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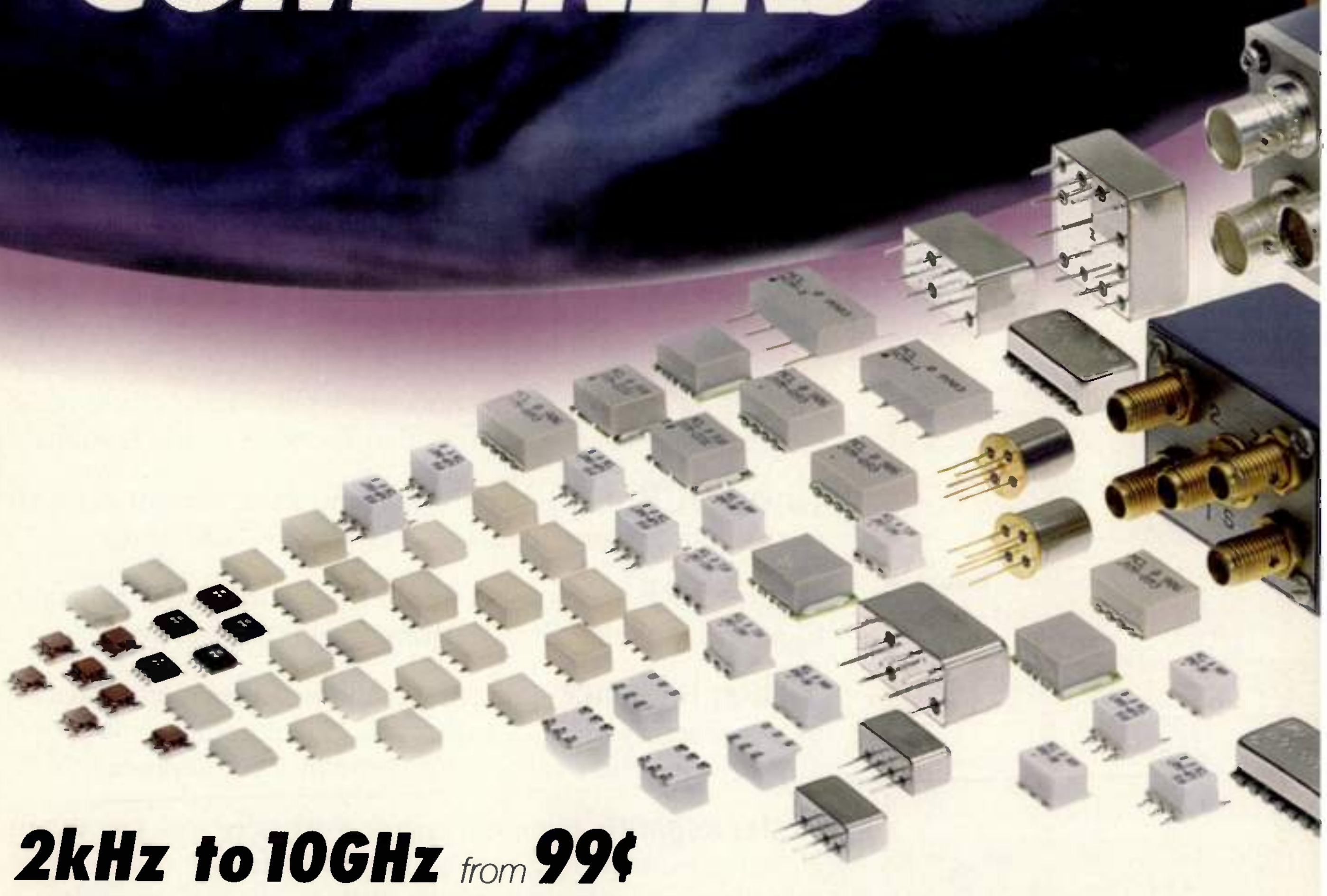

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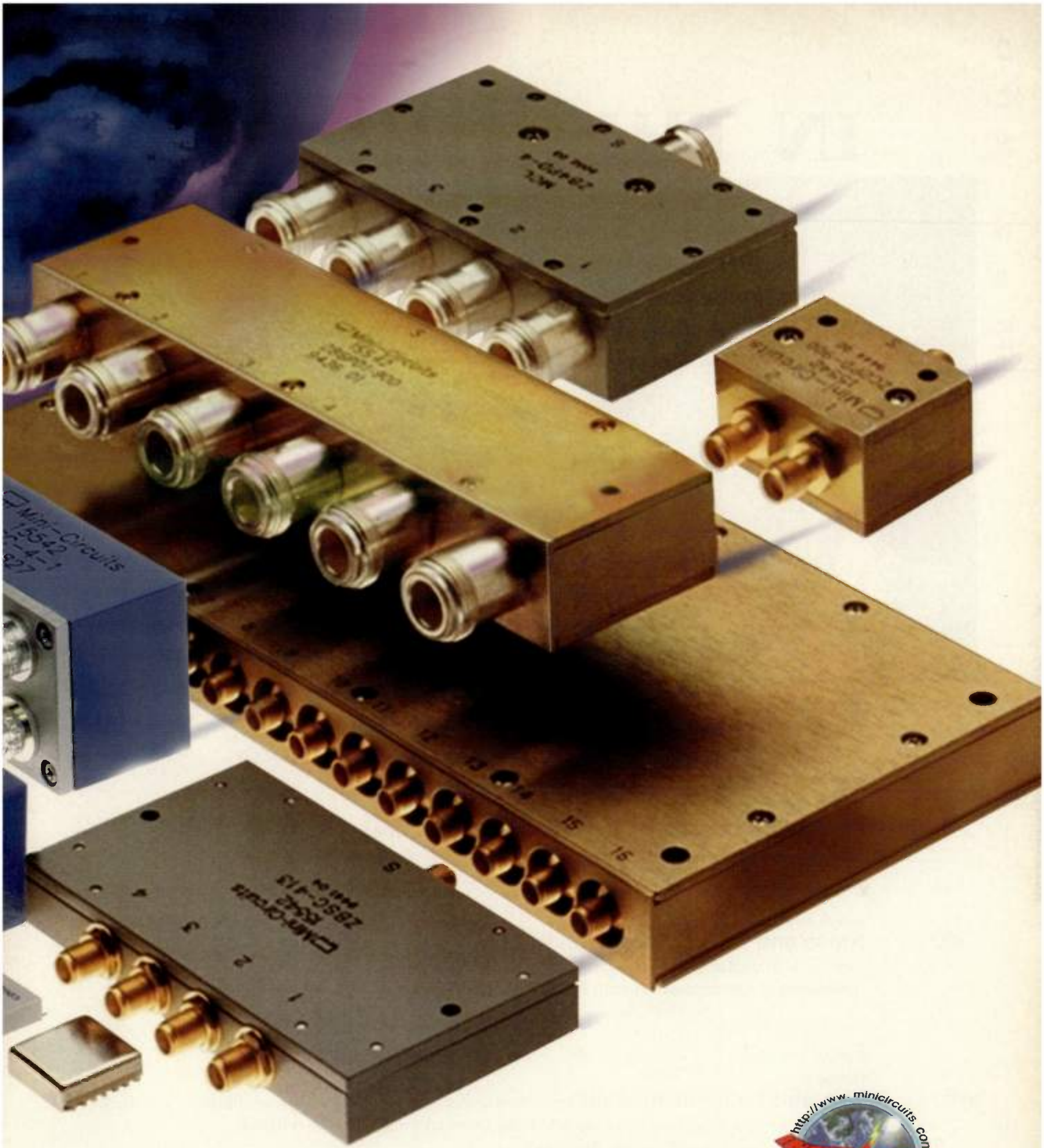

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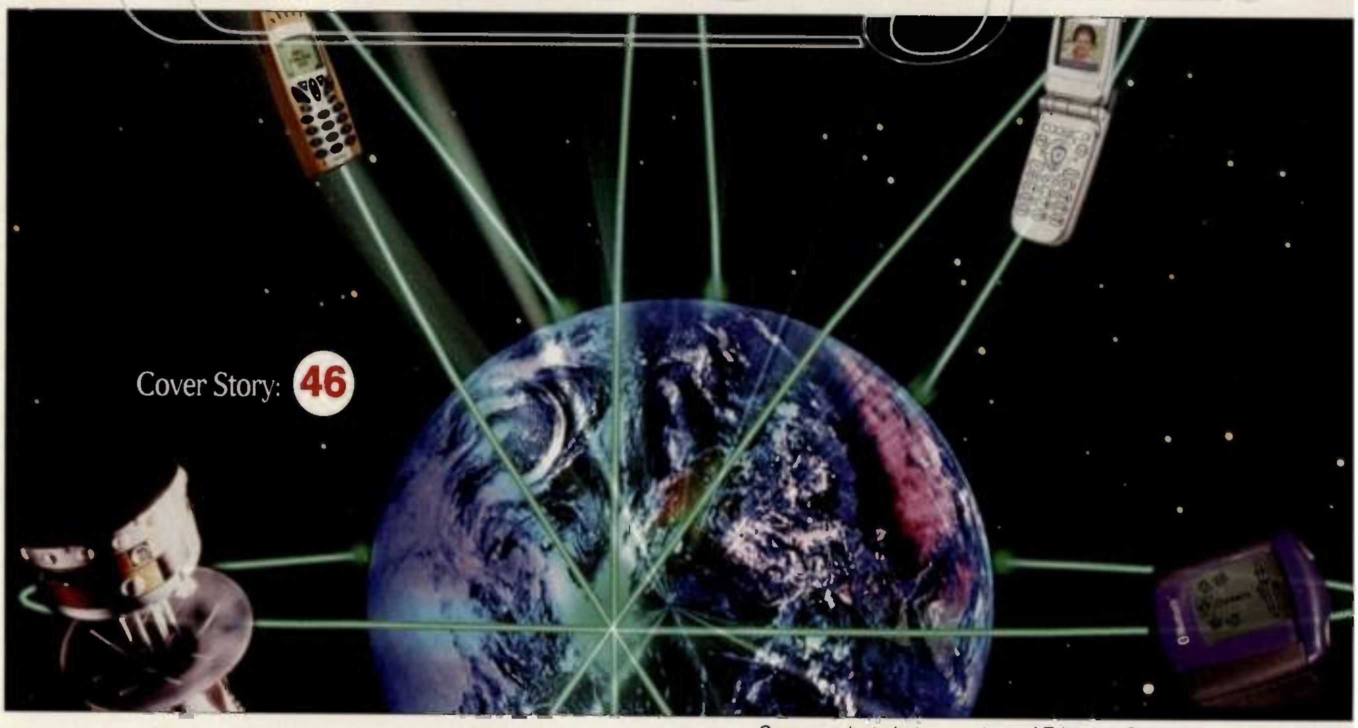

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GAL-1	DC-8000	12.7	11.8	±0.5	12.2	4.5	27	108	40	3.4	.99
GAL-21	DC-8[illegible]0	14.3	13.1	±0.6	12.6	4.0	27	128	40	3.5	.99
GAL-2	DC-8000	16.2	14.8	±0.7	12.9	4.6	27	101	40	3.5	.99
GAL-33	DC-4000	19.3	17.5	±0.9	13.4	3.9	28	110	40	4.3	.99
GAL-3	DC-3000	22.4	19.1	±1.7	12.5	3.5	25	127	35	3.3	.99
GAL-6	DC-4000	12.2	11.8	±0.3	18.2	4.5	36	93	70	5.2	1.49
GAL-4	DC-4000	14.4	13.5	±0.5	17.5	4.0	34	93	65	4.6	1.49
GAL-51	DC-4000	18.1	16.1	±1.0	18.0	3.5	35	78	65	4.5	1.49
GAL-5	DC-4000	20.6	17.5	±1.6	18.0	3.5	35	103	65	4.4	1.49

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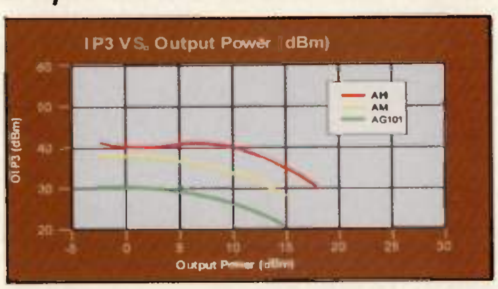

WJ High Dynamic Range Amplifiers				
Product	Frequency (MHz)	IP3 (dBm)	P1dB (dBm)	Bias current (mA)
AG101	250-3000	32	15	50
AM1	250-3000	37	18	75
AH1	250-3000	41	21	150

WJ announces a low cost, high-linearity amplifier. WJ's AG101 is a general purpose gain block that offers excellent dynamic range and low power consumption, based on a proven-reliable MESFET process with an associated MTBF of >100 years. The combination of flat IP3 and noise figure performance over frequency makes the AG101 attractive for both narrow band and broadband applications.

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RF editorial

What's next?

By Don Bishop
Editorial Director
dbishop@intertec.com

Ah, the glory days. Remember when the wireless telephone industry enjoyed annual growth rates of 40%? It was easy to get used to, wasn't it?

Exactly how much heat the industry will lose is difficult to estimate, but maybe handset manufacturers will have to adapt to growth rates of 20% or less. Only 20%? Phffft! Forget it!

So, we nail the casket shut on wireless telephones, and move on. What's next? Wireless LANs.

As a generation of mobile phone users, we're not through talking, although maybe we're talking as much as we can stand.

But as a generation of connected device users, we've only just begun. Let's connect all of our computers—home, auto, office, hand-held, implanted—and let's do it wirelessly, with 802.11a, home RF, Bluetooth, ETSI HiperLAN2 and 5-UP.

Let's make our wireless wireless, so there's no wire between our earpiece and handset for the hands-free handset headset ... oh, you know what I mean.

Teresa H. Meng, Ph.D., chief technical officer at Atheros Communications, sees a huge potential to reduce wireless LAN costs and improve network robustness with CMOS technology. "Together with wireless signal processing, more powerful CMOS processes may deliver a ubiquitous wireless fabric, allowing connectivity of a multitude of computation and consumer devices incorporating a variety of data rates and quality of service," Meng has written.

Successful implementation may require even higher frequencies. Instead of 2.4 GHz, the 5 GHz made might have to be pressed into service to avoid microwave interference and double the bandwidth, and for higher data throughput and multimedia application support as well.

Talk among yourselves

When we're tired of talking with each other, we can let our possessions talk among themselves. Computers, printers, projectors, televisions, DVD players, speakers, telephones, DSL or cable modems, and satellite dishes all can use wireless LANs to talk to each other wirelessly. Video and audio content can be downloaded from the Internet and played on entertainment systems in your home or in your office. Maybe in your head. If there aren't too many voices in there already. Any device with a keypad could control the computer, television, telephone, stereo and security system.

With a display, you could have access to e-mail, news and stock quotes. Heaven help me, not stock quotes. Not this year.

MTT-S

Are you coming to the IEEE MTT-S International Microwave Symposium in Phoenix? If so, you'll have an opportunity to hear Dr. Meng speak at the Monday morning plenary session. Clearly, Atheros has a vested interest in wireless LANs. But that doesn't mean wireless LANs aren't the next "wireless."

Also, don't miss the special memorial session for Al Gross that's scheduled for Thursday. I hope you read Roger Lesser's remarks about Al in the April issue. Phoenix was Al's home for many years, and the memorial session promises a look at the life of a remarkable individual.

As for diversions in the Phoenix area, my recommendation involves Frank Lloyd Wright architecture. Visit Taliesin West in Scottsdale if you have time before or after the conference (**www.franklloydwright.org**). Another suggestion: Drive to Tucson and tour the Desert Museum (**www.desertmuseum.org**). There's some fine hiking near the museum, although it might be too hot in mid-May.

Wireless should only be so hot.

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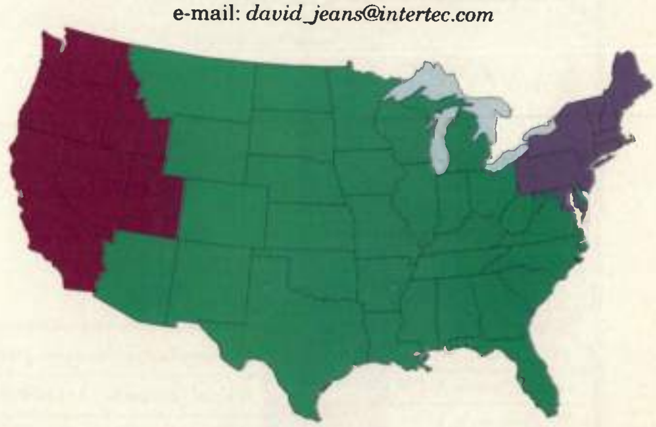

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RF calendar

MAY

22–24 **Eastec 2001** – *West Springfield, MA* – Information: Tel. 800.733.4763.

22–24 **International Microwave Symposium: IEEE-MTTS** – *Phoenix* – Information: Web site: **http://www.ims2001.org/**

JUNE

3–7 **Supercomm** – *Atlanta* – Information: Web site: **www.supercomm2001.com**

5–7 **Sensors Expo 2001** – *Chicago* – Information: Tel. 203.882.1300 x181. Web site: **www.sensorsexpo.com**

6–8 **2001 IEEE International Frequency Control Symposium/ Exhibition** – *Seattle* – Information: Web site: **www.ieee-uffc.org/fc**

24–27 **WCA Annual Conference** – *Boston* – Information: Wireless Communication Alliance (WCA). Tel. 202.452.7823.

JULY

9–12 **Embedded Systems Conference** – *Chicago* – Information: Web site: **www.embedded.com/esc**

AUGUST

13–17 **IEEE-EMC Symposium** – *Montreal* – Information: Web site: **www.ieee.org.**

SEPTEMBER

4–7 **Embedded Systems Conference** – *Boston* – Information: Web site: **www.embedded.com/esc**

24–26 **EDA: Front-To-Back** – *Santa Clara* – Information: Penton Media. Tel. 1.888.947.3734.

OCTOBER

1–4 **Communications Design Conference** – *San Jose* – Information: Web site: **www.CommDesignConference.com**

2–4 **Sensors Expo Fall** – Philadelphia – Information: Web site: **www.sensorsexpo.com**

DECEMBER

3–6 **Internet World Wireless West 2001** – *San Jose* – Information: Web site: **www.ccievents.com**

RF courses

AGILENT TECHNOLOGIES – *RF and Microwave Fundamentals* – Aug. 29–31, Dec. 4–6; *Network Analysis Measurements* – May 29–30, Oct. 16–17; *Spectrum Analysis Measurements* – May 31–June 1, Oct. 18–19. Information: Tracey Bull, Eskdale Rd., Winnersh Triangle, Wokingham, UK; Tel. +44.118.927.6741; Fax: +44.118.927.6862; e-mail: *tracey_bull@agilent.com*

ALEXANDER RESOURCES – *Making Money in the U.S. Wireless Internet Market* – July 10–11. Information: Jeff Stone, Alexander Resources,15851 N. Dallas Pkwy, Addison,TX 75001; Tel. 972.818.8225; Fax: 972.818.6366; e-mail: *jstone@alexanderresources.com.*

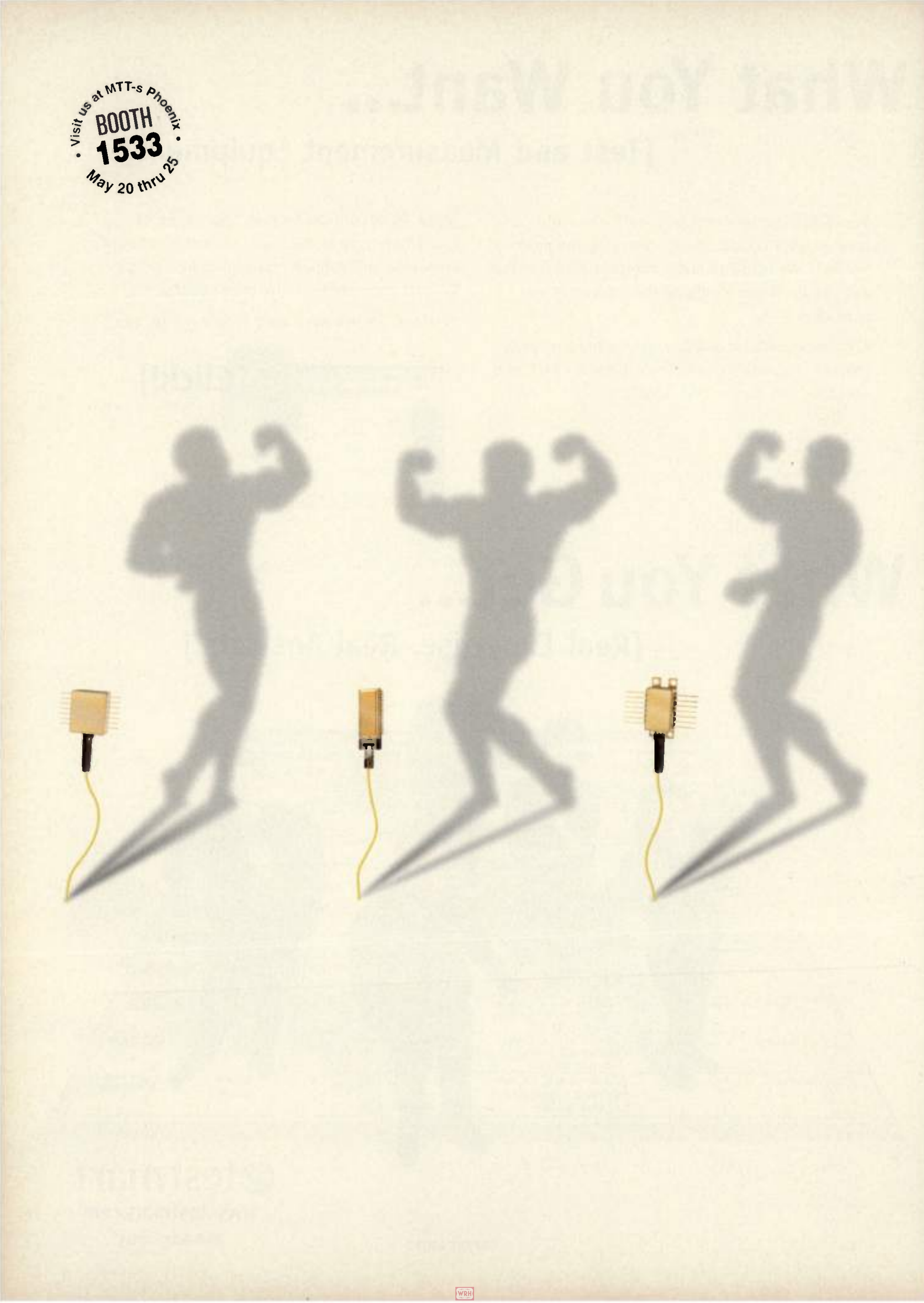
BESSER ASSOCIATES – *RF and Wireless Made Simple* – May 15–16; *RF and Wireless Made Simple II* – May 17–18; *Bluetooth: Operation and Use* – May 10–11; Mountain View, CA. Information: Besser Associates, 201 San Antonio Circle Building E, Suite 280, Mountain View, CA 94040; Tel. 650-949-3300; Fax: 650-949-4400; e-mail: *info@bessercourse.com*; Web site: **www.bessercourse.com**

R.A. WOOD ASSOCIATES – *Introductory RF and Microwaves* – Sept. 20–21; *RF and Microwave Receiver Design* – Sept. 24–26; *RF Power Amplifiers, Classes A–S: How Circuits Operate, How to Design Them, and When to Use Each* – Sept. 27–28, Lake George, NY. Information: R.A. Wood Associates, 1001 Broad St. Ste. 450, Utica, NY 13501; Tel. 315.735.4217; Fax 315.735.4328; e-mail: *RAWood@rawood.com;* Web site: **www.rawood.com**

UCLA – *Communication Systems Using Digital Signal Processing* – May 14–18; *Introduction to Data Compression* – May 30–June 1; *Digital Signal Processing: Theory, Algorithms, and Implementation* – Aug. 13–17; *Bluetooth: Technology, Applications, and Performance* – Aug. 20–22, Los Angeles, Information: Information Systems and Technical Management Short Courses. Tel. 310.825.3344; e-mail: *mhenness@unex.ucla.edu*; Web site: **www.uclaextenstion.org/shortcourses**

UNIVERSITY OF MISSOURI-ROLLA – *Grounding and Shielding Electronic Systems* – June 19–20, Boston; August 8–9, Toronto; *Circuit Board Layout to Reduce Noise Emission and Susceptibility* – June 21, Boston; August 10, Toronto; September 19, Denver. Information: Web site: **www.umr.edu/-conted>**

UNIVERSITY OF WISCONSIN MILWAUKEE – *Production Documentation Control / Configuration management* – June 13–15, Irvine, CA. Information: Tel. 800.222.3623; Fax 800.399.4896; Web site: **www.uwm.edu/dept/ccee**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The sky is not falling

By Roger Lesser
editor
rlesser@intertec.com

When did the sky start falling? I mean the telecom sky, of course. It seems like only yesterday (hey, it was only yesterday) that telecom was riding an economic wave. And then, suddenly the wave crested and the Chicken Little emerged to paint a tale of woe. The latest Chicken Little was Barron's. The way they tell it, the semiconductor and telecom worlds are in such bad shape that they will figure out what really happened in the Florida presidential election before the industries rebound. (By the way, if these industry "insighters" are such gurus, why are they still writing for Barron's and not sitting on a beach using cell phones as coasters?)

Well, I'm here to tell you that telecom may be down, but it isn't out by a long shot. What makes me the forecaster of prosperity? Commonsense. Ask yourself, have companies stopped designing products? Of course they haven't.

I've talked with a number of companies who, admittedly, are seeing a down economic quarter, but are looking to the future. And to get there they are designing new products and working with their component suppliers on the enabling technologies. I've yet to talk with anyone in the industry who believes that telecom is going to be the next dot.com fiasco.

