Emergence of the Specialty Foundry

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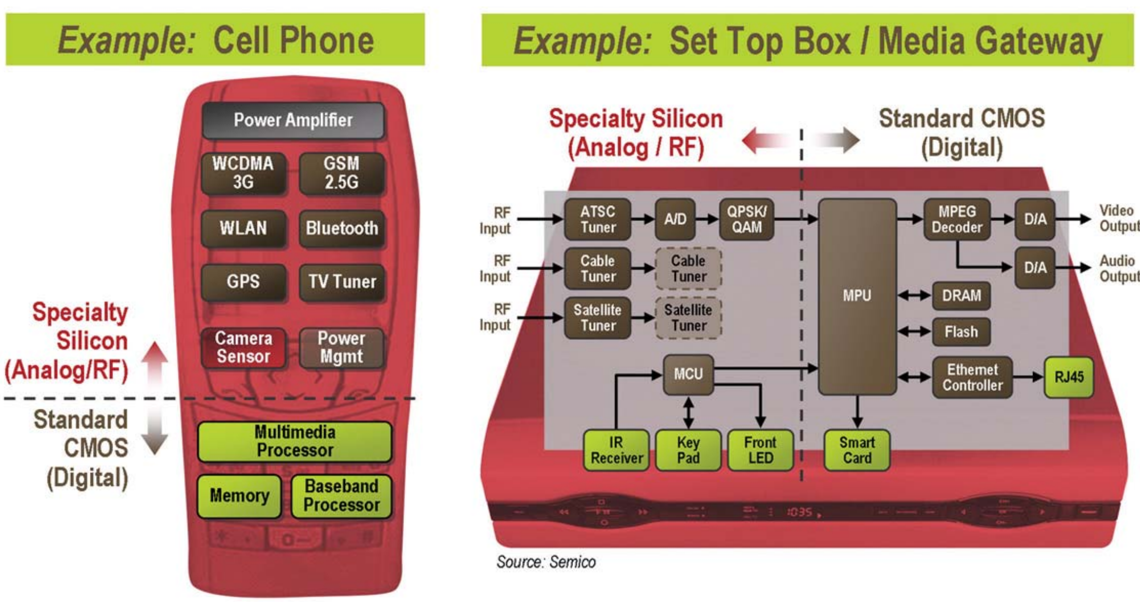
The explosion of analog content in today's consumer products has fueled the birth of a new breed of foundry focused on enabling a larger fabless presence in the analog market. Foundries have flourished in the digital space, as IC designers can readily conform to a standard process while still differentiating their end products through functionality and software. However, this is not the case in the analog space where integrated device manufacturers (IDMs) have traditionally dominated, as they derive benefits from the tight coupling between process and design. A new type of foundry is emerging that must bridge the gap for the fabless industry by combining IDM-like analog technology, design infrastructure and flexibility while preserving the supply chain efficiency of the digital foundry: the specialty foundry.

Why the Need Now?

As voice, video and data functions converge on platform devices, such as the mobile phone and set-top box, more analog interfaces are required for wireless and wireline communication, human interaction and power supply management, all packed in a smaller form factor. Higher levels of analog integration require more aggressive process nodes and more investment in process technology than was typical of prior generations. Indeed, most analog products today are built in 0.35-micron or larger geometries and in six-inch manufacturing lines. Higher levels of integration are pushing many new designs toward the 0.18-micron geometry, which requires eight-inch manufacturing capability. This creates a high barrier of entry for new and existing players in the analog market. The foundry model can lower this barrier by "pooling" investment in manufacturing capacity and technology of more advanced analog nodes such as 0.25-micron, 0.18-micron and even 0.13-micron.

