

# ANALOG ICs

## experiencing big growth

Analog remains one of the most diverse and profitable markets in the entire semiconductor industry.

RICHA GUPTA

**M**ost modern computers are digital. But they function in a world of continuously varying analog input such as sound, light, and heat. So, they must convert these analog signals into digital ones and zeros for processing. Every "digital" consumer product, from appliances and cell phones to music players, has analog ICs feeding its digital heart.

Analog ICs typically enjoy a far longer useful life than digital devices. While the circuit designs have been refined and the cost of the chips reduced as manufacturing processes improved, the basic functions of many analog devices continue to be useful in new electronic products after more than 40 years.

The analog circuit has to perform signal processing on time varying signals with a continuum of levels in either voltage, current or charge. In contrast the digital circuit only has to resolve one of two signal levels that represent a 0 or 1. While an analog signal has a theoretically infinite resolution, the signal degradation caused by noise (random variations) and non-linearity (distortion) that are present in the analog circuit are inherent design considerations that must be managed by the circuit designer.

The analog integrated circuit is different from the discrete analog circuit in that it is fully integrated onto a single monolithic piece of silicon; where the selection of individual elements is not possible. The analog integrated circuit designer has to work within the constraints of circuit elements, their range of values and their tolerances that the process technology allows.

Analog circuit synthesis to simplify the design process has been an unrealized industry fantasy for more than two decades. Great analog and mixed-signal designers are few in number because, in part, they must have command of real world

electronics and applications, semiconductor device physics, EDA tools, etc. The demand for analog IC designers has increased over the past few decades and they have never been considered a commodity to be hired and fired with revenue fluctuations

### The Need for Analog ASICs

Application Specific Integrated Circuits, ASICs, typically conjure up the notion of massively complex logic chips containing tens or hundreds of thousands (even millions) of transistors configured to solve a customer's unique set of problems. Unlike multi-function standard product ICs such as a micro-controller that can find its way into a wide variety of applications, ASICs are designed for one specific application and generally for one specific product or product family.

To better understand the role and applicability of ASICs, it is important to briefly review their historical origins.

The first Integrated Circuits from the early '60s contained just a few transistors and performed simple digital logic functions such as "and", "or", "nor", etc. These were called SSI devices, meaning Small-Scale Integration. As photolithography techniques improved, more and more transistors could be built on a single sliver of silicon. Soon, chip companies were developing Medium Scale "MSI" logic function like flip-flops, buffers, latches, etc (10-100 transistors). Large Scale "LSI" (100-1,000 transistors) and eventually VLSI (up to 100,000 transistors) ICs followed, providing lower system costs and higher levels of performance. Today of course, we have digital chips in excess of a billion transistors thanks to advanced sub-micron lithography and the low voltage, high speed processes upon which they are built.

The first digital ASICs were built using a standard cell library consisting of fixed-height, variable-

width 'tiles' containing the digital logic functions discussed above. The ability to reuse these blocks over and over saved time and money when designing a custom logic IC.

Analog ICs were initially comprised of a pair of matched transistors and soon expanded to include rudimentary Op Amps, Voltage Regulators, Comparators, Timers and much more. Analog applications typically involve much higher voltages so these ICs needed their own unique set of manufacturing processes. More recently, market demands for smaller size, higher speeds and lower power consumption have forced a merging of analog and digital functionality on a single silicon chip. Cells consisting of the basic analog building blocks discussed above were created and added to the digital libraries. These Analog cells were restricted to the digital fab processes developed for predominately logic applications.

Today, most ASIC companies offer some degree of analog functionality as a part of their services. In many cases, the analog functions are mimicked with digital design techniques. In others, compromises to the analog functionality must be made to facilitate the use of standard library cells that are designed to yield well in the fab processes developed for high speed, high density, low power digital designs. Often, these chips are referred to as Mixed-signal ASICs or as big "D", little "A" ASICs, meaning high digital content and minimal analog content.

Analog ASICs play a critical role in our lives. Without them, none of the portable electronic devices we use in our daily lives would exist. Imagine a world without Cell Phones, MP3 players and Navigation Systems. Building them with standard products would make them prohibitively expensive and physically impossible to carry in our purses or pockets. Every automobile contains dozens of ASIC chips for everything from climate control to airbag deployment; suspension control to entertainment systems. ASICs also play important roles in applications for hospital medical equipment, eMeters, home appliances such as washers and dryers, scuba gear, hearing aids, and much more.