And for another thing...

Check out the product pages of RF Design. Look at the new and updated products. What does that tell you? It tells me that component and other technologies are continuing to emerge. Also, I've seen projections from industry analysts that point to a continuing growing market for wireless applications. Admittedly, there is going to be a slowdown, but there will also be a quick recovery.

But, that assumes...

The quick recovery is going to depend on the applications new devices offer. The market is ready for new applications. As a good friend of mine recently said, when he bought a cell phone, everyone now has a cell phone. He is always the last to buy into a technology. Well, now that Phil has his phone, the market must be ready for something new. So, it's up to OEMs and service providers to jumpstart the telecom recovery by pushing forward with new applications.

We are taking a hard look at what is really going on in the industry and will offer you our analysis in next month's issue. Until then, I have one piece of advise to offer the doomsayers — Go buy some dot.com stock. I hear you can get it really cheap.

Roger

OFDM Forum promises vehicle communications

The Orthogonal Frequency Division Multiplexing (OFDM) Forum, an association working toward a single standard for high-speed wireless communications, held its first anniversary meeting in San Francisco in February.

To mark the event, the forum participated in an automated vehicle merge demonstration at the University of California at Berkeley's Partners for Advanced Transit and Highways (PATH) program research facility. Three vehicles using IEEE 802.11b technology with fully automated steering, acceleration and speed were used in a low-speed merge maneuver in which one car merged into a gap created by the other two without human assistance. PATH researchers plan to migrate the technology to OFDM in the near future to mitigate multipath issues and provide higher data rates for improved vehicle-to-vehicle communications.

Though the technology is currently only in the test stage, networking vehicles in this way has the potential to enable vehicles to operate much closer together. This would allow each motor lane to carry twice the amount of traffic.

In addition to this demonstration, the anniversary meeting was marked by the attendance of 11 of the most recent additions to the forum, including 3 Com, RF Integration, Runcom Technologies, and Littlefeet. The OFDM Forum has grown to include 56 members. Fifteen are listed as principal members.

Multi-tenant buildings could be hottest broadband market

The multi-tenant unit (MTU) market, including apartment buildings, office complexes, hotels and public buildings, is a prime opportunity for broadcast service providers and equipment vendors, according to Cahners In-Stat Group, Scottsdale, AZ. The research group forecasts that MTU broadband service and equipment sales will jump from $3.4 billion in 2000 to $8.5 billion in 2005.

About a dozen niche companies have carved out territory in the MTU broadband service arena, but major players such as AT&T, Sprint, Qwest and Verizon have responded to the increased interest and are now giving

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HJK-19	1850-1910	70-130	7	21	8.0	30	24	10.95
HJK-21	1850-1910	180-300	7	22	7.5	28	19	10.95
HJK-9LH	818-853	40-100	10	27	6.7	37	27	12.95
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HJK-21LH	1850-1910	180-300	10	25	7.2	28	19	12.95
HJK-9MH	818-853	40-100	13	31	6.7	37	27	14.95
HJK-19MH	1850-1910	70-130	13	30	7.4	30	23	14.95
HJK-21MH	1850-1910	180-300	13	29	7.2	29	19	14.95
** HJK-3H	140-180	0.5-20	16	37	8.0	44	44	16.95
HJK-9H	818-853	40-100	17	33	6.7	35	31	16.95
HJK-19H	1850-1910	70-130	17	34	7.7	28	22	16.95
HJK-21H	1850-1910	180-300	17	36	7.6	28	25	16.95
** HUD-3H	140-180	0.5-20	16	37	8.1	47	45	15.95
** HUD-19SH	1819-1910	50-200	19	38	7.5	38	36	19.95

*Units protected under U.S. patents 5,416,043 and 5,600,169.
**Additional patents pending.
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the market more attention.

Service providers roll out MTUs by establishing mini-points-of-presence (Mini-POPs) in buildings. Mini-POPs are smaller-scale versions of the aggregation devices that sit in telecom providers' central offices. In early 2001, the MTU broadband market slowed down as a result in a tightening in capital funding. Vendors are expanding the range of products available despite the slowdown however, and service providers are preparing to roll out value-added offerings such as voice, video and application services. As broadband becomes a commodity, these services will be vital to providers' success, Cahners said.

More power a must for new generation of mobile devices

As the world awaits more advanced mobile Internet devices, it is a new generation of power supplies that will allow these devices to be useful, according to a new study from Allied Business Intelligence (ABI), Oyster Bay, NY. While users try to use new Internet functions on mobile devices, many will experience frustrations with insufficient power supply in battery life and standby time.

Fortunately, according to the ABI study, "Wireless Power Systems: Powering the Next Generation of Wireless Devices," there is a movement toward more robust power supplies.

While semiconductor chip performance has risen over 3,000% in the last decade, battery performance has risen only 80%. If battery performance and reliability do not rise to the power demand of next-generation wireless devices, the growth of the sector could be affected.

Mobile commerce and mobile applications will require more complex mobile devices, including those that combine voice, data and multimedia applications. To allow these complex devices to perform properly, next-generation power supplies will be needed that possess a higher energy-density ratio.

The ABI study examines the dynamics of the battery industry and the potential market surfaced by the explosion of the use of mobile devices. The market potential of wireless handsets and other devices is given by region in detail. The report also shows the convergence in three major industries: wireless connectivity, Internet access and laptop usability and power.

Wireless technologies and devices currently in use are explored, along with next-generation wireless technologies and the standards that future products will have to meet. The report also dissects battery technologies and alternative power supplies under development.

WCA comments on FCC 3G report

The Wireless Communications Association (WCA) issued a statement on March 30 commending the FCC's report on third-generation (3G) wireless spectrum policy. The study is entitled "Spectrum Study of the 2500-2690 MHz Band: The Potential for Accommodating Third Generation mobile Systems."

The WCA's statement, issued by President Andrew Kreig, commended the FCC's researched findings, saying that the findings advance U.S. policies toward deregulation, coherent spectrum policy and market forces as the best way to promote advanced services for the public. Kreig also said that the report confirms what the WCA and others in the MDS/ITFS community had been saying throughout the proceeding. "There is no comparable spectrum to which MDS and IFTS licensees can be relocated," Kreig said. "Any attempt to segment the 2500-2690 MHz band, without undermining the deployment of broadband wireless services and the benefits that deployment will bring to the educational community, would raise substantial policy and regulatory issues that cannot readily be resolved."

The WCA was founded in 1988 and is a non-profit trade association representing the fixed wireless broadband industry. The association has 460 company members including carriers, vendors and consultants.

HOT WEB SITE

Interactive FCC filing service available online

Comsearch announces a cooperative effort with the Federal Communications Commission (FCC) to provide an online application filing system called ULS Express. ULS Express offers as much as 90% automatic completion and batch filing of the FCC Form 601, as well as access to Comsearch licensing experts. The interactive system is available for Part 101 Common Carrier Microwave, Private Operational Fixed Microwave, and Part 74 Broadcast Auxiliary Microwave service users. ULS Express works with the FCC's Universal Licensing System(ULS) and proprietary Comsearch databases to automatically pre-populate more than 90% of FCC Form 601 applications and allows users to prepare multiple applications simultaneously. Users can also download technical data to automatically populate appropriate fields on their Form 601 applications.

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BUSINESS BRIEFS

Link America, XEL Communications team — Link America, Dallas, TX, has been awarded a three-year contract with XEL Communications Aurora, CO, to sell the company's voice and data transmission products. Under the agreement, Link America will sell XEL products that include integrated access solutions for emerging voice and data networks.

Anritsu partners with Silicon Wave — Anritsu, Richardson, TX, and Silicon Wave, San Diego, have partnered to conduct interoperability testing and get Bluetooth-qualified products to market. Specifically, the partnership consists of an agreement between Anritsu and Silicon Wave that provides for the exchange of prototype units for the purpose of interoperability testing. The Anritsu Bluetooth Test Set conducts measurements in accordance with Bluetooth RF Test Specification V0.9, thereby helping Silicon Wave qualify the interpretation and implementation of the test protocol in its Bluetooth radio.

ISI joins Cisco AVVID Partner Program — ISI, Schaumburg, IL, has joined the Cisco Architecture for Voice, Video and Integrated Data (AVVID) Partner Program as a voice and IP telephony solutions member. The program is an interoperability testing and co-marketing program enabling product and services firms to deploy e-business solutions. It provides enterprise customers with Cisco AVVID Partner products and services that have been tested and verified to interoperate with Cisco network technology.

Spectrian receives follow-on order from Samsung — Spectrian, Sunnyvale, CA, has received a follow-on purchase order from Samsung for multicarrier power amplifiers to support the PCS CDMA2000 network in Korea. The purchase order is valued at more than $9 million, increasing Spectrian's CDMA2000 backlog to more than $14 million.

OFDM Forum, CABA sign reciprocal membership agreement — The OFDM Forum, an association organized to promote a single standard for high-speed wireless communications, has signed a reciprocal membership agreement with the Continental Automated Buildings Association (CABA). The OFDM Forum will work with CABA to establish the future direction of home and building automation.

Anadigics acquires Telecom Devices — Anadigics, Warren, NJ, has acquired Telecom Devices, Camarillo, CA. The acquisition will help Anadigics' fiber strategy by adding long wavelength PIN photodiodes and unique packaging capabilities to its fiber product line. The transaction will be accounted for as a purchase and is valued at $28 million, in addition to certain earn-out payments tied to future financial performance targets, for a potential consideration of as much as $45 million. If the financial performance is achieved, the earn-out payments will be payable in the second quarter of 2002.

XEMICS licenses Bluetooth IP from NewLogic — XEMICS, Neuchatel, Switzerland announces a licensing deal with NewLogic Technologies, Lustenau, Austria. The deal encompasses NewLogic's Boost Core and Boost software IP products. Terms of the deal have not been disclosed, but the agreement will allow XEMICS to add Bluetooth functionality to its Bluetooth integrated circuits.

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VARIETY

Designing the cellular network infrastructure

Cellular network design for greater profits and better quality of service.

By John Arpee

Initially, cellular networks were designed for maximum coverage at minimum cost.

At one time, Sacramento, CA was covered by eight cells[1] and New York City required no more than 24 cells. Now Sacramento requires hundreds of cells and New York is served by well over 2,000 cells.

The most amazing thing about all these additional cells is that there is no clear business case for them. The cells are required to support the additional traffic the networks now carry. Without them, there would be even more interference and quality degradation than exists today. The problem is that it is difficult to define the value of a new 'capacity' cell and to know where to draw the line or how to set priorities.

Network planning – the key to tomorrow's wireless infrastructure.

Network design criterion

Every design decision is based on four criteria: coverage, capacity, C/I, and cost. Coverage is how much area is served (km^2). Capacity is the ability to carry traffic (Erlangs today, bits tomorrow). C/I is a commonly used term that references the "carrier-to-interference ratio," but in this article we will define it as "the ratio of the signal you want to the signals you don't want" (dB). Cost is defined by $.

These principles apply to all cellular networks including code-division multiple access (CDMA) and 3G. In FM and time-division multiple access (TDMA) networks, interference has a direct impact on quality. Where there is low C/I there is poor quality. In CDMA networks, the network responds to high interference levels by increasing power. Because the total power output is limited, high interference can result in reduced capacity. And, if the interference is too severe at a location, the system may not be able to compensate. Another effect of cells sending too much signal out is the increases in overlap between cells, which also robs network capacity. Therefore, in CDMA, a direct relationship exists between interference and capacity.

In the mid 1980s, cellular design was all about coverage and cost. Because there was little traffic initially, capacity was not an issue. The spectrum-to-traffic ratio was large, therefore interference was easy to control.

In the early stages, sites were located on mountains, tall buildings or tall towers. New sites were periodically added to extend the footprint of the network. Whichever company could show the most covered area in its marketing literature won. The business case was straightforward. Everything was based on the projected traffic. Planners assumed that traffic on a cell was roughly proportional to the population covered by the cell. Over time, the traffic for the same population might increase with increasing penetration, but the proportions were assumed to hold. To calculate the cost of a new cell, the planners would use the traffic estimate to calculate the number of required channels. The number of channels plus the usual fixed costs determined the cost of the cell. The revenue generated by the cell was directly related to the amount of traffic.

Capacity cells were not initially required, but eventually the spectrum was used up and frequency reuse began abruptly. At this point, omni-directional antennas were replaced with directional antennas to form three- or six-sectored sites. This had ripple effects. The quality immediately degraded because of the sudden jump in network complexity and an increase in adjacent and co-channel interference. The cost-per-site increased immediately because there were now more antennas, more costly equipment to manage them and more channels required because of the loss of trunking efficiency. This sudden barrage of changes often resulted in changes in personnel and organizational structure.

In defense of quality

The fundamental problem, the industry discovered, is that there is no effective way to form a business case for capacity cells. According to cellular theory, capacity cells are required to maintain minimal C/I targets. The theory assumes perfectly flat terrain and evenly distributed traffic. Once the number of required channels in a sector reaches a threshold, the theory requires that a "split cell" be built to maintain acceptable C/I.

Some operators attempt a business case by esti-

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S5W2	S5W5	N5W5	5	±0.40
S6W2	S6W5	N6W5	6	±0.40
S7W2	S7W5	N7W5	7	±0.60
S8W2	S8W5	N8W5	8	±0.60
S9W2	S9W5	N9W5	9	±0.60
S10W2	S10W5	N10W5	10	±0.60
S12W2	S12W5	N12W5	12	±0.60
S15W2	S15W5	N15W5	15	±0.60
S20W2	S20W5	N20W5	20	±0.60
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mating the predicted amount of traffic that will be carried by the new capacity cell. They use the traffic estimate to calculate the revenue for the cell. However, the underlying assumptions behind this method are false. If a cell is purely offload, it will not generate any new traffic. This is because the traffic that it carries, by definition, is off-loaded from other cells. The net increase in traffic, and therefore in revenue, is zero.

Other operators justify new capacity cells with an increase in revenue. They explain that new urban cells generate new traffic while minimally off-loading neighboring cells. This interpretation assumes that usage increases because new cells improve building penetration and quality. Because the off-loaded traffic is low, and there is an incremental jump in traffic, it is argued that such a cell is actually a 'coverage' cell, not a 'capacity' cell. What is interesting is that a direct relationship exists between quality and revenue.

The rules of thumb

Typically, operators find that new capacity cells do not result in an incremental increase in traffic. When there is no direct revenue benefit, engineers resort to rules of thumb (ROT) to justify new capacity cells. Planning new cells based on rules of thumb is successful to the degree that the assumptions behind them are valid. In practice, the rules are bent when it is clear that the assumptions do not apply. Examples include micro-cells in high traffic areas where the RF is clearly limited to a confined area and directional cells along major traffic corridors.

This should make financial managers uncomfortable. There is no way to measure the value of individual projects. Typically, engineers ask for lots of capital to build many new cells and other projects to improve quality. Then management reacts with horror to the cost of the proposed projects, makes an arbitrary decision, and tells the engineers they can build fifty cells; leaving it to them to decide where to locate the cells.

The solution is to define the economic value of improving quality or preventing quality degradation. If such a definition exists, and there is a reliable way to predict the quality improvement that will result from a capital investment, then the economic viability of a project can be found by subtracting the capital cost from the value that results from the quality improvement.

There are various arguments against defining quality. Some people argue that it is unrealistic to assign value to quality because quality is subjective. Amazingly, other people claim that quality has no significant impact on revenue. When companies fail to define quality standards, they delegate quality standards to their engineers. This is unacceptable. If quality truly has no economic impact, then operators can save billions of dollars by not building new cells and allowing blocking and interference to increase. Churn, flaming news articles and customer lawsuits are merely distractions.

Current design methods rely heavily on ROT. For example, when the traffic on a sector reaches 12 Erlangs, it is time to build a capacity cell or allocate more spectrum. According to ROT, a criterion indicates when a new cell should be added, but it is up to the engineer to ensure that the new cell off-loads a decent amount of traffic without causing interference. Likewise, if one of the original cells in the network causes a huge amount of interference, it is up to the engineers to persuade management that it is worth building three smaller replacement cells so that interference may be controlled.

There is a tacit understanding of the trade-offs between coverage, capacity and quality, but no business case exists to support good design. A good engineer constantly balances the capacity and interference properties of new cells that they plan into a network. Design decisions regarding quality are made intuitively and the success of the outcome depends on how well the engineers negotiate with management. This is a sloppy way to run a business and it disintegrates when decisions need to be made with regard to multiple overlaid technologies and classes of service.

The value of quality

We can debate the value of quality for a long time without reaching any conclusion, but the networks that are in service today are nominally designed to meet certain quality targets. Therefore, an implied value of quality can be calculated. To derive the implied value, a simple model will be developed that defines total network cost as the sum of capital plus an unknown quality cost. The challenge is to have a model that adequately describes the trade-off between cost and quality without being too complicated.

To simplify the calculation, work with a degradation score:

$q = 1 - i,$
q = quality $(0 \le q \le 1)$
i = degradation score $(0 \le i \le 1)$

The most critical, and the most controversial, element in deriving the value of quality is a simple model that relates network load to quality. Our assessment is that a square law relationship is accurate for TDMA networks with more than 20 cells. It has been repeatedly demonstrated that this relationship exists by performing a series of optimization runs at increasing traffic loads. As traffic is increased by the same proportion across the network, the required number of channels per sector increases. Each increase in the channel count requires a new optimization run and the amount of interference increases with the square of the traffic load. This makes intuitive sense because a square law relationship is simply the second term of a Taylor series.

For CDMA and universal mobile telecommunications system (UMTS) networks, it may be more appropriate to use a function with a higher power of t. Those networks make extensive use of features that adapt to the RF environment. Quality is maintained until the network cannot sufficiently compensate and then quality degrades rapidly. Depending on how the network quality is modeled, the rate of degradation can be more or less abrupt. Skepticism exists about quality models that assume that overall network quality suddenly degrades at some magical traffic level. In an ideal network with every cell equally loaded and similar radio propagation characteristics, there may be some kind of abrupt degradation as all cells approach their capacity limits at the same time. In reality, however, conditions vary and quality degradation begins in traffic or interference hot spots. As the traffic grows, the affected areas spread out from the initial hot spots.

To be reasonably flexible without making the model too complicated, use the model below to relate degradation to traffic load:

$$i = \beta\left(\frac{t}{\rho}\right)^{\gamma}$$

i is the degradation score, t is the average traffic per cell, and β, γ, and ρ ar

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arbitrary constants. This model reflects a general relationship for a market.

A more sophisticated model is typically required to determine the appropriate values for the constants. For example, there might be a sophisticated model of a CDMA network that considers the radio propagation, traffic density, error correction and the behavior of the coder/decoder (CODEC) to produce a degradation score for a particular traffic level on the network. Running the models multiple times at various traffic levels, an engineer could tabulate a function that relates degradation to traffic. This simple mathematical relationship is used to make a point, but it is also possible to use the tabulated values directly.

Inserting the degradation model into an equation for total network cost (TNC), use:

total network cost = capital cost + interference cost =

$$= \frac{CT}{t} + \alpha i T$$

$$= \frac{CT}{t} + \alpha\beta\left(\frac{t}{p}\right)^{\gamma} T$$

C = cost-per-cell
T = total network traffic

By definition, T/t is the number of cells in the network. The capital (CT/t) is the number of cells times the capital per cell. Ignore the capital invested in switches, service centers and other overhead costs to ignore any cost that is not a function of t. In other words, additional costs may grow with the total traffic (T), but if they do not depend on the traffic per cell, they do not provide any information about how the air interface should be optimized. Ignore the savings provided by improved trunking efficiency because the only interest is in broad relationships. The equation is represented graphically by Figure 1.

Smaller Gamma values result in more shallow curves, and larger exponents result in sharper curves. ROT design criteria essentially assume Gamma = ∞. When Gamma = ∞ the total cost is equal to the capital cost until a threshold is reached and then the cost explodes. When Gamma = 2, we see that the average traffic per cell can vary by about 10% without a significant change in total cost. The total cost is roughly constant because the cost due to increased churn and decreased usage offsets the improved capital savings. As the traffic increases beyond 20%, the churn and usage costs accelerate dramatically and outweigh the capital savings.

Taking the first derivative with respect to t, the optimum traffic per cell can be found:

$$t = \left(\frac{C p^{\gamma}}{\gamma\beta\alpha}\right)^{\frac{1}{\gamma+1}}$$

To find the implied value of quality, assume that the initial traffic-per-cell is set for optimum financial performance and rearranging:

$$\alpha = \frac{C_0 P_0^{\gamma}}{\gamma\beta_0 t_0^{\gamma+1}}$$

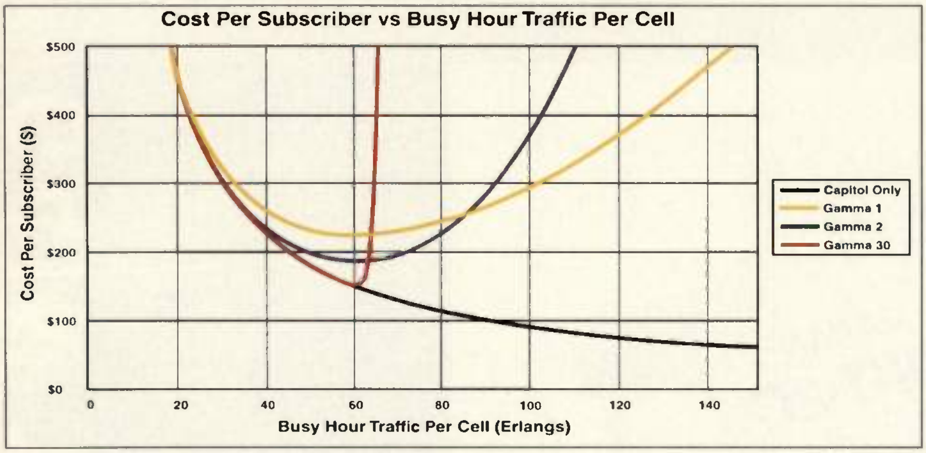


Figure 1. Cost-per-subscriber vs. busy hour traffic-per-cell.

This constant allows the determination of the dollar cost associated with a degradation metric. The units must be defined jointly with the units of the degradation metric so the product of the two results in dollars-per-Erlang. It is important to note that the value of quality has been reverse-engineered . In reality, the value of quality depends on pricing plans and the competitive environment.

Inserting the formula for alpha back into the equation for t for:

$$t = t_0\left[\left(\frac{\rho}{\rho_0}\right)^{\gamma}\left(\frac{C}{C_0}\right)\left(\frac{\beta_0}{\beta}\right)\right]^{\frac{1}{\gamma+1}}$$

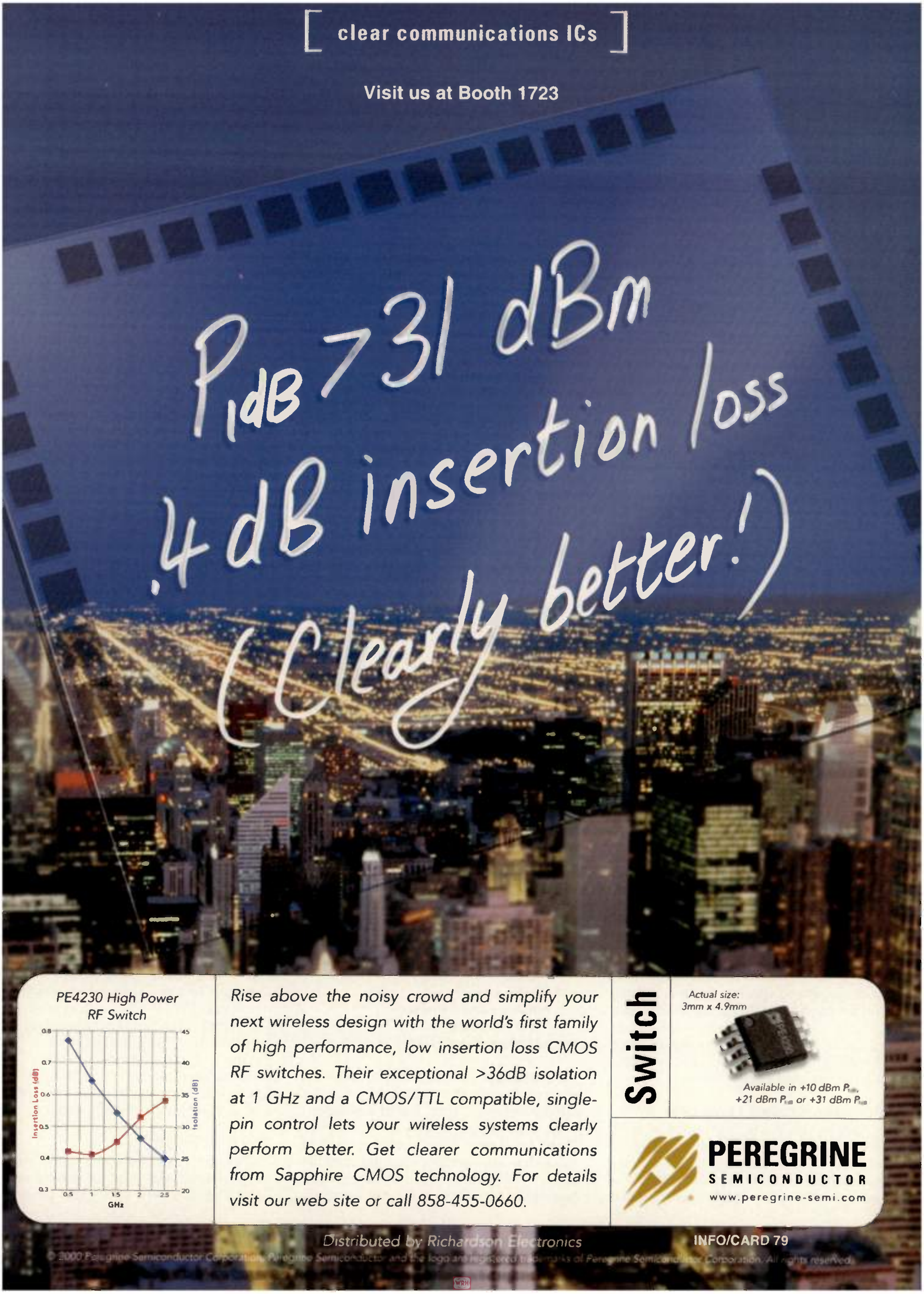
Set $\gamma = \infty$ to model ROT-based design criteria. Assume that traffic has no impact on quality below some threshold and then quality collapses abruptly as the threshold is reached. In that case the optimum traffic is insensitive to the capital costs:

$$t = t_0\frac{\rho}{\rho_0}$$

If $\gamma = 2$, the optimal traffic level depends on the capital cost and the rate at which quality degrades with traffic. The formula indicates that 25% more cells should be built if the total cost for a cell is cut in half. The β value is the gateway for evaluating the economic benefit of any proposed capital investment from new cells to new quality-enhancing technologies.

