EE Times Design

How small vendors compete in analog IC market

The Petrov Group -- 4/29/2013 5:56 AM EDT

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Can a small fabless analog vendor compete with the top five analog IC vendors in global markets? This question is being asked often, especially in the context of emerging Chinese end-system OEMs. Europe used to have many small analog IC specialists – most but not all have by now been acquired. In this case study, we will compare one such small but well-established company competing with the world's largest analog company.

The challenge for small companies is to anticipate market needs and develop products that will be ahead of and differentiated from the competition. A competitive comparison can show how relatively similar products are introduced by one big (Texas Instruments) company and one small (Systemcom) company. In principle, their products function in the same way, but use different approaches regarding their target application-- IC products for photometry, electrochemical and radiation sensing with current input sensors.

Systemcom Ltd., a fabless IC design house with 16 employees and $1M revenue, launched in July 2012 an analog front end (AFE) IC -- with current input and 13-bit ADC. Their AFE is developed as a family of modular products, designed as IP modules, as well as a standalone ASIC solution.

- The solution in the form of an IP module is used when a customer builds a larger system (SoC) from proven and characterized building blocks. IP modules with different characteristics allow more flexibility in the design of an electronic system, resulting in the system optimized for the particular application. The IP modules are designed for an extended temperature range, so together with a consumer and industrial temperature range, the application field is quite broad.

- The product as an ASIC solution is developed for customers who want a complete system ready for production. The application of the AFE family is based on an electronic system having a sensor with the current input, as in photometry, electrochemical and radiation sensing.

Systemcom's product targets broad general applications but is supported by the flexibility to allow customization of IP modules according to the customers' needs.

In January 2013, **Texas Instruments (TI)** introduced at CES2013 the industry's first integrated analog front end for photometry applications. TI, with over 35,000 employees including many from the former National and over $13B in revenue, is the largest analog IC vendor.

TI's AFE IC also targets photometry applications, including clinical and home-use pulse oximeters, blood glucose meters, and heart rate monitors. Since actual trends are leading toward portable electronics for health monitoring and diagnostics for home use, with options for communication and control from a distance (telemedicine), it was predictable that TI would develop such a product. This particular IC represents a case of dedicated ICs with a known application and customer base in the medical device industry.

So how should the two companies have approached the same application? In this example, the difference is a laser-like focus on identified large volume OEMs versus a broader and more flexible

offering to potentially more diverse customer groups.

Such approaches were expected and predictable but are very challenging for a small vendor which can't afford many product misses. It requires a small team of design and application experts who are able to make a more general synthesis of diverse customer requirements. Once again, TI's product line is sharply focused but it is also more limited and less flexible. Systemcom's product line is very broad and flexible -- covering a range of market segments.

The most pronounced product line differences are shown in the table below.

Brief comparison of AFE features

Parameter	Texas Instruments AFE44xx family	Systemcom SC-I-AFE-180F110	Comments and Comparison of SC's and TI's solutions
PERFORMANCE (full-signal path)			
Specified temperature range	0°C – 70°C	-40°C – 125°C	SC has a broader temperature range (commercial vs extended range)
TRANSIMPEDANCE AMPLIFIER (TIA)			
Full scale input current	50 uA (7 selectable current ranges)	1000 uA (8 selectable current ranges)	SC uses broad input current range for many diverse applications
AMBIENT CANCELLATION AND PGA			
Maximal gain setting	4	1296	SC's larger gain supports smaller input signal swing and improved resolution
Cancellation implementation / maximal current range for cancellation	Cancellation performed by external component (microcontroller) / 10uA in discrete steps	Cancellation performed internally by analog circuitry / entire selected current range (continuous)	SC's continuous cancellation procedure is suited for all ambient conditions
COMMUNICATION INTERFACE			
Communication interface	SPI	SPI	Both solutions use the same communication protocol

Strategy

Both product approaches have been very successful in the marketplace. Below is a more detailed analysis of success drivers:

1. Texas Instruments' AFE44xx family is suited to the pulse oximeter application, which inevitably results with an optimized and compact solution. Integrated additional features (like LED driver and fault diagnostics) make the AFE44xx an "all-in-one" solution for that photometric application. TI's approach, however, also makes the AFE44xx family very application-specific. The drawback is that AFE44xx is not suitable or could be redundant for many other sensors and applications. On the other hand, Systemcom's

AFE family is very modular and therefore far more versatile and applicable to a wide range of current output sensors and applications.

