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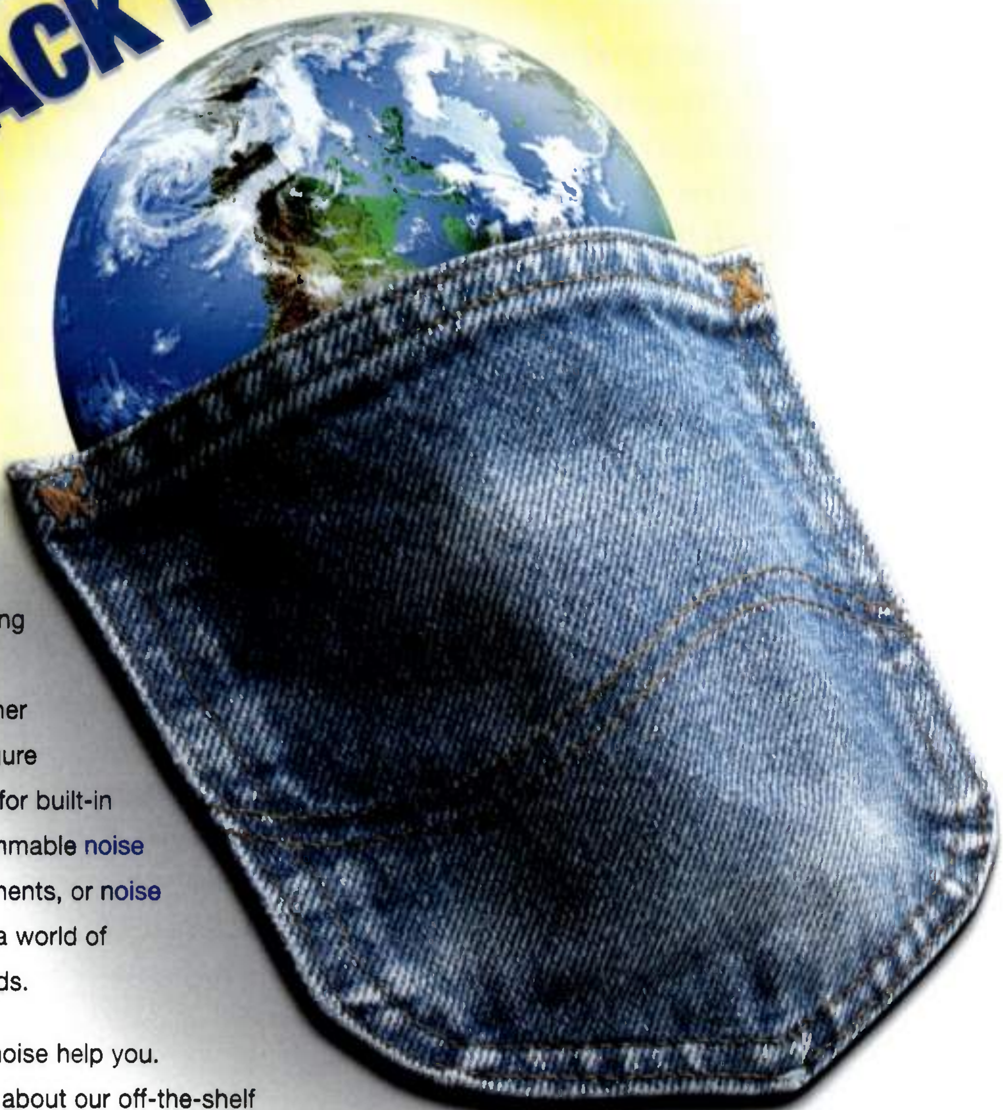

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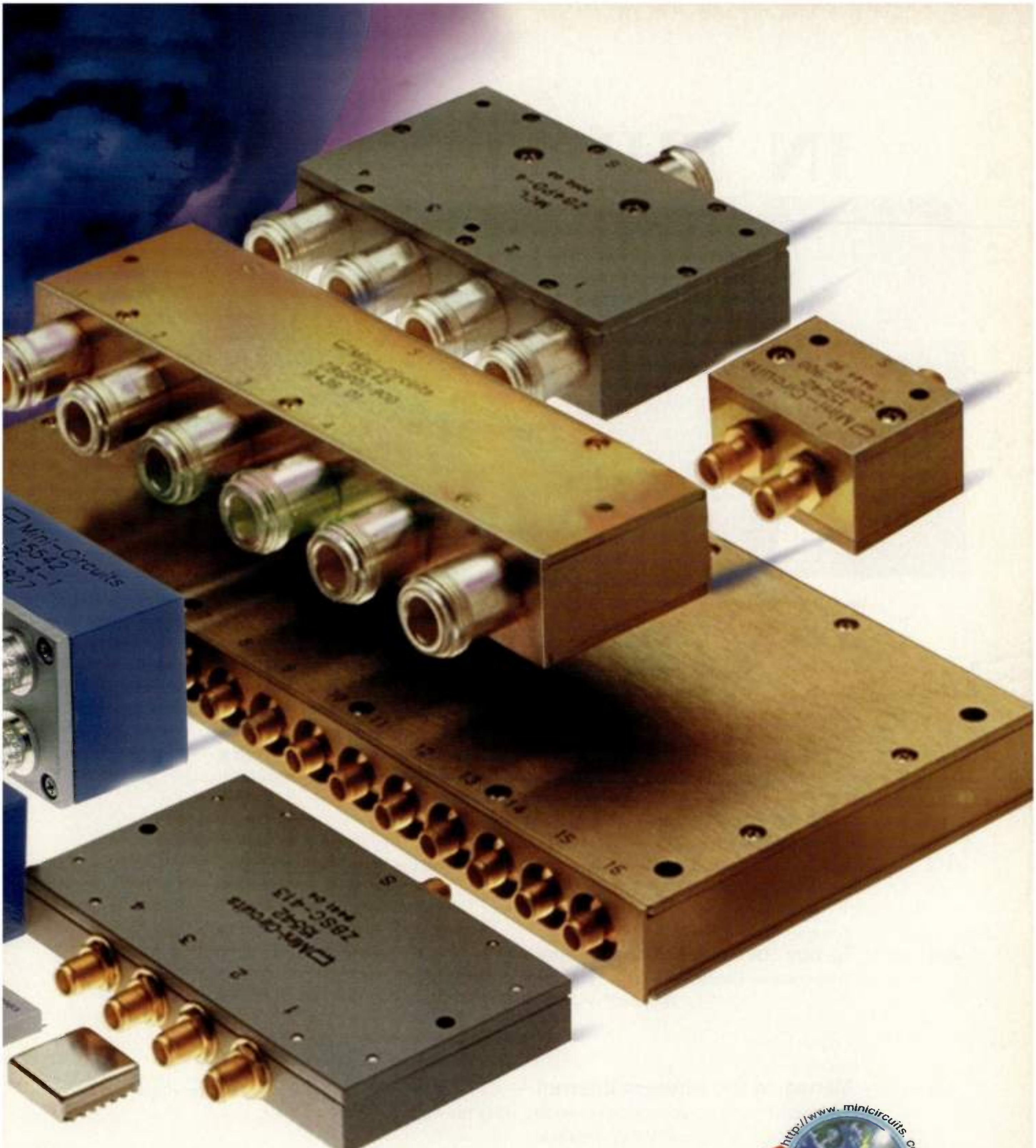

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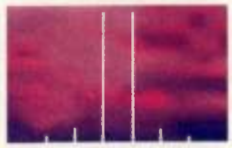

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RF editorial

A means to an end

By Don Bishop
Editorial Director
don_bishop@intertec.com

When you're fascinated by RF, it's easy to get caught up in the use of RF for its own sake.

For most other people, though, RF is a means to an end. If one particular use of RF can be replaced by something that gets the job done better, that's what happens. It might not happen right away because of the inertia of regulation and an installed base of hardware. But eventually, it happens.

What's fortunate for us is that, many times, the replacement for RF is ... more RF.

Two key reasons for using RF in the first place are bandwidth and mobility.

Early use of wireless telegraphy for transatlantic communications helped to overcome the narrow bandwidth of undersea cable. Communications among ships and between ships and shore stations underscored RF's mobility. Even so, radio carried a large proportion of messages between fixed points.

Transponders on earth-orbiting satellites replaced undersea cable and terrestrial microwave for a time, offering greater bandwidth at higher frequencies. Undersea and terrestrial cable made comebacks with optical fiber that replaced many satellite RF links.

Early radio broadcasting only served homes and businesses. There were no car and portable radios. The bandwidth offered by RF made it attractive for delivering entertainment, news and advertising.

With hardly anyone watching TV in moving vehicles (we hope), there's little reason to use airwaves for TV broadcasting. Television calls on RF almost entirely for its bandwidth compared to copper wire, the only other connection medium that was available when television began. Fiber to the home? Not much, not yet. Even what replaces or supplements VHF and UHF TV—cable and satellite—uses RF.

Combine bandwidth and mobility, and you're talking 4G cellular. Meanwhile, the somewhat-more-fancy 3G cellular can't offer Internet capability to match that of wire-, fiber- and satellite-connected Internet features. When it comes to much of what the Internet has to offer, consumers seem willing to sacrifice the mobility of cellular-style RF for the bandwidth of alternatives.

Low-power RF (Bluetooth) combines bandwidth and mobility, and it adds connectivity convenience. Stringing a few wires into a home or business for telephone, television and Internet isn't so bad. But fishing wires throughout a building for LANs and computer-controlled appliances can be difficult and expensive, if not sometimes dangerous (read: asbestos).

Current news about the pace of wireless communications growth omits some of the optimism about cellular and PCS that we're used to hearing. Motorola is closing its Harvard, IL, handset manufacturing operation. Ericsson is discontinuing its own handset manufacturing in favor of outsourcing. It seems that consumers are happy with their handsets, and they aren't buying replacements in the quantities that the manufacturers were ready to supply.

Don't be too sad for wireless. It's growing, just not as fast as it did yesterday.

In the meantime, other uses of RF that take advantage of its bandwidth, mobility and, in many applications, its connectivity convenience, will continue to show demand for infrastructure and devices.

RF

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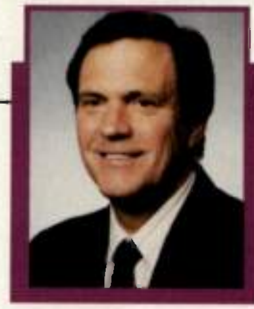

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RF calendar

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17–22 **OFC Optical Fiber Communications Conference/ Exhibit 2001** – *Anaheim, CA* – Information: Tel. 202.416.1980; Fax 202.416.6100; e-mail: *confserv@osa.org.*

20–22 **IP/SoC 2001** – *Santa Clara, CA* – Information: Allen Wood. Tel. 770.937.1148; e-mail: *awood@cmp.com.*

20–22 **Wireless 2001** – *Las Vegas* – Information: Tel. 202.785.CTIA.

23–24 **The US Programme 2001** – *Las Vegas* – Information: Jane Zweig, Herschel Shosteck Associates, Ltd. Tel. 301.589.2259. Fax 301.588.3311. Web site: **www.rttonline.com**

28–30 **IWCE** – *Las Vegas* – Information: Web site: **www.iwceconexpo.com**

28–30 **Satellite 2001** – *Washington* – Information: Phillips Business Information. Tel. 301.424.3338.

April

9–13 **Embedded Systems Conference 2001** – *San Francisco* – Information: Tel. 415.278.5322

30–3 **Global Summit 2001** – *Orlando* – Information: Web site: **www.tdma-edge.org**

May

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

22–24 **International Microwave Symposium: IEEE-MTTS** – *Phoenix* – Information: Web site: **www.nonlintec.com**

June

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

5–7 **Sensors Expo 2001** – *Chicago* – Information: Tel. 203.882.1300 x 181. 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.

August

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

RF courses

Alexander Resources – *3G Wireless: Promises and Realities* – March 26–27, Phoenix. 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 – *3G Made Simple* – May 14; *RF and Wireless Made Simple* – May 15–16; *RF and Wireless Made Simple II* – May 17–18; *Advanced Wireless and Microwave Techniques* – Feb. 12–16; *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**

Georgia Institute of Technology – *Phased Array Antennas for Radar and Communications* – March 13–16, Atlanta. Information: Continuing Education, Georgia Institute of Technology, Tel. 404.385.3502; e-mail: *conted@gatech.edu;* Web site: **www.conted.gatech.edu**

R.A. Wood Associates – *Introductory RF and Microwaves* – April 19–25; *RF and Microwave Receiver Design* – April 19–20; *RF Power Amplifiers, Classes A Through SS: How the Circuits Operate, How to Design Them, and When to Use Each* – April 19–20, Baltimore, MD. 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 – *CDMA Mobile Radio Design* – March 12–15; *Radar Interferometry: Principles, Processing, and Applications* – March 19–23; *Equalization Methods in Communications* – March 27–30; *Wireless Data Systems* – March 29–30, 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* – March 20–21, Dallas, April 19, Columbus, OH; June 19–20, Boston; August 8–9, Toronto. Information: Web site: **www.umr.edu/-conted>**

University of Wisconsin Milwaukee – *Product Documentation Control / Configuration Management* – March 21–23, Irvine, CA. Information: Tel. 800.222.3623; Fax 800.399.4896; Web site: **www.uwm.edu/dept/ccee**

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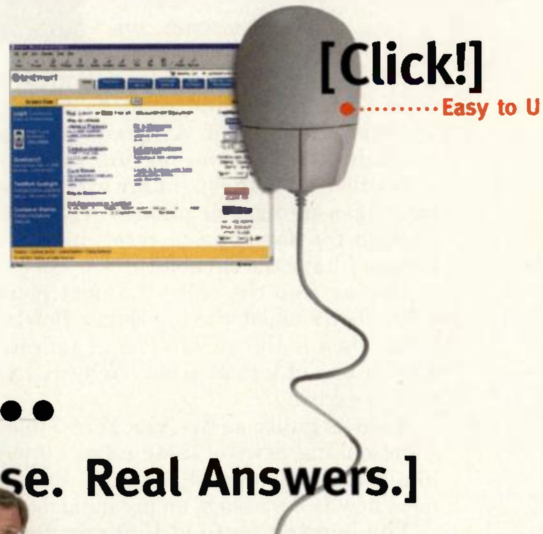

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INFO/CARD 3

Roger's rants

By Roger Lesser
Editor
roger_lesser@intertec.com

While watching the Super Bowl, I picked up a copy of the *New York Times* and read an article about how e-mail is becoming news itself. As I read it an imaginative commercial for Budweiser beer was playing. (The alien dog)

Another ad that caught my eye had people exchanging visual messages using cell phones. I thought, I'm not important enough for someone to send me a wireless message, even though I have the capability.

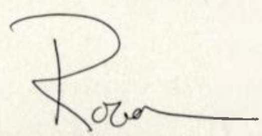
Coming into the office the next morning I read a report in *USA Today* about the top Super Bowl ads. Then it struck me, since when is this news? Then I reflected on the e-mail article, why is use of e-mail news? Why is having mobile messaging new or exciting?

I am as guilty as the *New York Times* and *USA Today*. Here I am making news of these items by writing about them. I feel like doing a Dennis Miller rant. But, I could be wrong. All I need now is a message on my handset that says, "Wassssup?"

The lagging state of U.S. wireless — Another recent *New York Times* article notes that the United States in lagging behind Europe and Asia in wireless applications. U.S. OEMs and service providers are letting Europe and Asia figure out what will work and what won't. The successful applications will then be adopted in the United States. So, if the United States OEMs are using overseas guinea pigs, does this mean that our fellow wireless users overseas thought wireless Internet was the only thing worthwhile? That visual message exchanges is why one should buy a cellular phone? OK, I'm being negative. On a positive note, when it comes to wireless applications, we can chant, "We're number 3."

"W" and the state of the military — Being retired military, I look at the current state of our Services as being in need of a real influx of money and morale. I still keep in touch with folks from my past military life. With George W. taking the helm many in the military thought we might see this influx come sooner than later. The impact for our industry would be in avionics, ground and airborne communications. I've been told that while more funds will be spent on the military, they will target morale issues such as housing and pay. Don't look for any real improvement in the defense electronics sector. OK, I'm being negative again. On the bright side, have you caught Will Farrell's impression of W. on Saturday Night Live? It's "impressedive."

Paper cell phone? — Have you heard about the paper-based cellular phone? It costs $15 and has one-hour of airtime. When you use it up you throw it away. I wonder if it has messaging?