Practical application

Once it is accepted that quality has measurable value, albeit approximately an ROI can be generated for any pro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posed project including capacity cells or the introduction of new interference-reducing technologies. To do this practically, there must be tools that predict the quality impact of proposed changes with a tolerable degree of accuracy. The ability to predict quality impact is essential to produce an ROI prior to implementation.

After a change is implemented, the impact on quality should be measurable, but this is not a trivial exercise. First, the impact on performance metrics is obscured by the amount of inherent noise in the metrics. Second, from a value standpoint, a single metric should be dealt with that indicates overall network quality. Instead, there are usually several incomplete or overlapping (ie. correlated) statistics. The solution for the first problem is to average the data over a sufficiently long interval. There is a tendency in the industry to only include statistics from the 10 busiest hours of the month and discard the remaining data. This is a statistically nonsensical practice. By including more hours of data, the accuracy can be improved dramatically.

Typical network performance metrics include: dropped calls, blocked calls, bit error rate (BER) and frame error rate (FER). E_b/N_0 or C/(I+N) signal quality data can also be collected. The network performance metrics are results of the signal quality. The goal of the engineer or optimization software is to maximize the signal quality, which should improve the resulting performance metrics.

One way to obtain a single quality metric is to only consider BER data. The logic is that performance statistics are correlated to BER. FER is directly related to BER. For a given network, histograms of the BER can be produced, as can predicted signal quality and measured signal quality. To apply TNC design criteria, map these histograms to scalar values. Using this approach, design tools can be obtained that produce predicted quality metric, which can be used to evaluate the merits of a project. Data can also be collected to evaluate and improve the accuracy of the design tool. This approach is examined in the case studies below.

ROI case studies – new cells

One of the main limitations of ROT is the inability to produce an ROI analysis for a new capacity cell. By placing a value on quality, an ROI analysis can now be performed. When a new capacity cell is added to a network, it reduces the traffic-per-cell by definition. If it causes about as much interference as it prevents, then the b of the network will remain the same. Savings will result because of the reduction in interference, which results from the reduced traffic load per cell. The ROI is simply the reduction in the TNC. The increase in the CT/t is the capital required for the new cell. The predicted decrease in the aiT term must be greater than the capital cost to justify the investment.

A capacity cell can be even more worthwhile if it reduces the amount of interference in the network. If the new cell is close to a traffic hot spot and has antennas that are low enough not to interfere with other cells, then interference will be reduced. In the quality cost model, the reduction in interference is indicated as a reduction of b. If many new cells have improved interference properties, there can be an overall improvement in quality or more traffic can be carried per cell without sacrificing quality.

Interference mitigation

Visiting the 3GSM show in Europe or the Cellular Telecommunications and Internet Association (CTIA) show in the United States, one is amazed by the number of companies offering some technology to "reduce interference and increase capacity." It is impossible to evaluate these claims using ROT, but it is possible using TNC. Consider a menu of typical options that an operator might pay to use:

1. *Hire more engineers*
2. *Network features*
   - *Frequency hopping*
   - *Automatic channel allocation*
   - *Automatic power control*
3. *Antennas*
   - *Custom antennas*
   - *Smart antennas*
4. *Better tools*
   - *Automated frequency optimization*
   - *Measured path loss data*

Admittedly, it is difficult to come up with a model that relates β to the number of engineers, but the compensation package might be changed. Most engineers have a bonus that is related to the performance metrics. It might make more sense to reward engineers based on the total network cost, which includes capital efficiency.

The other options can be evaluated by setting up trials that demonstrate the impact on performance metrics. The quality impact is then converted to dollars. In some instances, it is difficult to assess how much the amount of quality improvement is due to a new option and how much is simply due to increased attention to the network. The way to prevent this confusion is to give the market engineers a chance to clean up their market before testing any new methods. The resulting quality improvement can then be converted to dollars.

Once a new technology has been accepted, the engineers must have tools that guide them in the application of the technology. For example, smart antennas have been shown to improve performance, but the amount of traffic or the amount of improvement in a particular sector may not be sufficient to justify the cost. Many attempts to model the quality improvement simply add a few dB to the predicted C/I. This approach is woefully inadequate for most applications. The predicted degradation must consider the probability and severity of interference to produce a reasonable, accurate estimate that can be correlated with BER.

Multi-mode networks

ROT is marginal, at best, for single mode networks. For multi-mode networks, it is hopeless. As 3G becomes a reality, operators will be faced with supporting legacy 2G mobiles and multiple classes of 3G voice and data services. They will have to consider spectrum allocation, target quality levels, an array of interference mitigation techniques and changing market conditions.

TNC can be easily adapted for multi-mode networks by including a separate quality cost model for each service and a means for analyzing the intra and inter service interference. The total degradation cost is the sum of the degradation costs for each service. If the cost model and the models for predicting quality are reasonably accurate and well defined, optimization functions can be developed to jointly optimize the spectrum allocations and the financial performance of each service.

The final countdown

The arrival of complex multi-mode networks and the need for greater capital efficiency will force the networ

operators to adopt objective desigr methods. ROTs have been responsibl for present-day conditions, but they d not scale and they are useless for mak ing trade-offs between capacity anc quality or deciding how to allocate spec trum and capital between multiple ser vices. Placing a value on quality i: admittedly approximate, but it is les: approximate than blindly followin rules of thumb.

RF

1 In this context, a cell is a bank o radio transceivers connected to one o more transmit antennas and, typicall two receive antennas with practicall identical patterns. There are usuall one or three cells per location.

About the author

John Arpee co-founded ScoreBoard, in October 1993. He is responsible for the engineering department, which develops algorithms and methodologies for the company's new products and services, and works with customers to develop network growth strategies. Arpee has more than 15 years of radio engineering experience. Previously, at LCC International, he worked on a variety of early stage and mature markets both domestically and internationally. He grew the engineering department from 14 to 30 engineers that served most of LCC's North American customers. Prior to joining LCC, he worked at MCI Airsignal. He has written numerous articles and training documents, including *A Primer On Cellular System Planning*, 1990 April, Telocatur; and *NEXRAD Interactions with Radio Astronomy Telescopes*, DoD, Electromagnetic Compatibility Analysis Center, Annapolis, MD.

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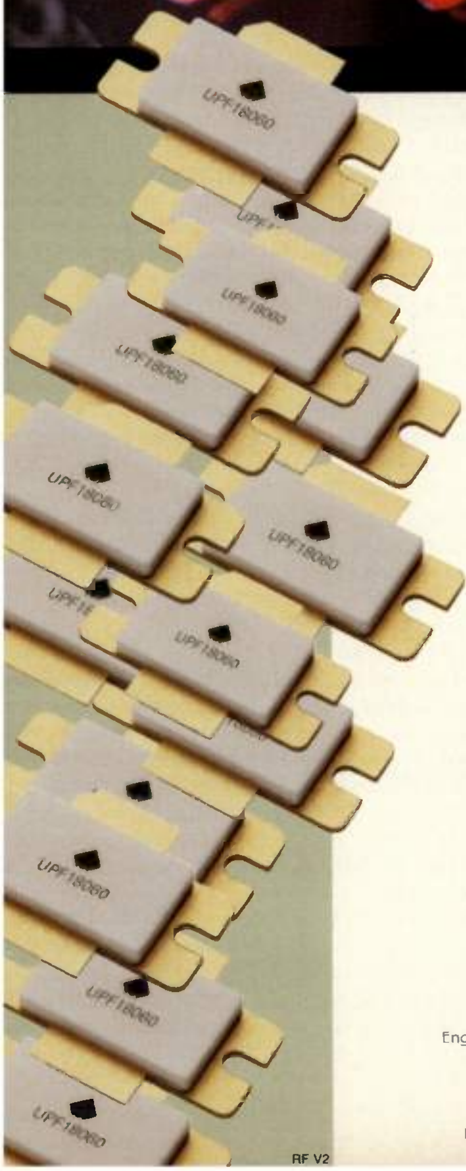

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Noise and ACPR correlation in CDMA power amplifiers

Noise is as critical a parameter in digital systems as it is in analog systems. Understanding bit and frame error rates and how they affect throughput is paramount in system design.

By Oleksandr Gorbachov, Yu Cheng and Jason S.W. Chen

(editors note: due to the complexity and length of the equations, they are on page 44.)

The issue of noise is one of the most important parameters when considering overall communication system quality. For wireless systems, major noise sources are the transmitter, the air interface and receiver noise.

Noise...the data killer

In code-division multiple access (CDMA) systems, the signal-to-noise ratio determines the bit error rate (BER) or frame error rate (FER) numbers that represent a digital information loss[1]. In transmitters, one of the critical noise sources is a power amplifier (PA). Usually, the PA's non-linear characteristics associate with spectrum re-growth. An adjacent-channel power ratio (ACPR) imposed by the non-linear effect of the PA has been investigated by many authors[2]. Some use the clipping noise power approach[3], while others use a hypothetical third-order intercept point approach[4]. Both methods are used to evaluate the system degradation characteristics due to an increased noise level for digitally modulated signals. Direct in-channel noise measurements are impossible because of the presence of a useful signal. Therefore, a statistical approach is used based upon CDMA systems. This approach allows a simple evaluation of increased noise on a basis of an ACPR measurement (or simulation) due to the digital signal passed through a non-linear PA .

Random signals and distorted noise power

Consider a PA driven by a statistical signal with the idealized, solid rectangular flat shape of an average power spectrum at a frequency band Δf (see Figure 1). This signal can be represented statistically in the frequency domain with a flat probability distribution function in margins[5, 6]. It implies that each average-power spectral component inside the flat shape is created from the instantaneous input signal on the same frequency with the additional probability of an appearance of a signal on that frequency. The *probability of an appearance* of the spectral component inside the limits df_1 is equal to the formula in equations (1) on page 44.

It's in the IMD

In (1), $g(P_{in})$ is the density of a probability distribution function for a PA input power. At the same time, the spectral component inside the limits df_2 exists with the similar probability. It can be assumed that the spectral components at limits df_1 and df_2 are not correlated. These simultaneous spectral components cause instantaneous intermodulation distortions (IMD) of a PA output signal at frequency offsets determined by a difference between f_1 and f_2 (the particular case in Figure 1 presents the IM_3 definition). For the out-of-channel spectral re-growth, the IMD contribution has been considered in [5] and [6]. For in-channel noise power elevation due to IMD products, the situation differs from the previous one. Again, referring to Figure 1, the IMD appearance at a frequency offset f_0 is possible from two parts of a spectrum: left, δf_1 and right, δf_2 (below, the left side is determined at $\delta f_1 > \Delta f/2$, and the right side at $\delta f_2 < \Delta f/2$). The probability of the appearance of IMD products at different frequency offsets may be represented as the equation in formula (2).

In (2), $g(IMD)$ is the density of a probability distribution function for IMD imposed by an instantaneous input signal. Assume that the main contribution to IMD is from frequency components with equal power levels (it has been verified experimentally for metal semiconductor field-effect transistor [MESFET] PAs). Then the effects occur at a frequency band near the saturation region for the average value of IMD at different frequency offsets (see equation (3)).

The first term in (3) represents the left side spectrum contribution to the total IMD value, and the second term represents the right side (see Figure 1). Remember that the total probability of an IMD appearance equals the sum of *particular probabili*

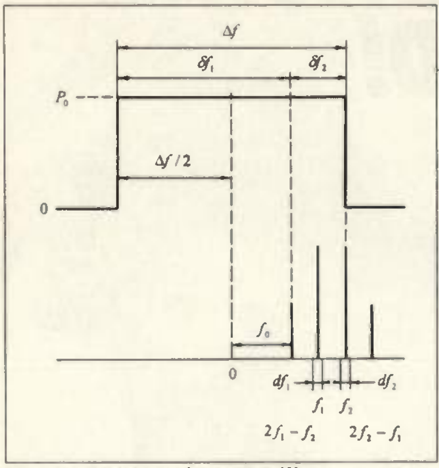

Figure 1. Elements of equation (3).

ties. The integral limits in (3) determining the two-tone frequency spacing are defined by the equations of the formula. The frequency-spacing margins, where the IMD products are placed, are at a frequency offset f_0 (see Figure 2–top). These margins have been previously defined in [5] and [6] for out-of-channel spectral re-growth (at $f_0/\Delta f > 0.5$). For in-channel (in margins of Δf) IMD products, the solid lines belong to the left side of a spectrum and dashed lines to the right side.

It can be observed that, at a specified frequency offset f_0, the total IMD product (3) combines components with different frequency spacing starting from near-to-zero and up to margins determined by (4) and Figure 2–top. For the lower order of IMD, the frequency spacing range is wider than it is for the higher ones. CDMA signals are narrowband and the difference in IMD products at a frequency offset is small through the range of the frequency spacing mentioned above. In this case, consider the mean values and equation (3) transforms into the formula in equation (5). The function $F(f_0)$ plays the role of a weighting coefficient for the IMD average value at different frequency offsets and its shape is presented in Figure 2–bottom (at $f_0/\Delta f > 0.5$, it has been defined in [5] and [6]). So, IMD products from (5), together with the proper noise of a PA (without input signal) and with a spectral density of N_0, create the total noise spectral component at a frequency f_0, as determined by the formula in equation (6). The total in-channel noise is given by the formula in equation (7).

The function (5) has been determined in [5] and [6] for CDMA signals by the formula in equation (8).

In (5), $IMD[mW]$ and $P_{in}[mW]$ are the IMD power at a specified input power in milliwatts. $g(P_{in}[dBm]$ is the density of a *power probability distribution* function for an input signal (usually, it has a logarithmic-normal distribution [7]). $Ta = g(P_{in}[dBm]$ is the *auxiliary transfer function* for the IMD [5]. The integral from the function T_a is proportional to the IMD at a given frequency offset, f_0. The function T_a versus P_{in} is convenient for a graphical representation of equation (8). It directly represents a contribution from the input signal statistics and IMD characteristics of a PA at each instantaneous drive power levels to the in-channel noise spectral power at f_0. The square restricted by the curve T_a and P_{in} axis is equal to the additive noise with the accuracy of a coefficient. Considering curves T_a versus P_{in}, The circuit can be tuned to decrease the additive noise imposed by the PA's non-linear characteristic at input power levels with high noise contribution.

AWGN or not

Observing the weighting functions $F(f_0)$, and assuming the constancy of IMD products through the frequency spacing defined above, it can be concluded that an in-channel noise power distribution is not additive white Gaussian noise (AWGN)-type. The noise-power spectral density elevates by 3 dB at spectrum margins over a center frequency. The noise influence on a system's performance is defined by the integral (7). In this case, one can represent an in-channel noise as AWGN with mid-values of a noise spectral density. For each IMD product contribution to a total noise, the mean weighting functions $F(f_0)$ are presented in Figure 2–bottom by horizontal dashed lines (–8.0 dB for IM_3; –11.2 dB for IM_5, and –13.6 dB for IM_7).

Then, comparing the in-channel noise power elevation defined by (8) and the out-of-channel spectral regrowth [5], [6] imposed by IMD products yields the following: It can be concluded that the mechanism of the appearance of these two figures of merit is virtually the same except for the different weighting coefficients. Therefore, ACPR measurements can estimate for in-channel noise power (manifold equipment exists for that[8]).

Discussing ACPR

For the small output power of a PA, the IM_3 virtually determines the total noise power. In this case, it is possible to measure an ACPR at "X" frequency offset, and use the IM_3 weighting function in figure 2b to define the reference between the noise and ACPR. However it is necessary to check the smoothness of the ACPR shape. It should resemble the shape presented in Figure 2–bottom. Furthermore, base-band matching networks (usually biasing ones) can sharply elevate IMD products and ACPR at certain frequencies [9]. To note, at small signals, the mean in-channel noise spectral component equals the ACPR spectral component at a frequency offset of $f_0/\Delta f = 0.72$, or f_0 = 885 kHz for CDMA-one systems (exactly the spectral mask frequency specified for PCS base station PA). However to use this test point, it is important to to check the input signal spectrum quality. Even 10 dB difference between ACPR measurements for input and output signals, due to an improper filtering of an input signal, results in 0.4 dB "alleged growth" of an in-channel noise power. The best frequency offset can be chosen at $f_0/\Delta f$ = 0.8 to 0.9. The reference position for the noise correlation will be as 1.0 to 2.4 dB.

There are some issues with ACPR measurement and simulation for their correlation with different orders' IMD products. For class AB MESFET PA modules driven by multi-carrier CDMA-one and W-CDMA (4.096 Mch/s) signals up to the systems' specified margins (defined by ACPR) at frequencies of 0.8, 1.8, 2.4, and 3.5 GHz the IM_3 related noise power exceeds the IM_5 -related noise power by more than 6 to dB. This means that, if choosing the ACPR measurement frequency offset at $f_0/\Delta f$ = 0.8, the mean in-channel noise spectral density will be equal to ACPR +1 dB, with an accuracy of 0.4 to 0.6 dB for maximal output power levels (ACPR +0.4 to 0.6 dB). Higher values of a frequency offset are undesirable because of an increased uncertainty of measurements for noise and ACPR correlation. In fact, the weighting functions in figure 2–bottom represent the clipping noise power imposed by a PA non-linear characteristic, and this noise is distributed through frequencies and divided on different terms. Usually each term varies insignificantly throughout the frequency, and the total additive noise power spectral density is not "white." The high portion of a clipping power is placed out of the channel margins and defined as Δf. For example, the related IM_3 noise power inside Δf comprises only –3.1 dB of a total noise power produced by IM_3. For IM_5

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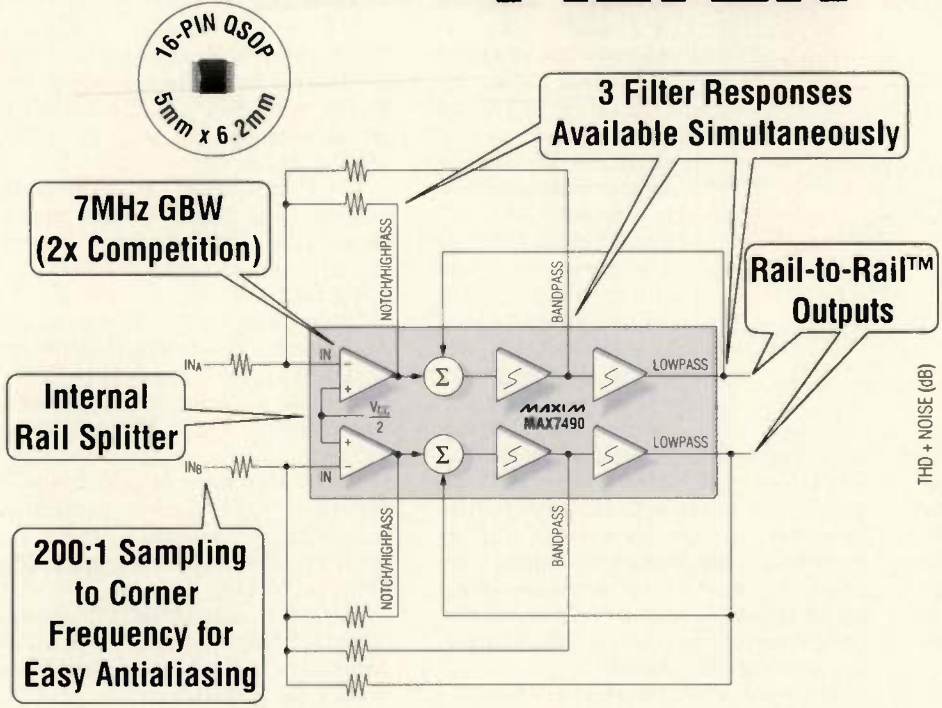

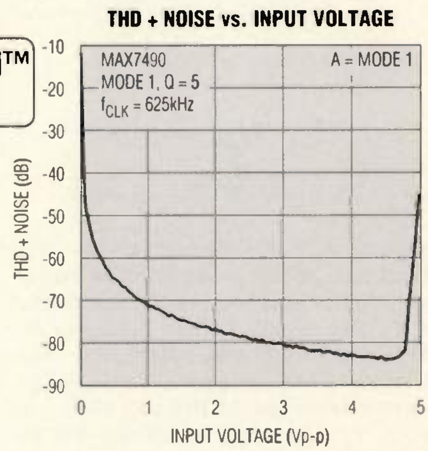

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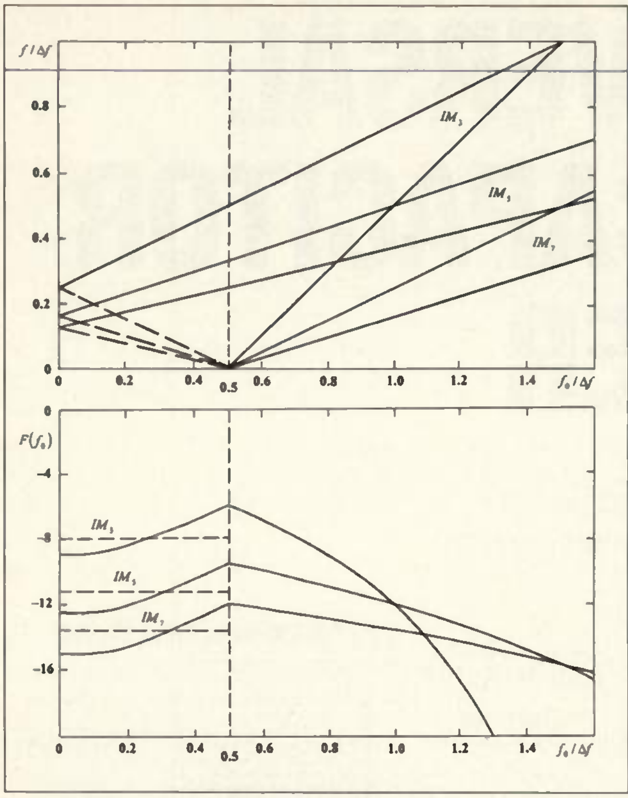

Figure 2. IMD products at frequency offsets.

this figure is –4.8 dB and for IM_7, –6.3 dB. Exact values of each noise power component may be evaluated by the formula in equation (8) by means of the IMD products' measurement. The validity of a proposed correlation method between ACPR and IMD has been verified experimentally for W-CDMA PA[5].

Methods and procedures

Certainly, the method proposed is valid for multi-bearer signals when the signal statistics result in a shorter, proper time for a random process[10]. In this case, for a linear PA, the amplitude and phase modulation (AM/PM) characteristic may be excluded from consideration owing to a fairly high-output power back off[3]. But, even for a single-user, CDMA reverse-link channel, one approach proposed allows the tuning of a PA circuit for the best BER (FER) performance.

The method is also valid for personal digital cellular/communications (PDC) and personal handiphone systems (PHS) communication systems with a flat shape of the signal power spectrum[6]. But, if a PA circuit is tuned for the best ACPR at a frequency offset of $f_0/\Delta f$ = 0.8 to 0.9, it automatically results in the lowest added in-channel noise power level for CDMA PA (including W-CDMA systems). This should not be considered a correlation between the in-channel noise power and ACPR for the center of an adjacent channel. It may result in an erroneous conclusion. However, the PA circuit's tuning needs a trade-off between ACPR and noise for PDC and PHS systems. For the best noise, the minimizing of IM_3 is important and, for the best ACPR, the higher orders of IMD products play a decisive role[6].

For the multilevel quadrature amplitude modulation (QAM) and hybrid phase-shift keying (PSK)/QAM, the results obtained may be applied directly.

For manifold orthogonal frequency division multiplexing (OFDM) modulation formats, an approach proposed is applicable. However, it requires some modifications due to the frequency hopping time and frequency guard intervals introduced, which result in a different statistical correlation between the individual spectral components.

The method also works with non-flat power spectrum signals such as Gaussian signals[11], however, the power spectrum statistics differ.

For a strict result, the multiple self-convolutions of a signal should be considered[11]. However, this simplified approach only takes into account the first convolution procedure. The formula in equation (8) represents the main contribution of IMD to a noise growth.

Conclusion

The in-channel noise growth evaluation imposed by a PA in CDMA systems is based on the two-tone IMD product approach and signal statistics analysis in a frequency domain that allows a noise evaluation by ACPR measurements. The ACPR test frequency offset is defined as $f_0/\Delta f$ = 0.8 to 0.9 for the best correlation accuracy. The method proposed is also valid for other digitally modulated communication systems with a flat power spectrum.

The analysis addresses and clarifies PA tuning procedures to achieve the best noise characteristics in the whole system. Finally, to avoid confusion, the base-band matching networks should be considered as a first order.

