NOW, IT'S PERSONAL

A two die solution to product integration is said to offer particular advantages.
By **Graham Pitcher**.

The twin thrusts of adding more functionality to products whilst reducing their size pose some interesting challenges for engineers and business managers alike.

The obvious solution – moving to an ASIC – isn't an economic move for many companies, even if they select a trailing edge process. Similarly, while FPGAs are suitable for a range of applications, the economics don't always make sense when it comes to consumer products. The need for some kind of programmable platform remains, but what form that might take is open for discussion.

One US based company believes it might have the solution for which engineers are looking and describes its offering as allowing the creation of 'personal standard products'.

Paul Hollingworth, vp of sales and marketing for Indie Semiconductor, explained the approach. "We're essentially offering custom microcontrollers; we take the best bits of an MCU, blend them with the best bits of an ASIC, then leave the worst bits behind." His view is that, while MCUs are easy to use, flexible and programmable, they are never a perfect fit for any particular application. "We get called in when customers want to integrate their design: for example, to bring in power and communications functionality, alongside custom elements. We're good at putting together small, low power, low cost designs quickly."

Indie, a fabless semiconductor company, was established in 2007 and has been known for most of this time as AyDeeKay, reflecting the names of the founders – Ichiro Aoki, Donald McClymont and Scott Kee. Its first products shipped in 2010 and, according to Hollingworth, it is now shipping 1million units a month, with plans to double this in the next year.

Only recently renamed as Indie, the company has its roots in Axiom Micro Devices, which commercialised research undertaken by two of the founders for their PhDs at the California Institute of Technology – Caltech. This work saw the development of the first CMOS power amp for the mobile phone market which shipped 250m units.

"That PA needed to handle a signal swing of 28V," Hollingworth noted, "while the breakdown voltage of the transistors was 3V. But the problem was solved and this has strengthened Indie's technical depth."
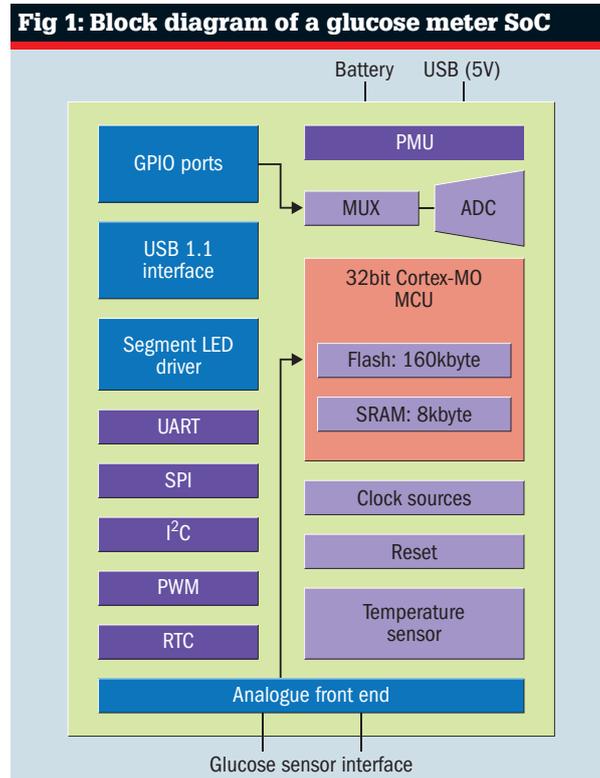
When Axiom was acquired by Skyworks, the founders decided to build another company, which would produce chips in volume that addressed more applications.

"We now have 20 developments in production," Hollingworth noted, "and a number of others in definition, with target markets including automotive and the Internet of Things."

The term 'personal standard product' explains what Indie is attempting to achieve. "Those 20 designs," Hollingworth continued, "were undertaken with particular customers. But at the outset of the development programme, we ask customers whether their product will be exclusively for them or whether it could become an ASSP. If they allow it to become an ASSP, we can then sell the design to other companies, which reduces the overall cost."