Europe to surpass North America in VoDSL

The worldwide market for voice over DSL (VoDSL) will rise to more than 3 million gateway ports by 2006, according to a report by Allied Business Intelligence (ABI), Oyster Bay, NY. This reflects a compound annual growth rate (CAGR) of 95% from 1999.

The report, titled *Voice Over DSL SME Markets for Integrated Access Devices and Voice Gateways,* examines the worldwide and regional markets for VoDSL voice gateways and IADs from 1999-2006. Shipment figures, installed base and average selling prices for equipment are included.

In addition to a rise in VoDSL, the report also finds that the world market for VoDSL integrated access devices (IADs) will rise to more than 2 million by 2006. Although North America will dominate in the initial deployments, ABI said, the European market is set to surpass North America by 2003.

VoDSL allows as many as 24 voice lines from a single DSL line. The need for high-speed data drives the technology, but the voice adds the revenue for the providers, ABI said.

FCC to allocate additional spectrum for wireless

The Federal Communications Commission (FCC) has adopted a *Notice of Proposed Rulemaking* to investigate the possible use of frequency bands under 3 GHz to support the debut of new advanced wireless services.

The proceeding will examine the types of advanced mobile and fixed-communication services of the future. It will include the technical characteristics of such systems, and the spectrum requirements needed to support the introduction of such services, including the amount of spectrum needed and frequency bands that could be used by such systems.

Also explored will be the possibility of introducing new advanced mobile and fixed services in frequency bands currently used for cellular, broadband Personal Communication Service (PCS), and Specialized Mobile Radio (SMR) services, as well as in five other frequency bands: 1710-1755 MHz, 1755-1850 MHz, 2110-2150 MHz, 2160-2165 MHz and 2500-2690 MHz.

The action by the FCC proposes to allocate the 1710-1755 MHz band for mobile and fixed services. It will also advocate designation of advanced mobile

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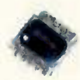

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Bluetooth competition grows increasingly fierce

The year 2000 saw a significant amount of Bluetooth products launch and ship. With this, competition has grown increasingly fierce among semiconductor product developers.

Though critics of the technology claim that Bluetooth promises too much and delivers too little, a study by Frost and Sullivan, London, predicts that global shipments of Bluetooth-enabled products will reach more than 11 million units in 2001, earning $2.5 billion in revenues.

The study shows that the hype surrounding Bluetooth has raised consumer expectations, putting the pressure on developers to deliver. This pressure, Frost and Sullivan said, will drive companies to get products out onto the market, and ultimately cause greater delay in delivery.

Another factor in the slow development in Bluetooth-enabled devices, the study said, is developers' discussions of the second specification of the standard, Bluetooth 2.0, before the first generation has had a chance to hit the market.

The drive behind the technology, however, continues to grow, and Bluetooth-enabled products are debuting despite lack of compliance with the first standard, Bluetooth 1.1.

CrossLink partner program expanded

Crossbow Technologies, San Jose, CA, has expanded its CrossLink Partners Program to include leading sensor, hardware, software and applications developers including Analog Devices, Arthur D. Little and Emation.

Crossbow founded the CrossLink Partners Program in summer 2000 to help build reliable, interoperable data acquisition and industrial control applications based on the Bluetooth wireless standard.

Companies working with Crossbow use the company's CrossNet wireless sensor architecture to develop remote data acquisition, overlay monitoring, security, compliance, actuation, data broadcast and logging, environmental facilities mapping, machine performance monitoring, and other applications.

WLAN equipment market to reach $3 billion in 2002

After several up-and-down years, the wireless local area network (WLAN) market gained acceptance as a legitimate enterprise technology in 2000 and is becoming a profitable opportunity for electronic equipment manufacturers, according to a report by Cahners In-Stat Group, Scottsdale, AZ.

The report predicts that the WLAN equipment market, including NICs, access points and bridges, will grow from $624 million in 1999 to $3 billion in 2002.

The release of IEEE 802.11b standard products in late 1999 and 2000 from several prominent network equipment and wireless vendors drove WLAN gear into wider acceptance, In-Stat said. The market will continue to to thrive as vendors unveil new prod-

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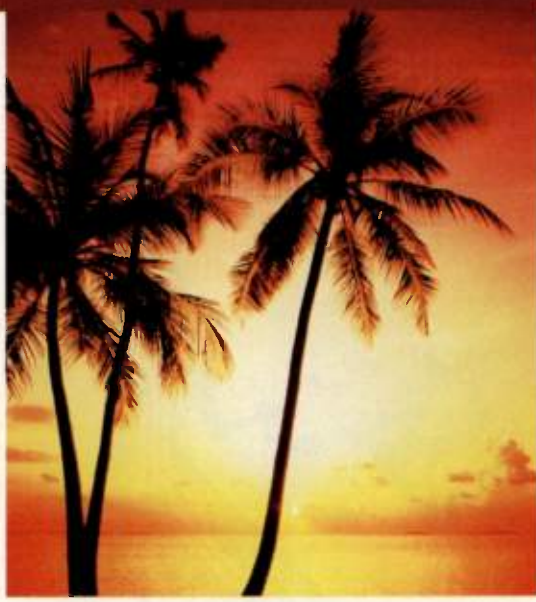

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MSA-2743	4	15.5	+28	50
ATF-54143*	0.55	17.4	+36	60 @ 3V

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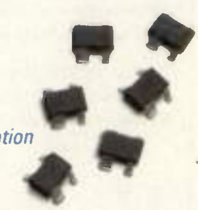

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Agilent Technologies, Inc. www.agilent.com 9/00 ucts with higher speeds, increased interoperability and lower prices.

WLAN technology sales are driven by an organization's desire to give employees greater mobility, In-Stat said. Wireless NICs have fallen to under $200, but are still more expensive than wired fast ethernet NICs priced at about $45. So, the need for mobility must be high for companies to invest in WLAN technology.

FCC may remove wireless cap

The government plans to consider ridding of or relaxing a cap on how much airwave space a single wireless company can own in a market, according to an article by the Associated Press (AP).

The FCC is taking into account competitive changes in the wireless industry, the AP said, and whether its rules could be hindering the growth of new services such as high-speed Internet access.

The FCC presently limits the amount of airwave space one operator owns in a geographic area. Given changes in the market, however, the FCC is considering lifting the cap and allowing companies to provide advanced services that require more frequencies.

The government has already started looking into ways to free up crowded airwaves for next-generation mobile services, the AP said, but the process is expected to take several months.

Lifting the cap or relaxing the wireless limits will enable companies to offer new options and stay competitive in the meantime.

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Mobile Telecoms' Web site is a link between telecommunications organizations and telecom professionals. It is comprised of recruiting specialists with experience in every aspect of the telecommunications industry and works in both domestic and international markets to provide telecom vacancies in every area possible. Features of the Web site include:

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Visitors to the site can search employment opportunities by industry organization or by job category. The site also notifies visitors of which job types are in high demand in the telecommunications industry.

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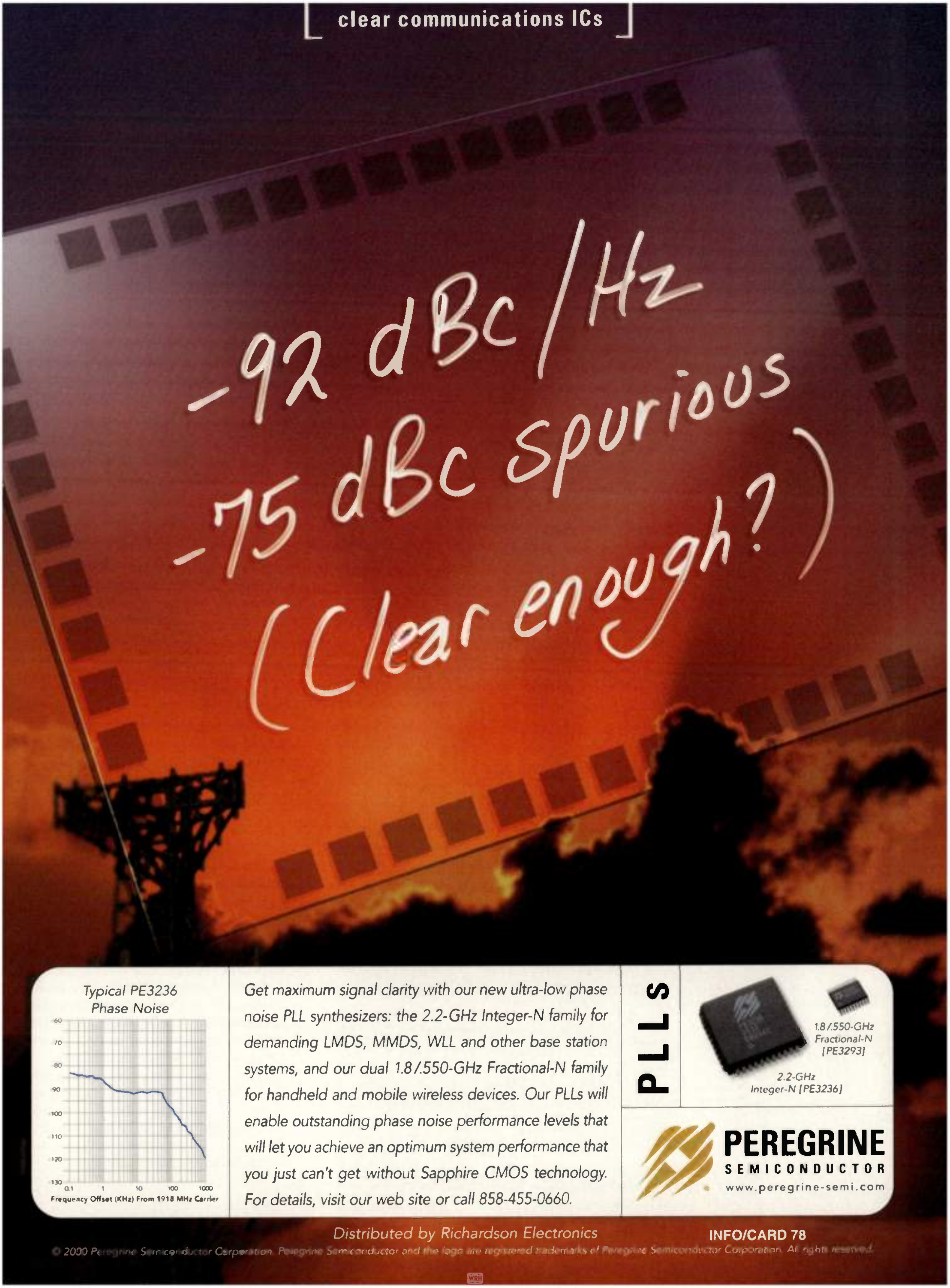

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Japan's Web phones could start U.S. trend

A fifth of Japan's population uses Net phones to chat, play games, read news, check stocks and search for local entertainment, according to an article by the Associated Press (AP). With a recent industry push overseas, this Web phone craze could make its way to the United States.

Led by NTT DoCoMo, the Japanese wireless Web industry is going global with exported services rather than manufactured products such as cars and electronics.

NTT DoCoMo is buying a 16% stake in AT&T's mobile phone unit for $9.8 billion, according to the AP, with hopes of expanding its i-mode business and mobile services to the United States. The company has also bought a $100 million stake in the Japan unit of America Online to develop AOL services for the international market.

Net phones have an overwhelming presence in Japan, where only a third of homes have computers, but one half of the population owns a cell phone. More than one half of American homes have PCs, however, lessening the need for people to find alternative ways to get online.

NTT DoCoMo intends to tap into the American market by providing a strategy that meets Americans' needs, however, and, according to the AP, says that i-mode can succeed in the United States as long as information and services are adapted to American tastes.

Home control networking to reach $3 billion by 2005

The home control networking systems market is undergoing a transition from closed-loop products to open, IP-aware products.

The result, according to a study by Allied Business Intelligence (ABI) Oyster Bay, NY, is that the U.S. home automation and controls equipment market is expected to grow from $1.1 billion in 1999 to $3 billion in 2005.

The report, titled *Home Automation Systems and IP-Based Control,* cited three factors contributing to the realization of the industry's true potential.

First, the Internet is the leading catalyst to a change in both systems designs and business models. IP-aware home control systems not only provide greater value to consumers, but also represent a means for service providers and appliance vendors to create new revenue streams.

Second, the immense interest in high-speed home networks is spilling over into control-oriented applications and services. Key players are looking to enable a more complete vision of the intelligent home that extends beyond high-speed data and entertainment networks.

Lastly, there has been a renewed effort to develop and improve technologies for home control applications. New control networking protocols promise to enable more reliable, lower cost products.

ABI does, however, caution that obstacles are ahead. According to the report, the impact of these technologies will not be materially felt until 2002. The industry must also still look to converge on a single standard.

BUSINESS BRIEFS

Embedded Wireless Devices, Panasonic team in Bluetooth development — Embedded Wireless Devices, Pleasanton, CA, and Panasonic, Japan, announce that they are co-developing a Bluetooth-enabled cordless telephony reference design that will allow OEMs to quickly develop wireless single- and multiline, multihandset telephony systems for residential and small office use.

Agere Systems' RF module achieves Bluetooth qualification — Lucent Microelectronics spinoff Agere Systems, Allentown, PA, announces Bluetooth qualification for its single-component radio frequency subsystem. The qualification will enable faster time-to-market for Agere customers that manufacture end products such as cellular phones, PDAs, PCs, and digital cameras.

Nokia, Shanxi Mobile to expand GSM in China — Nokia, New York, has agreed to expand Shanxi Mobile Communications' GSM 900 network in China. Nokia will install and supply GSM 900 expansion to increase the mobile network capacity by about 230,000 subscribers in the Taiyuan City area in northern China.

Qualcomm to license CDMA technology to Matsushita Electronic — Qualcomm, San Diego, has granted Matsushita Electronic Components, Japan, a worldwide license for Qualcomm's CDMA technology and patents. Qualcomm will receive royalties from the pact.

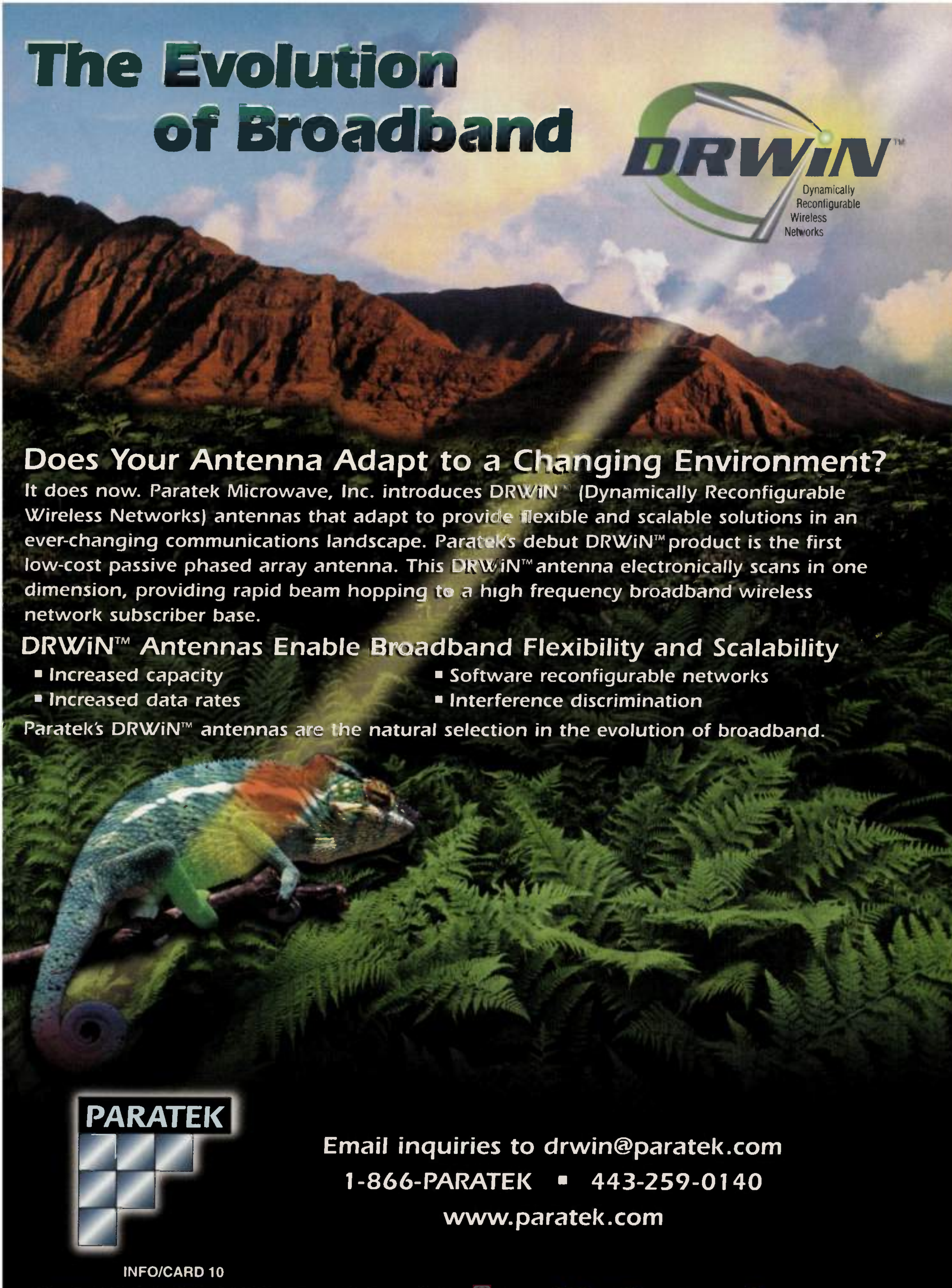
GigaAnt, Mobilsys collaborate on antenna solutions — GigaAnt will be supplying Mobilsys with several types of antennas for Bluetooth and GSM. Intensive development work is underway between the companies to ensure the function and launch of products for the mobile Internet.