RF

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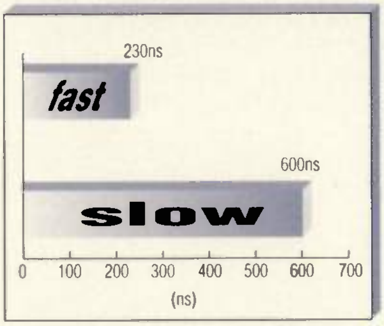

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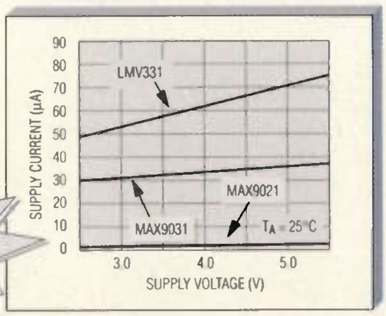

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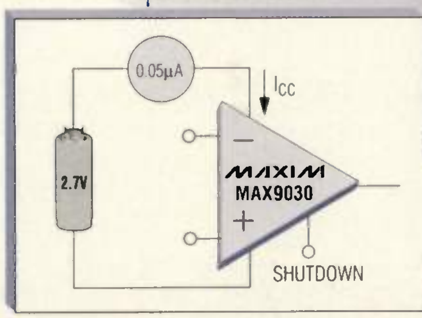

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(1) $$g(P_{in})\frac{1}{\Delta f}df_1 dP_{in}$$

(2) $$g(IMD)\frac{1}{\Delta f}*\frac{1}{\Delta f}df_1\,df_2\,dIMD = g(IMD)\left(\frac{1}{\Delta f}\right)^2 df_1\,df_2\,dIMD$$

(3) $$IMD(f_0) = \int_{-\infty}^{\infty}\int\int IMDg(IMD)\left(\frac{1}{\Delta f}\right)^2 df_1\,df_2\,dIMD + \int_{-\infty}^{\infty}\int\int\left(\frac{1}{\Delta f}\right)^2 df_1\,df_2\,dIMD$$

(4) $$\Delta f_2 = \Delta f_3 = f_0;$$
$$\Delta f_1 = f_0 - \frac{\delta f_1}{2};\Delta f_4 = f_0 + \frac{\delta f_2}{2},\ \text{for } IM_3$$
$$\Delta f_1 = f_0 - \frac{\delta f_1}{3};\Delta f_4 = f_0 + \frac{\delta f_2}{3},\ \text{for } IM_5;$$
$$\Delta f_1 = f_0 - \frac{\delta f_1}{4};\Delta f_4 = f_0 + \frac{\delta f_2}{4},\ \text{for } IM_7;\ \text{et}$$

(5) $$IMD(f_0) = \left(\frac{\Delta f_2 - \Delta f_1}{\Delta f}\right)^2\int_{-\infty}^{\infty} IMDg(IMD)dIMD + \left(\frac{\Delta f_4 - \Delta f_3}{\Delta f}\right)^2\int_{-\infty}^{\infty} IMDg(IMD)dIMD = \left[\left(\frac{\Delta f_2 - \Delta f_1}{\Delta f}\right)^2 + \left(\frac{\Delta f_4 - \Delta f_3}{\Delta f}\right)^2\right]$$
$$\int_{-\infty}^{\infty} IMDg(IMD)dIMD = F(f_0)\int_{-\infty}^{\infty} IMDg(IMD)dIMD$$

(6) $$N(f_0) = IM_3(f_0) + IM_5(f_0) + IM_7(f_0) + \ldots + N_0$$

(7) $$N_\Sigma = \int_{-\frac{\Delta f}{2}}^{\frac{\Delta f}{2}} N(f_0)df_0$$

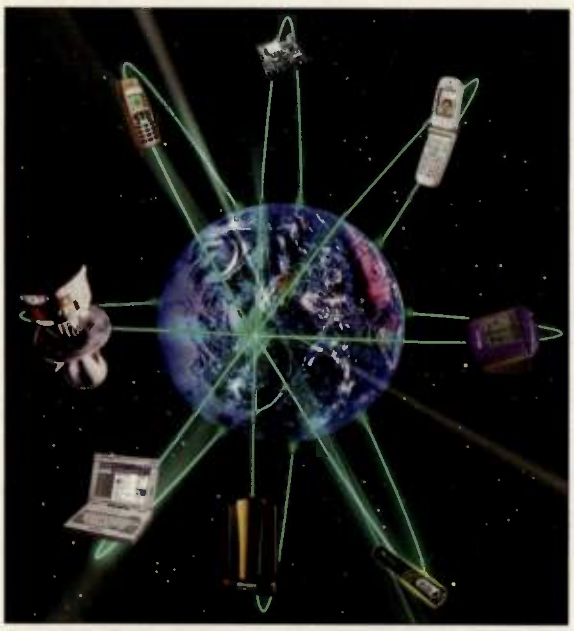
(8) $$IMD(f_0) = 4.342945F(f_0)\int_0^{\infty}\frac{IMD[mW]}{P_{in}[mW]}g(P_{in}[dBm])dP_{in}[mW] = 4.342945F(f_0)\int_0^{\infty} T_a dP_{in}[mW]$$

The dawning of the age of convergence

Convergence – entertainment, communications and commerce all merging into a single stream of discrete bits carried on a single common thread.

By Ernest Worthman

Convergence: not products...not technology...not people...but synergy! Convergence promises to be all thing to all people, but can it? Will it? Do you really want it to be? The term convergence still reminds me of the planetary alignment thing that the '60 generation claimed happened when, "the moon is in the 7th house, and Jupiter aligns with Mars"...aka the age of Aquarius.



Converging Technologies—A world of opportunity.

Today, convergence is being played as the final frontier — the end result of the impending integration of voice, data, video, music, the Internet, home automation, satellite delivery systems, instant messaging, and global positioning systems (GPS), just to scratch the surface.

Terms like Bluetooth, HomeRF, wireless Internet, the wireless access protocol (WAP), broadband, asychronous transfer mode (ATM), various flavors of digital subscriber lines (xDSL), wireless local loop (WLL) and others yet to be defined, all will likely play a part in the upcoming convergence.

What is it, really?

Many "adapt" the term convergence to benefit them as they see fit. One of the key issues with this term is that it *is* relational. It can relate to whatever product, technology or "solution" it is being applied to.

3G players are using it to bring video, stock quotes, music, messaging and other services to the mobile communicator.

Computer players use it to add wireless features to wired devices. In a recent advertisement I noticed that Bluetooth-based wireless access points and computer add-in cards are being listed right next to the wired Ethernet devices.

Bluetooth, HomeRF, 802.11x and other unlicensed wireless players are using the term to integrate home automation, Internet appliances, computer command centers and wireless Internet in a convergence that promises complete control over your lifestyle.

And still other players (like the entertainment industry) are integrating digital cameras with MP3 players (can wireless interfaces be far behind?)

Yet trying to make sense of convergence is overwhelming. Convergence should not stack after stack of protocols patching disparaging technologies and applications together. Rather, it should be a seamless, synergistic melding of the technologies and applications – one where they complement each other...where they are universally available...where they are reliable and dependable, no matter what, where or when.

Let there be technology

Promising technologies exist at all levels. From the global pipeline referred to as "broadband" to basic modulation schemes like orthogonal-frequency division multiplexing (OFDM), designers are seeking ways to implement these technologies on a system-wide platform.

But perhaps the most important of all is that ubiquitous pipeline that delivers the content. It doesn't matter if it's the Internet protocol (IP), ATM, DSL, or cellular digital packet data (CDPD). And it doesn't matter if its 802.11x Bluetooth, WAP, Wi-Fi (an acronym for wireless high fidelity). And it doesn't matter if it's spread spectrum, OFDM, code-division multiple access (CDMA) or any other coding scheme. It matters that the end user can get and send the content over one, single megabit-wide channel — the broadband.

Is it broadband?

Of late, one cannot open a technology magazine, view a technology advertisement or carry on a conversation with a generation "d" individual without hearing the term "broadband."

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Like convergence, many players morph the term broadband to suite their needs and applications. Internet service providers claim broadband to be anything that is faster than current dial-up technologies. Satellite providers use it to consolidate the gamut of signals being beamed down to us. Computer players use it to tie together wireless and wired Internets and Intranets and ship voice, data and video within the loop. And wireless and wireline providers are finding that broadband offers them the opportunity to partner, buyout and cross-platform.

Yet broadband will open a plethora of opportunities, once the bugs get worked out and everyone is on the same page.

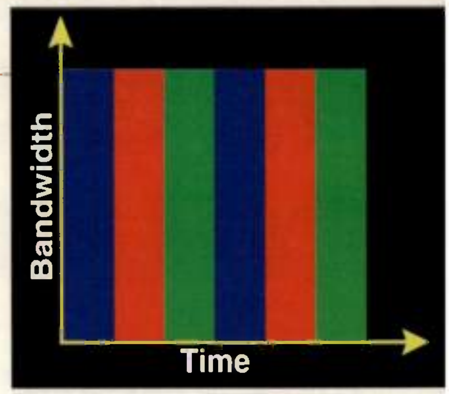

Figure 1. Packet data time slicing.

Let there be platforms

Broadband can be delivered by any number of platforms. Some are: Integrated services digital network (ISDN – to 128 kb/s), various flavors of digital subscriber lines (ADSL, HDSL, IDSL, MDSL, RADSL, SDSL, VDSL — to 25 Mb/s), microwave (to 1.5 Mb/s), T1/T3 (to 45 Mb/s), fiber (OC-48 — to 2 Tb/s), personal satellite systems (currently download only speeds to 2 Mb/s), and cable modem (to 4 Mb/s). And there are others as well. Most are derivations of the above technologies deployed in various standards around the world.

A broadband or "fat" data pipeline requires that all the components be digitally savvy. Content must be digitally codeable. The transmission medium must be digitally capable. And the destination site must be digitally-decode capable

Let there be packets and frames

Although many options are available for broadband delivery, essentially all of them implement either packetized data or frame relay data. And, while there are almost innumerable derivations for packet and frame transmission technologies, this article will focus on the most common.

Today, common broadband technology involves wrapping data in "packets." Each packet contains a certain amount of data. Packets can be either fixed or variable in length. Each packet can contain all of the data, or just part, depending on contents. Packet switching is based on the premise of all of the bandwidth, part of the time (see Figure 1). As packets are placed into the pipeline bandwidth is allocated as needed. This give all transmissions as much bandwidth as they need, a chunk at a time. This allows for a fast, bursty pipeline.

Currently, packet data is implemented in three major protocols: Internet protocol (IP), frame relay and ATM. All packets begin with a delimiter, followed by a header, the payload (contents), the

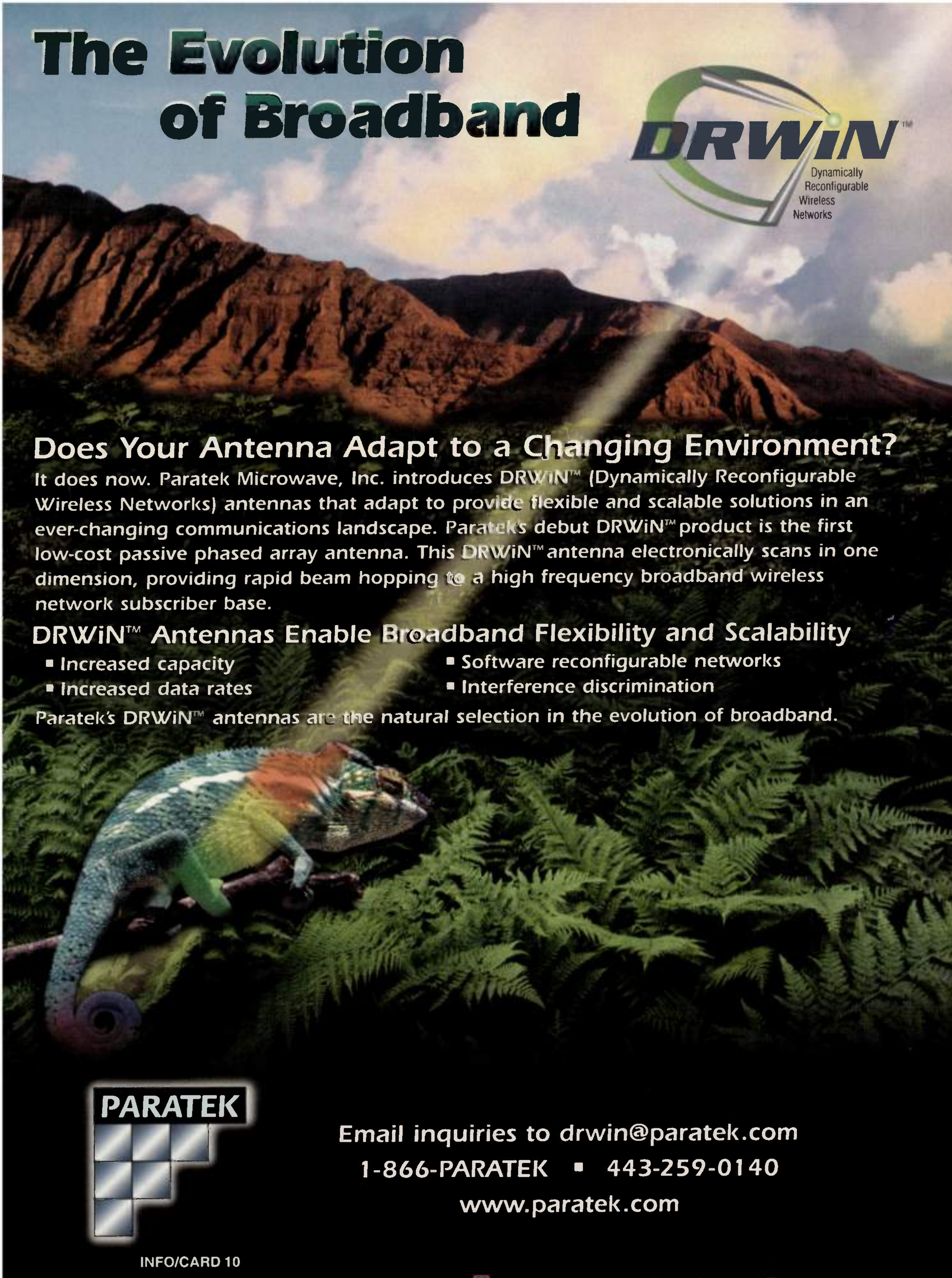

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Figure 2. Packet architecture.

trailer or delimiter (see Figure 2).

The major differences among them is that ATM packets are of a fixed length while frames and IP are variable. Each has its advantages and disadvantage.

ATM packets are easier to process. There are no variables when it comes to size and overhead. This makes it easier to predict system performance and to design the overall system. ATM and frame relay packets are called connection-oriented. This means that a virtual circuit must be established for the packet to traverse. However, once established, such a circuit reduces the need for overhead.

IP and frame relay packets are variable in length. Their main advantage is that they use bandwidth more efficiently because they can be adapted to available bandwidth readily. IP has the additional advantage in that it is "connectionless." Basically what this means is that the packet has a unique address in a universal system. It can find the address regardless of the path. However, this universal system requires a much larger address space because it has to search the entire universe, as opposed to following an ad-hoc established virtual circuit.

But what about voice?

Static data and video are fairly easy to process into packets. Broadcasters have been doing it for years, pretty much the same for computer graphics and other data.

Voice, on the other hand has some unique issues.

First of all, we are used to a certain grade of acceptable quality — that of the plain old landline. Second, society as a whole is not particularly tolerant of voice system delay (a significant reason satellite phones aren't extensively deployed). Such is not the case for data, which isn't sensitive to delay.

Of late, voice over the Internet (wireline or wireless in various forms) has become a significant industry. But early attempts to get voice into ones and zeros was dismal. It didn't come anywhere close to the quality we have come to expect. There were (and still are) issues with application and equipment incompatibilities, bandwidth, and legal and political issues as well.

Broadband has given some relief to this problem, but the main improvement has come in processing power.

Now, combine wide bandwidths with high-speed digital signal processors (DSPs) and suddenly, voice as data becomes attractive.


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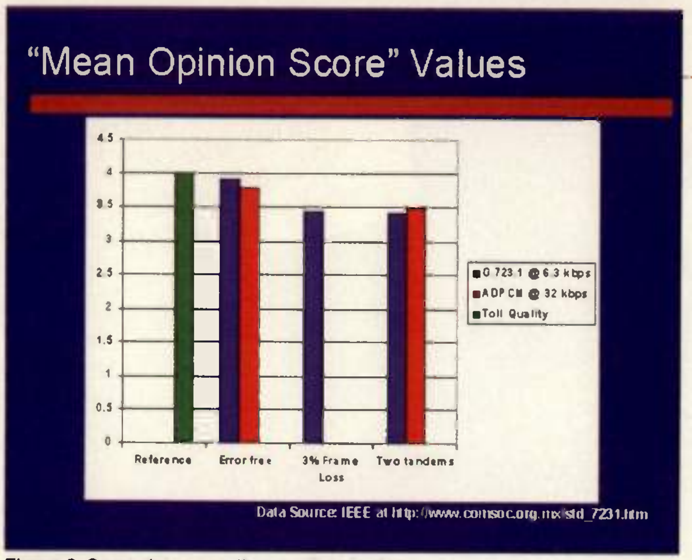

Figure 3. Some data regarding quality of voice.

The voice protocols

Today's protocols for voice traffic are comprised of voice over Internet protocol (VoIP), voice over frame relay (VoFR) and voice over ATM (VoATM). All use algorithms based on mixed excitation linear prediction (MELP) and, more commonly, code-excited linear predictive coding (CELP).

CELP coders using complex algorithms to provide good-quality analog-to-digital conversions at low bit rates have been around for more than 15 years. But only recently have they been integrated into large scale implementation because they extract such a high price in terms of processing power.

Typical CELP coders require hundreds of MIPs (millions of instructions per second) to produce acceptable quality. This has only been practical of late, with the development of high-speed DSPs.

Current algorithms for CELP are based on the International Telecommunications Union's specifications. For VoIP the standard is G.723.1, which calls for 5.3 and 6.3 kb/s. For VoFR, the standard is G.729 at 8.0 kb/s. So far, it seems that general opinions tends to notice degradation when the frame loss rate hits about 3%(see figure 3). Overall, VoXX systems work well if packets aren't too long, transmission speeds are kept up and voice packets are given priority.

DSP, the great enabler

The reality of convergence and broadband is that DSP is the basic hardware that will make it happen. DSPs are now reaching speeds and integration levels that make it both practical and possible to digitize information from all sources. DSP technology allows coding and compression of megabit information quickly and efficiently for transmission over broadband systems.

The next generation of convergence products will have embedded DSPs as the core enabler. One currently available device is an integrated DSP that includes a plethora of hardware-implemented protocols such as hypertext transfer protocol (HTTP), simple mail transfer protocol (SMTP), file transfer protocol (FTP), terminal connection

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Field of DSP dreams

In the near future, expect to see high-performance real-time embedded controllers addressing a “virtual multi-processor-based environment.” Multi-tasking will be the key with highly sectionalized processors that offer multiple interfaces so system designers can embed multiple hardware-based functions into systems.

The next generation of DSPs will be also be much more real-time capable. They will be 32-bit, superscalar, embedded RISC controllers utilizing high levels of integration, reliability and parallel processing. These functions will not only apply to the DSP, but control functions as well. Bandwidth will be in the hundreds of MIPs, and addressable memory will be in the gigabytes.

Furthermore, refinements in DSP techniques within embedded control loops will be the integrator among applications in the convergence of consumer, industrial, computer, automotive and communications markets. Expect to see devices such as third-generation mobile telephones with auto-location and preemptive artificial intelligence so your theater tickets will be waiting when you arrive, paid for, with your preferred seats reserved. Compact disk, MP3 and other various flavors of music players will be capable of wireless downloads. Multifunction communications devices will integrate music, digital video, messaging, voice and data, seamlessly. DSP-based, wireless-enabled in-car navigation systems will render the gene that prevents men from asking for directions, obsolete.

New DSPs will eliminate the concerns current generation systems have with benefits and drawback of floating point software support within an embedded control environment.

Given the advancements in sub-micron processes that will allow extremely packed semiconductor densities, software-based precision floating-point performance will become mainstream.

Within the next couple of years, DSPs will routinely achieve speed of 200 MHz and higher and 500 MIPs and up. Increased implementation of super-scalar architecture, along with 64- and 128-bit wide code and data pipelines and enhanced multithreading capabilities will become the mainstays of convergence and broadband technology. Power consumption will be reduced to less than 2 VDC and RFI will be minimized.

The industry believes

In short, the dream of worldwide, seamless application-independent content capable of traversing any channel, medium or platform will be realized. It likely won’t be tomorrow, or the day after, but certainly, once the technical, political, and infrastructure issues are finally addressed, and the lure of financial opportunity is identifiable, progress will astound us.

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Structured estimating – A new approach to a critical project parameter

Improve your project software cost estimates with a structured estimating process.

By Gary Constantine and William J. Vitaliano

Moving to a structured estimating process can substantially improve the accuracy and quality of software cost estimates. The cost-estimating process is crucial to major systems providers because it has a significant impact on the profitability of large programs. In the past, the process of estimating software development costs has been less-structured and has delivered variable results.

In recent years, however, many systems providers have implemented a more formal process in which standardized metric elements are used to provide a quantitative basis for generating program estimates. The accuracy of estimates has increased, and the structured approach helps build increased confidence in the accuracy of the estimating process that simplifies downstream negotiations. The method has been successful on two major projects.

Cost estimating — it's in the numbers.

The challenges

Large software projects present a complex estimating challenge. The methodologies, languages and standards used in the software development process are constantly changing. Human ingenuity has increased the difficulty of the measurement process, sometimes with nearly the entire value being added to the end results. Traditional bottoms-up measurement methods vary widely in accuracy because they depend, to a degree, on the skill and experience of the estimator.

Another problem with unstructured approaches is the lack of documentation created during the estimating process. This makes it difficult to quickly and reliably evaluate the inevitable changes and concerns that occur during the negotiation process.

The limitations of previous approaches

The spreadsheets historically used to document bottoms-up estimates have built-in limitations. A major concern with spreadsheet models is that they are vulnerable to errors whose likelihood increases as the model becomes more complex. Something as simple as entering the wrong formula in a cell could change the final estimate by millions of dollars. This type of error is difficult to catch because of the difficulties in auditing a one-of-a-kind spreadsheet model. Another problem with spreadsheet models is that they provide a single-point answer that does not normally take range-estimating into account.

To overcome these challenges, most systems providers work with a variety of structured estimating tools. The basic advantage of the structured approach is that it provides a standardized methodology that uses historical data to refine the estimating process. Over time, as metrics used for generating initial estimates are calibrated to actual project results, accuracy increases. The structured approach also generates, as a byproduct of the estimating process, phase distribution of effort and scheduling information that can dramatically improve the project oversight function. The importance of this effort increases as the size and complexity of systems continues to grow and pressure increases to minimize project costs.

Technology to generate estimates

Using structured estimating tools, the process begins when the engineering members of the proposal team develop a solution set for meeting the requirements of the request for proposal. At this point, the estimating members of the team begin building the model by entering parameters that

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ADE-13	2	50-1600	+7	8.1	40**	11	3.10
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ADE-28	3	1500-2800	+7	5.1	30	8	5.95
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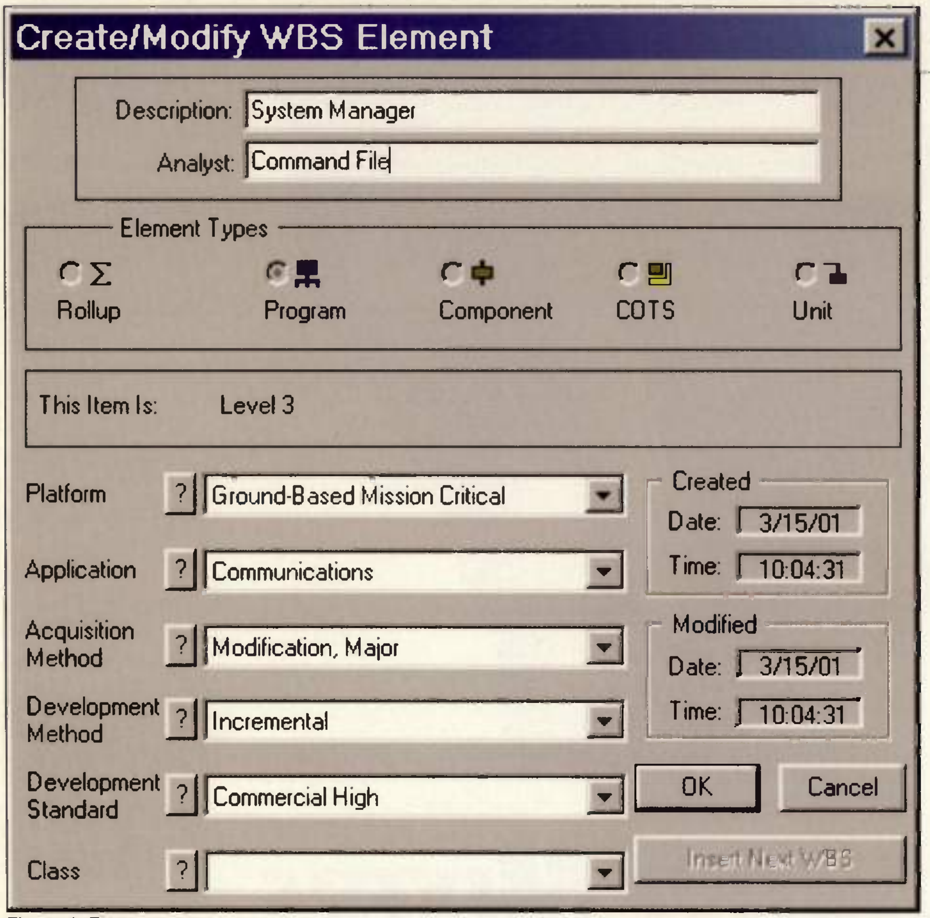

Figure 1. Element screen.

organize the costs in an understandable manner. An example of a typical parameter is one that measures the program's level of formality. A manned space flight, for example, requires a formal program that adheres to military standards so that high-level designs, detailed designs and test plans can be presented at standup presentations that require a considerable amount of preparation. The majority of military programs, on the other hand, now use high-grade commercial standards that simply involve technical interchange meetings demanding less preparation.