Alongside the company's main office in Southern California, Indie also has a design centre in Edinburgh and a joint venture in China, which offers application and PCB design support.

According to Hollingworth: "When you look at what a chip for an IoT application has to do, it defines most of the chips that we've developed. They all contain four main blocks:

Fig 1: Block diagram of a glucose meter SoC

Battery · USB (5V)

- GPIO ports
- USB 1.1 interface
- Segment LED driver
- UART
- SPI
- I²C
- PWM
- RTC
- PMU
- MUX · ADC
- 32bit Cortex-M0 MCU
  - Flash: 160kbyte
  - SRAM: 8kbyte
- Clock sources
- Reset
- Temperature sensor
- Analogue front end

Glucose sensor interface

sensing; processing; control; and communications."

Sensing options are essentially mixed signal and analogue blocks. "It's where there's most customisation," Hollingworth said. "Customers are always asking for different data converters, op amps and so on." The company can supply a choice of custom analogue peripherals from its library, with all blocks designed for reuse. A range of A/D and D/A converters is supported by low power elements such as sub microamp sensor interfaces.

Processing is handled by ARM Cortex cores. Hollingworth said: "Everything we have in production at the moment is based on a Cortex-M0 core, but we have products in design that are based on the M0+ and M4 cores. These cores have been laid out in house in a particular way that allows us to apply our 'secret sauce'; it's not just a 2 x 2mm MCU core, it also features 160kbyte of flash and 8kbyte of SRAM."

A further option offered by Indie is state machine based logic, where the lowest power and cost are required.

The Cortex-M0 core developed by Indie is known as 'Clough'. When running from flash, the core can operate at up to 20MHz; when running from SRAM, that increases to a maximum of 50MHz. Indie says the core is 'cost competitive' with 8bit MCUs and power consumption can be 'sub microamp'.

Clough is manufactured on two nodes – 0.18µm and 55nm – by Grace Semiconductor. "It has a good embedded flash process," Hollingworth noted.

Control elements include high voltage and power management blocks, with the company's products able to withstand up to 50V. "It's unusual for companies to have offer a process with can handle automotive voltages," Hollingworth pointed out, "as is the ability to do this in the same package as an MCU." This functionality is provided by X-Fab.

Communication is handled by a choice of RF or wired links. "We started by offering ISM based comms at 315/433MHz," Hollingworth explained,

"because that's a low cost option. But we have since added 802.11n and, more recently, Bluetooth Low Energy blocks." Wired comms blocks include UARTs, I²C, SPI and USB.

Indie assembles products using an SiP approach, where the two die – Cortex based logic and the customised elements – are assembled either side by side or stacked (see picture left). The device can then be supplied in a choice of packages.

Hollingworth contended this approach allows Indie to address a wide range of markets. "About half of our business is focused on automotive," he said, "with some consumer and industrial designs. We have deliberately gone after those markets where it is necessary to demonstrate high quality; and it's not easy to get customers in those markets to use new suppliers. We are certified to AEC-Q100 for automotive and ISO13485 for medical.

"What we've been able to do is to bring good chip and system design people to the projects and use the right components to build a chip optimised for the application."

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> **Paul Hollingworth**

Amongst recent projects has been a chip for a glucose meter (see fig 1). "We integrated a number of features into chip," Hollingworth said, "but also added things like a USB port. However, in the middle of the project, we changed the architecture because we developed a better way to improve accuracy and reduce power consumption. Even so, the design process took less than six months from specs to samples."

A general purpose MCU ASIC, called Kamcho (see fig 2), has the Clough MCU core, with additional features like an 8bit A/D converter with adjustable gain and a range of GPIO.

"It can be bought as a standard product, but is used more often as a starting point," Hollingworth said.

Indie claims it will specify, design and manufacture a device that is a 'perfect fit' for the application. "If you can find an MCU that meets your needs, then use it," Hollingworth concluded. "We're here when companies can't find the functionality they want or need a mix of technologies."

Fig 2: A high voltage wireless transceiver