Figure 1. Specialty Silicon in Today's Platform Consumer Products



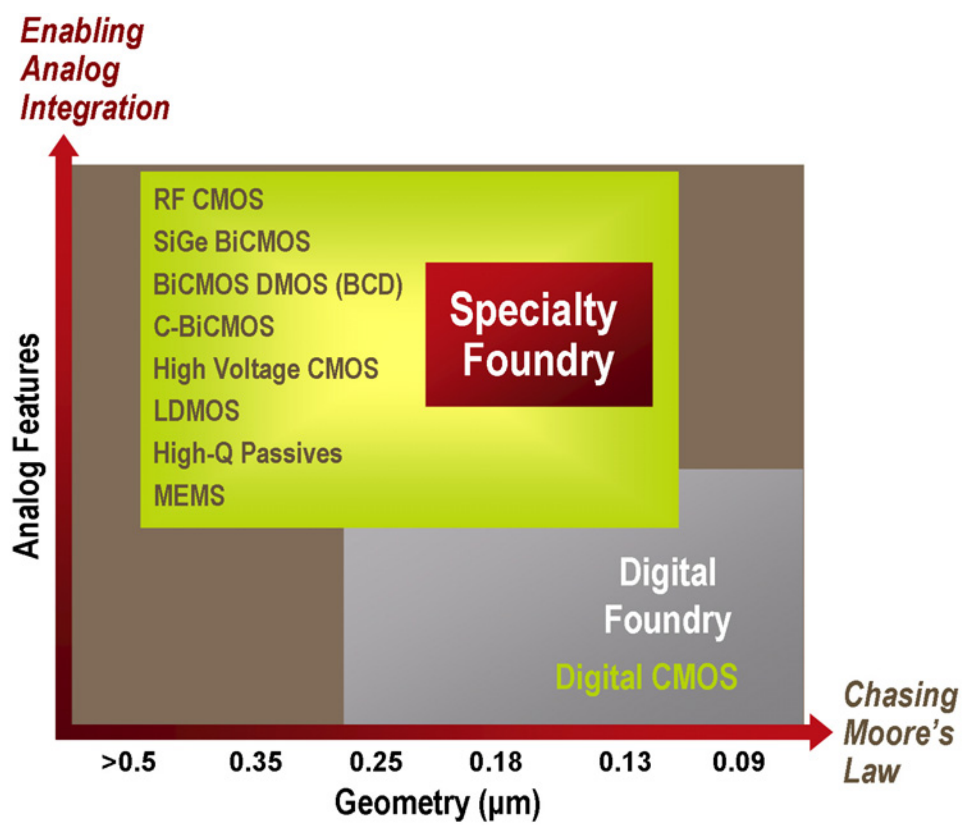
In addition, more integrated analog products result in higher wafer volumes than discrete products. This is because more integrated products consolidate the silicon area from several discrete products into a single die, so a single supplier will produce the equivalent silicon area of many discrete suppliers. The supplier must have the ability to scale production and, as typical with higher wafer volumes, provide second sources. This prompts fabless companies and analog IDMs to turn to a specialty foundry to help provide the right technology in a scalable and efficient business model.

A case study for this evolution already exists: the radio frequency (RF) transceiver. In the early mobile phone, the RF transceiver was built on a printed circuit board using many components, including low-noise amplifiers, mixers, synthesizers, passives and data converters. As the mobile phone evolved in complexity and reduced in form factor, more highly integrated solutions were sought, resulting in what we see today: all components built on a single RF IC, typically in a specialty process technology (i.e., SiGe BiCMOS or RF CMOS). The continued growth of the mobile phone market, coupled with the trend toward a single chip, has resulted in a high-volume, highly integrated RF transceiver device that derives significant benefits from the emerging specialty foundry model. Today, a large percentage of the world's RF transceivers are built or second sourced at specialty foundries, helping fabless companies to not only participate, but also take leadership positions in this market.

This same evolution, from multiple discrete devices on a board to an integrated single-chip solution, is taking place in other analog systems as well, such as power management. Initially, this occurs in mobile applications where form factor is at a premium, but is likely to occur in other systems as technology for integrated power management becomes more readily available. The specialty foundry can again help foster this evolution by providing both the appropriate technology and the efficient scale in technology investment and capacity.

Finally, higher levels of analog integration require a more mature design ecosystem, which includes electronic design automation (EDA) tools, models, design kits and intellectual property (IP). The foundry model can help foster such an ecosystem by providing a common analog platform that enables IP re-use between processes, applications and across different analog market segments.

Figure 2. Specialty Foundry Investing in Features to Enable Analog Integration, Rather than Digital Scaling



What is a Specialty Foundry?

A specialty foundry must first be a foundry. This may seem obvious, but in the analog realm, this concept has been blurred because the best analog technology was available primarily from IDMs who would offer foundry services to maximize factory utilization. This model can create a conflict of interest when IDMs need the capacity for themselves. Pure-play foundries, by definition, do not manufacture their own products; thus, they do not compete with their customers for capacity. Recently, several pure-play foundries have emerged and offer competitive specialty technology while maintaining a business model focused on manufacturing for customers, rather than on the development and marketing of their own products.

A specialty foundry must provide a wide range of analog features in a modular platform, which enables the design of a broad portfolio of analog products while facilitating the convergence of multiple functions on fewer ICs. Analog features include those required for mixed-signal design, such as advanced CMOS and linear passive elements; those required for RF design, such as active components like SiGe bipolar transistors and passive components like high-Q inductors; and those required for high voltage and high power, such as area-efficient LDMOS transistors. These features must be competitive with those available at IDMs, and in some cases, compete effectively with products implemented in other technologies, such as GaAs or digital CMOS. GaAs technology, for example, can compete in performance with specialty silicon in some RF applications, while digital CMOS can compete by pushing the tradeoff between performance and cost in some mixed-signal applications. By providing high-performance and lower cost features in a modular platform, these tradeoffs can be evaluated by the customer at the product planning stage. A modular platform allows the combination of CMOS transistors, high-quality passive elements, high-voltage transistors and SiGe transistors on a single die. Product developers can create more highly integrated products by combining a superset of features, or more targeted products by combining a subset of features while sharing base IP across product lines.

A specialty foundry must provide a higher level of design support than what is typical for a digital foundry. Analog designs push process margins beyond what is typical for digital designs, requiring more accurate modeling of analog devices. In addition to better models, a more sophisticated design platform is required to help product developers manage the integration of analog features. While some design support can be performed in-house, the increased complexity of design and process technology makes it more efficient to push this function to the specialty foundry. This not only provides quality by leveraging “pooled” investment, but is also becoming a time-to-market necessity for product companies.