The program generates an estimate for each phase of the project, organizing the costs in any manner desired by the project team. The transparency of the estimate makes it possible for the project team to easily consider its reasonableness and, if necessary, make adjustments to the program parameters. An advantage of this approach is that it allows the user to enter probability levels for each parameter. This makes it possible to determine the impact of changes in various program parameters. The result is that the estimate includes a most-likely value, as well as a range of probable values based on the uncertainty factors entered by the estimators.

Model accuracy

Estimators typically use the model for a rough order of magnitude estimates, firm proposal estimates and management evaluation of software development activities. In most cases, they consistently achieve a high level of accuracy for proposal estimates. The key to achieving these high levels of accuracy is a comprehensive calibration effort. The model is calibrated by evaluating completed programs in which the costs are known. The person who performs the calibration interviews the engineering lead on the program in an effort to understand variables such as the skill level of the developers involved and the characteristics of the project. A model is created to estimate the program after the fact. This is an iterative convergence process consisting of comparisons between the model's parameter selections and resultant cost estimate, and the real-world program characterization and cost.

After calibrating a considerable number of programs, general trends start to emerge. An awareness emerges about the capabilities of an organization and the requirements of its customers as they fit into the continuum measured by the model. The skill level of different groups can be compared within the organization and trends such as an increase in a particular group's performance can be identified as its members gain more experience. This process is critical to a successful structured estimating program. By fine-tuning the process it, is possible to dramatically improve both the accuracy and consistency of estimates over time.

The negotiating process

Much of the advantage of using structured estimating tools comes well after the estimating process has concluded. A characteristic of structured estimating is that it delivers not simply a number, but also a methodology that makes it possible to trace exactly how the number was generated. The fact that estimators can easily provide backup information to explain the estimating process increases the customers' confidence. In many cases, even after the bid is accepted, the negotiating process may continue. Furthermore, the model provides an audit trail and makes it possible to evaluate the impact of changing program assumptions.

The model can also provide a framework for evaluating the performance of the project. Comparing actual results with detailed model estimates can provide early visibility of problems and can determine the resultant impact on the overall cost and schedule of the program. In certain cases, early results from a program may cause estimators to question parameters used in creating the model. In such a case, the model can be quickly updated to factor in the effect of changing early assumptions and determining the impact on the overall program budget and schedule. The model can also assist management decision-making by enabling management to compare the expected results of different program management alternatives.

For example, the use of parametric costing on a recent government proposal saved 1,000 hours and helped promote the use of less-expensive design alternatives. In the past, one manufacturer has used the bottom-up and similar-to basis of estimate (BOE) approaches to determine program development costs. On a recent project in response to the government's cost as independent variable (CAIV) initiative the firm tried the parametric costing approach in conjunction with the BOE approach. A commercial knowledge base consisting of extensive industry

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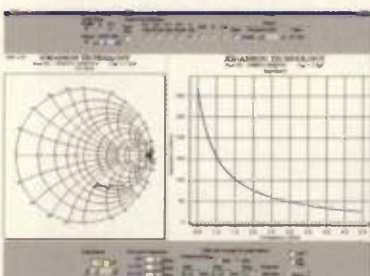

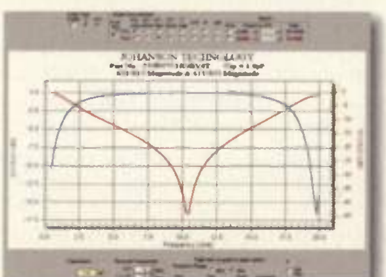

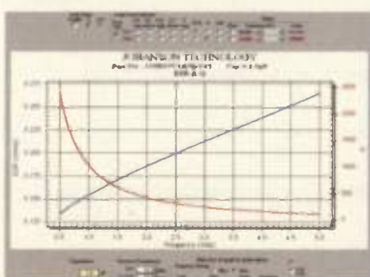

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data was used to estimate the development and production cost of a new system. The use of the knowledge base saved a considerable amount of research time and guesswork on the part of the cost engineer and made it possible to evaluate alternative approaches on a much more timely basis. The conclusion of the development team was that the parametric costing approach provided a useful alternative to the bottoms-up and similar-to BOE approach that could offer significant benefits in future programs.

The estimating challenge

The example OEM recently received an invitation to bid on a government project. A critical part of the proposal was developing an accurate development and production cost estimate. In the traditiona process, estimates of this type are pro duced by first breaking the system dowı into its individual components, both elec trical and mechanical. The electrical hard ware components, which typically consti tute the bulk of the cost on Harris' pro jects, are analyzed down to the individua printed circuit board (PCB) level. At thi point, cost engineers search through pre vious programs to find similar boards tha were produced in the past. Once some thing similar is identified, the enginee makes an estimate such as: "The PCI used in the earlier project took 500 hour to design. The one in the current projec will actually be a little easier. Let's esti mate the cost at 425 hours." Because thi process is used so frequently, many majo government contractors have people dedi cated to collecting and organizing costin data from previous projects.

The CAIV initiative

On the study under discussion, th customer requested a differen approach. The motivation was not actu ally in saving time during the proposa process but rather in reducing life-cycl costs through the CAIV initiative. Thi initiative involves a twofold process The first is a planning activity estab lishing and adjusting program cos objectives through the use of cost-per formance analysis and tradeoffs. Th second component involves execution o the program in a way that meets o reduces stated cost objectives.

Early in the acquisition process, th high leverage of CAIV-inspire cost/performance/schedule tradeoff should shape the requirements an proposed design objectives. Later, th overall cost objectives can be allocate to specific cost and system elements The bottoms-up and similar-to BOI approach is not conducive to CAI methods because it takes so long t compare alternate design approache from a cost standpoint. That's why th customer suggested that a parametri costing approach be used on this projec in support of the standard approach.

Engineers examined several types o software packages that use the paramet ric costing approach. All of these pack ages provided estimating software an knowledge bases built on extensive real world data and expertise. The engineer selected programs called SEER-H an SEER-SEM, primarily because they fel that its interface is more intuitive an easier to use. This software packag

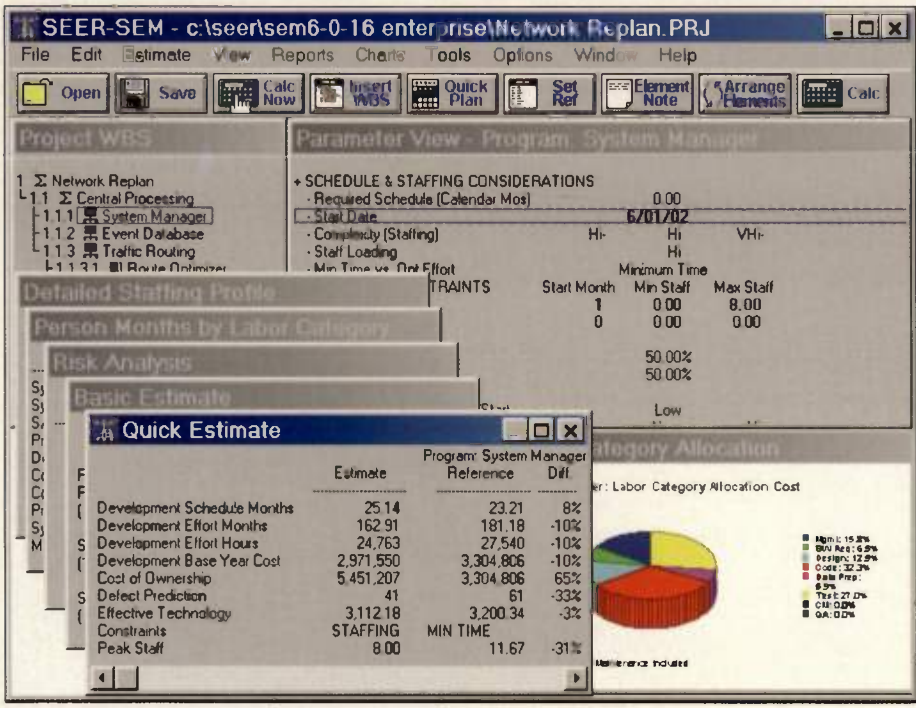


Figure 2. High level project overview.

reduces the learning curve by avoiding the use of less-than-obvious adjustments to present the estimating objective more clearly. It also bases the price of individual PCBs on their number of components rather than on their weight, an approach that usually provides more realistic results. The program is sensitive to the difference between mechanical and electrical elements as well as costs between labor and materials. It provides databases that are compiled from thousands of real-world projects to help make accurate estimates. Finally, it provides many tools that allow users to assess risks, make trade-offs, perform sensitivity analysis and create technology forecasts.

Developing the parametric model

The proposal team started by developing the systems architecture, including defining the input, processing steps and output. Throughout the process the cost engineer worked closely with the project team to develop a good understanding of the system at a high level. This is an essential part of the costing process. It helps the cost engineer comprehend the requirements of the system fully, so they are satisfied in making tradeoffs that may be required from a cost standpoint as the project moves further along. During this period, the cost engineer also began constructing the parametric model by entering high-level systems data into the software package.

As the proposal matured, the electrical systems engineers and software engineers diagrammed the system and the cost engineer began adding more detail. The cost engineer used the software tools to describe each component, identify its quantity, material composition, design and manufacturing processes involved. At this level, the SEER-H model began predicting recurring and nonrecurring development and manufacturing costs by identifying similar components from its database. While SEER-H is primarily designed to model the development process, it does include manufacturing cost estimation capabilities that are usually sufficient for low production programs. If higher quantities will be produced, then it would probably make sense to also develop a design for manufacturing-type models such as SEER-DFM.

Alternative cost comparisons

As usual, the proposal development process involved a continuing series of changes and tradeoffs. The cost engineer stayed involved with the project and continually updated the model to reflect the latest thinking of the design team. The use of the parametric approach made it possible to provide near-real-time feedback about the team on the effect of choosing various options for the development and manufacturing costs. Using the conventional costing methodology approach, the lengthy period of time required to develop new cost estimates means that a considerable amount of effort may be put into design approaches that will later be ruled out from a cost standpoint.

The cost engineer included higher level costs (costs for the program management office) as a common factor that was automatically allocated to various elements of the project. This saves

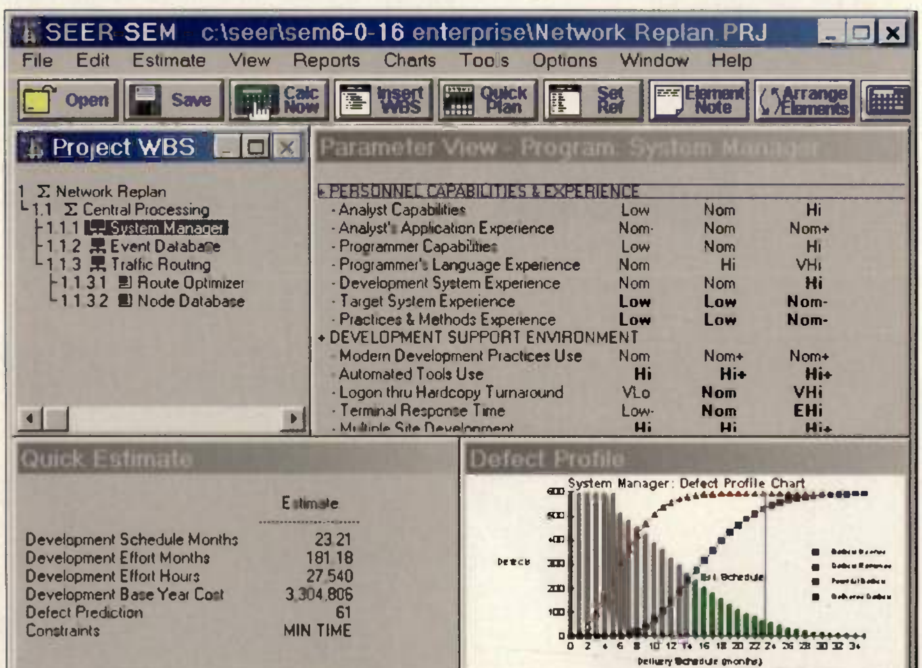


Figure 3. System overview and cost estimates.

the need for what would have otherwise been a series of time-consuming calculations. The model also sped the development of productivity curves that estimated the rate at which manufacturing costs could be reduced during the life cycle of the project. Whenever the design was changed, these curves were automatically updated based on assumptions that had been entered previously, eliminating additional manual calculations.

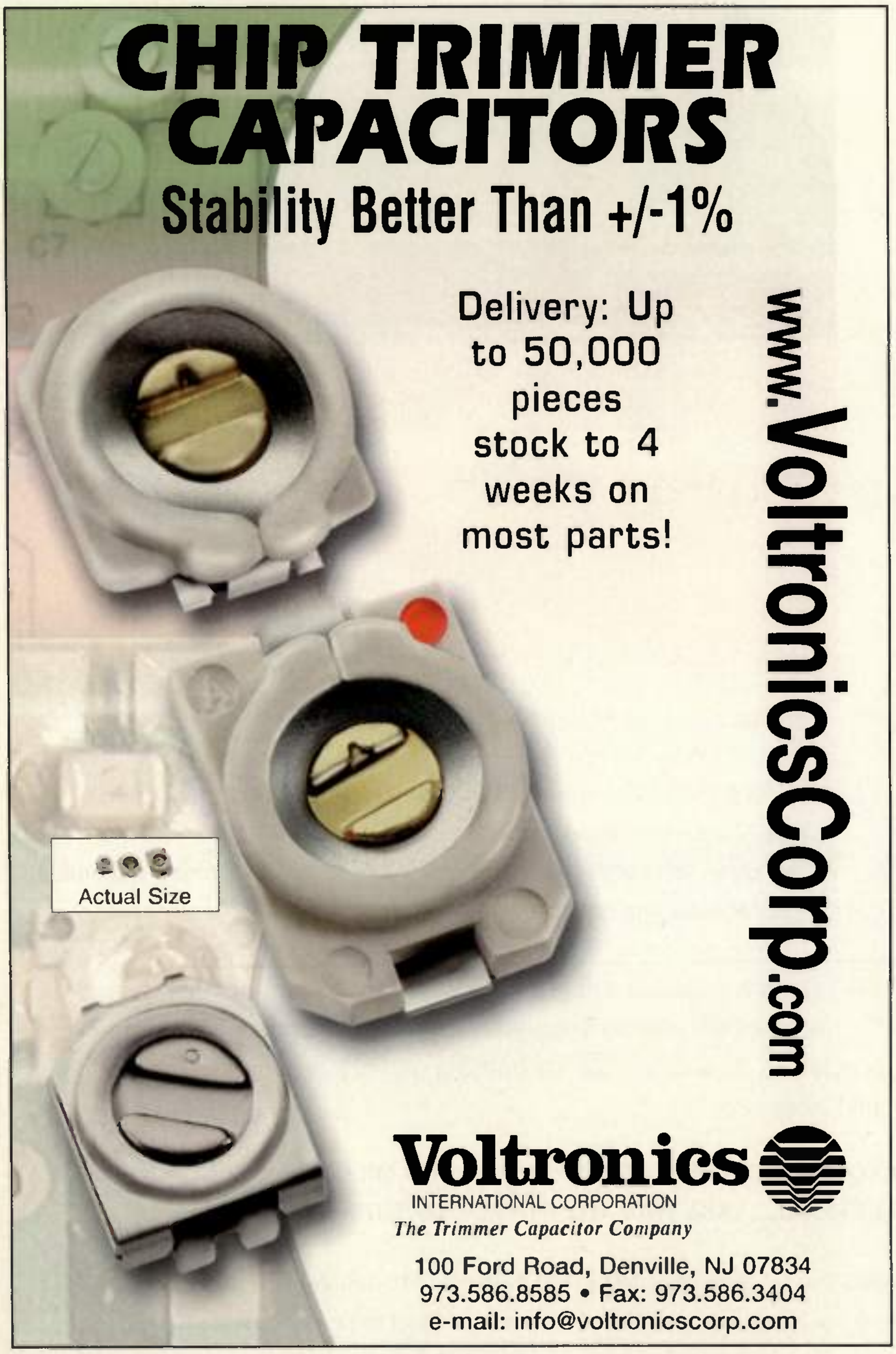
The results: time-savings

The parametric cost approach saved a considerable amount of time on this project. The database provided by the software is more comprehensive than the existing project library. The software automatically selects appropriate historical projects, eliminating the time previously spent searching through the library. The software also removed the need for the cost engineer to create and maintain a complicated spreadsheet. However, there is still a need to capture, analyze and organize cost history data to calibrate, and if necessary, validate the model. Finally, the program can automatically generate a range of reports, including all of those that were needed on this project. The team also used the parametric results to perform engineering and management reviews of the cost data The result was a substantial time-savings — about 1000 hours of cost engineering support were saved using SEER tools.

At the same time, engineers involved in the project believe that the quality of information provided by the parametric approach is superior to the conventional method. The capability of the program to quickly evaluate the cost of alternate approaches saved considerable time during the proposal process by providing information that guided engineers toward a cost-effective approach sooner than without the process. The ability of the parametric costing approach to allow consideration of cost from the earliest possible stage of the design process is the primary reason why the government is encouraging its use and, based on the experience of this project, it works. Because this was the first use of this parametric model approach, a comparison was made using the conventional estimating approach at the end of the project and the results matched closely (within 7%).

The parametric approach is clearly an effective alternative that should be considered on larger projects with a high magnitude of nonrecurring development and manufacturing expenses.

RF



About the authors

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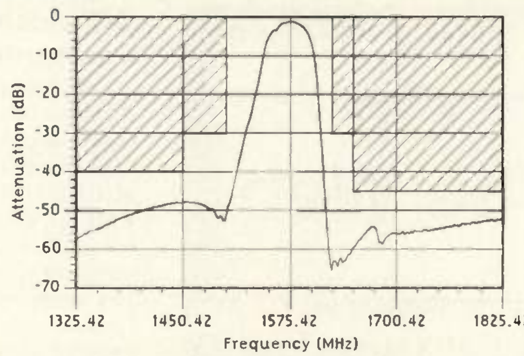
SAWTEK GIVES YOU DIRECTION

Sawtek...Your Total SAW Solution!

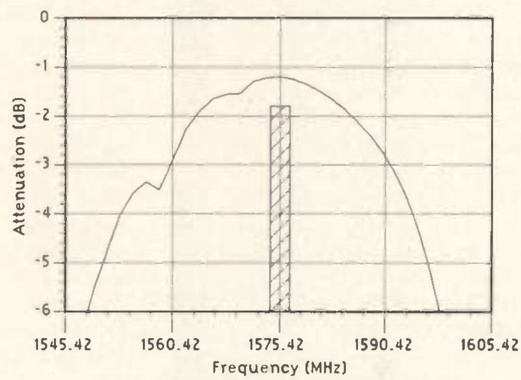
Location-based products using Global Positioning Satellite (GPS) signals will revolutionize wireless service by allowing carriers to locate subscribers during emergencies. Handset frequency spurs are a concern for designers because losing the locator signal could have dire consequences. Sawtek's new GPS RF SAW filters alleviate this concern with greater than 50 dB typical attenuation over the 1648–1920 MHz range. Sawtek also delivers superior insertion loss – 1.3 dB typical, all in a package 94% smaller than the ceramic alternative. Get the size, sensitivity and insertion loss advantage, only with GPS RF SAW filters from Sawtek.



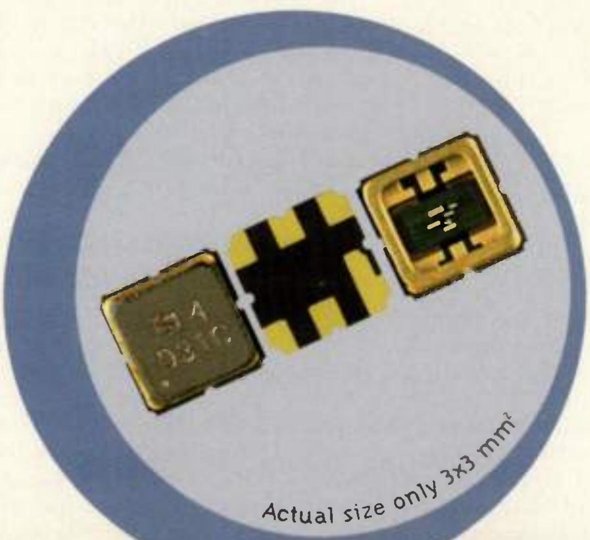
FREQUENCY RESPONSE

SAWTEK GPS RF SAW FILTER 855969

- Excellent attenuation: Up to 58 dB (typical)
- Superior insertion loss: 1.3 dB (typical)
- Small size: 3x3 mm^2 – 94% smaller than ceramic



PASSBAND RESPONSE



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INFO/CARD 68

On The Web

Site dedicated to algorithm suite

NCTI introduces a new Web site dedicated to the ClearSpeech technology developed by the NCT Algorithm Group. The new site provides fact sheets for each of the ClearSpeech algorithms, wave files that demonstrate the ability of the ClearSpeech algorithms to remove noise from speech communication signals, and access to the newly released Windows-based software program ClearSpeech-PC. The site also includes information about NCT's fixed-point platform, the ClearSpeech Module, which provides a digital processing core.

NCTI Algorithm Group
INFO/CARD 115

Manual, automatic applications on Web

Aries Electronics announces the expansion of its Web site's *RF Test Socket* segment. The expanded site now features a full listing of design footprints for both manual and automatic applications, enabling engineers to view all available footprints to determine requirement-matching. New data on the site includes Giga test reports on the Aries 1.27 20-pin SSOP Test Socket and the .5mm 64-pin QFP Test Socket, providing complete information on the sockets' performance.

Aries Electronics
INFO/CARD 116

DC blocking capacitor brochure

Dielectric Laboratories announces its new *Ultra Broadband DC Blocking Capacitor* brochure. Featured in this brochure are the Opti-Cap and Milli-Cap broadband solutions, as well as 0603- and 0805-size broadband DC blocks. The Opti-Cap takes advantage of Milli-Cap characteristics such as the 0502 footprint, high Q, low series inductance and combines it with high value capacitance for coverage from DC-to-light (12 KHz to 40+ GHz). While the DC blocking capabilities are the key feature, the overall size of .055" 2 with an 0502 footprint, combined with single-step assembly, makes this useful for fiber-optic applications such as OC-192 and OC-768. The Opti-Cap is designed for conductive epoxy attachment to the board. The Milli-Cap provides broadband width resonance-free performance with low loss and high series resonance. This product covers the bands applicable to digital radios, LMDS, SONET, filters, and test equipment. The technology uses single-layer capacitors in a surface-mount package that allows for coverage in frequencies of 20 MHz to 40+ GHz, depending on the product selected.

Dielectric Laboratories
INFO/CARD 117

Design guide features latest LED chip technology

Lumex's new *eLEDs* design book is a 140-page design guide for engineers in need of discrete light-emitting diode (LED) solutions. The book features LEDs that use the latest die technologies. The *eLEDs* design book describes four major categories of discrete LEDs including bare-leaded LEDs, printed circuit board indicators, panel indicators, and LED arrays. A range of products is described, from basic two-leaded LEDs to intricate chips-on-board devices with more than 100 LED chips. Also included in the catalog is a tutorial on LED technology, which explains how it works, commonly used terminology, how to select the right device, and how to operate these devices within their safe electrical limits. Full technical specifications, including part numbers, LED die compositions, emitted color, peak wavelength, lens color, brightness, typical and maximum forward voltage, and viewing angle, are given for every device

Lumex
INFO/CARD 118

Handbook covers digital video interfaces/ processing

Video Demystified, A Handbook for the Digital Engineer (3rd Edition), by Keith Jack, is a standard reference for digital video hardware engineers and programmers. The third edition has been completely updated and contains new chapters on analog and digital interfaces, H.261, and H.263, consumer DV, and DTV. The book also covers all international video standards in detail, MPEG 1 and MPEG 2, color spaces, video processing, and contains reference data in easy-to-use tables. The book includes a detailed glossary as well, which features practical, tutorial-style explanations of terms. The two accompanying CD ROMs have various test images to evaluate video performance, including still and image sequences of various resolutions. The CD ROMs also include a complete searchable *Deluxe eBook* version of the book, with hyperlinked references and bookmarks.

LLH Technology Publishing
INFO/CARD 119

Data book/short-form catalog covers ICs

TDK Semiconductor announces its new *2001 Data Book / Short Form Catalog* covering its recently introduced line of ICs for the communications and broadband Internet markets. The volume includes technical data sheets on products released during the past 18 months, including ICs for optical fiber network equipment, portable communications, embedded modem and digital set-top boxes. Products more than 18 months old are highlighted in product briefs. A complete listing of worldwide sales and distribution locations is included and a CD ROM version with additional product updates will be available later this year.

TDK Semiconductor
INFO/CARD 120

High Performance Electromagnetic and Network Simulation and Optimization Tools

From: Zeland Software, Inc., 39120 Argonaut Way, PMB 499, Fremont, CA 94538, U.S.A., Phone: 510-623-7162, Fax: 510-623-7135, E-mail: zeland@zeland.com, Web: http://www.zeland.com

Products:

IE3D Planar and 3D Electromagnetic Simulation and Optimization Package
FIDELITY Time-Domain FDTD Full 3D Electromagnetic Simulation Package
MDSPICE Mixed Frequency Domain and Time-Domain SPICE Simulator
COCAFIL Cavity coupled wavguide filter synthesis package

Applications:

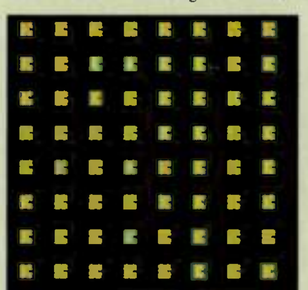
Microstrip, CPW, striplines, suspended-strip lines, coaxial Lines, rectangular waveguides, high speed digital transmission lines, 3D interconnects, decoupling capacitors in digitial circuits, PCB, MCM, HTS circuits and filters, EMC/EMI, wire antennas, microstrip antennas, conical and cylindrical helix antennas, inverted-F antennas, antennas on finite ground planes, and other RF antennas.

