutions and single chip sensor interface AFEs with processing power. Consuming 457µA and requiring only 36mm^2 of board space, the XR10910 offers the industry's smallest, lowest power interface for systems with 16 analogue sensors.

The XR10910 will be the first in a growing family of sensor interface products from Exar, with smaller channel count versions on the horizon, along with versions that offer digital outputs.

Sensors enable the smart products and technology we use every day. Sensor conditioning products like the XR10910 will continue to play a key role in how these sensors interface with our increasingly digital world. Designers will continue to weigh the benefits of specifying an integrated AFE against those of a discrete solution and semiconductor manufacturers will continue to expand their AFE portfolios in an effort to supply AFEs to a broader range of markets.

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