Repeater Technologies' OfficeCell receives FCC certification — The FCC has granted type acceptance to Miami-based Repeater Technologies' 850 MHz and 1.9 GHz OfficeCell fiber optic distributed antenna systems for in-building wireless coverage. OfficeCell uses single-mode fiber to distribute RF energy throughout most types of structures.

Monitor Products acquires Quartztek — Monitor Products, Oceanside, CA, has signed a letter of intent to acquire Quartztek, Phoenix, AZ. Terms of the transaction have not been disclosed.

Merrimac's Microwave Product Group receives ISO 9001 certification — Merrimac Industries, West Caldwell, NJ, announces that Factory Mutual Research has awarded the ISO 9001 Certification to Merrimac Industries' RF/Microwave Products Group manufacturing facility. The certification verifies that the group complies with the internationally recognized standard for quality systems and the model for quality assurance in design, development, production, installation, and servicing.

Motorola Semiconductor, Surf Communication Solutions team — Surf Communication Solutions, Maynard, MA, and Motorola Semiconductor, Austin, TX, announce an agreement to provide bundled silicon and software solutions targeted to the high-growth telecommunications access market. The agreement is intended to provide OEMs with the most advanced universal port solution available for converged packet voice, packet fax, V.9x modems and high-speed data services.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Mounting high-power flanged RF devices to multi-layer PCBs

Mounting of high-power amplifiers to RF systems has traditionally been expensive, and real estate intensive. Not any more.

By Kedaar Kale and Adam Loveridge

Conventional mounting techniques are expensive when power amplifiers (PAs) or other high-power flanged RF devices are mounted to printed circuit boards (PCBs). In traditional techniques, the devices are usually mounted on a single-layer board. This board is then mounted onto a metal carrier, which acts as a heat sink and a ground reference for the RF signal. This metal carrier must occupy a large area so that good continuity and heat sinking can be obtained.

While this method works well, it requires a lot of board real estate and hardware. There is now an improved method for mounting high-power devices that occupies less area and gives better ground continuity.

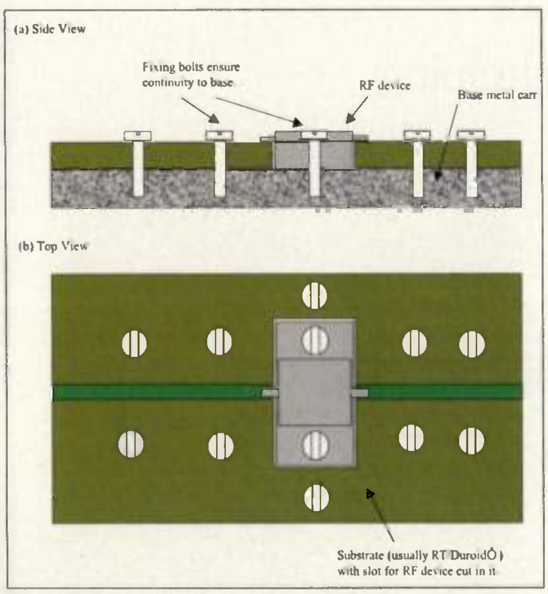

Figure 1. Conventional mounting techniques.

Conventional mounting technique

Figure 1 shows two views of the conventional mounting technique. Figure 1(a) shows the side view of the RF device mounted within a cut-out i the PCB. Bolts are used to fix both the device an the PCB to the base metal carrier. To ensure goo heat conduction and ground continuity, the bas metal carrier is sizeable compared to the R device itself, than would otherwise be present in multilayer board. With the desire for smalle lighter circuits in modern RF equipment, this is distinct disadvantage.

Figure 1(b) shows the top view of the arrange ment. It becomes clear that the RF device is place within a cut-out in the PCB material (usuall RT/Duroid or similar low-loss RF material). Th screws are shown indicating the fixing of the uppe dielectric to the base metal carrier below. Whe this process is finalized, the area used is substar tial in relation to the size of the device.

The new method presented here reduces the siz of the overall circuit by incorporating heat sinkin into the PCB. It also overcomes the discontinuity i the RF ground plane.

Layers and dielectrics

Figure 2 shows the construction of a board mad using the new technique. Multilayer PCB design are described in terms of copper plane constructio layers. For the example described here, layer 1 i

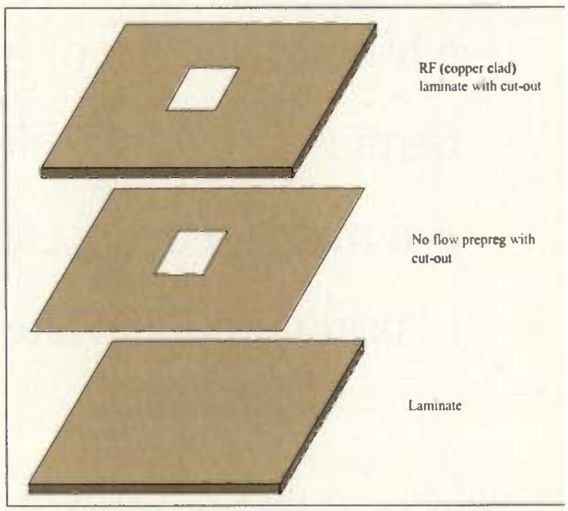

Figure 2. Expanded diagram of layers in new technique.

the RF signal layer, layer 2 is the RF signal groun layer 3 is the ground for the PA device, and layer is another RF signal layer.

Between these layers are the differer dielectrics used for the construction of the mult layer PCB. In this example, a RF laminate h been used for good RF performance within circu elements around the device. Reduced flow diele tric (usually called no-flow pre-preg) is below thi It has a high glass transition temperature t restrict its flowing during the bonding proce required for assembly of the PCB. However, does flow somewhat in processing.

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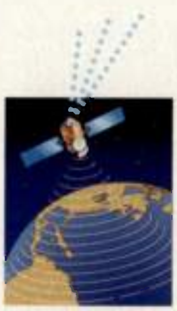

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ZJL-4G	20-4000	12.4	±0.25	13.5	5.5	30.5	75	129.95
ZJL-6G	20-6000	13.0	±1.6	9.0	4.5	24.0	50	114.95
ZJL-4HG	20-4000	17.0	±1.5	15.0	4.5	30.5	75	129.95
ZJL-3G	20-3000	19.0	±2.2	8.0	3.8	22.0	45	114.95
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ZKL-2R5	10-2500	30.0	±1.5	15.0	5.0	31.0	120	149.95
ZKL-2	10-2000	33.5	±1.0	15.0	4.0	31.0	120	149.95
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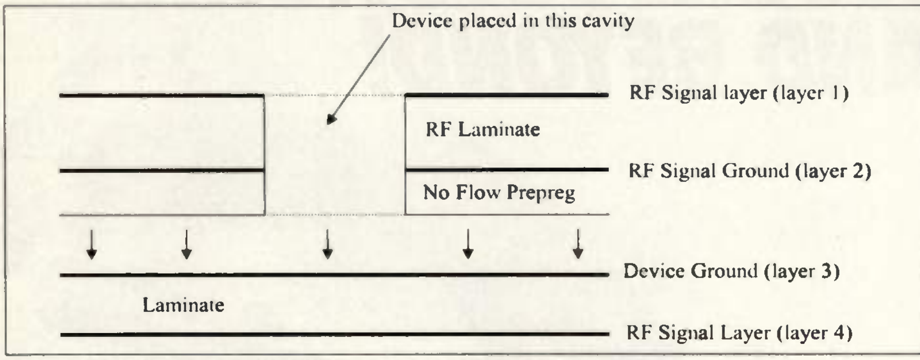


Figure 3. Side view cross-section of the multilayer technique.

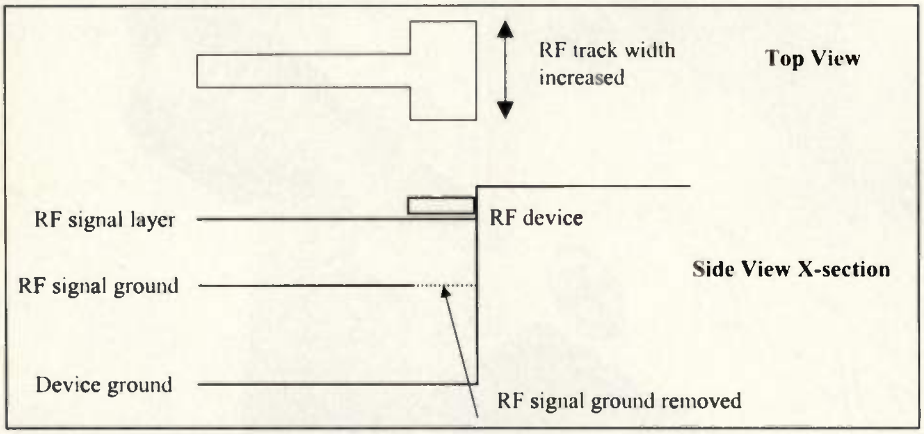


Figure 4. A solution to ground discontinuity.

The no-flow pre-preg should be kep as thin as possible to prevent bulging of the pre-preg into the cavity wher the multilayer board is finally pressec and bonded together. As a guideline 100 mm would be the maximum thick ness. The height of the RF laminat can be adjusted so that the overal thickness of the first two layers anc first two dielectrics is the same as th overall height of the device being placed in the cavity.

Assembly

Figure 3 shows the exploded dia gram view of the dielectrics used in th multilayer PCB described above. First a cut-out is made for the device in th top RF dielectric and in the no-flow pre preg. These two dielectrics are ther bonded together. Next, this sub-assem bly is bonded to the lower RF dielectric Though the pre-preg is no-flow, during construction some flowing of the dielec tric may occur under the heat and pres sure required for the bonding process This will cause some bulging of no-flov

pre-preg into the cavity. In some cases, this may not be a concern as the device may fit loosely in the cavity. In most cases, however, an alternative approach can be taken.

No cut-outs are made before the construction of the PCB. Any excess flow (e.g. from the pre-preg) will then be to the outside walls of the PCB, which can be cleaned up without much difficulty.

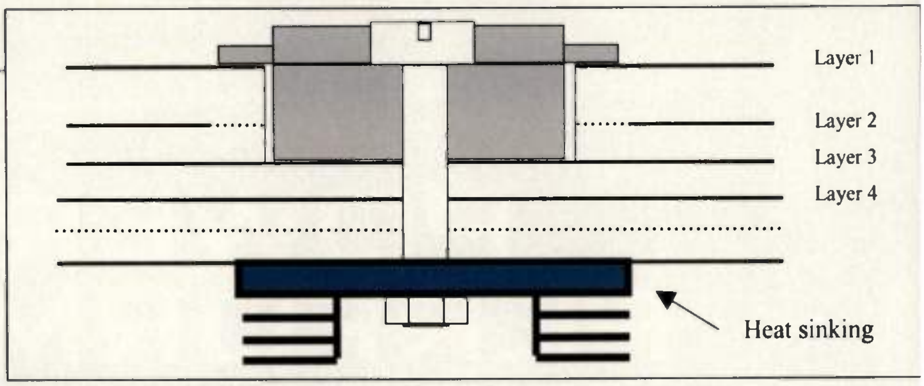
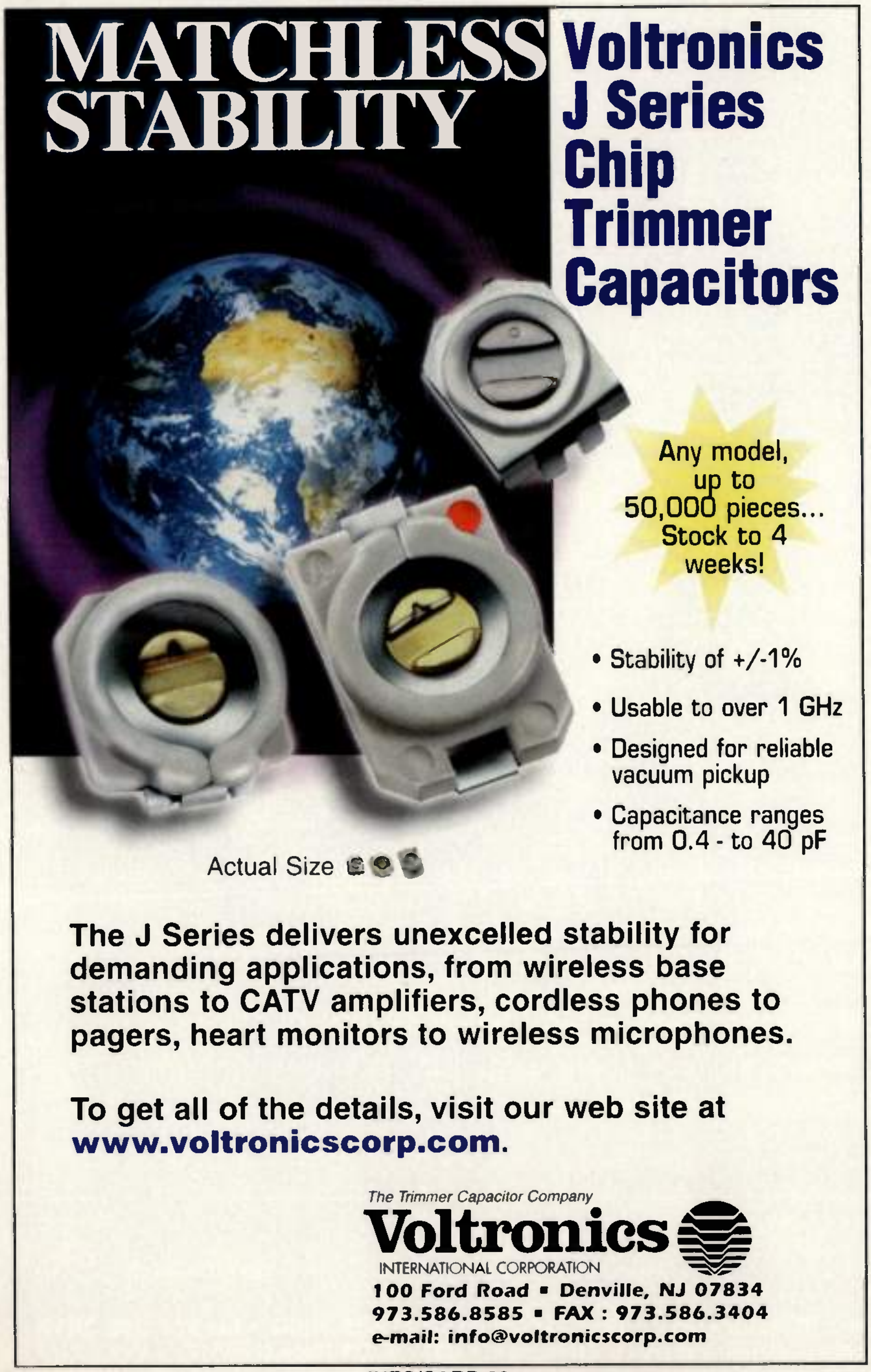


Figure 5. X-section view showing RF device with solved ground continuity problem.