### Worldwide Analog Market

For 2012, expect analog IC product revenue to be up by around 3 percent, representing a modest but significant increase over last year. Growth will be seen in communications and consumer electronics segments especially, driven by the higher demands

for handsets and portable devices, and by the increasing manufacturing consumption originating from the Asia Pacific region. The Asia Pacific region continues to grow in share relative to the global analog market, at the expense of other regions, and especially as production continues to move away from the Americas.

Analog IC content is found throughout all five major market segments, with the greatest growth seen in wireless communications applications, particularly within mobile phones, with substantial growth also coming from the higher volume consumer electronics like televisions. Analog remains one of the most diverse and profitable markets in the entire semiconductor industry: ASSPs account for the majority of revenue, with high performance power ICs and data converters experiencing the fastest growth.

Databeans, the market research company divides the analog market into two general segments. The first is general purpose analog, which are designed taking a 'standard cell' approach in mind and are products found across all application markets.

The other major segment of analog products is application specific in design and restricted to their respective application markets (automotive, computer, consumer, communications and industrial). Because these products are tied to individual applications, they are far more vulnerable to the sudden ups and downs found in their respective markets.

The analog ASIC market is huge. In fact, research firm IC Insights reports that almost 60% of the nearly \$37B of analog ICs sold in 2010 were ASICs.

### Analog's healthy green future

New platforms and technologies coupled with SoC and analog/mixed-signal integrations will be the next pull-through that moves analog into an exciting and more competitive market. The impending market change for analog is supported by the demands for medical, energy solutions and LED lighting, in addition to the continued strength of consumer demand for electronics, especially smartphones, notebooks and tablets. These end-markets are vast, rich in consumers and devices, and are on the rise. With significant shortages and a lower number of competitors in the sector, compared to the broader semi market, analog is poised to undergo significant changes to technologies, competitive landscapes, and increased integration into chip-based solutions.

## “Automotive and medical markets are targets for Analog and Mixed signal ICs”

**Somshubhro (Som) Pal Choudhury, Managing Director, Analog Devices India**



Demand for Analog and Mixed signal ICs are growing across several verticals such as consumer, industrial, defense, energy, automotive, communications infrastructure and medical electronics. As we digitally process information, the interface to the outside world becomes more and more important. System on a Chip (SoC) and System in a Package (SiP) are becoming more prevalent with the need for faster processing, handling more pixels/data, providing better measurement accuracy, occupying smaller footprint, consuming lesser power, all the while at a lesser cost and faster time to market. Solutions to the above challenges from companies like Analog Devices Inc. with our Converter, RF, MEMS, and amplifier leadership and SoC and/or package level integration are the drivers for analog and mixed signal IC growth.

According to the market research firm Databeans, the growth projections of Analog ICs is 9% CAGR with respect to revenue and over 11 percent for units for the next 5 years, which is more than the overall semiconductor market growth. While the semiconductor market is expected to be flat this year compared to last year, Analog ICs are projected to grow 3%.

Growth in the last 5 years have been primarily by the communications and consumer electronics segments, driven by the higher demands for handsets and portable devices, and by the increasing consumption originating from the Asia Pacific region. MEMS accelerometers have become common because of gaming consoles, mobile phone and tablets. The proliferation of base stations, DSL and cable for Broadband all required the critical analog and mixed signal ICs. Analog remains one of the most diverse and profitable markets in the entire semiconductor industry, ASSPs account for the majority of revenue growth, with high performance power ICs and data converters experiencing decent growth.

Automotive and medical markets are targets for Analog and Mixed signal ICs as the quantity of electronics going inside automobiles is increasing and the medical electronics is getting smaller, smarter with better diagnostic technologies while the demand is increasing with aging population, increased longevity and lifestyle oriented diseases. Industrial automation, energy and defense sector are growing with more factory automation, solar energy, electronic warfare and so on.

Trends - Historically, amplifiers and data converters have been the cornerstone of Analog IC design, with designers specialized in continually improving those blocks for higher precision, higher performance, and better noise immunity. But today, Analog design also involves combining multiple functions with an eye toward specific applications. Low Power and more integrated signal chain is the requirement for most end markets today. While historically the primary challenge was to extract the relevant signal from the background noise, increasingly the challenge has been to extract the relevant signal from the dense traffic of other signals or interferers.