Important Announcements:

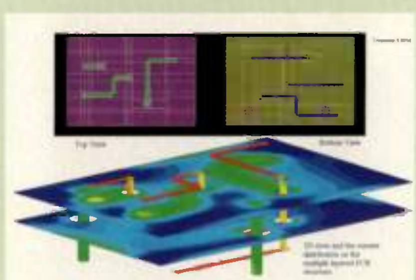
- The IE3D 8.0 is released. The most important features added into the IE3D 8.0 are: (1) Boxed Green's functions for structures in enclosures; (2). Periodic Green's functions for large antenna phase arrays; (3) Multiple robust advanced iterative matrix solvers (AIMS) for accurate and fast simulations of large structures using much less RAM. The IE3D has complete modeling and design capability for patch antennas, wire antennas, microwave and RF circuits, MMICs and RFICs, multile layered PCBs and BGA structures. The IE3D also has robust and efficient advanced symbolic electromagnetic optimization.
- The FIDELITY Release 3 has complete SAR analysis features for the wireless applications. It will offer multiple frequency independent head models.
- The MDSPICE 2.1 is released. The MDSPICE 2.1 features robust s-parameter based time domain simulation for non-linear circuits in both analog and digital circuit design. Its results normally meet the casuality condition with accurate time delay prediction. The MDSPICE also features wide band SPICE model extraction.
- The COCAFIL is released. The COCAFIL allows precise modeling and synthesis of waveguide filters.

IE3D and FIDELITY Simulation Examples and Display

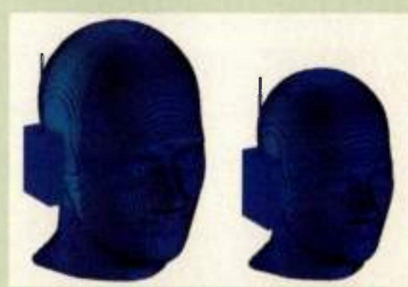
An 8 by 8 patch array modeled with all coupling included on the IE3D 8.0 using 100 MB RAM



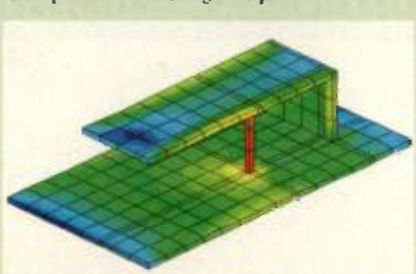
IE3D modeling of a multiple layer PCB structure with traces, vias, ground and power planes



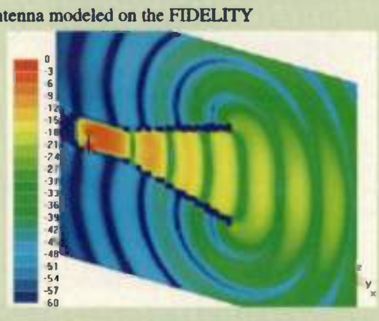
The human head models without frequency limitation on the FIDELITY for SAR research



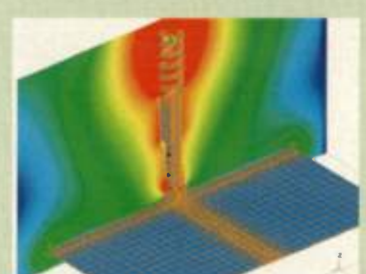
IE3D modeling of an inverted-F antenna with finite thick plate and finite size ground plane



The forward and backward radiation from a horn antenna modeled on the FIDELITY



FIDELITY modeling of a cylindrical helix antenna



Zeland Software, Inc. provides excellent technical support and services.
Zeland Software, Inc. is also the north American exclusive representative for the LINMIC product from Jansen Microwave GmbH

INFO/CARD 33

ASIC tool provides auto parasitic extraction

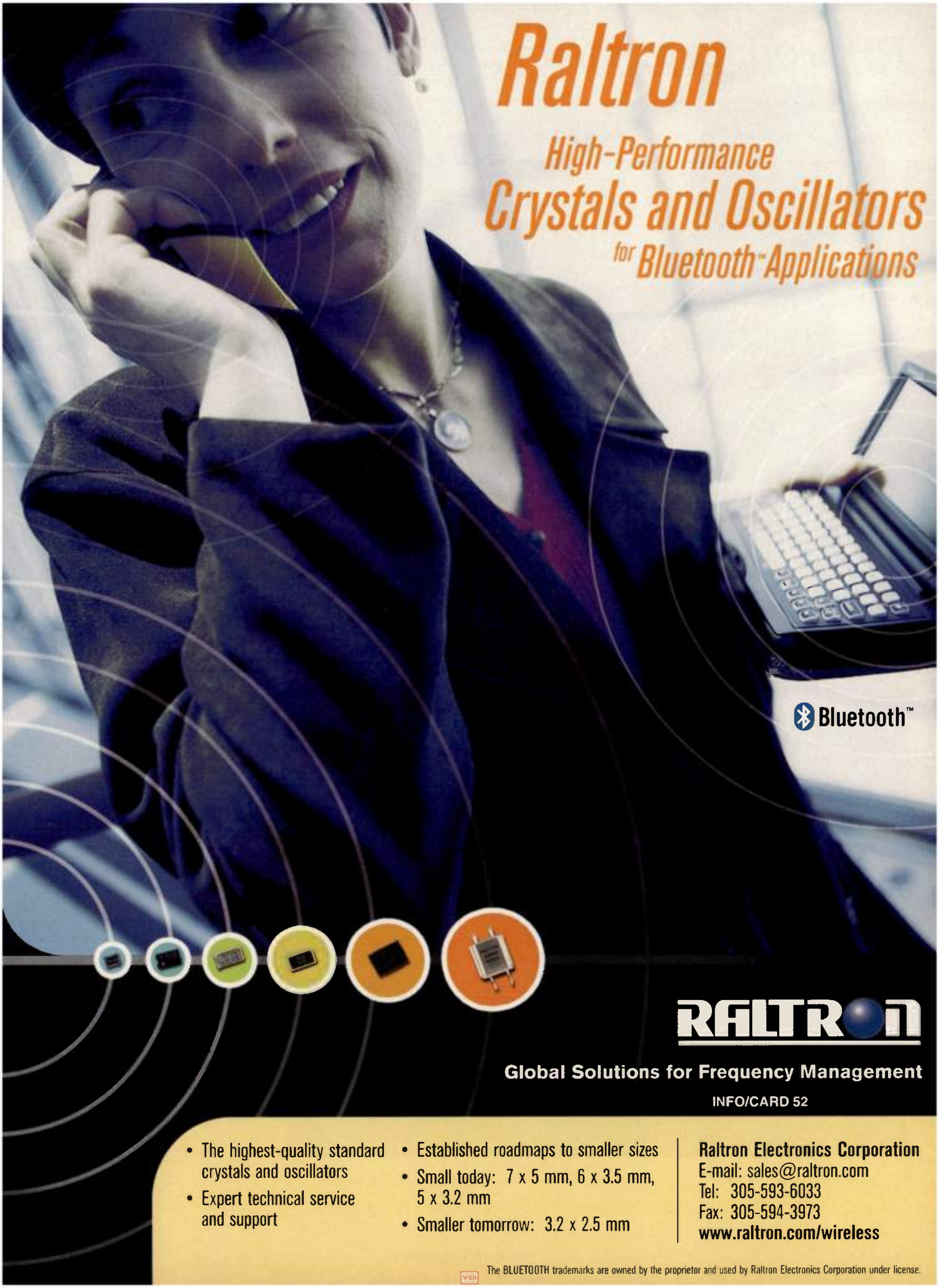
OEA International's NET-AN tool is used by full-custom IC designers to analyze clock skew, interconnect delays, and signal coupling (crosstalk) problems in high-performance microprocessors, communications devices, and other custom ICs. To fit within the ASIC design flow, NET-AN has a new push-button automated flow that starts with a list of nets and automatically produces delay and skew information. It extracts fully distributed RCLM parameters using a 3D field solver and generates results in minutes while running on standard engineering workstations. NET-AN includes all cell geometry within a "sphere of influence" distance from the selected net and extracts accurate and correctly distributed capacitance at every point of the net. In addition, NET-AN uses a full Spice simulation in the flow, including the full Spice subcircuits for drivers and loads.
OEA International
INFO/CARD 121

Modulation analysis for GSM/ EDGE signals

Anritsu announces modulation analysis software that expands the measurement capability of the company's MS8608A and MS8609A transmitter testers to include GSM and EDGE. With this software, the transmitter testers can conduct power, frequency, and modulation accuracy measurements on next-generation signals. Modulation analysis functions include carrier frequency, frequency stability, RMS phase error, and magnitude error. The software allows for the creation of constellation, eye, and trellis diagrams for detailed analysis, as well as for transmitter power measurement using an accurate thermal power meter. Additional measurements include output RF spectrum, measurement of rising/falling edge of antenna power, adjacent channel leakage power, and spurious emissions.
Anritsu
INFO/CARD 122

EMC test management pack offers flexibility

Schaffner announces a new EMC test management software package. Compliance 3 is a flexible, fully configurable Windows-based test management tool for creation, execution, data acquisition and reporting of EMC emissions and immunity tests. In addition to a comprehensive library of standard test programs and subroutines, Compliance 3 allows engineers to customize any aspect of the test program. Routines can be edited, created and combined in functional blocks using a graphical flow-chart approach and complex test programs can be constructed for efficient production. The software provides direct control of EMC test equipment and can be used as an interface to other equipment being used to monitor or control the EUT. Compliance 3 is a multi-lingual package and can be interface-customized.
Schaffner
INFO/CARD 123



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High-Performance
Crystals and Oscillators
for Bluetooth™ Applications
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RALTRON
Global Solutions for Frequency Management
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• The highest-quality standard crystals and oscillators
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• Smaller tomorrow: 3.2 x 2.5 mm
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PALADIN PM7815 AMPLIFIER

PMC-Sierra offers an enhanced version of its Paladin digital signal processor (DSP) controlled broadband power amplifier architecture for wireless infrastructure equipment. Designed to support previously unattainable 15 MHz applications, the PM7815 architecture eliminates transmitter distortions and improves spectral efficiency in wireless base transceiver stations (BTS) at lower power. Key features of the Paladin-15 chip design are the ability to enable 15 MHz multi-carrier WCDMA and cdma2000 applications without using costly, power-hungry, feed-forward radio frequency (RF) amplifiers. When bandwidths of more than 5 MHz are required, wireless service providers typically use multiple feed-forward amplifiers that consume large amounts of power, compromise reliability, and increase deployment and maintenance costs. The device eliminates these bottlenecks and accelerates the deployment of new generations of wireless equipment. A single 2G or 3G power amplifier employing this technology meets or exceeds bandwidth requirements for more than 90% of the world's licensed wireless spectrum. The device can be used in any second-generation (cdmaOne, GSM/EDGE) and third-generation (WCDMA, cdma2000, EDGE) power amplifier at any frequency. The chip operates at a high 93 MHz sampling rate and uses firmware that enables software reconfiguration of the BTS, while enhancing reliability and delivering power efficiency. PM7800 Paladin-10 DSP devices provide off-of-the-shelf chip solutions for digital wireless BTS power amplifier linearization. Deployed in a typical 10,000 BTS wireless network, the Paladin-15 architecture would save about 15 mW of power or about $20 million per year with power costing 15 cents per megawatt hour. The chip overcomes the need for expensive and time-consuming manual amplifier calibration by automatically adapting to, and compensating for, each amplifier's unique distortion pattern. This eliminates the need for tuning and alignment during manufacturing and in the field.

PMC- Sierra
INFO/CARD 124

Paladin–15 enhanced digital power amplifier.

Broad bandwidth frequency mixers

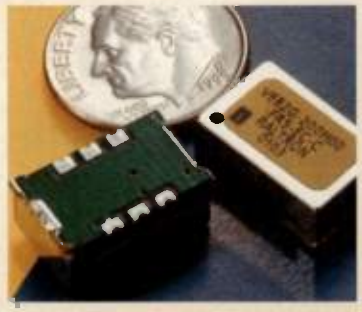
Mini-Circuits debutes a wide bandwidth series of mixers. The ADE-1 and ADE-11X offer 0.5 to 2 GHz bandwidths, low conversion loss, L–R isolation, and IP3s as high as +15 dBm typical. Constructed on a low-profile, surface-mount package with open cover, the design allows water wash to drain and offers solder-plated leads for fault-tolerant solderability and all welded connections.

ADE-11X – specifications:

Frequency (MHz) LO/RF	10 to 2000
Frequency (MHz) LO/IF	5 to 1000
LO Level (dBm)	7
IP3 (dBm)	9
Conv. Loss (dB)	7.1
L -R Isolation (dB)	36
L - I Isolation (dB)	37

Mini-Circuits
INFO/CARD 125

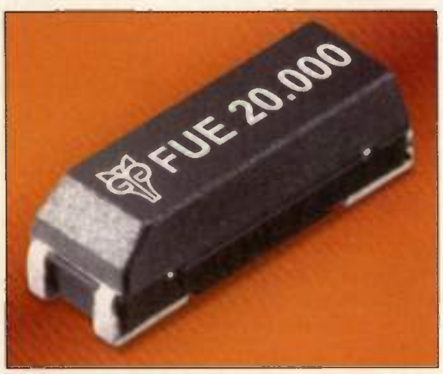
200 MHz inverted mesa crystal VCXO



Raltron announces a new 200 MHz VCXO that reduces system-accumulated jitter and noise. The VC-8000 VCXO uses an inverted-mesa quartz crystal to combine higher frequency, lower noise, increased stability, wider pullability range, and faster on/off times. The device functions as a signal-enhancing filter for asynchronous communication systems that imbed their own content data, clock, and error correction data. It offers characteristics such as high-Q filter with narrow bandwidth and does not allow noise, jitter, or other perturbations to get through. This results in a newly regenerated signal that is noise-free. The unit provides a voltage-controlled reference output frequency as high as 200 MHz, with less than 1 picosecond jitter, and an overall frequency stability of +30 ppm. Long-term stability is specified at +2 ppm per year and pullability is specified at ±100 ppm. The VC-8000 operates from either 3.3- or 5-volt rails.
Raltron
INFO/CARD 126

Crystal for wireless and portable apps.

Fox Electronics introduces a new crystal that provides a cost-effective alternative for portable, wireless and other applications with space and budget constraints. The FUE crystal measures 13.4 mm x 5.08 mm x 4.6 mm. It offers a frequency range of



3:579545 MHz to 66.6667 MHz, a frequency tolerance of ±50 ppm, a frequency stability of ±80 ppm or less, and an operating temperature range of –20° to +70° C. A surface-mount device (SMD), the crystal is manufactured completely encased in a plastic package. The crystal can be furnished in standard 1,000-piece tape-and-reel packaging for use with automatic assembly equipment.
Fox Electronics
INFO/CARD 127

Low-jitter, low-noise SAW oscillator

Micro Networks has developed a series of voltage-controlled SAW oscillators (VCSO's) targeting high-performance telecommunications applications. The M600 series of VCSOs features low

phase noise and jitter over a frequency range of 300 MHz to 900 MHz. These devices are well-suited for phase-locked loop applications, as well as clock and data recovery and clock smoothing circuits used in OC-12, OC-48 and OC-192 SONET/SDH systems. The M60Q series is available in a 28-pin surface-mount package and offers an output disable feature that forces the output into a static condition. This enables an external clock to control the output frequency. Operating from a single +5 VDC supply, the M600's differential outputs are 10/100K PECL logic-compatible.
Micro Networks
INFO/CARD 128

SDM programmable oscillators

Vectron International Technology Express introduces a series of SMD programmable clock oscillators for use in telecommunications and networking applications. The model VPC1 programmable crystal-controlled oscillators are housed in an industry-standard 5 x 7

MINIATURE

SURFACE MOUNT VCO's from $12.95 (qty. 5-49)

The big news is Mini-Circuits miniature family of ***50 to 2500MHz*** ROS voltage controlled oscillators! Each unit is housed in a shielded 0.5"x0.5"x0.18" non-hermetic industry standard package for highly efficient wash-thru capability, reliability, and cost effectiveness. Models with "PV" suffix typically operate from a 5 volt power supply and require 5V tuning voltage to cover the frequency range. This makes them ideal for integration with monolithic PLL chips and commercial synthesizers in the 180 to 1605MHz band. The series also features broad band 12V models optimized for 50 to 2500MHz linear tuning, up to one octave band widths, and low phase noise.

Support your customers demands for smaller size and better performance, switch to ROS VCO's today!

ACTUAL SIZE

Mini-Circuits...we're redefining what VALUE is all about!

Model	Freq. Range (MHz)	V_{tune} (V) Max.	Phase Noise• Typ.	Harmonics•• (dBc) Typ.	Voltage V	Current (mA) Max.	Price $ea. (5-49)
ROS-205PV	180-210	5	-110	-30	5	15	17.95
ROS-285PV	245-285	5	-100	-20	5	20	17.95
ROS-660PV	640-660	5	-107	-17	5	15	19.95
ROS-725PV	710-725	5	-105	-19	5	15	19.95
ROS-900PV	810-900	5	-102	-25	4.5	12	19.95
ROS-960PV	890-960	5	-102	-27	5	12	19.95
ROS-1000PV	900-1000	5	-104	-33	5	22	19.95
ROS-1435PV	1375-1435	5	-101	-26	5	20	19.95
ROS-1600PV	1520-1600	5	-100	-26	5	25	18.95
ROS-1605PV	1500-1605	5	-98	-17	3.3	16	19.95
ROS-100	50-100	17	-105	-30	12	20	12.95
ROS-150	75-150	18	-103	-23	12	20	12.95
ROS-200	100-200	17	-105	-30	12	20	12.95
ROS-300	150-280	16	-102	-28	12	20	14.95
ROS-400	200-380	16	-100	-24	12	20	14.95
ROS-535	300-525	17	-98	-20	12	20	14.95
ROS-765	485-765	16	-95	-27	12	22	15.95
ROS-1000V	900-1000	12	-102	-30	5	25	15.95
ROS-1100V	1000-1100	12	-103	-26	5	25	15.95
ROS-1121V	1060-1121	11	-111	-11	5	30	15.95
ROS-1410	850-1410	11	-99	-8	12	25	19.95
ROS-1720	1550-1720	12	-101	-17	12	25	19.95
ROS-2500	1600-2500	14	-90	-14	12	25	21.95
ROS-1200W	612-1200	18	-97	-28	12	40	24.95
ROS-1700W	770-1700	24	-100	-25	12	40	24.95
ROS-2150VW	970-2150	25	-96	-15	5	25	29.95
ROS-2160W	1160-2160	20	-97	-11	10	30	24.95

•Phase Noise: SSB at 10kHz offset, dBc/Hz. ••Specified to fourth.

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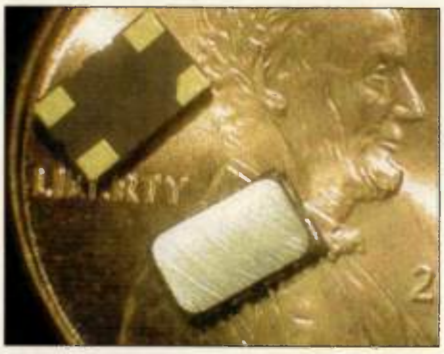
F 295 Rev C

mm ceramic surface-mount package and have a frequency range to 160 MHz. The oscillators are programmed to a specified frequency prior to shipment using an EPROM. The units are HCMOS- or TTL-compatible and available with either a supply voltage of 5.0 VDC ±10% or 3.3 VDC ±10%. Operating temperatures are 0° to +70° or –40° to +85° C. Options include ±25, ±50 or ±100 ppm frequency stabilities and a tri-state or power-down function. Jitter performance as low as 7 PS rms is available. In addition to the 5 x 7 ceramic SMD version, the oscillators are also offered in a 14-pin (VPAINPA2) or 8-pin (VPB1NPB2) hermetically sealed metal package and a plastic SMD package (VPE1).
Vectron International
INFO/CARD 129

TCVCXO now with reduced footprint

ILSI America has reduced the ceramic package size of its surface-



mount TCVCXO 1707 series oscillators to 5 X 3.2 mm, which is about half the size of the current industry-standard package of 5 X 7 mm. The oscillator covers a frequency range of 12.6 to 19.8 MHz with a stability of ±2.5 ppm over an operating temperature range of –20° C to +75° C. Pullability is 5–15 ppm with a control voltage of 1.5 VDC ±1 VDC. Supply voltage is 3.3 VDC, with a maximum current of 2.0 mA @ 3.OVDC.
ILSI America
INFO/CARD 130

Low phase noise frequency synthesizers

EM Research announces the HFS-series low phase noise frequency synthesizers for up/down converter mixer local oscillator applications. Developed for use in ISM, GSM, WLL, and MMDS/LMDS system transceivers, these products are available as fixed-frequency or externally programmable, covering the frequency range (in bands) from 40 MHz to more than 8 GHz. Product features include fast switching speeds in step sizes of 50 KHz to 2.5 MHz, typical phase noise characteristics of – 95 dBc/Hz at 10 KHz

Your Choice!

Consider Synergy's full range of
LOW COST, very HIGH PERFORMANCE
VOLTAGE CONTROLLED OSCILLATORS.

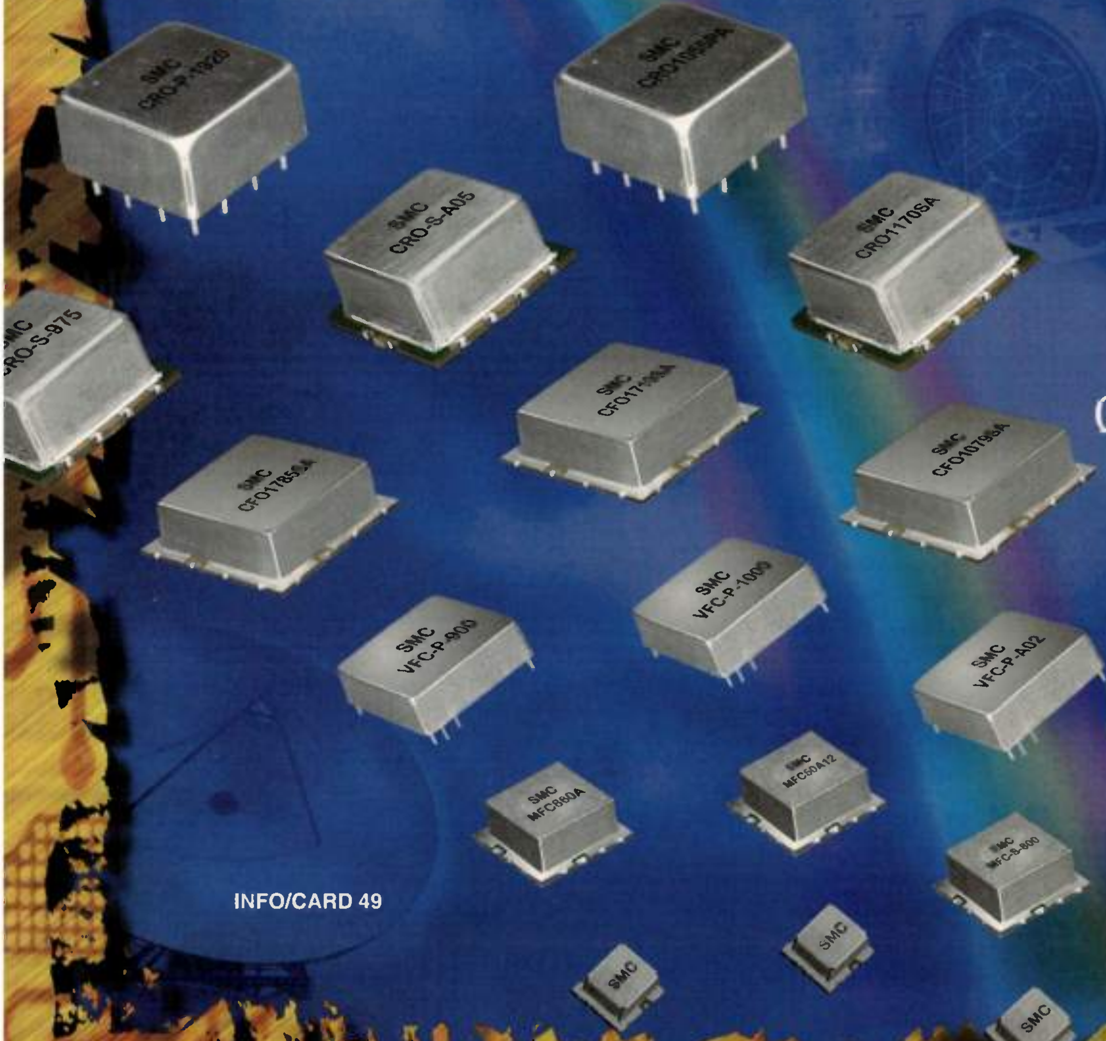
CRO, CFO and MFO series - Ceramic resonator based with extemely low phase noise and high stability. Frequency range (350 MHz to 2100 MHz).
MFC, VCO and VFC series - Microstrip resonator based offering superb phase noise performance and bandwidth from optimized to over an octave frequency generation. Frequency range (40 MHz to 6100 MHz).
TFC series - Microstrip resonator based and miniature style package for optimized bandwidth with frequencies ranging from 100 MHz to 3000 MHz.
Series 5 - Dual isolated output with excellent phase noise and good stability. Available from 50 MHz to 1000 MHz in optimized bandwidths.

All models are available in various surface mount and through hole packages ideally suited for automated manufacturing techniques.