The cavity for the RF device is manufactured by z-plane drilling (mechanically or by laser drill – laser drilling is more accurate but the most expensive) Even though z-plane drilling is costly the cost is justified by being able to go down to any layer. And, it prevents layer-3 copper (or any other layer being drilled down to) from being broken by a mechanical drill bit.

Layer 1 to 4 vias can be drilled and plated next. This process plates the cavity and provides a low-impedance connection between the signal ground and the device ground, which aids the connection due to adjacent vias and the capacitive effect between the ground planes. Additional layers can now be added to the build as required.

Heat extraction

Two possible methods exist to take the heat away from the device:

1. The device ground layer is used ideally deposited with more copper.

2. Through-holes are drilled and plated through the cavity to the bottom of the board, where suitable heat sinking can be attached or mounted. This includes the possibility of mounting the board directly to a metal box, which can act as the heat sink.

In both cases, plated through-holes would be required for the device' mounting bolts.

A solution for thickness

If the no-flow pre-preg presents a significant thickness, then a discontinuity in the RF signal ground can occur for the RF signal track leading into the RF device. The ratio of the width of the track to the dielectric thickness needs to be kept constant This is done by removing the RF signal ground adjacent to the device, and increasing the RF track width in this area accordingly (as shown in Figure 4). This reduces the discontinuity in the RF ground for the tracking Figure 4 also shows a step in the

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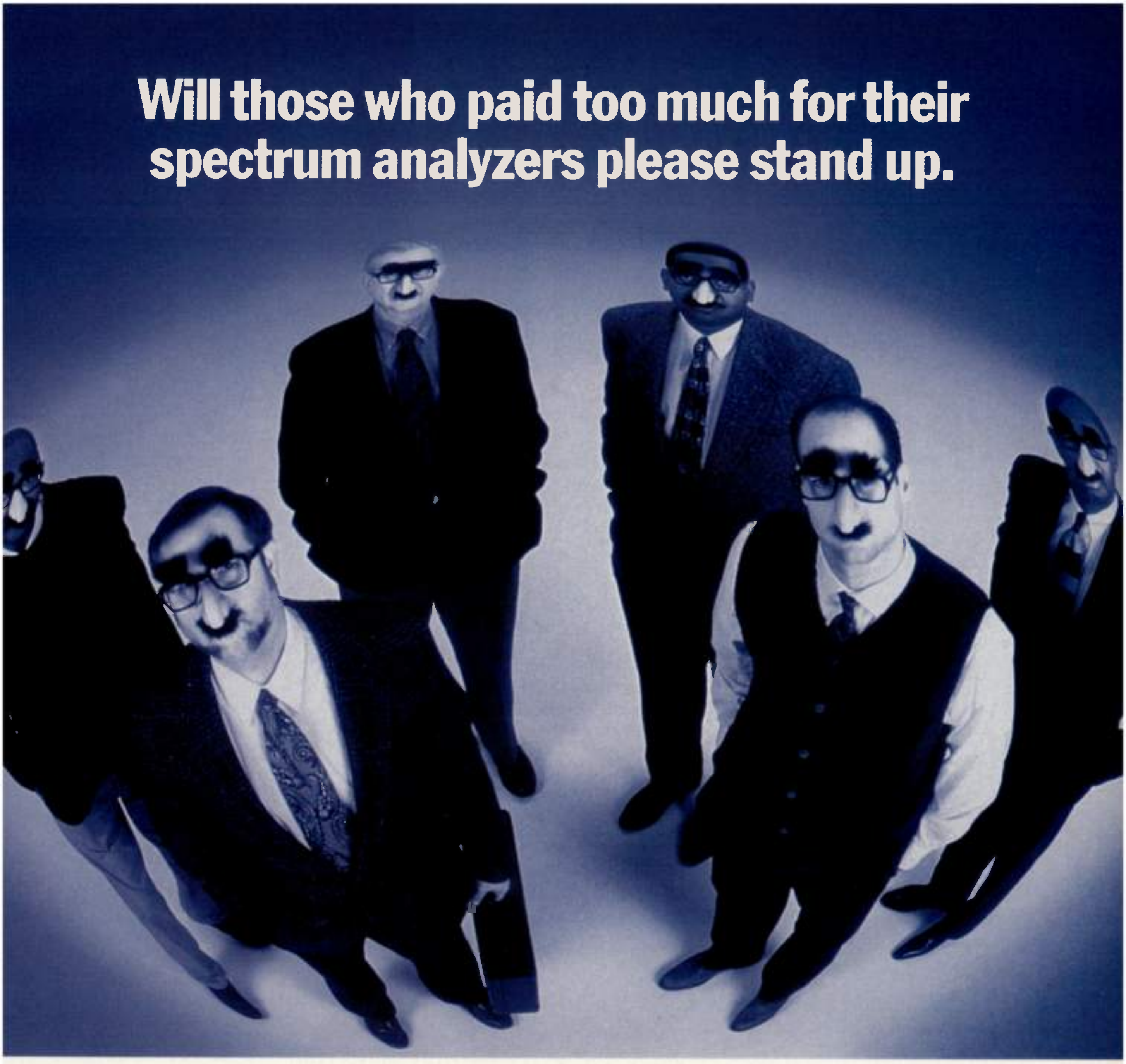

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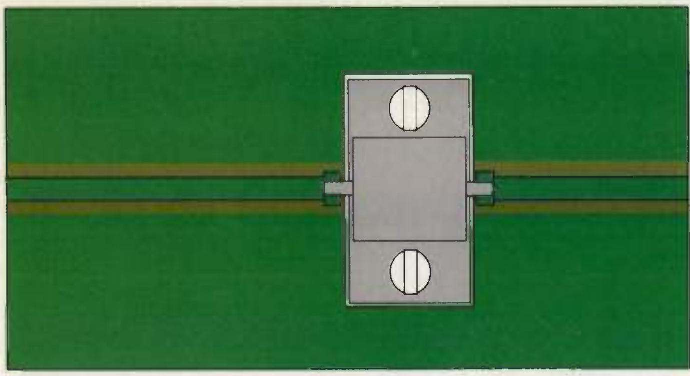

Figure 6. Layer 1 plan view.

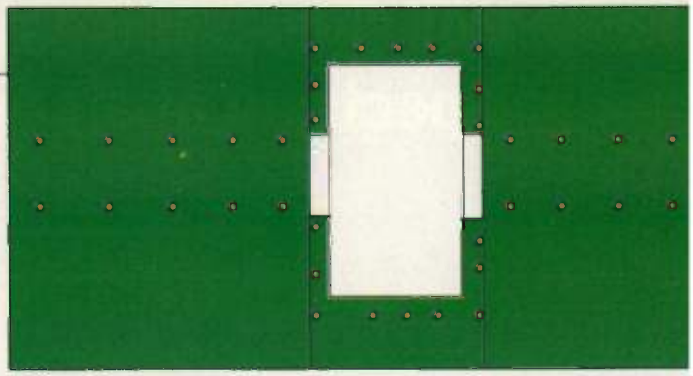

Figure 7. Layer 2 plan view.

width, which in itself may cause unwanted effects (e.g. reflection). Figure 5 shows the completed assembly, which solves the ground discontinuity problem.

Figures 6 through 9 are a series of diagrams showing the layer-by-layer plan views of each part of the new method's construction of a multilayer PCB.

Figure 6 shows layer 1 with the device clearly visible and the tracking to the device shown. The track has been widened near the pins of the device to overcome the ground discontinuity effect discussed in section 5.

Figure 7 shows layer 2, the RF signal ground, in which the via holes can be seen clearly and the cut-out for the cavity can be seen.

Figure 8 shows layer 3, the device's ground layer. Once again, the via holes can be seen clearly and the bolt holes for the mounting of the RF device. The via holes are placed in several locations around the device for good connection between the RF signal ground and the device ground.

Figure 9 shows the final layer of the construction - layer 4 - which is another RF signal layer. The via holes passing through this layer are, of course, isolated from any signal tracking on this layer to prevent shorting of th tracking (note that figures 8 and appear identical. However, there ar slight differences in the model).

Conclusion

A new technique for mounting high power flanged RF devices has been presented. The technique improves on th conventional method for mounting thes devices by making use of a multilaye construction of PCB. This improve ground continuity, reduces the area o board used and gives integrated hea sinking. In addition, possible difficultie with regard to discontinuity of th

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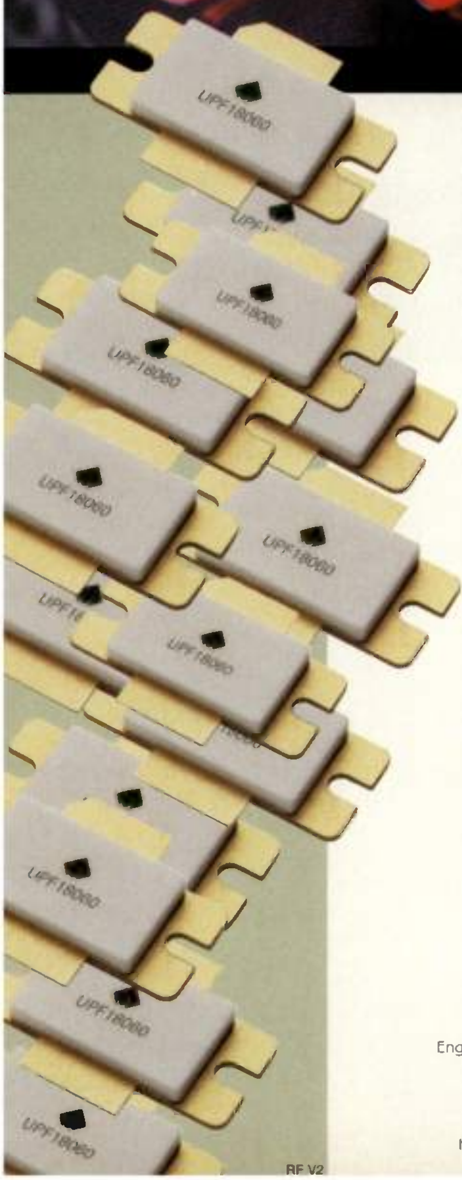

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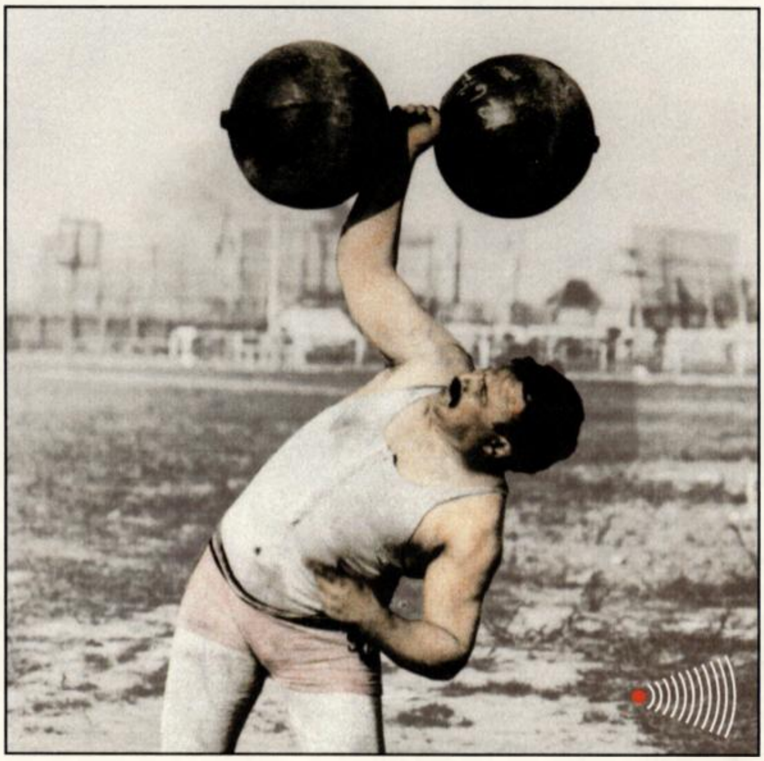

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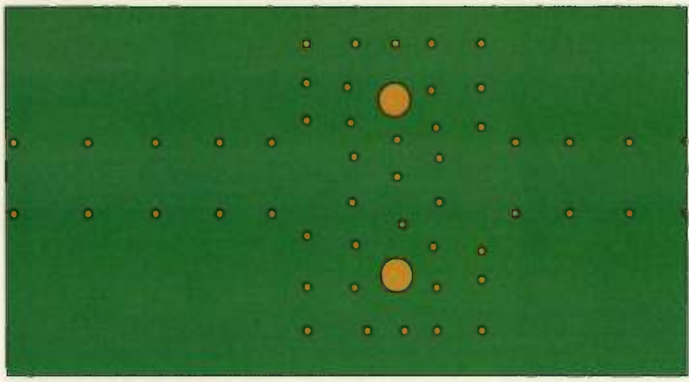

Figure 8. Layer 3 plan view.

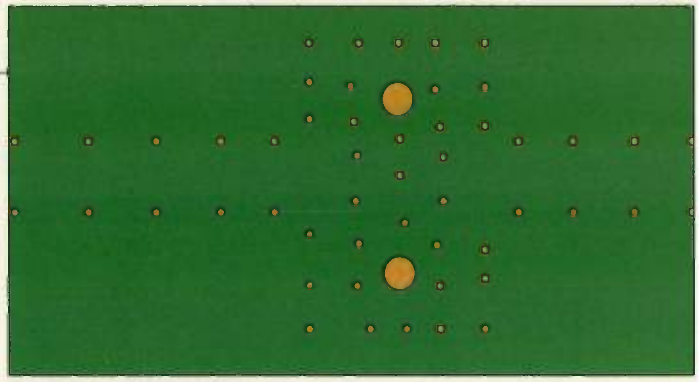

Figure 9. Layer 4 plan view.

grounding near the component's pins have been overcome by the use of a larger track width. The use of accurate mechanical drilling, or preferably z-plane laser drilling, has been recommended to prevent damage occurring to layers during the construction process.