Advanced Packaging Technologies is and will remain one of the most important battlegrounds over the next 5 years and we are seeing a great deal of System in a Package (SiP) activity with all our key customers. Though counter-intuitive, System in a Package (SiP) is coming out more economical than System On a Chip (SoC) for Mixed Signal IC designs. “Digitally assisted Analog”, with digital controllers in amplifiers and converters for power management and limited post processing functions is the trend, not necessarily for 10’s of millions of gates, but for some integrated digital (Big-A, Small-D). Ultra-low power requirement is primarily being driven by consumerism of medical electronics today, but for longer term wireless sensor networks might be the big driver. Combo motion MEMS sensors expected to grow strong continuing on the tremendous growth of MEMS accelerometers in the tablet and mobile markets. From a design support perspective, Analog/Digital Mixed simulation is becoming a necessity among the design community.

Now we are all very familiar with shrinking geometries in the Digital world. But the Analog Domain is not subject to the same lithographic shrinking that CMOS Digital devices enjoy. Analog circuits do not scale as aggressively as digital, cost per function may actually go up. Hence, analog designs stay at each node much longer as sometimes it is much more economical to stay there.

**“Imbalances in component supply and demand could pose a challenge to the growth of the analog IC market.”**



**Eric Zhang, Assistant Technical Marketing Manager, Fairchild Semiconductor**

Some professional market research analysts are forecasting that the global analog IC market will grow at a CAGR of 4.7% in the period 2011-2015.

For 2012, expect analog-IC product revenue to be up by around 3%, representing a modest but significant increase over last year. In particular, growth will be seen in the communications, lighting and consumer-electronics segments, driven by higher demand for handsets and other portable devices and increased consumption within the Asia-Pacific region. Here are three examples of very attractive opportunities in analog ICs:

One of the key factors contributing to the growth of this market is the need for controller electronics in a variety of products. The global analog IC market has, for example, been seeing the development of new applications for analog ICs in LED lighting systems.

Mobile devices are now ramping up, including media phones and pads that have larger screens and deliver higher performance. Judging by the trend in battery capacity and the new USB power delivery standard, ratings of 7.5W and higher will definitely be the new trend for smart phones and tablets.

Because analog circuitry doesn't scale easily when you move to smaller geometries in the fabrication process, and because it isn't easily portable between foundries, modern semiconductor system design seeks to minimize analog content and perform as much signal processing as possible within digital topologies and firmware.

One of the key factors contributing to the growth of the analog IC market is the need for controller electronics in end-products. For example, the global analog IC market has been witnessing emerging applications for analog ICs in LED lighting systems. However, imbalances in component supply and demand could pose a challenge to the growth of the analog IC market.

Trends - One major trend is higher integration combined with lower power consumption. Another is high performance at the most competitive price points. There is also a trend of combining more digital functions, along with the analog IC, in a chipset that best suits the requirements of the end application.

**“There are many opportunities for the advancement of analog-IC design that enable the next wave of applications and products.”**



**Keith Pazul, Product Marketing Manager, Analog and Interface Product Division, Microchip Technology Inc.**

There continues to be more and more intelligence built into end products. Real-world phenomena are still analog (i.e., pressure, temperature, flow, velocity, acceleration, position driving motors, communication, etc.). Therefore, connecting these more intelligent solutions to the outside world still requires analog capabilities. There will always be a requirement for analog content in applications.

The application areas that are fueling the largest percentage of Microchip's analog growth include automotive, LED lighting, smartphones, tablets, PCs, networking, and home automation.

There are many opportunities for the advancement of analog-IC design, to solve customer problems and provide solutions that enable the next wave of applications and products.

Major challenges to market growth include an overall weak macro-economic environment and identification, deployment and customer acceptance of the next big application, or applications, to consume large quantities of analog ICs.

Trends - The technology trends that we see in analog ICs include smaller lithographies, higher integration (more functions in less space), higher intelligence, and higher power in smaller spaces.

**“As with most markets, cost is always a barrier to market growth for analog IC.”**



**Farshad Zarghami, Vice President, Microsemi Corporation**

Analog IC applies to a virtually every market and application. At Microsemi, we focus on analog IC that apply to power management, sensor interface, RF, power over Ethernet (PoE), and high reliability applications. We see the demand for analog IC in these markets increasing at a healthy pace with new opportunities surfacing on a daily basis.

Power management exists in virtually every electronics application and with every increasing complexity of these applications; the complexity of the power management function becomes more complex as well. The power management analog IC are evolving from simple LDO and switchers to complete power management IC (PMIC) that include digital control loops, adaptive voltage and current capability, power measurement/monitoring, and temperature compensation.

