Exposing the Hidden Costs of Using Off-The-Shelf Analog ICs

Bob Frostholm, JVD Inc.

With the demise of industry wide second sourcing and the move to developing purely proprietary designs, Analog IC companies have raised the profit bar to new heights. Less affected than their digital brethren by the cyclical nature of the chip industry, Analog IC companies have successfully carved product niches to weather the financial storms.

With the notable exceptions of cellular phones, notebooks, and other highly competitive consumer driven applications, Analog product designs can easily last for years, even decades without change. While the world cries out for "cost down" in nearly every application, most Analog IC companies respond with more expensive, feature rich choices for next generation designs. Great news if you want to redesign your product every couple of years. But who can afford that?

Once a product is in production, it's difficult to implement lower cost manufacturing and procurement strategies when the chip average selling price remains constant. Our customer's engineers, who at one time were charged solely with designing to a specification, are now challenged with meeting ever-shrinking cost targets as well. The engineer has in fact become a part-time cost accountant, relying on his own technical shrewdness to seek suitable substitutes that can shave pennies from a product's cost.

There are many hidden costs associated with using off the shelf Analog solutions. As you will see shortly, the biggest hidden cost is the cost of the off-the-shelf product itself.

In the early years of Analog ICs, there were a handful of big players, each with a unique niche. National was the king of op amps, Fairchild the ruler of regulators, Signetics championed the timer market and Motorola controlled the communications chips. With only a few companies and a few Analog chip designers, each company selectively second sourced the best products of their competitors to broaden their own product offerings, ultimately giving all of them a somewhat similar product portfolio. Without product differentiation, price, service and support played an important role in winning orders. Pricing was aggressive and ASPs dropped rapidly once a second source was available.

Flash forward a few decades and the landscape looks quite different. The legacy companies have changed quite a bit; Philips consumed Signetics, Motorola split into Freescale and On Semiconductor, while National ate Fairchild, then spit it out again years before TI gobbled up National. Many of their old mainstay Analog products remain, augmented now by thousands upon thousands of newer, sole-sourced, proprietary devices.

Additionally, many new players have joined the Analog fray. Dozens of Analog chip companies have grown up or sprung up in the ensuing years, spurred on by the

semiconductor foundries (independent wafer fabrication facilities) that have helped lower the barriers to entry by avoiding the burdensome capital costs of building a dedicated fab. Nearly all have bestowed us with more proprietary IC designs, rich in features and benefits, and not cheap.

Bipolar processes, once the mainstay of Analog ICs, pretty much reached their limitations and have been supplanted by various CMOS, BiCOMOS and BCD processes that are better able to meet the more stringent power and speed requirements of today's customers. The products offered by the Analog players have changed dramatically. As Voltage Regulators like the uA723 and uA7805 evolved into more sophisticated products, the term Power Management arose, creating a whole new category of Analog chips, adding control, protection, high efficiency, watchdog timers, multiple outputs and more.

Since Analog does not scale well to the fine line geometries (low and sub-micron) the way digital circuits do, the capital equipment remains in production longer. These fabs are readily depreciated long before their useful lifetime expires, greatly lowering manufacturing costs.

Many authors have opined that competing on price is a suicide strategy, calling it a going out of business strategy. In the early years, semiconductor processes were not as stable as they are today. Yields were dicey. Second-sourcing protected the customer if their primary vendor had a manufacturing problem, and everyone did at one time or another.

Second sourcing a competitor's Analog chip was never easy, always problematic. Unlike digital, where the rules are well defined in terms of what voltage a logic "1" and "0" represented, Analog chips use critical external resistors and capacitors and a second-sourced chip had to exhibit exactly the same performance with the identical external components as the original. As simple as it seems, this is not an easy feat. Many chip engineers used to argue that it was more difficult to create a second source product than it was to develop a new proprietary device. This may account, in part, for the demise of second sourcing. Nonetheless, some second sourcing was very successful and customers benefited greatly.

Number of Analog IC Offerings
Compiled from ICMaster

Functional Element	Number of Product Offerings
Voltage Regulators	98,050
Op Amps	58,300
Voltage Detectors	43,925
Switch-Mode Power Supply Controllers	40,375
DC-DC Converters	30,375
Other Amplifiers	27,600
Voltage References	11,875
Voltage Comparators	10,125
Analog Misc	4,800
Voltage Followers	1,850

Take for example the NE555. Sourced by some 15 different companies at one time or another, the ubiquitous 555 timer cumulatively sold in the billions of units at prices approaching ten cents. Will we ever see the likes of the 555 timer again? Not likely.