RF

About the authors

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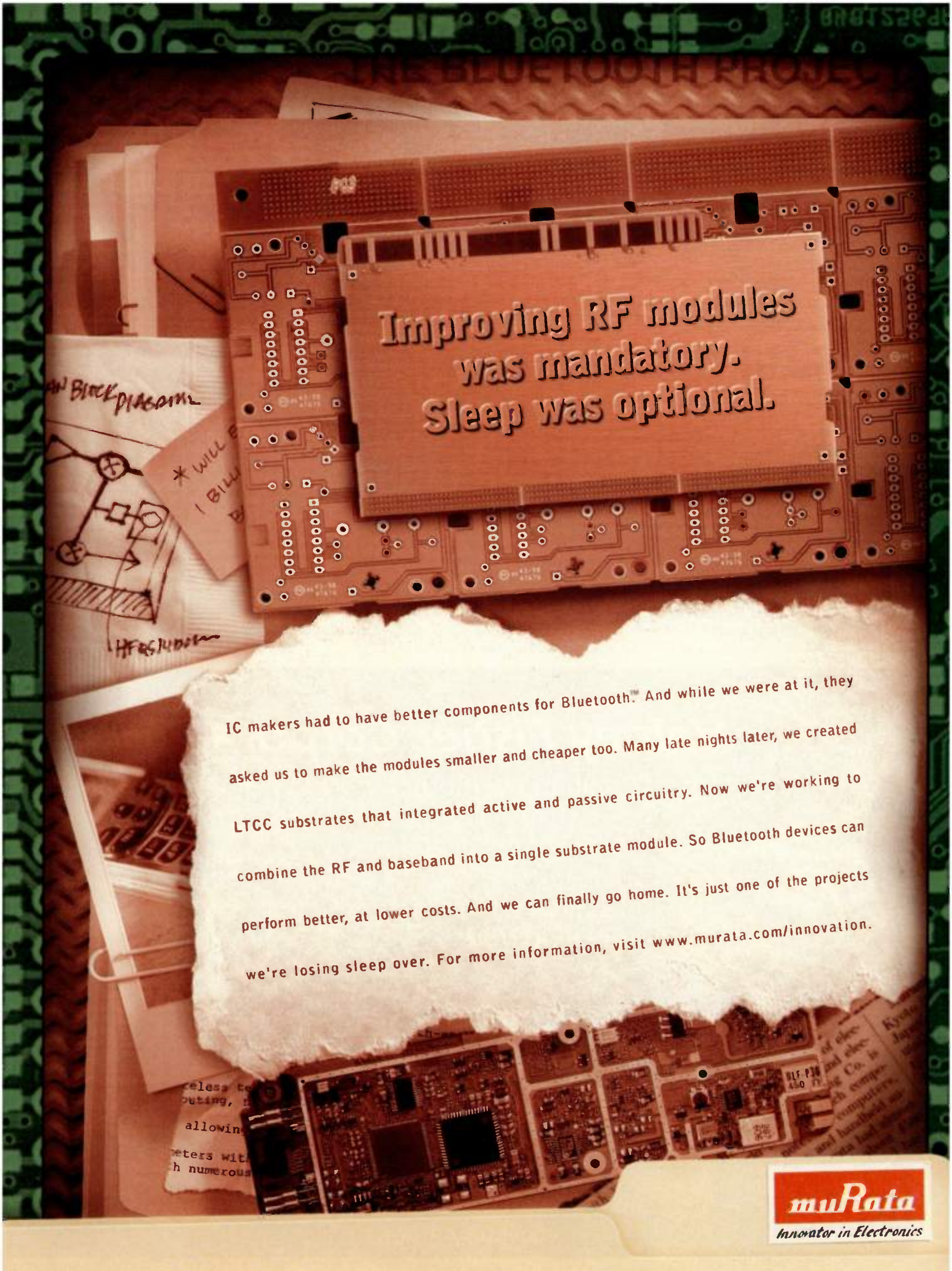
Adam Loveridge is a principal engineer in Wireless R&D Group, Central Research Laboratories, Hayes, Middlesex. He holds a BEng degree from Salford University. He joined Central Research Laboratories three years ago and was previously employed by Ericsson, Nokia and GEC. He can be contacted at +44 (0)20 8848 9779. E-mail: *aloveridge@crl.co.uk*.

The authors wish to thank Central Research Laboratories' PCB manufacturers for useful discussions regarding the technical capabilities of modern PCB houses. and Central Research Laboratories' Wireless R&D Group for their support in completing this work and article.


Improving RF modules was mandatory. Sleep was optional.
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TEST & MEASUREMENT Survey

The world of test and measurement

You use it everyday.
Does your T&M equipment meet your needs?

If there is one constant in product design and production, it's test and measurement equipment. From initial prototyping to quality assurance, test and measurement equipment assures the producer and the end user that the product meets spec.

While no one has yet produced the "perfect" test and measurement setup, manufacturers are working toward that end. In fact, at the recent Wireless Symposium, test and measurement manufacturers presented new test equipment to meet future requirements such as Bluetooth, 3G and beyond.

The editors of *RF Design* hear from test and measurement manufacturers on a regular basis. Now, we would like to hear from you, the reader, about what you think about the equipment you use.

To take part in *RF Design's* survey, please go to our new online home at **www.TelecomClick.com** or go to **www.rfdesign.com**. You can also take part in the survey by faxing the survey form found on page 42. The survey will be conducted through the end of May 2001.

The results of the survey will be posted online and presented in the June 2001 issue of *RF Design*. Please note that this survey is unscientific and will reflect only the opinions of those who took the survey.

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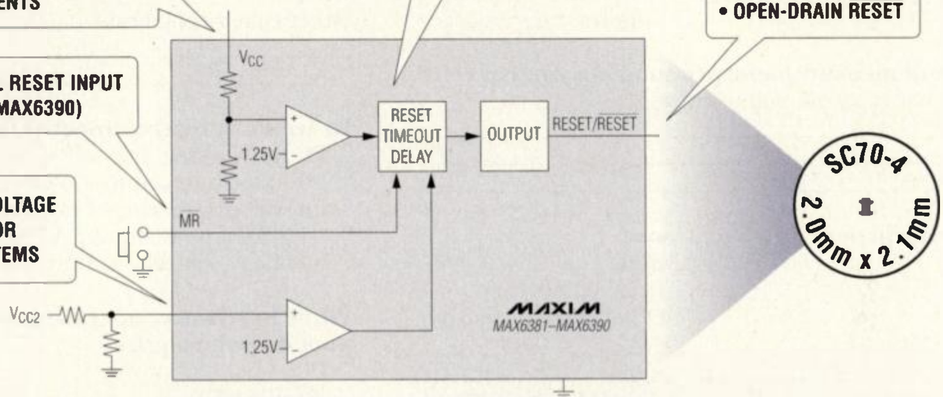

- Reset Thresholds from 1.58V to 4.63V, in Approx. 100mV Increments (2.5% Accurate Over Full Temperature Specifications)
- Low Quiescent Current (3µA Typical)
- Additional Reset Input Can Be Used to Monitor a Second Voltage (MAX6387/8/9)
- MAX6390: V_{CC} Reset Timeout of 1120ms (or 1200ms) with Short 140ms (or 150ms) Manual Reset Timeout
- 1.2s Minimum Timeout Option Compatible with the New Dragonball VZ Processor (MC68VZ328)

PART	PUSH-PULL RESET	PUSH-PULL RESET	OPEN-DRAIN RESET	MANUAL RESET INPUT	ADDITIONAL RESET INPUT
MAX6381/4/7	✓			MAX6384 only	MAX6387
MAX6382/5/8		✓		MAX6385	MAX6388
MAX6383/6/9/90			✓	MAX6386/MAX6390	MAX6389

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TEST & MEASUREMENT Survey

FAX back: 720-489-3253

What is your involvement in specifying, purchasing, or vendor selection? (check all that apply)
- ☐ specify
- ☐ evaluate
- ☐ plan
- ☐ purchase
- ☐ research
- ☐ approve

What test and measurement products do you currently use? (please list type and manufacturer)

____
____
____.

What are your primary applications?
- ☐ T&M
- ☐ QA
- ☐ D&D
- ☐ R&D
- ☐ field engineering
- ☐ Other (please identify)

____
____
____.

Are there any of your test and measurement needs that cannot be met by off-of-the-shelf test equipment? If not, why not?

____
____
____.

Please rate your level of satisfaction with current products.
(rate level of satisfaction on a 1-5 scale with 5 being the highest)

ease of use ____
functionality ____
features ____
price/performance ratio ____
technical support ____
brand name ____
industry standard ____
protocol support (interfaces) ____
interconnectivity ____
other (please elaborate) ______________________
____
____.

What do you look for in test equipment?
(rate level of satisfaction on a 1-5 scale with 5 being the highest)

ease of use ____
functionality ____
features ____
price/performance ratio ____
technical support ____
brand name ____
industry standard ____
modularity ____
digital-based ____
virtual-based (software only) ____
protocol support ____
USB ____
Firewire ____
RS232 ____
IEEE-488 ____
Other (please elaborate) ______________________
____
____.

In terms of interconnectivity, do you require:
- ☐ PC networking
- ☐ interface/interconnect to other test equipment
- ☐ interface/interconnect to a common data pool
- ☐ wide area interconnect (VPN, Internet, LANs)
- ☐ mobility – (wireless interconnect)

What hardware, operating platforms and systems support do you require?
- ☐ PC
- ☐ Windows 9X
- ☐ Windows CE
- ☐ Macintosh
- ☐ Mainframe
- ☐ 32-bit
- ☐ VME
- ☐ Palm support
- ☐ Other (please elaborate)
- ☐ DOS
- ☐ Windows 2K
- ☐ UNIX (and variants)
- ☐ VAX
- ☐ 16-bit
- ☐ Compact PCI
- ☐ VXI
- ☐ PCMCIA support

____.

What software tools do you use (and/or prefer)?
- ☐ Proprietary *(comes with the test equipment)* use___ prefer___
- ☐ Open source (UNIX-based) use___ prefer___
- ☐ Proprietary industry standard *(Microsoft-based / OS / 2)* use___ prefer___
- ☐ Other (please elaborate)

____
____.

What is your primary market?
- ☐ commercial
- ☐ industrial
- ☐ military
- ☐ other (please elaborate)

____.

What improvements and requirements for future generations of test equipment would you like to see?

____
____
____.

What is your job title?

____
____
____.

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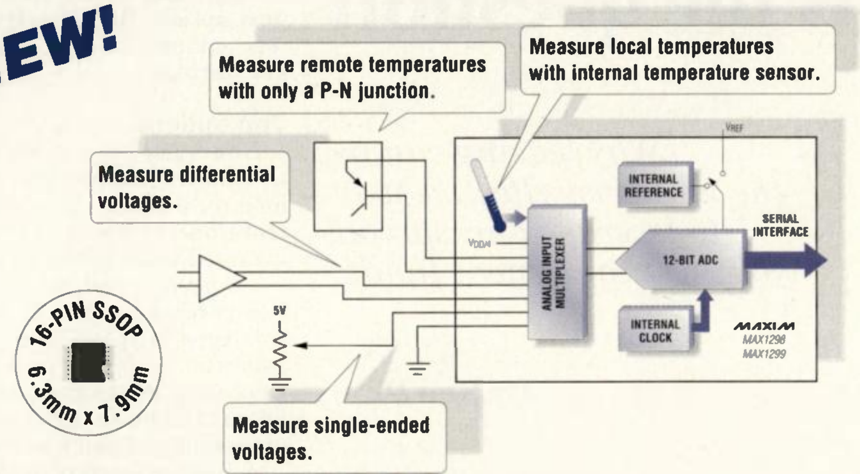

- Internal Temperature Sensor: ±1°C Accurate from -40°C to +85°C
- Single Supply: +2.7V to +5.5V
- Low Power
  - 250µA (Operating Mode)
  - <10µA (Shutdown Mode)
- Measure Two Temperatures—Remote and Local
- Software Configurable Inputs
  - Voltage: Single-Ended/Differential
  - Temperature: Internal/External P-N Junctions

PART	RESOLUTION (BITS)	SUPPLY VOLTAGE (V)	SUPPLY CURRENT (µA)	REFERENCE VOLTAGE (V)	PRICE ($)†
MAX1298	12	+4.5 to +5.5	250	Internal +2.5V or external	3.95
MAX1299	12	+2.7 to +3.6	250	Internal +2.5V or external	3.95
MAX1098	10	+4.5 to +5.5	250	Internal +2.5V or external	3.30
MAX1099	10	+2.7 to +3.6	250	Internal +2.5V or external	3.30

†1,000 pc. resale, FOB USA

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To buy... or to lease... that is the question

Why leasing can be the most cost-effective way to leverage and spread your test equipment funds.

By Ken Pine

Today's rapidly accelerating technology can present engineers with difficult decisions when it comes to acquiring high-performance test and measurement equipment.

The constantly shifting tax rules and regulations could make what was once a fairly straightforward decision one that could easily require the advice of a certified professional accountant.

For busy, time-strapped engineers, leasing can be an ideal solution for managing costs, reducing risk, and keeping abreast of the latest innovations. Leasing offers several options over purchasing: cost, in that you only have to pay for the amortized time that you have it; maintenance, in that maintenance can be included in the lease terms; tax advantages, in that leasing offers better tax options than owning; and regular updates, in that equipment can be cycled after a certain, predetermined period.

The Lease/purchase dilemma.

Overall, leasing has changed over the years and in many cases the changes can benefit your bottom line. Other times ownership is still the best option. But, if you are considering leasing test equipment, here are some ideas to help you get started.

The options

Generally, two different types of leases are available. An operating lease is essentially a long-term rental agreement for periods extending from one to two years. Cost depends on the expected value of the equipment at the end of the lease period, and can be in the range of one to two percent per month of the original value. In this type of lease, ownership of the equipment remains with the party extending the lease. Operating leases for test equipment are rare for all but the most stable of instruments due to the uncertainty of value at the end of a year or two.

A finance lease typically runs for three to four years, and transfers ownership of the equipment to the user at the end of the agreement. Cost is determined by amortizing all but one dollar of the original value over the term with an interest charge determined by the financial market and the credit worthiness of the user. Typically, the monthly fee runs two to three percent.

As was mentioned earlier, it is important to understand that business accounting rules and the IRS treat each of these types of leases differently. An operating lease does not require the value of the instrument to be posted by the user as a financial obligation. The monthly fee can be attributed to a particular project and treated as an ordinary expense. On the other hand, a finance lease requires the company to post the total amount of all payments for the term as an obligation. In addition, for tax purposes, a finance lease is considered a conditional sales contract, meaning the monthly payments cannot be directly deducted. The equipment would have to be capitalized and the tax deduction determined by IRS depreciation schedules.

The variables

Before deciding to lease, the user must consider the project at hand, the lease terms available, and the cash position and financial requirements of the company.

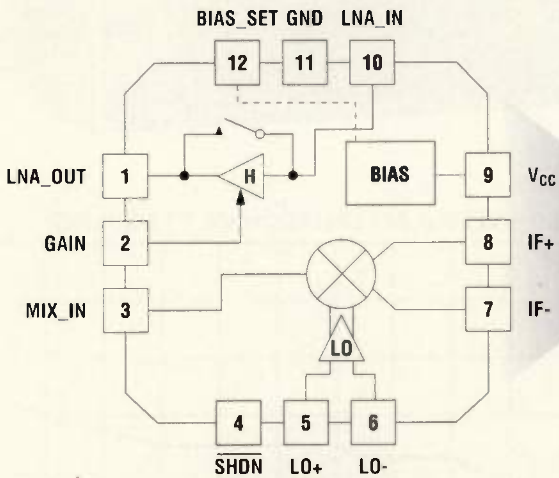
- If the project at hand is going to extend over a period beyond a year, and the test equipment will no longer be needed or might be obsolete at completion, an operating lease would be the ideal choice.
- If a company needs to conserve cash, leasing is

Continued on page 48

W-CDMA 2GHz LNA/MIXERS DRAW LESS THAN 8mA

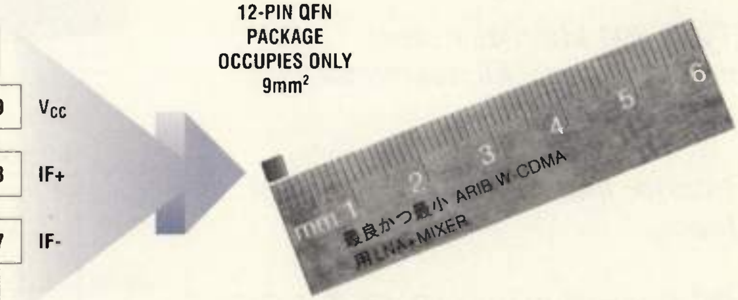
Perform Better than Discretes in Less than Half the Size

The MAX2387/8/9 are designed for the emerging ARIB (Japan) and ETSI-UMTS (Europe) third-generation wideband CDMA (W-CDMA) markets. These SiGe devices consist of a dual-gain LNA and a low-current, ultra-low-noise mixer, both optimized for 2110MHz to 2170MHz operation. Their high gain and IP3 simplify meeting system noise and interference specifications, and the adjustable-gain LNA increases dynamic range while reducing average current consumption to less than 8mA. The new 12-pin leadless QFN package measures only 3mm x 3mm, which saves valuable board space. For applications not requiring an on-chip LO buffer, Maxim offers the MAX2389.



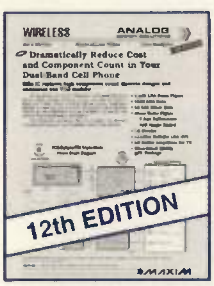
MAX2387/MAX2388

12-PIN QFN PACKAGE OCCUPIES ONLY $9mm^2$



PART	LO INPUT POWER	LNA GAIN (HIGH GAIN/LOW GAIN) (dB)	MIXER GAIN (dB)	CASCADE NOISE (2.5dB FILTER LOSS) (HIGH GAIN) (dB)	CASCADE IIP3 (2.5dB FILTER LOSS) (HIGH GAIN) (dBm)	SUPPLY CURRENT (HIGH GAIN/LOW GAIN) (mA)
MAX2387	-10dBm ±3dB	15/-16.5	10	2.4	-5.7	10.7/7.2
MAX2388	-10dBm ±3dB	15/-3	10	2.4	-4.2	10/6.7
MAX2389	-4dBm ±3dB	15/-3	10	2.4	-7.8	7.9/4.7

IP3s range from +3dBm to +4dBm for the LNA and from +5dBm to +9dBm for the mixer.