VOLTAGE

CONTROLLED

OSCILLATOR

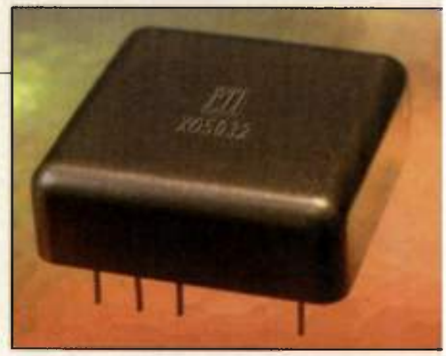


INFO/CARD 49

For additional information, contact Synergy's sales and application team.
201 McLean Boulevard, Paterson, NJ 07504
Tel: (973) 881-8800 ❖ Fax: (973) 881-8361
E-mail: sales@synergymwave.com
World Wide Web: www.synergymwave.com

SYNERGY®
MICROWAVE CORPORATION

offset and –120 dBc/Hz at 100 KHz offset. The miniaturized surface-mount package size is 1.25" x 1.0" x 0.25". The devices operate over the temperature range of –30° C to +70° C.
EM Research
INFO/CARD 131



Low-noise VCO for microwave radios

Z-Communications introduces the CLV1540E for the microwave radio market. This device uses unequalled SSB phase-noise performance with superior harmonic suppression. The unit generates frequencies between 1.52 and 1.565 GHz within 0.5 to 4.5 VDC of control voltage, while using an average tuning sensitivity of 23 MHz/V. This device exhibits a clean spectral signal of –110 dBc/Hz, typically, at 10 kHz from the carrier while attenuating the second harmonic to better than –20 dBc. It features 1.1:1 linearity over frequency and temperature and its design allows for quick implementation into PLLs where the error voltage can be taken directly from the IC's charge pump circuitry. This oscillator operates off a 5 VDC source and draws only 24 mA, typically. It is specified to operate over the extended commercial temperature range of –40° C to +85° C. It pushes less than 2 MH/V within a 5% change of the supply voltage and pulls less than 2 MHz with a 14 dB return loss, any phase.
Z-Communications
INFO/CARD 132

Surface-mount wireless applications oscillator

PTI introduces a new surface-mount TCXO/VCXO product for wireless applications. The model X03080 is available for frequencies between 10 and 125 MHz offering ±75 ppm over the temperature range of –30° C to +70° C. This unit features a 5 V supply, phase-noise performance, and aging performance housed in a .98 x .69 x .22" true SMT reflow package. PTI also now offers additional options to model XO5032. A range of options (frequency, power supply voltage, temperature range, stability) is available for specific requirements. This ovenized oscillator is suitable for applications that require precision timing, stability and small size. New features include an output of 7 dBm ±3 dBm into 50Ω, operation from –20 to +60° C.
PTI
INFO/CARD 133

Tough Environment. Top Performance.

Stanford Microdevices has expanded its industry-leading silicon-germanium (SiGe) amplifier line with two new power devices ideally suited for driver-amplifier functions in wireless equipment operating in the most demanding signal environments.

SOT-89 Package

Offering the wireless system designer typical GaAs linearity at silicon prices, these cost-effective heterojunction bipolar transistor (HBT) units produce high output IP3 performance across the DC-3000 MHz frequency band. SGA power devices are excellent choices for wireless infrastructure driver amplifiers, CATV amplifiers, as well as wireless-data and wireless-local-loop amplifiers. Stanford Microdevices delivers the power you need for your toughest operating environment.

For more information, visit us at stanfordmicro.com.

Part Number	Frequency Range (MHz)	Device Voltage (V)	Id (mA)	P1dB (dBm)	IP3 (dBm)	Gain @ 1 GHz (dB)	Gain @ 2 GHz (dB))	NF @ 1 GHz (dB)
SGA-9189	DC-3000	5	180	26	39	18	12	2.5
		3	165	22.5	35	18	12	2.2
SGA-9289	DC-3000	5	270	28	41	18	11	2.9
		3	315	26	39	17	11	2.6

*Data at 2 GHz unless otherwise noted

STANFORD MICRODEVICES

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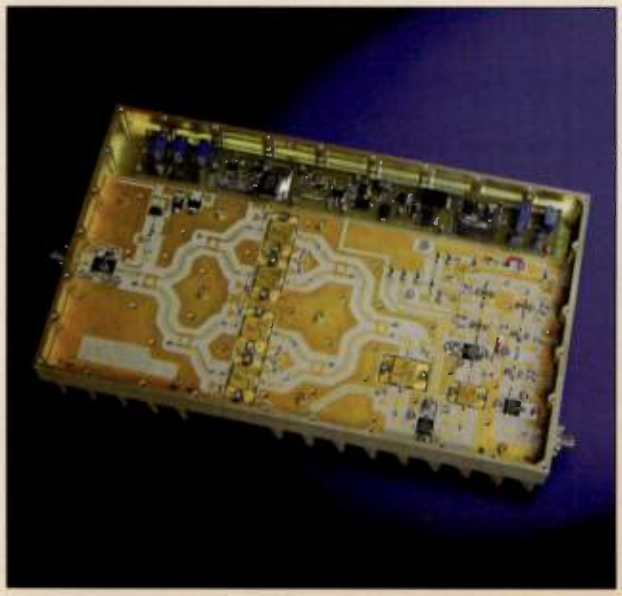
INFO/CARD 25

Extended-band GSM single-channel amplifier

Aethercomm introduces the SSPA 0.925-0.960-100, a high-power, extended-band GSM single-channel amplifier. This model covers the 925 to 960 MHz GSM band and features a 1 dB compression point of 51 dBm with 34 dB of gain. Input and output VSWR are <1.5:1 and the operational voltage is 28 VDC. It offers a minimum of 32% efficiency over the operating temperature range of –10° C to 60° C. The gain variation over temperature is <±0.5 dB with temperature compensation. Gain variation over frequency is typically ±0.2 dB and reverse IMD is 90 dBc. Transmit noise figure is typically 10 dB and harmonics are typically <40 dBc. The SSPA can operate from –40° C to +85° C. Standard features include temperature compensation, 30 dB dynamic range forward power sensor, reverse power monitor, temperature monitoring, and output open/short circuit protection. This unit may be packaged in any enclosure that can be installed in a 19-inch rack mounted system. Typical sizing is 5" H x 13" L x 2" W. The SSPA can be resized with no loss in performance.

- Single-channel GSM SSPA
- P1dB = 51 dBm
- 35 dB gain ± 1.0 dB
- ± 0.2 dB gain variation



Aethercomm
INFO/CARD 134

AMPLIFIERS

GaAs power amp enhances transmission rates

The CMM3566-LC W-CDMA power amplifier is designed for wireless data transmission at 3.5 GHz. The part is manufactured in a miniature, 4 mm square, leadless chip carrier package. It is intended for use in subscriber units and base stations that operate in the 3.45 GHz to 3.5 GHz frequency range. Typical features include operation at 7 VDC, 30 dB gain at operating output, and +24 dBm linear output power. The amplifier is packaged in a low-cost and space-efficient LCC-8 plastic package measuring 4 mm x 4 mm x 1.8 mm.
Celeritek
INFO/CARD 135

PASSIVE COMPONENTS

Low-value multilayer chip inductors

Venkel introduces a line of low-value multilayer chip inductors dubbed the LMCI series. These multilayer chip inductors offer low inductance and an operating temperature range of –40° C to +85° C. Additionally, the devices feature monolithic structure for enhanced reliability and excellent solderability for either flow or reflow soldering. Well-suited for high-frequency applications, they are available in size 0603 with inductance from 1.2 nH to 100 nH and in size 0805 with inductance ranging from 1.5 nH to 470 nH. Venkel also introduces the MRFI wire-wound type RF chip inductors, which are compact and provide Q values at high frequencies. These MRFI inductors provide higher SRFs, giving them a stable performance. All styles are offered in standard EIA sizes.
Venkel
INFO/CARD 136

Film-foil capacitors offer low dissipation factor

Seacor introduces KP-44 polypropylene film-foil capacitors that feature high insulation resistance and high pulse handling capabilities along with low dissipation factors and capacity as low as 47 pF. These devices replace polystyrene and polycarbonate units and offer capacitance values ranging from 47 pF to 0.22 µF. Operating voltages are from 160 to 1,000 VDC. The dv/dt is 1,000 V/ms. and tolerances are as low as ±1%.
Seacor
INFO/CARD 137

Power inductors provide 30 inductance values

The series SPD73 and SPD74 shielded surface-mount power inductors offer 30 inductance values ranging from 1.2 mH to 1,000 mH. Resistance values are as low as 20 mΩ, and current ratings are up to 8 A. Both series are constructed using a ferrite bobbin core and matching ferrite sleeve. The SPD73 is 7.3 mm X 3.9 mm, and the SPD74 is 7.3 mm X 4.7 mm. Inductors are supplied on tape and reel.
API Delevan
INFO CARD 138

SEMICONDUCTORS

Bluetooth and 2.4 GHz WLAN transceiver

Hittite Microwave introduces the HMC310MS8G, a multifunctional RFIC that incorporates a power amplifier (PA) and a low-noise amplifier (LNA) with a transmit/receive switch

NEW PRODUCTS

NO. 81

RF/IF MICROWAVE COMPONENTS

$44.95ea. Qty.1-49

0dB SMA ATTENUATORS ARE OW COST DC TO 18GHz SOLUTION

1ini-Circuits BW-S10W5 precision fixed ttenuators provide 10dB nominal ttenuation with ±0.60dB accuracy (add .5dB typ above 12.4GHz) in the broad)C to 18GHz frequency band. Built ough to handle 5W average with 125W naximum peak power, these small .20" units exhibit excellent VSWR with igh temperature stability and high epeatability. Equipped with stainless teel SMA-Male/Female connectors and vailable off-the-shelf.

$1.19ea. Qty.1000

3dB "DO-IT-YOURSELF" OUPLER DELIVERS COST SAVINGS

esigned to lower costs through automated anufacturing, the TCD-18-4 from ini-Circuits needs only a commercially ailable 50 ohm external chip resistor, d a complete 5 to 1000MHz directional oupler is realized. Electrically, this patented) ohm coupler provides 17.9dB±0.5dB minal coupling with ±0.6dB (max.) flatness. idband, typical mainline loss is 0.7dB and rectivity is 20dB (typ). The 50/75 ohm lo-it-yourself" TCD family contains 9 units th 9 to 20dB coupling for 5 to 1000MHz.

FEATURED PRODUCT

BLUE CELL TECHNOLOGY

$5.95ea. Qty.10

1700 TO 2100MHz 2WAY SPLITTERS DELIVER LOW HEIGHT AND LOW COST

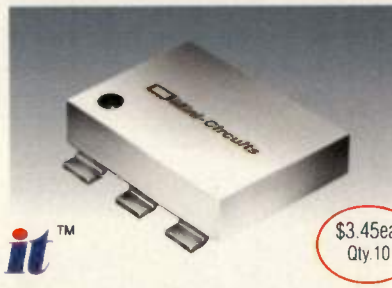
Leading characteristics of Mini-Circuits 2way-0° SBB-2-21W Blue Cell™ power splitters include superb temperature stability within the 1700 to 2100MHz band, low 0.070" height, high repeatability, and low cost. Electrically, these 50 ohm units display excellent 0.6dB insertion loss and 22dB isolation typical. The item is part of Mini-Circuits patented family of 10W (max. power input) "SBB" model 2way power splitters for the 800 to 2300MHz band.

1400 TO 2400MHz MIXERS HAVE LOW PROFILE AND HIGH IP3

Mini-Circuits MBA-15MH Blue Cell™ mixers are a low 0.070" profile solution for today's compact 1400 to 2400MHz wireless products. This patented mixer offers high 18dBm IP3 (typ, center band) to help suppress intermodulation products, plus low 5.5dB typical midband conversion loss with superb temperature stability and low cost. High repeatability is achieved through state-of-the-art automated manufacturing.

BLUE CELL TECHNOLOGY

$7.95ea. Qty.10

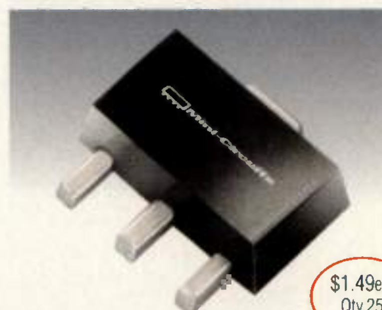


it™

$3.45ea. Qty.10

0.5 TO 1700MHz TRANSFORMERS PROVIDE 1.5:1 IMPEDANCE

Mini-Circuits patented ADT1.5-17 surface mount RF transformers are ideal for 50 to 75 ohm impedance matching and provide 1.5:1 impedance ratio in the broad 0.5MHz to 1700MHz band. Referenced to midband loss of 0.3dB typical, insertion loss is 1dB in the 2 to 1100MHz frequency band, 2dB from 1 to 1500MHz, and 3dB band wide. The low profile package stands only 0.112" high, and operating temperature range is -20°C to +85°C (max.). Available off-the-shelf.



$1.49ea. Qty.25

DC TO 4GHz MMIC AMPLIFIER HAS HIGH RELIABILTY

Mini-Circuits has unveiled the GAL-51, a newly developed surface mount MMIC amplifier for the DC to 4GHz band. When operated at 1GHz/25°C, the unit delivers high 17.5dB gain (±1.0dB flat DC-2GHz, typ), maximum output power of 18dBm typical (at 1dB comp.), and high 35dBm (typ) IP3. These 50 ohm amplifiers are housed in an SOT-89 package with exposed metal bottom for excellent heat dissipation, and displays low 78°C/W (typ, θjc) thermal resistance. Value priced.

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for 2.4 GHz applications including Bluetooth, HomeRF, and low-power WLAN radios. The RFIC meets the Bluetooth Class 2 and 3 requirements when used in conjunction with 2.4 GHz ASICs. This low-current transceiver requires no external circuitry to operate the amplifier power down features.
Hittite Microwave
INFO/CARD 139

LDMOS RF power transistor for telecom basestations

UltraRF introduces a diffused meta oxide silicon (LDMOS) RF power tran sistor. The UPF21090 is specificall designed for basestations in universa mobile telecommunications system (UMTS) operating at 2.1 to 2.2 GHz The device can be used as a high-powe wideband code division multiple acces RF power amplifier operating in Clas A or AB. The device operates at 2 VDC with a broadband RF outpu power rating of 90 W. Fabricated usin UltraGold II LDMOS technology, th discrete transistor features industry standard packaging and an all-gol metal system for high reliability. Th device has compatible source and loa impedance and can be dropped int existing power amplifier designs wit little or no circuit-matching changes.
Ultra RF
INFO/CARD 140

RFIC for wireless basestation markets

The AD8302 is Analog Devices' lates addition to its range of wireless RF/I ICs for the cellular basestation marke It enables design engineers to buil into their products a simple diagnosti and calibration circuit to monitor sys tem performance and diagnose signa purity. The RFIC provides system-leve performance in a single monolithic I by simultaneously performing indepen dent gain and phase measurement between two RF or IF input signals The device measures the precise ampl tude difference between the two inpu signals over 60 dB dynamic range scaled to provide the user with 30mV/dB output. The phase measure ment range extends to 180 degrees an provides the user with a 10mV/degre output scaling. The device integrate two wideband logarithmic amplifiers, wideband linear multiplier / phas detector, precision 1.8 VDC referenc source and analog scaling and interfac circuitry, running off a singl 2.7 – 5 .5 VDC supply.
Analog Devices
INFO/CARD 141

IC eliminates need for filters

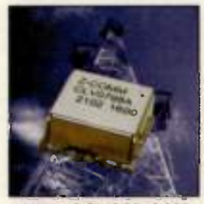
The new RF2483 multiband, direc quadrature modulator IC features low noise floor and includes gain co

The world leader in VCO and PLL technology.

Patented high-performance, low-noise CLV VCOs.

Our patented, ultra-low noise circuitry in our CLV VCO product line runs about 15dB quieter than anything the competition can offer. Finally, you have the margin you need for today's advanced radios!

Part Number	Maximum Start Freq (MHz)	Minimum Stop Freq (MHz)	Tuning Voltage (Vdc)	Tuning Sensitivity (MHz/V)	Phase Noise @10 kHz (dBc/Hz)	Harmonic Suppression (dBc)	Supply Voltage (Vdc, nom.)	Supply Current (mA, typ.)
CLV0815E	806	824	0.5-4.5	11	-113	-35	5.0	11
CLV0950E	865	1035	1-10	27	-114	-11	5.0	24
CLV0915A	902	928	0-4	17	-108	-30	3.0	10
CLV1085E	1050	1086	0.5-4.5	21	-112	-20	5.0	20
CLV1385E	1370	1400	0.5-4.5	18	-110	-20	5.0	20
CLV1550E	1500	1600	0.5-5.0	44	-106	-35	5.0	22
CLV2465E	2436	2496	1-4	26	-107	-20	5.0	25

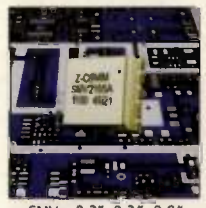


MINI - 0.5"×0.5"×0.22"

VCOs for every application.

Unmatched performance for your next PCMCIA-compatible design!

Part Number	Maximum Start Freq (MHz)	Minimum Stop Freq (MHz)	Tuning Voltage (Vdc)	Tuning Sensitivity (MHz/V)	Phase Noise @10 kHz (dBc/Hz)	Harmonic Suppression (dBc)	Supply Voltage (Vdc, nom.)	Supply Current (mA, typ.)
SMV0162A	125	200	0.7-8.3	12	-100	-6	5.0	36
SMV1570L	1540	1600	0.5-2.5	128	-90	-15	2.7	9
SMV2165A	2118	2218	0-3	148	-91	-10	3.3	16
SMV2390L	2290	2485	0-4	116	-90	-11	5.0	16
SMV2660L	2620	2700	0.5-4.5	90	-91	-17	5.0	21



SMV - 0.3"×0.3"×0.8"

Another first – the world's smallest VCO!

Utilizing the latest in thin-film and 0201/0107 component technology. We have your compact VCO solution for your next hand-held design!

Part Number	Maximum Start Freq (MHz)	Minimum Stop Freq (MHz)	Tuning Voltage (Vdc)	Power Output (dBm)	Phase Noise @10 kHz (dBc/Hz)	Harmonic Suppression (dBc)	Supply Voltage (Vdc, nom.)	Supply Current (mA, typ.)
USSP2330	2300	2360	0.5-2.5	0±3	-83	-15	2.7	8

USSP - 0.2"×0.2"×0.06"

Higher integration PLL solutions.

Unmatched performance combining CSP packaging technology with our patented ultra-low noise CLV technology. Complete evaluation kit available.

Part Number	Start Freq. (MHz)	Stop Freq (MHz)	Step Size (kHz)	Int. Phase Noise (°RMS)	Phase Noise at 10kHz (dBc/Hz)	Output Power (dBm)	Supply Voltage (Vdc)	Supply Current (mA)
PLL0210A	200	230	100	0.50	-105	3.5±2.5	+5	25
PLL0930A	900	960	100	0.75	-101	3±2	+5	40
PLL1260A	1230	1290	1000	0.75	-102	1±2	+5	40
PLL1456A	1420	1490	1000	0.75	-103	1±2	+5	40
PLL2710A	2670	2740	1000	1.25	-98	1±4	+5	30

PLL - 0.63"×0.866"×0.14"

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INFO/CARD 105

trol. The IC exhibits carrier and sideband suppression, typically greater than 40 dBc at maximum gain, while maintaining 50 MHz input bandwidth and output IP3 of +19 dBm. The device has a 35 dB gain control function, which helps the system's designer manage gain, noise and distortion budgets in the transmit path. Other features include a 2.7 V power supply and 700 to 1,000/1,700 to 2,200 MHz output frequency range.
RF Micro Devices
INFO/CARD 142

SIGNAL SOURCES

PCS, LMDS/ MMDS PLLs

Peregrine Semiconductor introduces two new products targeted at cellular and PCS basestations, LMDS and MMDS broadband wireless access systems, wireless local loop systems, and terrestrial satellite systems. The

PE3339 an PE3340 ar low-noise Integer-N PLLs capable of frequency synthesis up t 3.0 GHz. A external prescaler i not required to operate these phas locked loop (PLL) ICs for many applications where the desired local oscillato (LO) is between 2.2 and 3.0 GHz.
Peregrine Semiconductor
INFO/CARD 143

High-performance SAW oscillaotrs

Micro Networks introduces a serie of voltage-controlled SAW oscillator (VCSOs) directed at telecommunications applications. The M600 series c VCSOs features low phase noise an jitter over a frequency range of 30 MHz to 900 MHz. These devices ar

TOGETHER, TAKING OEM PERFORMANCE TO A HIGHER LEVEL.

A NEW BRAND OF RF AMPLIFIER FOR OEM.

Combining the top talent in engineering from AR and Kalmus, AR/Kalmus brings a new level of technology and field-proven integrity to the OEM marketplace, meeting the most demanding customer needs in military, communications and Industrial/Scientific/Medical applications.

No other brand offers this product range or depth, this much experience or guaranteed performance. AR/Kalmus amplifiers are all backed by best-in-the-business warranties and a worldwide support and service network.

AR/Kalmus: Booth 1212.
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World Class Mark of Performance

INFO/CARD 48

ar® KALMUS

well-suited for phase-locked loop app cations, as well as for clock and da recovery and clock smoothing circui used in OC-12, OC-48 and OC-19 SONET/SDH systems. The devices a available in a 28-pin surface-mou package and offer an output disab feature that forces the output into static condition, enabling an extern clock to control the output frequenc Operating from a single +5 VDC su ply, its differential outputs a 10K/100K PECL logic-compatible.
Micro Networks
INFO/CARD 144

Oscillators offer 1 to 133 MHz frequencies

The new CFPP one-time factory pr grammable oscillators are housed in a industry-standard 7 x 5 mm ceram surface-mount package. They provide readily available alternative to fixe frequency components for a wide ran of production applications, includi telecommunications transmission sy tems and process equipment. Th CFPP-72 series oscillators operate fro a 5 VDC supply and cover the 1 to 13 MHz frequency range. The low-pow CFPP-73 series takes a 3.3 VDC supp and offers frequencies up to 100 MH Both variants can be specified for ope ating temperature ranges from 0 +70° C or from –40° to +85°C, with fr quency stabilities down to ±50 ppm
C-MAC MicroTechnology
INFO/CARD 145

DIGITAL HARDWARE

VME board for embedded DSP apps

The model 4294 Quad Power P board features four MPC7400s ar offers high-speed interfaces includi velocity interface mezzanine, periphe al component interconnect, RACEwa VME64 and Ethernet. The board designed for OEMs and systems inte grators requiring supercomputing pe formance for wireless local loop base tations, beam-forming basestations ar other signal analysis tasks. The 6 VME board is based on the 450 MH Motorola Power PC MPC7400 micr processor with AltiVec technology.
Pentek
INFO/CARD 146


0.5
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5.0
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Just add
ntelligence, discipline
and initiative.

Triple 10-bit A/D converter

The SPT7853 is a triple 10-bit CMOS analog-to-digital converter (ADC). The converter provides designers with three ADCs in one 52-lead TQFP package. The ADC achieves low-noise performance at sample rates up to 30 MSPS. At video input frequencies (3.58 MHz), the dynamic performance of each ADC is 54.5 dB signal-to-noise and distortion for a typical 8.7 effective number of bits. Channel-to-channel cross talk is at least –66 dB, which results in no discernable channel-to-channel noise injection.

Signal Processing Technologies
INFO/CARD 147

DATA TRANSMISSION PRODUCTS

Wideband, programmable downconverter

Intersil introduces its latest addition to the ColnmLink~ family of software-defined radio (SDR) circuits. The 1SL5416, a quad-programmable downconverter (quad-PDC), specifically targets 3G

wireless protocols. Its filter configuration allows the integr tion of four discrete wideband channels in a single circu and it includes all the necessary post processing functions complete the entire channelization process.

Intersil
INFO/CARD 148

High-speed wireless Ethernet bridges

Wi-LAN has launched the AWE 120-58, 12-Mb advanced wireless Ethernet bridge for use in the 5.8 GH unlicensed frequency band. The AWE 120-58 and AWE 120-24 (formerly Hopper Plus 120-24) advanced wireless Ethernet bridges are suitable for broadband wireless access service providers looking to offer high-speed Internet access. Both products support point-to-multipoint, point-to-point, and backhaul applications ar are based on patented multi-code direct sequence sprea spectrum (MC-DSSS) technology.

Wi-LAN
INFO/CARD 149

TRANSMISSION COMPONENTS

Capacity-enhancing smart antennas

Metawave announces the commercial availability SpotLight 2200. The dual-band feature of the antenn allows operators to use a single antenna array to carry bot 800 MHz CDMA and 1900 MHz PCS services. The dua band antenna option reduces antenna loading and zonir delays. Metawave is also developing a smart antenna inte face to PCS base stations. The PCS version will work wit an operator's PCS base station to boost network capacit and improve network performance metrics. The PCS sma antenna systemsupports the IS-95, 1XRTT and 1XE CDMA air interfaces.

Metawave
INFO/CARD 150

GPS SAW filter for location-based products

Sawtek's new GPS RF SAW filters offer location-base product providers with SAW filters that provide greater tha 50 dB typical attenuation over the 1.648 to 1.920 GHz rang Sawtek also delivers low insertion loss, –1.3 dB typical, in package 94% smaller than the ceramic alternative.

Sawtek
INFO/CARD 151

What Goes In Comes Out.

AR/Kalmus: Booth 1212.
AR - Amplifier Research: Booth 522.
MTT-S, Phoenix, May 22-24.

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If you're testing a driver amp or other piece of wireless equipment, you know the value of "nada". Because AR "S" Series amps are uniquely linear, the output signal is nothing more than an amplified, faithful representation of the amplifier's signal input.