The continued proliferation of WiFi products for communications and the 'internet of things' continue to drive demand for RF products that support higher data rates and/or extreme reductions in operating power.

The internet of things will also drive demand for low power sensors that can be installed with minimal infrastructure modification, installation cost, and periodic maintenance. This will drive the demand for analog IC that can perform analog signal processing at very low operating currents.

Increasing functionality in automobiles is driving the need for high speed communication within the vehicle. This creates the opportunity to implement PoE systems that connect a variety of low and high bandwidth end points to the vehicle control system, without the need to run separate power, control, and data wiring.

Consumer electronics continue to drive growth in analog IC products with adoption of motion sensing (accelerometers and gyroscopes) into smartphones and tablet computers significantly increasing the demand for sensor interface IC. Increasing functionality in smartphones requires higher speed processors which consume higher amounts of current from the battery. This continuous cycle of increasing functionality and increased processing horsepower places pressure on the power management IC to increase conversion efficiency and reduce operating currents. Wireless sensors are also expected to drive the demand for sensor interface IC, power management IC, and low power RF transceiver IC.

We see analog IC evolving into smart subsystems that combine high performance analog circuits with optimized local processing capability that pre-processes analog data and/or provides local management of power systems. Such integration pose challenges to the analog IC integration because the fabrication process desired for high performance and/or power analog is often divergent from the fabrication process for digital processing. However the ability to combine analog with local processing offers significant value to the system designer by reducing the complexity of the overall system.

As with most markets, cost is always a barrier to market growth for analog IC. Unlike digital IC which improves in cost with each fabrication process node migration, analog IC does scale linearly with process geometry reduction. This places more emphasis on circuit design techniques required to optimize circuit area in order to reduce cost and without compromising performance.

Trends - We see an ever increasing trend towards devices which combine higher efficiency, lower power, and more sophisticated control and analysis capability – smart analog if you will. This demands sophistication in circuit design techniques, exploitation of processes that combine high integration, high performance, and high power handling capability, and the ability to implement ultra low power control and computing functions. In our high integration power and space targeted products, this also includes 3D packaging and sophisticated yet cost effective multi-chip modules (MCMs).



**"Analog ICs market is expected to witness a major boom with the growing demand in mobile and home applications."**



**Kulbhushan Misri, Analog IP, Sensors, Freescale Semiconductor India**

Analog IC`s provides immense opportunity in automotive and consumer market. With the growth in automotive safety, driver information system, body electronics and sensors the market is set to grow. Analog integrated circuits are also being used in connectivity, healthcare, industrial, consumer industry.

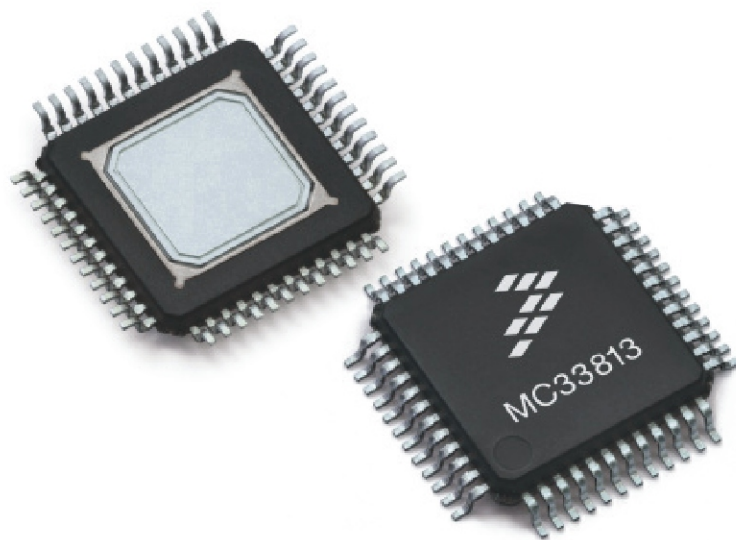
Analog ICs market is expected to witness a major boom with the growing demand in mobile and home applications. The Asia Pacific region will play a big part in this growth due to increases in both consumption and manufacturing.