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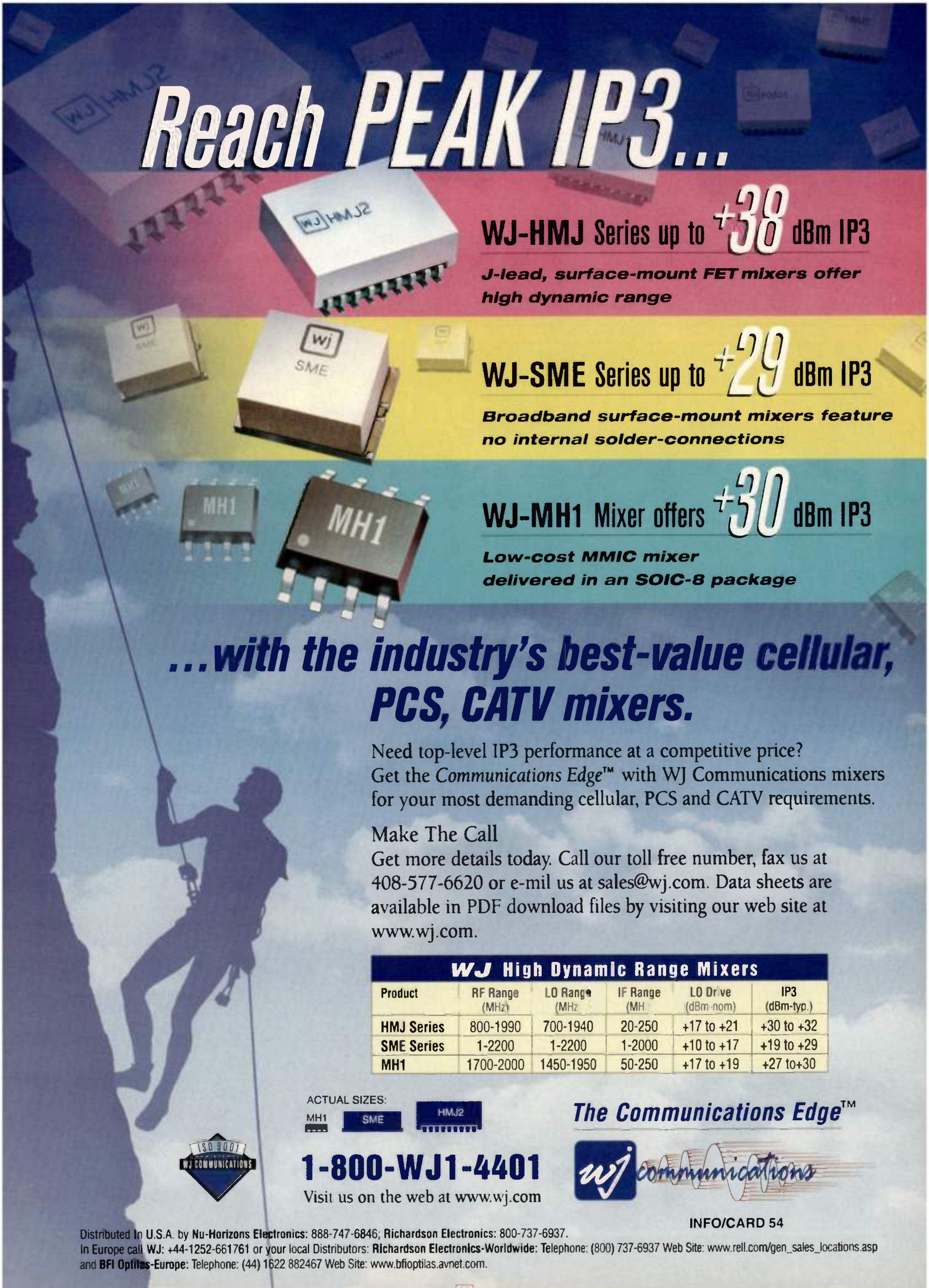


WJ High Dynamic Range Mixers

Product	RF Range (MHz)	LO Range (MHz)	IF Range (MHz)	LO Drive (dBm-nom)	IP3 (dBm-typ.)
HMJ Series	800-1990	700-1940	20-250	+17 to +21	+30 to +32
SME Series	1-2200	1-2200	1-2000	+10 to +17	+19 to +29
MH1	1700-2000	1450-1950	50-250	+17 to +19	+27 to+30

always a desirable option. For example, instead of spending $33,000 cash for a new oscilloscope that is slated for a project expected to last 12 to 18 months or more, the user can choose instead to lease the equipment for approximately $600 to $900 per month.

- Depending on a company's financial position, an operating lease may be very attractive, even if the term of use is indeterminate, and obsolescence is not an issue. The possibility of acquiring an important, and high-cost piece of test equipment without an impact on the financial statement could be the most important consideration.

Renting might also be considered when the possibility of obsolescence is the primary concern. The cost is much higher than a lease, typically running up to five percent of original value, but the risk is minimal. The equipment can be returned at any time when changes in clock speed or frequency range change substantially, as they often do in products such as logic analyzers, digital oscilloscopes, and signal analyzers.

When leasing is chosen as the desired option, it may take some time to determine the best direction and type of lease or rental agreement. It is always prudent to talk to those that have had some experience with leasing test equipment because leases can become quite complex and riddled with small print. It is also best to deal with reputable and reliable companies that specialize in leasing and have a large inventory of maintained products.

In the long run, it pays for engineers to know the differences between leasing and renting, as well as the type of lease that best suits them. By evaluating your projects and determining your purchasing criteria – whether you need to conserve cash or take risk mitigation – you will be better informed to choose the right avenue for your testing needs.

RF

About the authors

Ken Pine is the Alliance Programs manager at TestMart. Pine oversees the development, expansion, and maintenance of TestMart's growing worldwide supplier relationships, which currently number more than 70 alliance partners. Previous to joining TestMart, Pine held senior-level positions at Dolch Computer Systems, including director of international marketing and senior product market manager, where he managed the company's entire product line, marketed Dolch's portable computers and displays, and established a highly effective distributor network. Prior to working at Dolch Computer systems, Pine oversaw sales and marketing activities at Wordsong, Intech Instrument Division and BP Instruments. Pine earned a B.S. in engineering science from UC Berkeley. He can be contacted at: **www.testmart.com**

Managing the wireless Internet

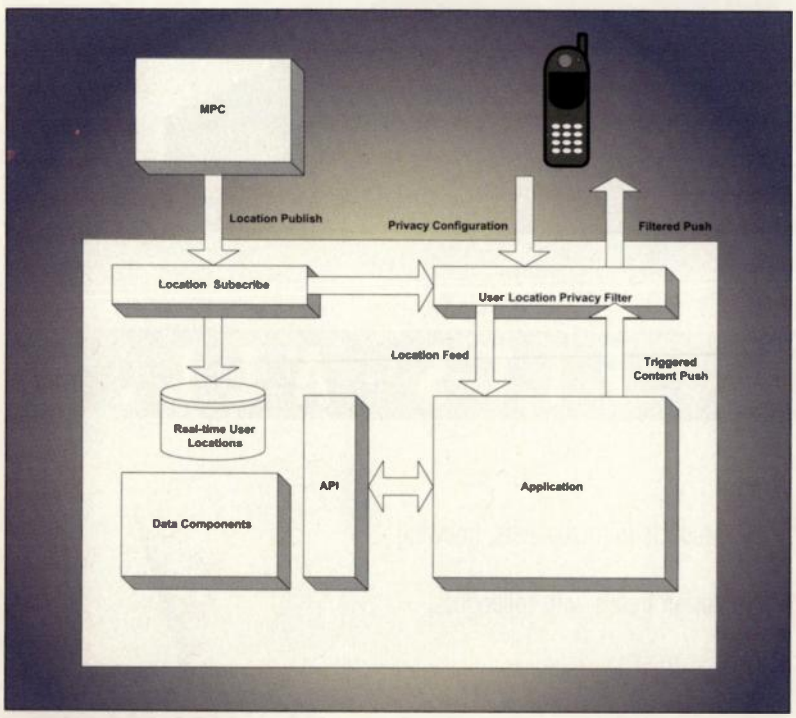
Can a software platform for location-precise mobile data management and wireless Internet services affect the wireless industry?

By Geoff Hendrey

Location and mobility are the defining characteristics of a cellular phone or personal digital assistant (PDA). Yet initial wireless Internet applications have not taken advantage of location as a form of content or service triggering.

Location-based services (LBS), however, are now beginning to emerge as one of the most exciting topics in mobile communications. Such services are based on a software platform that uses the geophysical location of the mobile unit (MU) as part of its algorithm for generating presentation content.

Location has been a critical component of network and transport layer protocols for many years.



Location services platform.

Cellular networks have long struggled to provide continuous connectivity while the MU moves between cells.

For cellular networks, mobility is a problem that has been overcome through the implementation of cellular handoff and roaming. Mobility also presents a great challenge to Internet applications using terminal connection point (TCP) and Internet protocol (IP). At the network layer, Mobile IP and IPV6 have addressed some routing problems, while others have been tackled by ad-hoc routing protocols such as data set ready (DSR) and ad-hoc on demand distance vector (AODV). At the transport layer, issues associated with TCP error recovery have been identified and patched for the mobile environment.

So, the exploration of mobility is not new to mobile computing, but the practical application of location information to end-user services is a recent innovation. The challenge is to manage, aggregate, access and present this location data to a MU.

FCC E911 mandate

The diversity of technologies available for MU location in the United States cannot be understood without briefly covering the Federal Communications Commission's Enhanced 911 (FCC E911) mandate. Because response time to emergency calls to fire and police is critical, the FCC has mandated that carriers implement a technology for locating their wireless customers automatically. Many carriers have complied with the Phase 1 requirements by selecting a technology to meet the FCC mandate. Deployment of the technology will begin this year to meet Phase 2 compliance by October. The E911 mandate makes a distinction between embedded GPS solutions and network-based locating methods. GPS solutions must be accurate to 50 meters, while network-based methods have a less-stringent requirement of 150 meters.

Surveying the locating technologies

Location-based services are enabled in part by the technologies that physically locate the MU. These technologies can be grouped into two categories: global positioning system (GPS)-based methods and network-based methods. There are several subgroups within each category.

- GPS — GPS-based methods use signals generated from 24 government satellites orbiting the earth to determine the position of the MU. Though accurate to a few meters, GPS signals are difficult to receive indoors. Of late, there are commercially available GPS solutions that overcome many of these problems and achieve signal lock quickly even indoors and in urban canyons.

The main disadvantage to the GPS solution is that it requires the user to purchase a new mobile phone equipped with GPS technology. Many carriers may be averse to this "churn" because a customer purchasing a new phone is likely to switch carriers.

- Network-based — An alternative to GPS employs network-based methods. At a high level,

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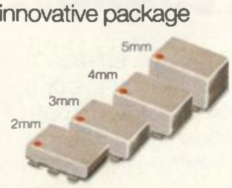

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ADE* TYPICAL SPECIFICATIONS:

Model	Height (mm)	Freq. (MHz)	LO (dBm)	Conv. Loss Midband (dB)	L-R Isol. Bandwide (dB)	IP3 (dBm) @ Midband	Price ($ea.) Qty. 10-49
ADE-1L	3	2-500	+3	5.2	55••	16	3.95
ADE-3L	4	0.2-400	+3	5.3	47••	10	4.25
ADE-1	4	0.5-500	+7	5.0	55••	15	1.99
ADE-1ASK	3	2-600	+7	5.3	50••	16	3.95
ADE-2ASK	3	1-1000	+7	5.4	45••	12	4.25
ADE-6	5	0.05-250	+7	4.6	40	10	4.95
ADE-12	2	50-1000	+7	7.0	35	17	2.95
ADE-4	3	200-1000	+7	6.8	53••	15	4.25
ADE-14	2	800-1000	+7	7.4	32	17	3.25
ADE-901	3	800-1000	+7	5.9	32	13	2.95
ADE-5	3	5-1500	+7	6.6	40••	15	3.45
ADE-13	2	50-1600	+7	8.1	40••	11	3.10
ADE-20	3	1500-2000	+7	5.4	31	14	4.95
ADE-18	3	1700-2500	+7	4.9	27	10	3.45
ADE-3GL	2	2100-2600	+7	6.0	34	17	4.95
ADE-3G	3	2300-2700	+7	5.6	36	13	3.45
ADE-28	3	1500-2800	+7	5.1	30	8	5.95
ADE-30	3	200-3000	+7	4.5	35	14	6.95
ADE-32	3	2500-3200	+7	5.4	29	15	6.95
ADE-35	3	1600-3500	+7	6.3	25	11	4.95
ADE-18W	3	1750-3500	+7	5.4	33	11	3.95
ADE-30W	3	300-4000	+7	6.8	35	12	8.95
ADE-1LH	4	0.5-500	+10	5.0	55••	15	2.99
ADE-1LHW	3	2-750	+10	5.3	52••	15	4.95
ADE-1MH	3	2-500	+13	5.2	50••	17	5.95
ADE-1MHW	4	0.5-600	+13	5.2	53••	17	6.45
ADE-12MH	3	10-1200	+13	6.3	45••	22	6.45
ADE-25MH	3	5-2500	+13	6.9	34••	18	6.95
ADE-35MH	3	5-3500	+13	6.9	33••	18	9.95
ADE-42MH	3	5-4200	+13	7.5	29••	17	14.95
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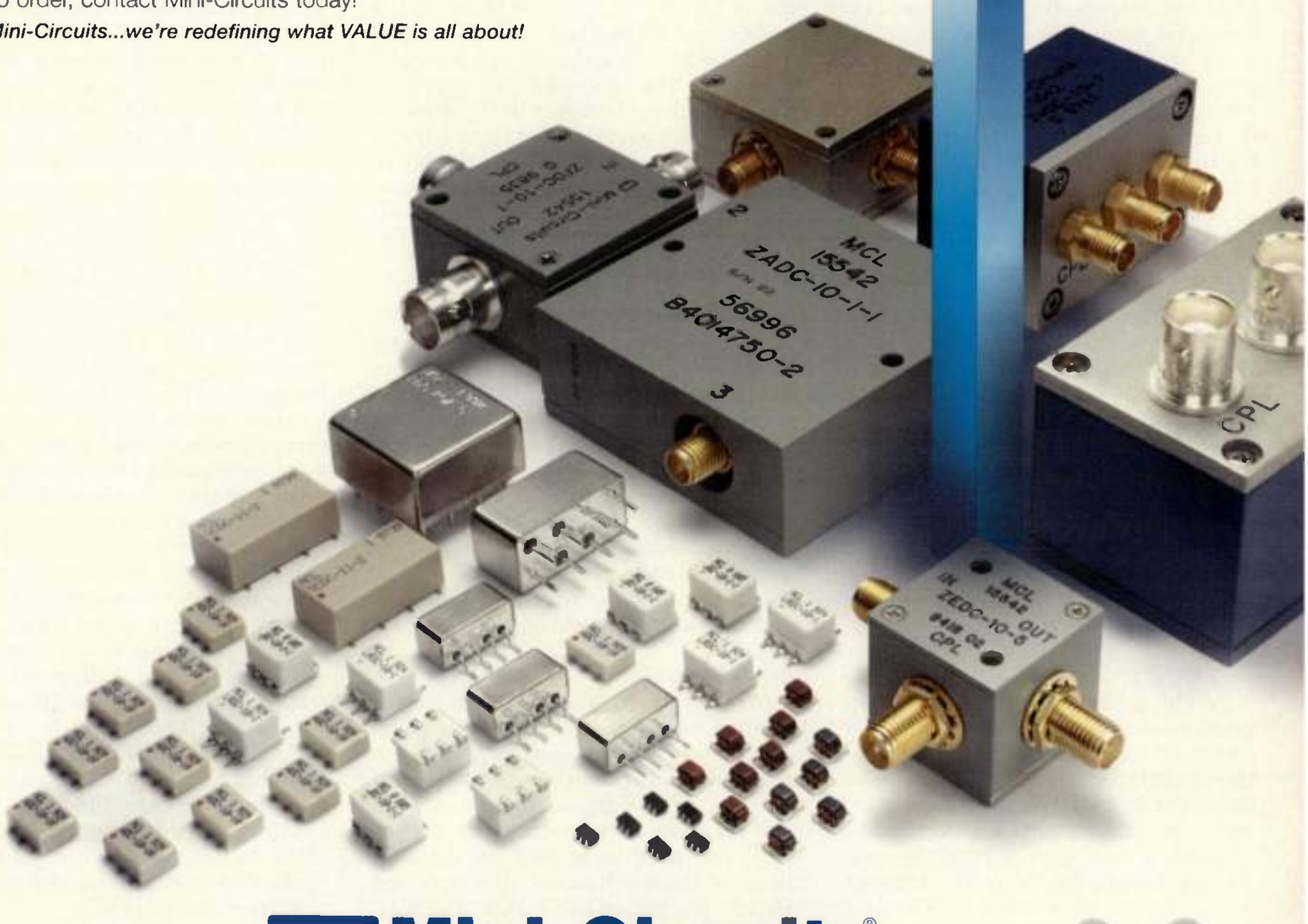

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these methods involve triangulating the radio emission of the phone or using RF multipath "fingerprinting" to identify the most likely position of the radiating source. There appear to be significant performance advantages to the multipath method over triangulation in urban environments. Accuracies of 30 meters are being quoted by major manufacturers of multipath systems, which is well within the 150-meter requirement of the E911 mandate. While less accurate than GPS, and perhaps more expensive for the carrier to integrate, network-based methods work on existing phones. This means a massive locatable user base and reduced churn for the carrier.