2. Unlike Systemcom's SC-I-AFE-180F110, TI's AFE44xx features a fully-differential transimpendance amplifier (TIA) which eliminates the need for a single-ended to differential converter. This provides better overall simplicity in design but probably at the expense of linearity. The fully-differential TIA inherently biases the photodiode to the voltage of 0V which increases the photodiode's capacitance. SC-I-AFE-180F110 is designed to bias the photodiode with higher reverse voltage, thus reducing its capacitance and consequently its response time. Such a sensor biasing solution makes SC-I-AFE-180F110 suitable for interfacing other current output sensors, e.g., electrochemical sensors.

3. The four-stage-PGA in SC-I-AFE-180F110 offers a gain of up to 1296 and a transresistance of 64kΩ by TIA. Such a combination of gain and transresistance allows significantly smaller resistance values in TIA and consequentially faster response time. The AFE44xx family provides 1MΩ transresistance by TIA, combined with a gain up to 4 in a single-stage-PGA. The PGA used in the SC-I-AFE-180F110 is based on the switched capacitor architecture, which in general exhibits lower noise performance when compared to solutions based on resistive amplifiers. Both products use the averaging technique to reduce noise and improve SNR.

4. AFE44xx provides limited ambient (light) cancellation (up to 10uA), which involves a procedure run by a microcontroller and DAC to perform this cancellation. Such a solution requires more time to complete and suffers from residual offset (because of 10 discrete steps of DAC). The relative measurement in SC-I-AFE-180F110 offers ambient light suppression performed by the analog circuitry itself regardless of the amount of ambient light. In other words, this allows high gain amplification of the desired signal relative to the ambient light. Furthermore, the ambient light suppression doesn't rely on the procedure run by a microcontroller or digital post-processing, so it is therefore simpler and faster. The amount of ambient light to be suppressed depends only on the selected current range (up to 1mA) and is not performed by DAC; this reduces the residual offset.

5. The pulse oximeter application allows small low-gain amplifier and ambient light suppression to be done by a microcontroller instead of the analog circuitry; this ultimately simplifies the design and reduces power consumption. In the end, it all comes down to the requirement for specific application and the sensor used. Versatility means a wide spectrum of sensors and possible applications but it also requires an effort to implement it for a specific application. In contrast, a dedicated application means a more optimal, off-the-shelf solution.

In summary -- how a small analog vendor successfully competes

TI's product is developed for a focused medical application. It targets a narrow market segment – a segment with a significant potential due to the rise of low cost, portable medical devices. Customers can efficiently build a medical device around this product since it is already developed and tested for that focused application. For some other application based on photometry, but with different sensor characteristics, TI's product would largely be inadequate.

Systemcom's solution was developed with a different philosophy in mind. It targets potential customers who use different sensor types used in today's market but also targets sensors that will be introduced and commercially available in the near future. Applications for Systemcom's product using suitable sensors are found across multiple vertical market segments -- medical and biomedical (pulse oximeters like TI's product, glucose meters, etc), environmental, automotive, industrial, communication and cutting-edge mobile devices segments. All Systemcom building blocks were designed as IP modules-- the modular approach allows a tailored and optimized solution for a particular application -- e.g., number of gain stages to reach an overall amplification figure. Based on the particular requirements from a customer, Systemcom can quickly provide an optimized product - either in the form of an IP module or ASIC. This significantly reduces the development cost due to an already optimized design on the block level and allows a very fast time-to-market introduction. Otherwise product integration into the end-system would require a more extensive effort due to additional application development and testing not performed

earlier in the development phase. For a small vendor, the benefits of a shorter and cost-effective development cycle would prevail in the overall cost analysis.

The above analysis validates the fundamental differences in the market approach among large and small vendors.

- A large vendor develops a dedicated IC with well-defined and limited functionality covering the needs of targeted customers.

- A small and highly specialized analog vendor develops a more general product for various applications in the form of IP modules and ASICs with customization features and strong support for integration into larger end-systems.

There is plenty of room in the market for both approaches. Customers benefit from the two similar products that are offered, each with an emphasis on different application and system characteristics.

More detailed data about above product lines are given at the companies' websites:
http://www.systemcom.hr/
http://www.ti.com

Editor's note

The Petrov Group confirmed that there is no relationship between Petrov Group and Systemcom or Texas Instruments.