In his book, "THE LONG TAIL: Why the Future of Business Is Selling Less of More," Chris Anderson addresses the dynamics of

choice and explains why. The gist of the book is that the more choices we have, the less of any one item will be sold.

Look at the IC Master (www.icmaster.com) and investigate DC to DC Converters…1,214 pages, with 25 parts per page…over 30,350 DC-DC converters from which to choose. Most assuredly, there are no billion-unit devices here.

The Need for Analog ASICs

With so many standard products to choose from, is there really a need for Analog ASICs?

The answer is unequivocally, yes. According to market research company In-Stat, ASICs represented 59% of the Analog market in 2010, while Dataquest places the figure closer to 54%.

Regardless, it is evident that the demand for Analog ASICs far exceeds that of standard Analog ICs.

Why?

A. Differentiation
B. IP Protection
C. Cost
D. All of The Above

2010 Analog IC Sales Forecast

Standard Analog	Market ($M)	% of Total
Amps & Comparators	2,579	7.0%
Interface	2,050	5.6%
Voltage Reg. & Ref.	7,734	21.0%
Data Conversion	2,776	7.5%
Total Standard Analog	15,139	41.0%

Application-Specific Analog	Market ($M)	% of Total
Consumer	2,879	7.8%
Computer	3,232	8.8%
Telecom	9,691	26.3%
Automotive	3,895	10.6%
Industrial/Other	2,080	5.6%
Total Application-Specific Analog	21,776	59.0%
Total Analog Market	36,915	100.0%

Source: IC Insights

Lack of Differentiation

Years ago, product design was centered on available components. There's a bin of parts; pick the ones you need and cobble together a system. Today, differentiation, although never absent from the equation, plays a more critical role. Many of today's products target applications that are manically focused on accuracy, resolution, power and speed. For the Analog IC supplier, the slightest edge in specsmanship can make the difference between winning and loosing a socket.

The quantity and variety of Analog ICs being introduced gives the OEM a large number of options to choose from when beginning a new design. While there is no one chip that is the best solution for every OEM, Original Equipment Manufacturers work equally diligently to incorporate the latest, greatest ICs. But, if all their end products relied solely on the same off-the-shelf ICs, there would be little differentiation.

Analog ASICs provide the perfect solution for OEMs seeking to offer unique products into the marketplace. Features not available in standard products are often easily incorporated into an ASIC. Similarly, features found in standard products that are not needed for a particular product can be eliminated and thus reduce the cost of the overall solution. Analog ASICs allow the end equipment manufacturer to introduce the customization that incorporates their company's uniqueness.

Lack of IP Protection

Additionally, the use of standard Analog products opens the door to design plagiarism. Competition is tough enough without openly exposing your design to the world. The use of standard products reveals exactly what you are doing and how you are doing it. While it may have taken your company 15 months to design, debug and release your new product to market, by exposing your complete circuit design, your competitor can avoid the first two lengthy and expensive steps and move almost immediately into production.

Moreover, since most products are not patented, there is little recourse but to slug it out in the marketplace when a near identical product shows up. Your competitor comes at you with a strong advantage; no design costs to recover. Not having these expenses to amortize puts him at a significant cost advantage.

When planning your next product, look at all the costs associated with your design. A detailed spreadsheet delineating the costs of development, components, production tooling, labor, reliability and qualification testing and more offers a somewhat incomplete picture. It is equally important to analyze the cost of competition. Rarely do companies incorporate into their product planning the hidden costs of competition. What will happen to sales and gross margins if a competitor enters the market 3 months, 6 months or 9 months after you with an indistinguishable product from yours at a substantially lower price point?

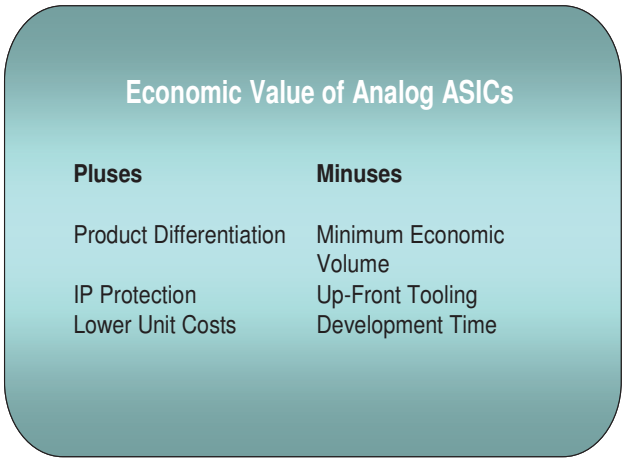
Marketing teams need to model carefully the impact of such an event. Delaying the introduction of a competitive solution is financially the same as introducing your product sooner. Financial spreadsheets often will account for the impact of shorter or longer design cycles but ignore the time function of competition.