First-generation LBS services

First-generation location blind services (LBS), are those that allow users to request information about their physical surroundings. First-generation LBS require users to manually enter their location, (e.g. ZIP code or street address). Because the users are responsible for locating themselves, a first-generation LBS is decoupled from the underlying technology. That is, the LBS does not rely on the network to provide the MU's location. Consequently, first-generation LBS would typically be accessed from a stationary home computer.

Examples of first-generation LBS are MapQuest, CitySearch and other local information services. A mobile form of first-generation LBS would be a service such as that provided by AvantGo, which requires a user to download location-based information prior to arriving at that specific location. When accessed from a MU, the user follows the same steps as when accessed from a stationary PC, though often with more difficulty due to the MU's input device limitations.

Second-generation LBS services

Second-generation LBS, (also called location-aware), are services capable of extracting some location information from the underlying network without user entry. For example, ZIP code level or cell sector location information is currently available to developers of Palm OS applications through the Palm Net data network. Second-generation LBS are not accessible from a stationary PC because automatic locating capability is not currently available for the desktop computer.

User initiation of services is a characteristic of second-generation LBS, which operate in pull mode. All LBS deployed today, such as services provided by Vindigo, are second-generation, typically providing mobile-user to static object content (e.g. "find the closest theater to the MU").

Third-generation LBS services

Third-generation LBS, (also called location-precise services), have the capability to automatically provide or proactively initiate services relative to the precise location of the MU without the user making an explicit input or request. Such a self-initiating service is said to operate in trigger mode. A trigger is a condition arising, in part, from the geophysical location of the MU. The trigger then allows delivery of information to be offered based on the location of that MU.

Trigger-mode services can overcome many of the current problems with mobile applications that include general user aversion to making even a simple request via keypad or stylus. Configuration of trigger-mode services can typically be completed from a traditional Web browser and have the beauty of providing the user with relevant information and services when and where the user needs them without the user having to ask.

Software platform solutions

To take advantage of the emerging location technologies, applications developers will require access platforms that specifically address the development of location-precise applications and include support for trigger mode services. These platforms will need to be built around a comprehensive, distributed and scalable software architecture based on flexible standards to allow for the rapid, flexible and robust deployment of LBS.

Interconnection to MPCs

Worldwide, a variety of formats for location information will be produced by mobile positioning centers (MPC) for consumption by authorized external entities. While organizations such as the location interoperability forum (LIF) are working toward the development of standardization, it is expected that in the immediate future, the positioning data formats are likely to be, and will need to be, universally presented. A robust LBS platform will need to support all standards for location data.

The most obvious strategy for obtaining a location document from an MPC is to poll. That is, when the MU requests a LBS, a request is made to the MPC to report the MU's position. This works for pull-mode services that are user-activated. The scenario is more complicated for push-mode services. In push, or trigger mode, the LBS desires constant access to the most recent position of the user.

Polling multiple distributed location servers is not a realistic option for specific reasons. First, the MPC will suffer from flooding, much like a ping attack, as all of its clients attempt to position their user lists as often as possible. Additionally, the position of users is unlikely to be updated regularly in most MPCs. For example, a MPC that relies on RF signals radiated from a mobile phone may be able to position a MU only during an active call, or a system registration event. This makes periodic polling an inefficient solution for trigger mode services. Furthermore, a constant polling will create network congestion and inefficiencies at costs that might not be affordable to adequately deploy LBS. Take, for example, the case of a mere one million users whose location would be updated every five minutes. This simple scenario will require 12 million MU location updates per hour. Scalability will be challenged.

Privacy concerns

A model that will allow for automatic location information updating without being a function of changes in the users location will quickly raise privacy concerns. Service providers and applications developers alike will need to ask and answer basic questions: How does an application gain permission to subscribe to a MU's current location? How does the MU control disclosure of the user's position to other users and services?

Several unique and complex solutions to these problems would employ either systems that are configured and controlled by the user of the MU or systems that are triggered by the user. For example, using the accepted Web-based function of user profiles, a developer working from a profile-based software platform could write an application allowing mobile users to customize their profiles to choose when and where location information is to be updated. This functionality allows the platform to perform the monitoring of location-specific data on behalf of the user. The framework is open so that content developers

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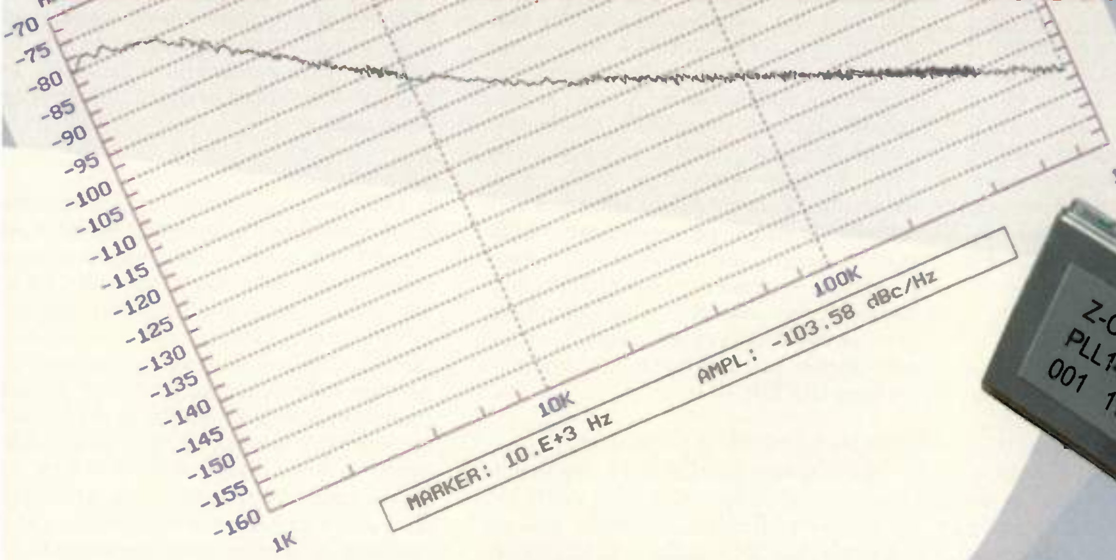

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can easily make new local content and services available for user configuration and customization. Another method would be to deploy, for voice-enabled devices, a voice-geocode solution. Using advanced speech recognition, text-to-speech and speech-to-text technologies, a voice-geocode can be engineered to allow users to speak their location information. This ultimate privacy system allows users to benefit from location information when desired without the fear of Big Brother watching.

Profile trigger-mode services

A detailed example can illustrate the power of location-precise profiled trigger mode services. Consider a Web site that provides local movie listings. The Web site, given a user's current location, would have the capability to list movie theaters nearest to that user, along with current show times for each movie and ticket price.

An application developer could easily create a series of triggers as a function of a user-defined profile. These triggers would leverage the data residing in the database and accessed by users of the services. The user of a MU would be provided with information only when proximate to a movie theater showing a specified movie or movie type within a specified time element. The user would also indicate the form of "alert" that would be initiated, such as a short message service (SMS) or browser message. Therefore, by defining a profile, a user would protect both the time and location privacy of the MU and filter only information relevant to that user's needs at certain times and in certain locations.

The net effect of the profile is that when the user's MU comes within a certain distance of a movie theater showing the latest requested movie, the MU will be sent a page message, but only if the MU's profile has defined the page as being acceptable.

Necessary data components

In many cases, developers of a simple pull- or push-mode application may want to provide a series of value-added services to enrich the experience of the user. Services such as mapping, driving directions, city guides, Yellow Pages, weather forecasts or proximity of other points of interests (ATM, bank, parking, restaurant) may be important considerations to the user of a MU. Therefore, LBS will be driven in part by large volume of localized information maintained by a variety of organizations and distributed over the Internet. As a result, content providers will require a simple way to expose their data to developers and ultimately mobile users. A total end-to-end solution must consider these data components as probable necessities for LBS. Such an application server platform solution must easily offer this rich content via simple protocols that provide remote component access to developers of servlets, java server pages (JSP), common gateway interface (CGI) scripts or even embedded java, by passing necessary documents over hyper text transfer protocol (HTTP).

Managing moving point data

The inherent particularity of a mobile device is the simple fact of mobility-the ability to constantly move while remaining connected. To maximize the functionalities that can be delivered to a wireless device, enablers will need to adequately manage, in real time, the movement of wireless devices. The real-time database of mobile user locations presents a rich data source to allow for new functionalities for location-precise services, offering what is referred to as mobile-to-mobile and static-to-mobile services. Examples of mobile-to-mobile applications are business networking, a dating service or a mobile game that provides alerts when users come within proximity of each other. Static-to-mobile service is, for example, a retail location that wishes to advertise to mobile users who enter a polygon surrounding that location.

These services will not come without significant technology and innovations. Again, remember that a user base of one million "locatable" handsets in an urban area whose locations information are updated every five minutes will generate more than 12 million updates per hour. To compound the problem, a single position update may easily trigger multiple queries. This enormous base of perpetually moving data points and perpetual checking of profiles presents a completely new challenge to databases. A common oversight of young location-based enabling services is the failure to take into consideration the challenges represented by moving point data. It should be noted that, without enhancements, current professional database products simply cannot provide adequate update and query times for any large quantity of moving point data.

In order to cope with this computationally complex problem, a limited number of companies have developed proprietary software systems to significantly optimize database products to handle the management of moving point data.

LBS services for tomorrow

Location-precise services can improve human-machine interaction by increasing the relevance of information served to mobile devices. Over the next 12 to 18 months, organizations with emerging wireless strategies will seek to location-enable their wireless services to provide differentiated proximity-based consumer services. These services will require scalable, robust and deployable location-enabling platforms. Few of these total solutions are currently under development and few have the capabilities to completely handle end-to-end functionalities. Businesses contemplating a location-based service strategy will need to carefully define their strategy. The world of LBS is complex, and choosing the appropriate enabling partner is an integral part of that strategy. The answers to six simple questions will help in the selection process: Do you understand all locating technologies? Do they have the tool set required to develop intelligent location-precise services? Do they have prior experience in "live" markets (Japan, Korea, Europe)? Is the solution built on an open and scalable architecture? Can they handle mobile-to-mobile queries? And finally can they deploy applications built around trigger services?

RF

About the author

Geoff Hendrey co-founded Gravitate in 1999. Prior to founding Gravitate, Hendrey served as a systems engineer for Trimble Navigation where he developed wireless digital modem hardware for GPS correction receivers. He holds an MS in electrical and computer engineering from Carnegie Mellon Institute of Technology. In addition, he has filed seven patents since July 1999 in m-commerce, mobile-to-mobile and location-precise wireless. He can be reached at: Gravitate Inc. 713 Linden Avenue South San Francisco, CA 94080 P: (650) 873-4373 F: (650) 873-4393 E-mail: *geoff@grvt8.com*

Advances in SAW technology

The latest in surface acoustic wave technology meets the demands of miniaturization, dependability and economics.

By Darrell L. Ash

In today's world, "going wireless" is associated with eliminating cumbersome wires and cables; making it possible to roam untethered anytime, anywhere, with fully operational systems.

There are three basic wireless systems in the modern market. One is represented by cellular phone systems, including systems that have a range of as long as several kilometers (such as cellular phone systems). The second is represented by two intermediate-range unlicensed systems: spread-spectrum systems and narrowband systems. Such systems have a typical range of 300 meters or more, due to higher transmitter power (up to 1 W) for spread-spectrum links, and greater receiver sensitivity (–115 to –110 dBm) for narrowband links. The third is the short-range unlicensed system that has a typical range of 1 to 100 meters.

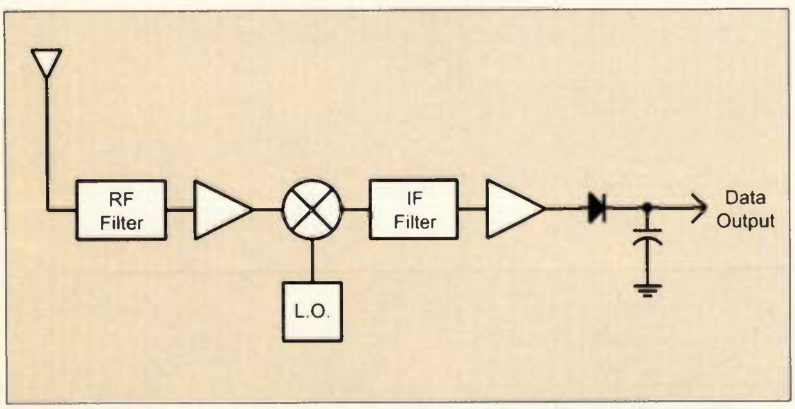

Figure 1. A diagram of a simple, single-conversion superheterodyne receiver.

The variety of applications for short-range wireless systems surpasses that of the long-and intermediate-range systems. Short-range applications include automotive keyless entry, garage door and gate openers, wireless security systems, data links, wireless barcode readers, electronic personal ID, remote meter reading, animal tagging, in-house arrest systems, wireless keyboards, wireless mice and wireless joysticks, among others.

Some desired attributes of the receivers and transmitters used in these short-range systems include low-cost, low-power consumption, miniature size, no adjustments, good frequency stability, good range, the ability to operate in a crowded frequency spectrum and ease of application by engineers with limited RF training. One of the more stringent applications requires a receiver and a transmitter to be included in a small wristwatch.

To meet these stringent TX/RX specifications, surface acoustic wave (SAW) technology has risen to the challenge.

Current TX/RX technologies

• *Transmitters*

Current low-power transmitters primarily include either SAW-stabilized oscillators or crystal-stabilized frequency synthesizers. Crystal-stabilized frequency synthesizers have greater frequency accuracy than SAW transmitters, but consume more power, have more spurious frequencies, are physically larger and cost more. The bulk crystals used as the frequency reference for such synthesizers are also fragile and frequently break when subjected to drops or impact.

SAW-based transmitters are rugged in comparison. Cost, power consumption, size and ruggedness are the most critical requirements for such step recovery diode (SRD) transmitters. The additional cost, power consumption, fragility and size of frequency synthesizers are only justified if the system uses a narrowband receiver that requires additional frequency accuracy.

• *Receivers*

The most popular current receiver technologies are the super-regenerative, superheterodyne and amplifier-sequenced hybrid (ASH) receivers. The inductor/capacitor (LC)-based super-regenerative receivers are rapidly being replaced by the other two receiver technologies. This is due to the poor frequency stability, reliability and out-of-band rejection of unwanted signals of the earlier designs. Desirable attributes of the super-regenerative receiver are low power consumption and low cost.