Apart from above, one more industry that will fuel the growth of the analog IC market is the solar energy market. India's thirst for energy will double by 2020. The solar industry has the ideal prerequisites to play an eminent role in meeting this demand. Apart from this, both the consumer and automotive market coupled with Healthcare and security are the market that will fuel the growth for analog. Analog is the interface of technology to the real world and thus it will only grow with the time to come as newer applications come into being.

Looking at the applications, both the application, the one that perform specific function like timing control, RF transceivers, touch sensors, display drivers, LED drivers, etc and analog ICs that fits in multiple application such as comparators, data converters, amplifiers etc will see a rise in demand. Since there is a continuous demand for features and applications and new technologies are coming every day, products have a short life cycle. Regular shifts in customer interests make demand difficult to predict, so by the time ICs are developed and ready to be shipped, their application areas are already at risk of being replaced. Such a scenario is a potential nightmare for businesses in the analog IC market.

From design perspective one of the major challenges would be integrating analog. It is becoming increasingly difficult to design analog component for Soc that tends to be more digital oriented then analog oriented also the volt is decreasing. Thus with newer nodes, smaller volt, it is getting difficult to do analog design that is integrated in the SoC

Trends - Analog has been a sturdy player and it is definitely here to stay. Looking at the technology trends, high performance which includes working on lower supply and lower current and enabling complete system to consumer less power has been driving the trends in analog domain as well. The performance includes higher audio quality, better control, better precision etc. Infact, when the technology shrinks the analog content may increase from going from one node to another which means higher integration which demands multiple analog function onto one chip.

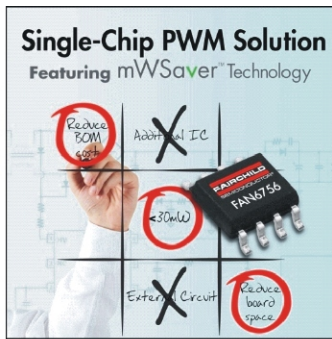


## Products

**Analog Devices** has over 60,000 customers worldwide, has a portfolio of 10,000+ semiconductor IC solutions and every year comes up with 300+ new and innovative products. Analog IC portfolio of Analog includes converters, amplifiers and complete Radio Frequency (RF) signal chains. ADI leads in the Precision and High speed converters with over 48% market share, larger than rest of the other players combined. In high-end performance amplifiers, Analog Devices has a 42% market share. ADI continues to innovate in MEMS with more integration and lowest power. Complete RF chain with integrated single chip transceivers find applications from short-hop Automated Meter Reading (AMR) to powering the radios on both macro and micro base stations.

More and more, Analog Devices is creating innovative Application Specific Products (ASSPs) for its customers, integrating the core technologies into a single chip or a package, miniaturizing the end devices, while reducing power and enhancing performance. Besides core Analog ICs, solutions for Clock, Digital Signal Processing, Power Management, Video processing etc. rounds up the ADI portfolio. For more information, check out [www.analog.com/india](http://www.analog.com/india)

**Fairchild Semiconductor** will maintain its focus on analog ICs related to power supplies, mobile devices, motion control, lighting and automotive solutions. In addition, Fairchild supplies high performance chargers for mobile devices, including media phones and tablets. Fairchild also provides motor-driver application ICs for the home-appliance and industrial markets, such as BLDC controllers and power-drive ICs. As well, Fairchild offers LED driver ICs for lighting applications.



**Microsemi** provides industry leading analog IC products for a wide variety of markets including:

- Power over Ethernet (PoE): PoE IC as well as complete Midspan products
- RF: Front end modules (FEM) for WiFi radio applications
- Power Management: DC-DC converter IC and PMIC for consumer, commercial, and industrial applications
- Microphone preamplifier: pre-amplifier IC for ECM and MEMS microphones in consumer and commercial applications
- Sensor Interface: ambient light sensors (ALS) and general purpose sensor interface processing IC for automotive, commercial, and industrial applications
- Ideal Bypass Diode: low resistance ideal bypass diodes for solar panel applications
- LED Backlight: LED backlight drivers and integrated power supplies for LED TV and other consumer commercial LED display applications
- Hi-Rel: Radiation hardened and/or high temperature analog IC design for extreme conditions in aviation, military, medical, and industrial applications.

**Freescale** offers analog mixed signal and power solutions which include monolithic ICs using proven high volume SMARTMOS mixed signal technology, and system in package devices utilizing power, SMARTMOS, and MCU dies. Our products enable longer battery life, smaller form factor, component count reduction, ease of design, lower system cost and improved performance in powering state of the art systems. ■