Hiding your circuit design in an Analog ASIC creates a serious impediment to your competitors who might otherwise attempt to reverse engineer your ideas into their competing product.

Cost, Cost, Cost –

…Standard Products Just Cost Too Much

Let's begin by dealing with the elephant in the room. Analog ASICs are not for everyone. Like any component choice, they must offer the best economic value for the application. Any associated up-front NRE costs (Non-Recurring Engineering) must be factored into the equation along with hard tooling (wafer fabrication masks, test hardware and software and more). In addition, there is the issue of time. Analog ASICs can take from six months up to a year or more to be ready to use in a production environment. And of course, there is a minimum quantity that must be consumed to assure the value is received. These must all align properly to justify development of an Analog ASIC



Analog ASIC NRE and tooling costs vary greatly; from $60-$75K on the low side to several hundred K dollars on the high end. Initially, the emotional impact of a large up-front charge can be blinding and often the gut reaction is to dismiss the option entirely without further investigation. Unfortunately, this is where most Analog ASIC discussions erroneously end, when in fact, it is just the beginning.

For the most part, we live in a free market economy where everyone is entitled to make money. No one designs and tools production for ICs for free. The OEM pays for this one way or another. When you buy a standard Analog IC, some portion of the price you pay is used to cover the development cost of that chip. The real question becomes, what portion of the price you pay is actually the cost to make the chip? A simplified analysis is derived by viewing a chip company's financial statement. The critical metric is Gross Profit Margin (GPM).

Gross Profit = Company Annual Sales – Actual Cost to Build the Products Sold

If a company spends $10M to build its products and sells them for $20M, its GPM is 50%. Simplistically, the remaining $10M is applied to development, tooling, sales and other associated company costs and anything remaining is net profit. When viewed in the annual report, reflecting sales over a 12 month period, GPM is an average; meaning half of the company's sales during that year achieved more than the reported GPM and half were below the reported GPM.

Depending on the GPM of the products you selected for your new design, it may be cost advantageous to consider replacing them with an Analog ASIC as you develop your product. For example, an analog circuit uses several off the shelf Analog ICs, including a Linear Tech Gain Programmable Precision Instrumentation Amplifier, a National Micro Power Ultra Low-Dropout Regulator, an Analog Devices 40 µA Micropower Instrumentation Amplifier, and much more. The combined high volume Bill of Materials cost was $3.56 and was easy to integrate into an Analog ASIC. By integrating the equivalent functions into an Analog ASIC, JVD reduced the $3.56 cost to well under one dollar. The product lifetime is expected to be ten years, with monthly volumes averaging 15K units.

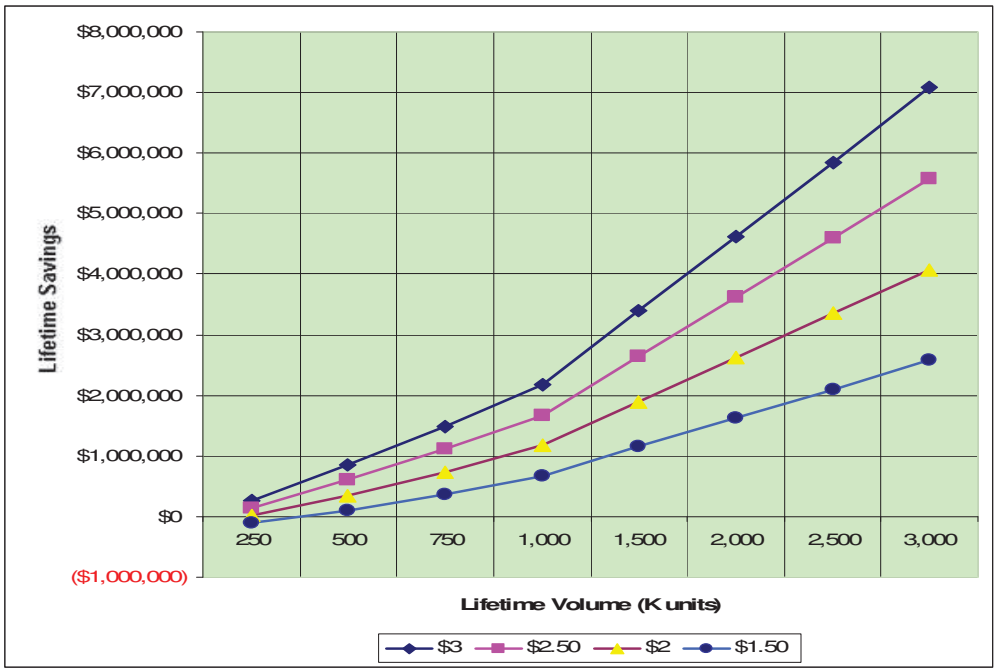
After amortizing in the NRE and tooling costs associated with the development of the ASIC, the following sensitivity analysis was developed. It is expected that during the lifetime of the ASIC that there may be some degradation to the prices of the standard Analog ICs. The analysis projects lifetime savings based on not only under and over achievement of the lifetime volumes of the chip but also the fact the future cost savings may be less than today's based standard product price changes.