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Compact PCS diplexer

The recently introduced W1807D compact PCS diplexer from Wireless Technologies is designed for use in the A, B and C PCS bands. The diplexer features low insertion loss (less than 1 dB) over the PCS band (1.850/1.910 GHz and 1.930/1.970 GHz) with a transmit/receive isolation greater than 70 dB. The return loss is less than 18 dB and its compact footprint, 2" x 2" x 6", allows applications in microcells, repeaters, extenders and bi-directional amplifier systems. The diplexer is suitable for tower-mounting applications with a power rating of up to 40 W using SMA connectors. The IMD is better than –130 dBc.
Wireless Technologies
INFO/CARD 152

Two-way splitters/ combiners

Mini-Circuits introduces the ADP-2-1, a low-profile, two-way-0° power splitter/combiner with 0.5 MHz to 400 MHz frequency range. Engineered and

packaged in a 0.155" water-washable package, this device exhibits low 0.3 dB insertion loss (above 30 dB), 0.10 dB amplitude unbalance and a good 0.5° phase unbalance. It is suitable for instrumentation applications in 50Ω systems.
Mini-Circuits
INFO/CARD 153

Directional couplers available from 0.5–50 GHz

Krytar introduces the model 202050010 broadband directional coupler for operation in the frequency range from 1 GHz to 40 GHz. Nominal coupling is 1 ±1 dB with frequency sensitivity of ±1 dB. Minimum directivity is 14 dB from to 20 GHz and 10 dB from 20 to 40 GH Maximum VSWR is 1.5:1 and 1.7: respectively. Insertion loss is less than 1 dB 1.8 dB. Couplers are available with choice of 2.4 mm or K female connectors.
Krytar
INFO/CARD 154

Quad-band antenna embeds into notebooks

RangeStar Wireless debutes a qua band, embedded antenna for notebo applications. The antenna can b mounted on a notebook's hinge an supports GPRS, Bluetooth and 802.11 unlicensed applications. The antenn supports vertical and horizontal pola ization and provides hemispherical co erage. It offers a peak gain of +1 dBi i the 900 MHz band, +0 dBi in the 1 GHz band, and +3 dBi in the 2.4 GH and 5.2 GHz band.
RangeStar Wireless
INFO/CARD 155

EMC/RFI

Tapped filter networks for EMI/RFI suppression

KOA Speer introduces the LFA series of tapped filter networks for the suppression of EMI/RFI noise. These components are designed to filter out the high-frequency content of digital signals and are commonly used in I/O ports and other high-frequency/high-speed applications. The networks are housed in a low-profile, 20-pin QSOP containter. Each network has a resistance range of 10Ω to 10 kΩ and a capacitance range of 10 pF to 220 pF. Resistance tolerances are ±5%, ±10% and ±20%, and capacitance tolerances are ±10% and ±20%. The TCR is ±250 ppm/°C. Body style options include wide SOIC, QSOP, TSSOP and 0.6, 0.5 or 0.4 mm die packs.
KOA Speer
INFO/CARD 156

FIBER OPTICS/IR

Optocoupler in slim packaging

The Telefunken Miniflat four-pin optocouplers feature a 2 mm height profile. They consist of a photo transistor optically coupled to a GaAs infrared-emitting diode. Intended for current isolation, the eight new TCMT11 optocouplers are for miniaturized products such as PCMCIA cards, notebook modems, telecommunications products, programmable logic controllers and other designs requiring a high level of package integration. They provide an insulation voltage of 3,750 Vrms, and feature a transistor output and a forward current of 60 mA.
Vishay Intertechnology
INFO/CARD 157

POWER/BATTERIES

Low-voltage supervisor pairs with processors

The MIC2775 low-voltage supervisor IC monitors power supplies as low as 1.5 VDC. Available in the Ittybitty SOT23-5 packaging, the IC features a choice of factory-programmed voltage options and ultra-low quiescent current. The quiescent power supply cu rent is a portable-friendly 3.5 mA. Bot an active-high and an active-low re output are provided in addition to manual reset input for a reset switch for daisy-chaining onto existing pow supervision circuitry.
Micrel Semiconductor
INFO/CARD 158

INTERFACE/ INTERCONNECT

SMA family offers diverse products

Compel Electronics announces tl availability of its SMA connector serie Operating from DC to 18 GHz, the ne line offers typical insertion loss of <0.(dB and VSWR of <1.15:1 with 50 impedance. RF leakage typically me sures <90 dB. Brass or stainless ste housings are available with gold, pass vate or ternary alloy plating option Designs are available to accommoda flexible, conformable and semi-rig cable, PCB mount, and panel or bul head mounting. All styles are availab in straight, angled and swept righ angle configurations.
Compel
INFO/CARD 159

SUBSYSTEMS

Substrate for GaN, III-V and II-VI thin-film depositior

Meller C-plane sapphire substrat can be custom-fabricated in sizes small as 50 mm round and 31.75 m square by 0.330 or 0.440 mm thick a flat to less than 5 mm. Featuring 00 surface orientation, and less than 0 nm RA roughness, they are suitable f the epitaxial growth of GaN and oth III-V and II-VI thin films used in tl manufacture of bright blue and gre LEDs. Supplied with either one or t sides polished, the substrates are al available for carrier applications whe thin films of silicon or GaAs are p ished on top of the wafer. These ultr flat wafers are lapped to less than 0 fringes at HeNe and parallel from 20 less than 5 arc-seconds with ±1.2m piece-to-piece uniformity.
Venmark International
INFO/CARD 160

WE WALK THE TALK

Maxrad & Richardson Electronics — Partnering for Success

Success is a direct result of industry leadership, and reflects an unwavering commitment to quality. The Richardson Electronics and MAXRAD team maintains the highest standards of integrity, responsibility and excellence. Together, we provide the quality, value and expertise that you need to succeed in the global wireless communications industry.

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Creative Solutions, Exceptional Performance

Introducing Maxrad's new patent pending, 2.4 GHz ISM adjustable sector panel antenna. The MSP24013MB provides field adjustable horizontal beamwidth options of 45, 60, 90 or 120 degrees with a VSWR of less than 1.5:1. This unique design delivers industry-leading front to back ratios with excellent cross pole discrimination. It is the ideal solution for wireless broadband applications where coverage of a geographical sector is needed.

MSP24013MB Specifications

Nominal Gain	Front to Back Ratio	Horizontal Plane	E-Plane Beamwidth	VSWR	Typical Cross Poll Discrimination
13 dBi at 120°	> 32 dB at 120°	120°, 90°,	16° at all	<1.5:1	270° - 0°, 0° - 90° = -20 dB
14 dBi at 90°	> 42 dB at 90°	60° and 45°	horizontal		235° - 270°, 90° - 135° = -28 dB
16 dBi at 60°	> 42 dB at 60°	options	beamwidth		180° - 235°, 135° - 180° = -32 dB
17 dBi at 45°	> 42 dB at 45°		options		

Note: For applications in which adjustability is not necessary, the sector panel antenna can be ordered with fixed horizontal beamwidths of 45, 60, 90 and 120 degrees.

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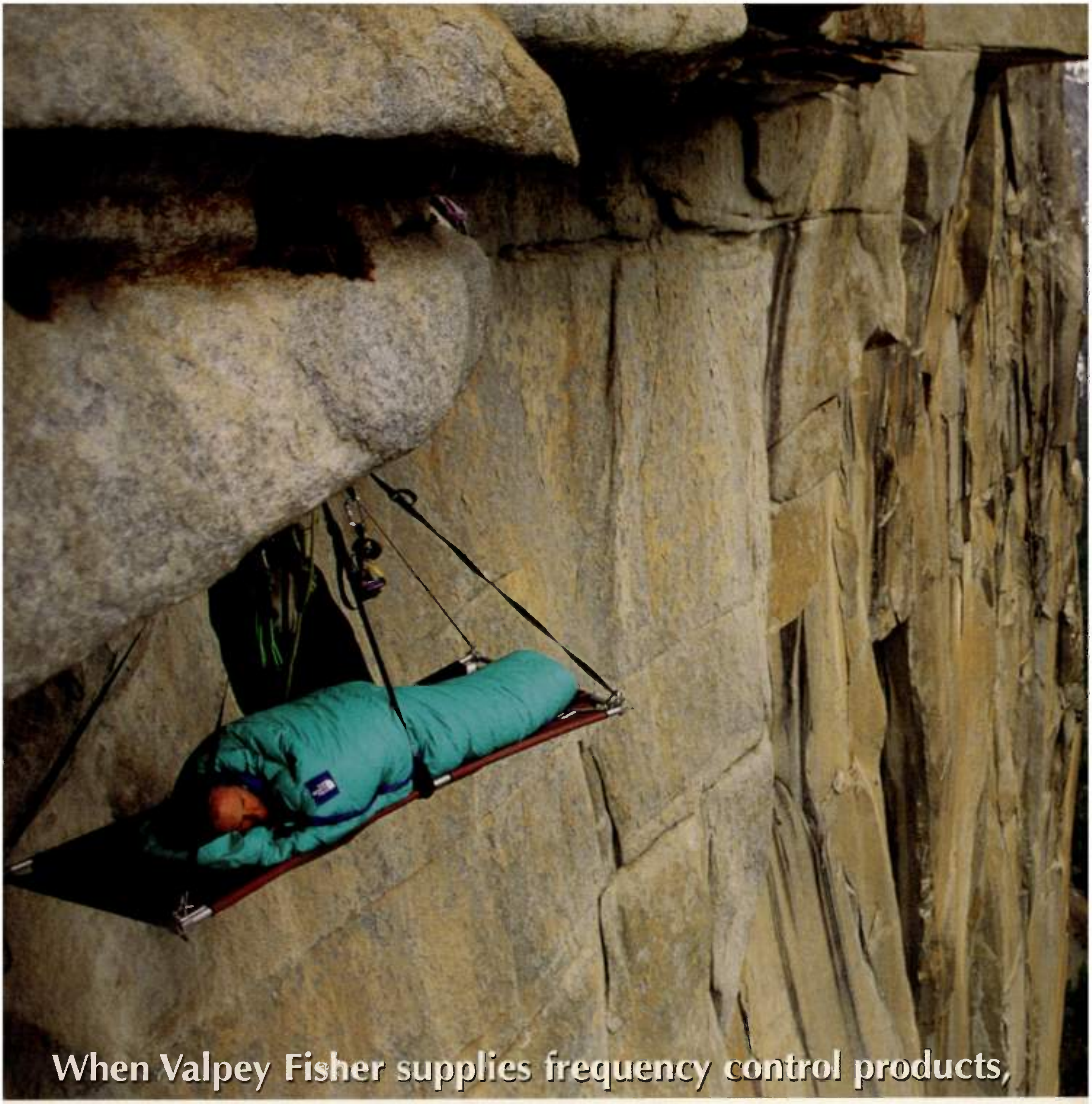
INFO/CARD 67

Glossary of Terms Used in This Issue of RF Design

2G – second generation of wireless communications systems
3G – third generation
A/D – analog-to-digital
AC – alternating current
ACPR – adjacent–channel power ratio
ADC – analog–to–digital converter
AGC – automatic gain control
AMPS – advanced mobile phone system
AODV – ad-hoc on demand distance vector
ASIC – application–specific integrated circuit
ASK – amplifier shift keying
ASP – application service provider
ATM – asynchronous transfer mode
AWGN – additive white gaussian noise
BER – bit error rate
BPSK – binary phase shift keying
CCRR – co–channel rejection ratio
CDMA – code–division multiple access
CDPD – cellular digital packet data
CGI – common gateway interface
CMOS – complementary metal-oxide semiconductor
CMRR – common-mode rejection ratio
CW – continuous wave
DC – direct current
DCS – distributed communications system or digital cellular system
DDS – direct digital synthesis
DECT – digital european cordless telephone
DSP – digital signal processor
DUT – device under test
EEPROM – electrically erasable programmable read-only memory
EM – electromagnetic
EMC – electromagnetic compatibility
EMI – electromagnetic interference
ESD – electrostatic discharge
ETSI – european telecommunications standards institute
FCC – federal communications commission
FDD – frequency division duplex
FER – frame error rate
FET – field-effect transistor
FHSS – frequency-hopping, spread spectrum
FIFO – first-in, first-out
FIR – finite impulse response
FSK – frequency shift keying
GaAs – gallium arsenide
GaN – gallium nitride
GFSK – gaussian filtered frequency shift keying
GMSK – gaussian minimum shift keying
GPIB – general-purpose interface bus
GPRS – general packet radio service
GPS – global positioning system
GSM – global system for mobile communications
HBT – heterojunction bipolar transistor
HDR – high data rate
HEMT – high electron mobility transistor
HSCSD – high–speed circuit-switched data
HTTP – hypertext transfer protocol
I and Q – in–phase and quadrature
I/O – input/output
IC – integrated circuit
IF – intermediate frequency
IM – intermodulation
IMD – intermodulation distortion
InP – indium phosphide
IP – internet protocol
IR – infrared

Continued on page 10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ISM – industrial, scientific, and medical
JSP – java server pages
LAN – local area network
LDMOS – laterally diffused metal oxide silicon
LMDS – local multipoint distribution service
LNA – low–noise amplifier
LO – local oscillator
LOS – line of sight
LPF – low–pass filter
LSI – large scale integration
LTCC – low–temperature co–fired ceramic
MDS – multipoint distribution systems
MMAC – million multiply accumulate operations
MMDS – multichannel multipoint distribution service
MMIC – monolithic microwave integrated circuit
MOSFET – metal–oxide semiconductor field–effect transistor
MOU – minutes of use
MSPS – million samples per second
NRZ – non–return to zero
NTC – negative temperature coefficient
OEM – original equipment manufacturer
PA – power amplifier
PAR – peak-to-average ratio
PCB – printed circuit board
PCS – personal communications system
PDA – personal digital assistant
PDC – pacific digital cellular
PECL – positive emitter-coupled logic
PHEMT – pseudomorphic high-electron-mobility transistor
PIM – personal information management
PLL – phase–locked loop
PPM – parts per million
PSK – phase shift keying
QPSK – quadrature phase shift keying
RFI – radio frequency interference
RFIC – radio frequency integrated circuit
ROM – read–only memory
SDH – synchronous digital hierarchy
SMA – standardization management activity
SMD – short message delivery
SMR –specialized mobile radio
SMS – short messaging service
SMT – surface–mount technology or surface–mount toroidal
SNR – signal–to–noise ratio
SOIC – small-outline integrated circuit
SONET – synchronous optical network
SPDT – single–pole double–throw
SSPA – solid state power amplifiers
TCP – transmission control protocol
TDD – time division duplex
TDMA – time–division multiple access
TETRA – trans european trunked radio
TTL – transistor –transistor logic
TXCO – temperature–compensated crystal oscillator
UART – universal asynchronous receiver transmitter
UDP – user datagram protocol
UMTS – universal mobile telecommunications service
UTRA – UMTS terrestrial radio access
VCO – voltage-controlled oscillator
VCXO – voltage–controlled crystal oscillator
VOFDM – vector orthogonal frequency division multiplexing
VSAT – very small aperture terminal (satellite service)
VSWR – voltage standing wave ratio
WAP – wireless application protocol
W–CDMA – wideband code–division multiple access
WLAN – wireless local area network

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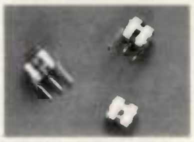

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Connecter: N(F)/SMA/TNC

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HSA-TV2

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Worried?

by Ernest Worthman
technology editor
eworthman@intertec.com

It was inevitable that the blood-letting in the stock market, coupled with the economic slowdown (the recession that isn't really happening, according to the usual airheads in Washington) would eventually show up in real dollars. And, unfortunately, it has done just that, in the form of downsizing, outsizing and rightsizing (I assume these are the politically correct buzzwords).

Fortunately, the wireless industry is probably more recession-resistant than some other industries (wouldn't want to be one of those arrogant dot-commies who finally realizes that knowing how to work a computer isn't the primary marketable job skill on a resume).

The lists — As I searched the Web for information about layoffs, the majority of what I came up with were non-telecom players (except, of course, Motorola and a few others) - Charles Schwab, Polaroid, Chrysler, Samsonite, etc. Furthermore, a lot of the downsizing is happening in the computer hardware (Compaq, Intel, Cisco) and software (IBM/Lotus, Egghead) industries, and *especially* in vertical markets (Internet consulting, ASPs, third-party software). But, except for the most vulnerable companies and the vertical markets, the numbers I've seen don't seem as catastrophic as similar past times. Most announced layoffs are under the 10% figure.

In my humble opinion, this bodes well for the RF industry. Even with the "sky is falling" mentality of the mainstream media, I really think the telecommunications, and particularly the RF industry, really is in a better place than many others.

You had to know it was coming — It would be almost impossible for me to think that any rational human being, beyond puberty, didn't see this coming. The dot-com rocket was out of control from day one. Computer pundits have been warning for a couple of years now that the consumer market technology level was topping out (meaning the market was getting saturated with current technology and the return on upgrades/replacements was diminishing as people weren't rushing out to get the few extra MHz).

Furthermore, the conservative element of the stock market industry had been warning about the unsteadiness in the market with so much venture speculation and amateur money out there.

So, tell me you didn't really fall into the false security provided by the "golden era" of the las few years.

OK, so now what? — Well, now that we're al grounded in reality again, what will happe when the smoke clears?

First of all, realize that some of what is goin on in the readjustment is geared toward settlin Wall Street's jitters. Often the "outsized" numbers include attrition and rotation as well. Thi makes it look like the company is belt-tightenin and calms investors nerves. Yet, the "back door remains open. And layoffs happen all the tim anyway, good times or bad.

Second, the last few years have put a lot of cas into companies' coffers. To avoid additional tax liability and obscene profits, some companies hire beyond the immediate need. These "good times jobs were only as good as the economy. They ar the first to go when the cash flow dries up.

Also realize that not everyone is affected acros the board. For example, the TRW Systems & Information Technology Group is looking to hir about 145 IT people over the next three months Raytheon has over 1,000 jobs listed on it **www.nationjob.com** site. A quick search for engineers on **www.dice.com** brought up over 45,00 jobs. When I typed in telecommunications as search topic on **www.headhunter.com**, it cam up with over 5,000 jobs — so many it suggested tighten the search criterion.

But what if it IS you? — Sure, some of us ar going to be outsized - that's a fact. If you are on of them, realize that it really is only a temporar hiatus. Even though there is a strong wireles infrastructure, the real technology convergence i just beginning. You are in a sector that, b default (once the bugs get worked out), will likel see the largest expansion and offer the mos opportunity during this century.

Don't lose sight of the future — As you ponder the future, consider the fact that this could b the cloud's silver lining. I know of many individual for whom an "employment cleansing" is the bes thing that could happen (It happened to me once) It gives them the opportunity to sit back, take deep breath and reassess their current philosophy.

There is also a great deal of advice for those wh are caught in the fray. But most of it is just common sense. Losing your job is a shock in the best o times. With the present (hyped) gloom-and-doon environment, it's easy to fall into the trap an panic. Don't — now-a-days, everyone's been there There is a line from the movie *Apocalypse Now* tha is one of my favorites. I paraphrase it to read something like "reality is keeping your head while everyone around you is losing theirs."

It was good advice over there, and I think it' still pretty good advice over here.

Ern

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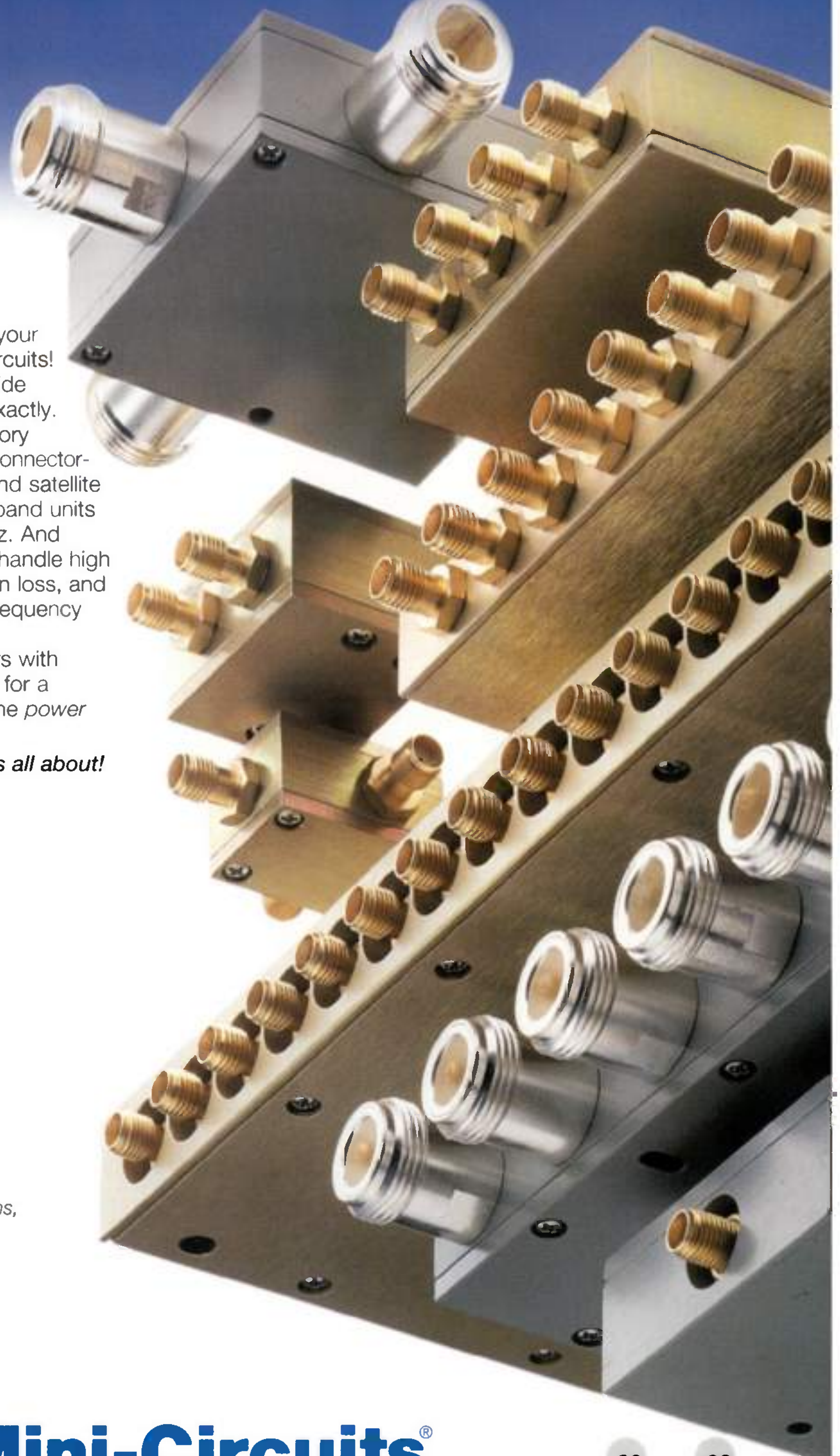

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4WAY	83	0.47-8.40
5WAY	6	0.80-1.98
6WAY	25	0.80-5.00
7WAY	4	1.00-1.99
8WAY	62	0.50-8.40
9WAY	3	0.80-4.80
10WAY	11	0.75-2.40
12WAY	9	0.50-4.20
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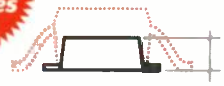

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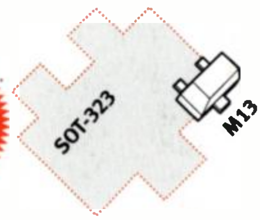
Part Number	Corner Freq*	V_{CE}	I_C	Package
NE856M13	3 KHz	3 V	30 mA	**M13**
NE685M13	5 KHz	3 V	5 mA	**M13**

**Review Application Note AN1026 on our website for more information on 1/f noise characteristics and corner frequency calculation.*

1/6 SIZE



New M13

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Part Number	Description	NF	Gain	Freq	Package
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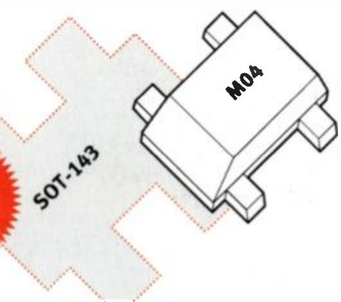
NE661M04	25 GHz f_T LNA	1.2 dB	22 dB	2 GHz	**M04**
NE662M04	23 GHz f_T LNA	1.1 dB	20 dB	2 GHz	**M04**

HALF SIZE

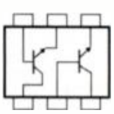


New M04

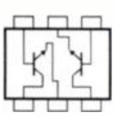
Half the footprint area of a SOT-143

Twin Transistor Devices

Cascode LNAs, cascade LNAs and oscillator/buffer combinations are just three possible uses of these versatile devices. *Matched Die* versions pair two adjacent die from the wafer to help simplify your design, while *Mixed Die* versions — an NEC exclusive — let you optimize oscillator performance while achieving the buffer amp output power you need. 40 different combinations available.

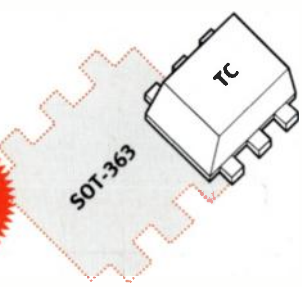


Part Number	Description	Q1 Spec	Q2 Spec
UPA810TC	Matched Die/Cascade LNA	NE856	NE856
UPA814TC	Matched Die/Cascade LNA	NE688	NE688



Part Number	Description	Q1 Spec	Q2 Spec
UPA826TC	Matched Die/Osc-Buffer Amp	NE685	NE685
UPA840TC	Mixed Die/Osc-Buffer Amp	NE685	NE681

HALF SIZE



New TC Twin Transistors

Half the footprint area of a SOT-363

Data Sheets and Application Notes are available at **www.cel.com**

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