A specialty foundry must maintain a roadmap focused on the markets it serves, rather than a roadmap focused on advancing to the next geometry (Moore’s Law), as is the mantra of the digital foundry. For example, the requirements for next-generation RF ICs are being driven by the evolution of wireless standards. A specialty foundry must understand how this will change requirements for the analog interfaces and proactively put the right process features in place to meet the new product requirements. For instance, the move from 2.5G to 3G in the cellular market is forcing a higher level of digital content in the RF transceiver, making a more advanced 0.18-micron or 0.13-micron technology more attractive. To maintain a low die cost in these advanced nodes, a specialty foundry must increase the density of passive elements, such as the capacitors and inductors. In the case of wireless LAN (WLAN), the move from 802.11a,b,g to 802.11n means a larger transceiver with multiple power amplifiers (PAs) to support simultaneous communication on multiple channels. The integration of multiple PAs does not benefit from smaller process geometry, but rather from features that improve PA efficiency, form factor and isolation. The specialty foundry roadmap must include these elements. Similarly, next-generation power management products have increasing digital content while addressing voltage requirements that range from low voltages for portable systems to high voltages for systems powered by a car battery or a wall outlet. To serve this market effectively, a specialty foundry must provide a broad portfolio of technology from 0.50-micron to 0.18-micron and provide area-efficient power cells optimized in several voltage steps from 5V to 120V. Customers can optimize their products by selecting the right technology node (driven by the amount of digital content) and power cells optimized for the right voltage (thus not forcing over-design by using a high-voltage device in a medium-voltage application), resulting in the most cost-effective product that meets the requirements of the application. Traditionally, this close tie between application and process technology has been the domain of IDMs and has been a barrier for fabless companies trying to enter these markets. The specialty foundry must bridge this gap and continue to monitor and innovate for the markets it serves to keep its roadmap focused on addressing the next-generation needs of both fabless and IDM customers.

What's Next?

The emergence of the specialty foundry and fabless analog companies, combined with the need for more highly integrated analog products, brings an opportunity for a more comprehensive ecosystem of IP providers, assembly and test services, and EDA solutions to support the growth of the analog industry. The specialty foundry is at the confluence of these trends and can enable the evolution of this model.

The specialty foundry can help IP providers by offering inexpensive prototyping, by supporting modular technology for IP re-use, and by providing an active channel for IP distribution. Analog IP, unlike digital, involves design support to help with integration or optimization, a service that may be provided by the foundry. While the specialty foundry is often expected to carry some IP and provide some level of design service, it must walk a fine line so as to not compete with other IP providers and help nurture an environment that builds a healthy support structure.

The assembly and test of analog products is becoming more complex with increased adoption of multi-chip modules (MCMs) and system-in-package (SiP) technologies. SiP technology will fuel growth in the analog market, as analog functions that may otherwise have been sub-optimally integrated with digital systems-on-chip (SOCs), can now be built in more cost-effective analog technology and integrated with digital chips in a single package. The use of SiP makes system-level simulation, verification and test more complicated, as multiple chips from different foundries are combined in a package, which is manufactured by yet another party. This calls for a tight relationship between the foundry and the assembly and test vendors to help simplify the development cycle. This same problem calls for new solutions from the EDA industry such that SiP products can be verified by simulation early in the design cycle, reducing time-to-market. Within a die, the analog sub-system is also becoming more complex, as RF, high-voltage and digital functions are combined and must be co-simulated. While this is possible today at a high level, many effects are difficult to simulate. For example, to understand the impact of process variation on a complicated mixed-signal design, statistical simulations of a complex system must be performed, which is often too time-consuming with today's simulation technology. In addition to simulation tools, improved verification tools can help further analog integration. Effects, such as over-voltage conditions, reliability, latchup, electromigration and electrostatic discharge (ESD), all critical to the first-time success of a high-voltage design, are often left out of a structured verification process. These effects are then left for the design and layout engineer to verify manually or the test engineer to discover during product qualification. Providing cost-effective tools to enable more structured verification of these effects can help speed time-to-market. The specialty foundry can play a key role by bringing its technology and application knowledge to the EDA vendors and, as tools become available, help structure a design flow for its customers to include these effects for a time-to-market advantage.

The Bottom Line

The specialty foundry is filling a critical need in the supply chain by enabling fabless companies to increase their market share in the analog space, a market traditionally dominated by IDMs. Specialty foundries provide analog technology in a pure-play business model, provide the sophisticated modeling infrastructure and design support needed for analog design, and focus their roadmaps on the next-generation needs of the analog market, rather than on chasing the geometry curve. The specialty foundry is enabling an ecosystem to serve the emerging analog fabless industry, including IP providers, assembly and test vendors, and EDA companies, and must actively encourage the future growth of this specialty infrastructure as it plays its part in bringing the analog fabless model to its ultimate potential.