Total Lifetime Cost Savings

		Cost of Components Being Replaced			
		$3	**$2.50**	**$2**	**$1.50**
Lifetime Volume in K Units	250	$262,500	$137,500	$12,500	($112,500)
	500	$850,000	$600,000	$350,000	$100,000
	750	$1,487,500	$1,112,500	$737,500	$362,500
	1,000	$2,175,000	$1,675,000	$1,175,000	$675,000
	1,500	$3,400,000	$2,650,000	$1,900,000	$1,150,000
	2,000	$4,625,000	$3,625,000	$2,625,000	$1,625,000
	2,500	$5,850,000	$4,600,000	$3,350,000	$2,100,000
	3,000	$7,075,000	$5,575,000	$4,075,000	$2,575,000

Sweetspot based on current volume estimates and current costs of off the shelf components

Nevertheless, the argument is compelling in terms of the savings by using an Analog ASIC versus standard analog ICs.



Conclusions

Studying GPM can offer an early indication of the viability of your design conversion to an Analog ASIC. Take the time to review the GPM of your selected Analog IC vendors. Remember, half the sales revenue of these companies is generating GPM greater that the figures shown in their annual report. Where do the products you use fit into that equation?

If you are purchasing new designs, chances are that the products you are using are well into the upper half. If you are thinking of saving money with a cost down of your product, and you have the time to develop a custom solution, you might want to consider an Analog ASIC.

Selected Analog IC Players
Approx. Gross Profit Margins

	2010	2009	2008
ADI	65%	55%	61%
LTC	77%	75%	77%
Maxim	60%	52%	61%
MPS	56%	59%	61%
National	66%	63%	64%
Semtech	58%	55%	54%
SMSC	50%	51%	52%
Volterra	61%	60%	57%

Source: Respective 10K reports

Analog ASICs can be a bargain. Why else would 55+% of the entire Analog IC market be ASICs? There are many answers to this question, but if you're using Standard Analog ICs, chances are you are paying too much for them.

While cost is a compelling reason to move to an Analog ASIC because it is an easily measured metric, do not underestimate the value of IP Protection and Unique Differentiation. Many times these critical aspects of an Analog ASIC's economic value are overlooked.

For example, an ASIC does not necessarily have to be a custom integrated circuit. There are many standard Analog chips in the market that are simply priced too high. It may make good economic sense to consider having an Analog ASIC company developed a chip that mimics a standard product. Often there is sufficient margin in standard products that a mimicked ASIC version can be produced and sold for considerably less money. Such a chip would bear a unique part number and the IP of your design would be indecipherable to someone wanting to copy you.

Bob Frostholm is Director of Sales and Marketing at Analog ASIC company, JVD Inc. (San Jose, CA.) www.jvdinc.com

Bob has held Sales, Marketing and CEO roles at established and startup Analog Semiconductor Companies for more than 35 years. Bob was one of the original marketers behind the ubiquitous 555 timer chip. After 12 years with Signetics-Phillips, Fairchild and National Semiconductor, he co-founded his first startup in 1984, Scottish based Integrated Power, which was sold to Seagate in 1987. He subsequently joined Sprague's semiconductor operations in Massachusetts and helped orchestrate its sale to Japanese based Sanken Electric, creating what is now known as Allegro Microsystems. Several years later, as vp sales and marketing, he rejuvenated sales revenues by 10x and facilitated the sale of SEEQ Technology to LSI Logic. Bob is the author of several technical articles and white papers. Email: bob.frostholm@jvdinc.com