Plug and play front end

An off the shelf analogue front end deals with high and wide ranging voltages in industrial applications. By **Tim Fryer**.

Many industrial sensors have high or wide-ranging analogue output voltages and so the industrial control and automation applications they serve often require isolation, high resolution and support for a wide range of input voltages. In many cases, fpgas and microcontrollers cannot accept these high analogue voltage inputs directly and so an analogue front end (afe) is needed to provide both protection and capability.

To cater for such needs, Maxim has recently introduced Cupertino, a 16bit high accuracy, multi-input isolated afe. The move is a big step forward from the company's Analog Essentials range of peripheral modules that was introduced last year. Each member of this family of 15 boards performed a solitary function that the designer could introduce to their fpga or microcontroller boards, and could be connected by a Pmod-compatible connector. While Analog Essentials helped some designers, a customer survey revealed that others wanted more.

Christian Gruber, a signal chain technical expert signal with Maxim Integrated EMEA, takes up the story. "The Essentials boards allowed designers to introduce some analogue functions into fpga designs. This helped some people, but it didn't really help when you have an industrial input or output. When we were looking at our survey of what is important for people today, the feedback we got is that they want integration support, they need fast time to market and they want system know-how. So we introduced Maxim Integrated, where we are going away from a core product to a whole system approach. The next step we came up with was to do a complete reference design with Pmod capability."

A reference design called Cupertino, along with family members Fresno and Campbell, was that next step. First of all, why Pmod? Pmod was developed by Digilent and a wide range of Pmod boards is available to enhance fpga development boards. Maxim's Analog Essentials and Cupertino are Pmod-compliant as they use the Pmod connector and pin standards.

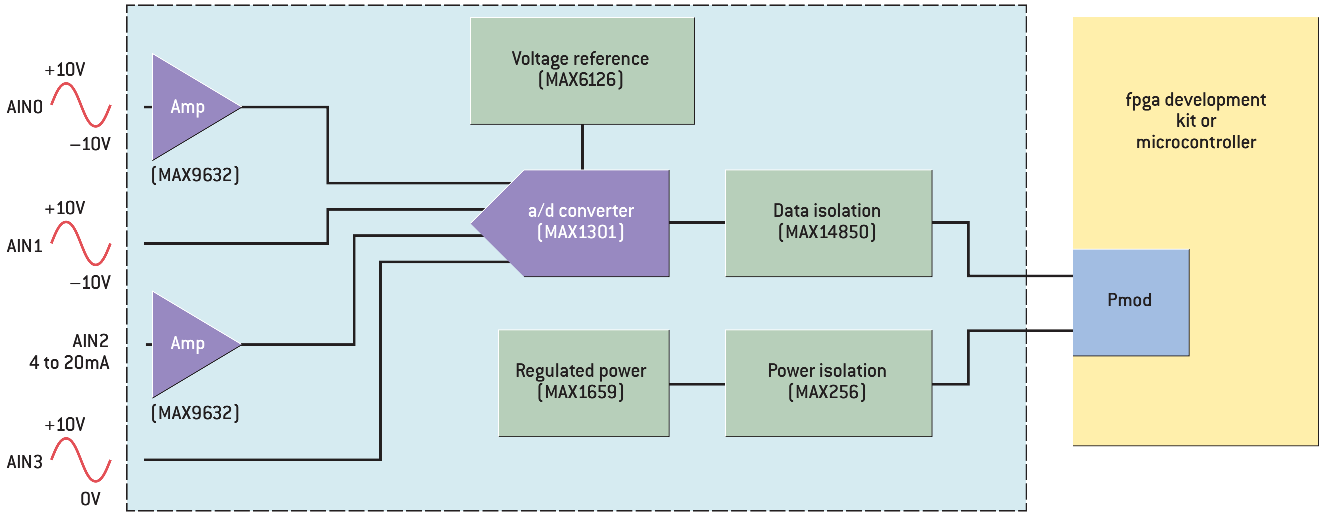
"The beauty of the Pmod connector/interface is that it is so simple," said Gruber. "Power, ground and few digital interface signals are all that is required. The six or twelve connector pins can easily be air-wired to almost any fpga or microcontroller development board that provides access to the required signals. Support for the Pmod standard seems to have traction. We have seen Pmod adapters showing up on other micro and FPGA platforms as well. For example, the Arduino open community development platform has a Pmod adapter board. Also Altera's Industrial Network Development board has connectors that are physically the same as Pmod and have the proper signals, but they are just called I/O ports."

Support for common fpga and mcu platforms

Currently, Maxim supplies fpga configuration files and embedded drivers for a few Xilinx fpga development boards and the plan is to provide code support for other common fpga and microcontroller platforms.

The Cupertino board can be used in any application that needs high-accuracy a/d conversion, but it is targeted mainly at industrial sensors, industrial automation, process control, programmable logic controllers and medical applications. It is more than just a 16bit a/d converter, providing a high accuracy isolated afe solution for industrial sensors. It can be configured to monitor simultaneously four

Fig 1: The Cupertino subsystem design block diagram



different sensors that output different signals (-10V to +10V, 0 to 10V and 4 to 20mA current loop signals). It also provides data isolation and regulated/isolated power rails for the a/d converter and input conditioning circuit.

Core components in the Cupertino design include the MAX1301 a/d converter, the MAX9632 amplifier, the MAX256 power isolator and the MAX6126 voltage reference. The most recent part, introduced last year, is the MAX14850, which provides a data isolated solution without the use of a transformer. As Gruber points out: "What is new is that this group of components has never been integrated on one board as one solution"

Two additional afe subsystem designs have also been recently released. The Fresno and Campbell boards are both single input afes using the MAX11110 16bit a/d converter configured for 0 to 10V and 4 to 20mA input signals respectively. Both provide the same data and power isolation benefits as Cupertino, which has both current and voltage inputs. The Fresno or Campbell designs are intended for use in applications where there is only one sensor to monitor and can therefore be lower cost to implement. The MAX11000 a/d converter also has a higher sampling rate than the MAX1301 device used in the Cupertino.

According to Gruber, the advantages of this reference board include high accuracy, combined with data and power isolation all in a small board area. "We have not seen another multi-channel high accuracy fully isolated analogue front end for industrial sensors in a Pmod-compatible form factor out there right now. Most existing solutions from our competitors are on huge EV kit boards with oversized components."

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Fully capable reference design

These competitive solutions, by virtue of their size, therefore have their limitations. This is where having a small, but fully capable reference design with standard connections, provides not just part of the design process, but potentially part of the design solution, as Gruber explains: "The EV kits you can buy normally have a USB interface on a huge board and you have to design a board to get the optimum performance out of your part. The problem is with some of our customers' applications might be talking about a 0 to 20mA input – we are talking about small pcbs with 3 or 4cm design. With this huge EV kit optimised to get the last mV out of the part, it is impossible to translate one for one, because it is not optimised for space.

"So we decided to produce a small design with a layout proposal of which 90 to 95% can reused directly. It is already trimmed to be small and trimmed to use small parts. Admittedly, with a smaller design, there will be trade-offs. It is not using the huge optimised card that has twice the capability you need and have three times the voltage to provide optimal performance. We tried to do a very good precision analogue design in a very tiny space with tiny products that can be integrated into an end product – that was the intention behind Cupertino."

Gruber puts the success of maintaining quality in a small package down to properly matching high accuracy components in the signal chain path. "The input buffers are optimised for matching the input signal to the a/d converter," he said "The precision reference is matched to the a/d converter and the converter itself has excellent performance. The overall result is high accuracy performance while maintaining a low noise floor, especially considering isolated power is included on board. The Cupertino is also flexible. In cases where the input signal source has a significantly low source resistance compared to the 17kΩ input resistance of the MAX1301's integrated input buffers, then the additional on-board input buffers can be eliminated."