• **Superheterodyne** – Figure 1 shows a block diagram of a simple, single-conversion superheterodyne receiver. This receiver achieves the stable gain necessary to achieve high sensitivity through simple frequency diversity. Because the RF and IF amplifiers are not at the same frequency, feedback from the IF amplifier output to the RF amplifier input does not cause a stability problem. Even more stable gain can be added by increasing the number of conversions or IFs. In addition, more rejection of unwanted signals is achieved by splitting the filtering between RF and IF filters, thus eliminating the crosstalk that occurs when filters are cascaded at the same frequency. As a result, this receiver architecture achieves good sensitivity and good out-of

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ERA-33SM	DC-3000	17.4	13.5	3.9	28.5	40	1.72
ERA-3SM	DC-3000	20.2	11.5	3.8	23.0	35	1.72
ERA-6SM	DC-4000	11.3	▲17.9	▲8.4	▲36.0	70	3.90
ERA-4SM	DC-4000	13.5	▲16.8	▲5.2	▲33.0	65	3.90
ERA-51SM	DC-4000	16.1	▲18.1	▲4.1	▲33.0	65	3.90
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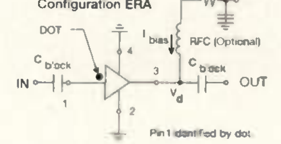

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band rejection. If the RF filter is wide enough, or is tunable, varying the local oscillator frequency can change the reception frequency of this receiver. One significant disadvantage is that frequency selectivity in the RF filter must be compromised to allow frequency agility. Other disadvantages include relatively large physical size, high power consumption, the need for a stable local oscillator, oscillator radiation, mixer spurious responses (especially the image frequency) and critical circuit-board layout.

The relatively large physical size is due to the need for a SAW device or a crystal to stabilize the local oscillator; a SAW or other technology for an RF filter; and a SAW, ceramic or LC IF filter. The IF filter can be large because of its relatively low frequency. The high power consumption is primarily due to the need for the local oscillator to develop an RF level high enough to drive the mixer into non-linearity while minimizing intermodulation and cross-modulation distortion in the mixer.

• **Amplifier-sequenced hybrid receiver** – Figure 2 shows a simplified block diagram of this receiver's architecture. This receiver achieves the stable gain necessary to obtain high sensitivity through time diversity. The high-gain RF amplifiers, on each side of the SAW delay line, are turned on and off by a pulse generator. When one amplifier is on, the other is off and vice versa.

Because the two amplifiers are not on at the same time, feedback from one amplifier to the other does not cause the circuit to become unstable. The delay line serves as a storage element; supplying signal to the second amplifier while the first amplifier is off.

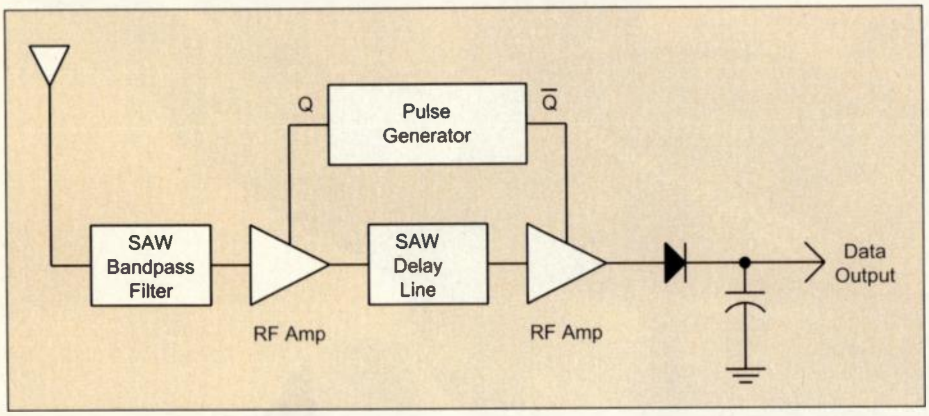

Figure 2. ASH simplified block diagram.

Filtering in this receiver is provided by the SAW bandpass filter and the SAW delay line. Normally, two filters at the same frequency would be limited in out-of-band rejection to much less than the resultant cascaded 100 dB by the crosstalk level that could be achieved with a particular circuit layout. However, the switching of the amplifiers effectively gates crosstalk around the delay line filter out. This provides a single-ended connection to the antenna and a differential connection to the RF amplifier, taking advantage of common-mode rejection, and, effectively eliminating crosstalk around the SAW bandpass filter. The result is a receiver with sensitivity and frequency selectivity similar to a superheterodyne receiver.

The ASH receiver architecture offers several advantages over previous architectures. All of the functions, except the two SAW devices, are included in a single custom integrated circuit. Because the SAW devices are at RF rather than a low IF, they are extremely small.

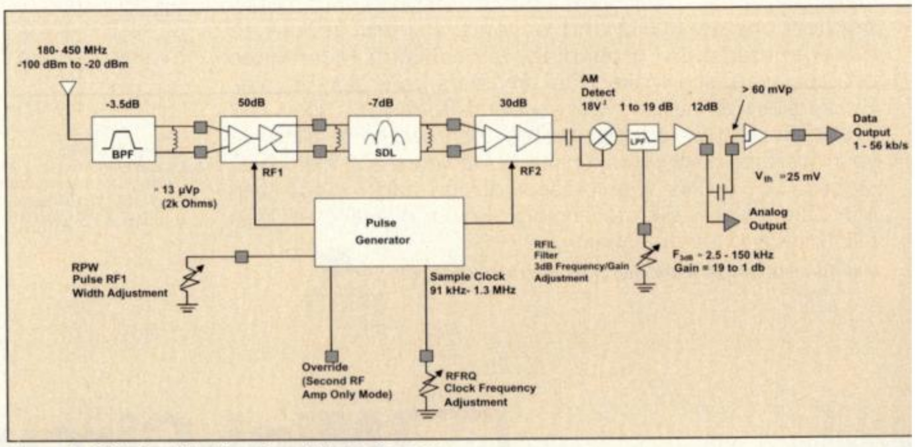

Figure 3. ASH simplified functional block diagram.

This makes it possible to include the entire receiver in a small hybrid package. No adjustments are needed because the frequency of the receiver is entirely determined by the two SAW devices. No RF oscillators are needed, which eliminates concerns about LO radiation, mixer-spurious responses and the associated DC power consumption. Because the RF amplifiers consume more power than the rest of the active circuitry, the switching of these amplifiers further reduces the overall power consumption by at least 50%.

Figure 3 shows a functional block diagram of the ASH receiver, including the custom IC, SAW devices, various control resistors and baseband coupling capacitor. The diagram also displays the gain and loss values for the signal path.

The output of the second RF amplifier drives a square law detector, which is realized using a Gilbert cell. The IC includes a post-detection three-pole low-pass filter whose bandwidth is controlled by a single resistor: RFIL. The output of the low-pass filter is capacitively coupled to a data slicer with a fixed threshold. The output of the data slicer can drive a single CMOS gate.

SAW-based hybrid transceiver

• *Requirements*

The development of a small hybrid transceiver was driven by the market requirement for short-range wireless data links with two-way communications capability. Requirements for such systems included a smaller size than the present hybrid receiver and transmitter; a lower cost than that of using separate receiver and transmitter modules; data rates as high as 11

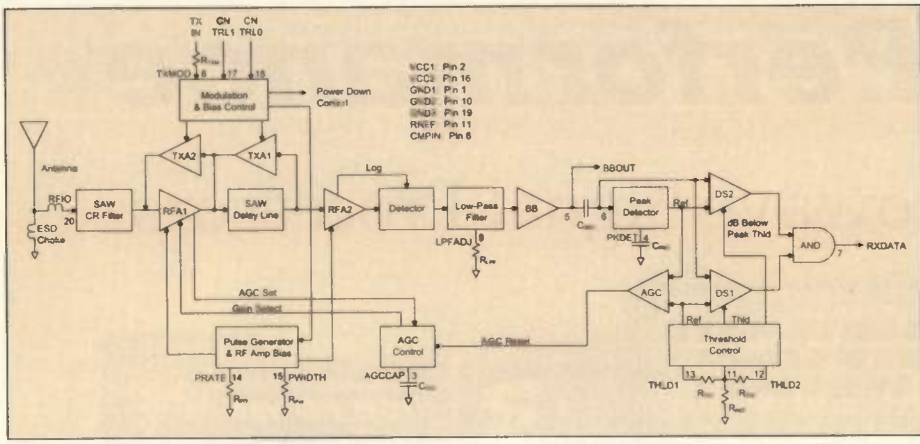

Figure 4. ASH transceiver block diagram.

kb/s; full receiver sensitivity from 300 MHz to 1.0 GHz; a much higher in-band RF saturation level than the present receiver; low current consumption; and the capability to work with on-off keying (OOK) or amplitude shift keyed (ASK) modulation. Also, the user should have access to the pulse generator, low-pass filter bandwidth, and threshold and transmitter power controls. ASH receiver architecture was used because the superheterodyne architecture did not fit the size and current requirements for the receiver. It was also considered to be more difficult to realize a superheterodyne-based transceiver using components in common with both receive and transmit functions.

• *Transceiver realization*

Figure 4 displays the block diagram of the resultant transceiver. The same two SAW devices used in the ASH receiver were used for the transmitter function. This was accomplished by adding a pair of amplifiers to the custom IC, TXA1 and TXA2, that are turned on in the transmit mode. TXA1 and the SAW delay line used in the receiver form the transmitter oscillator. TXA2 is the transmitter output amplifier. The receiver's input SAW-coupled resonator bandpass filter acts as the harmonic filter on the transmitter output. The RF amplifiers in the receiver, RFA1 and RFA2, are disabled in the transmit mode. The Q of the delay line allows the new transmitter to be OOK modulated as high as 38 kb/s with a typical rise time of 7 to 8 μs (for higher data rates, ASK modulation is used).

This result is realized by leaving the oscillator amplifier (TXA1) on while modulating TXA2. The typical rise time for the modulated transmitter output, in the ASK mode, is less than 1 υσ.

The transmitter modulation input was designed to allow quasi-linear modulation of the transmitter amplitude. Thus, shaping the data input to the modulator can control the modulation sidebands of the transmitter's RF output. This allows fitting the modulated transmitter into a restricted bandwidth. By the same means, the power output of the transmitter can be controlled by the value of the user-accessible resistor, R_{txm}, in series with the modulation input port.

Thus, the ASH receiver architecture was easy to convert to a transceiver by reusing the same two SAW devices used in the receiver to stabilize the center frequency and provide harmonic filtering in the transmitter. Because the same IC provides the transmit and receive functions, and both functions share the same SAW devices, the size and cost of the new transceiver have been minimized.

The RF amplifiers in the new custom IC were designed to have a 3 dB bandwidth exceeding 1.0 GHz, making it possible to have full receiver sensitivity from 300 MHz to 1.0 GHz. To increase the RF saturation level of the receiver component in the new transceiver, it was necessary to make three changes to the original ASH receiver.

Referring to Figures 3 and 4, the first change was in the detector. The first receiver uses a single square law detector following the second RF amplifier. This detector saturates at a receiver input level of –80 dBm. This problem was addressed in the transceiver by using distributed detection along the entire second amplifier, simulating a logarithmic detector. A modified Gilbert cell detector was also used at the output of the last amplifier. The outputs of all of these detectors were then summed together and fed into a three-pole gyrator low-pass filter. Thus, as each of the detectors reach saturation level, the outputs of the previous detectors still function. Figure 5 is a plot of the RF input level at the input to RFA1 versus the detected level at the

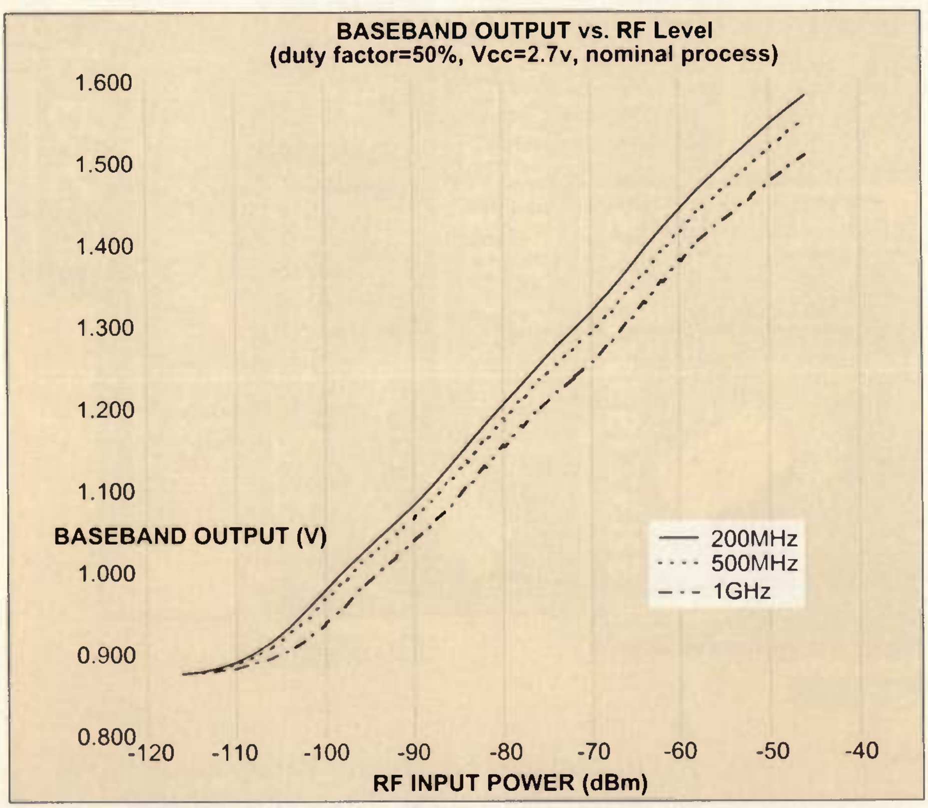

Figure 5. Transceiver RF input vs. detected output.

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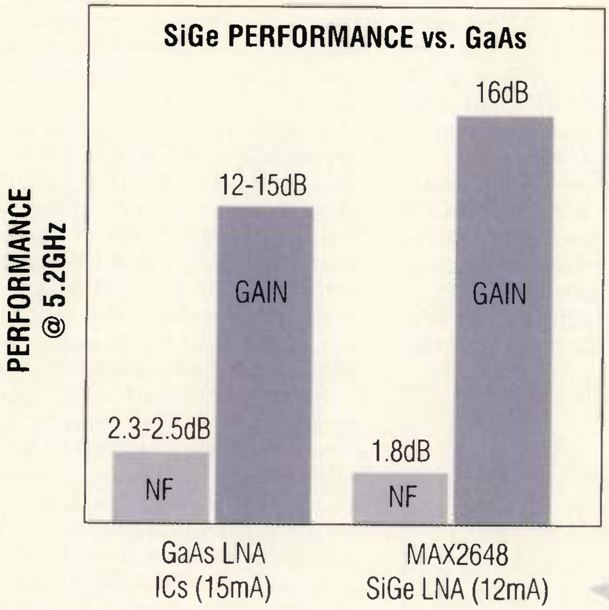

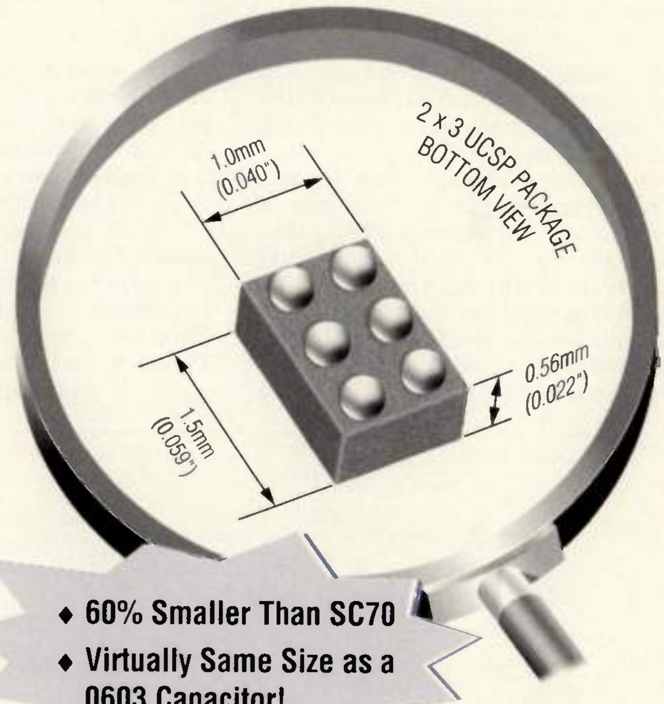

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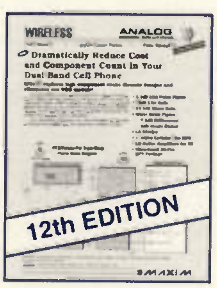

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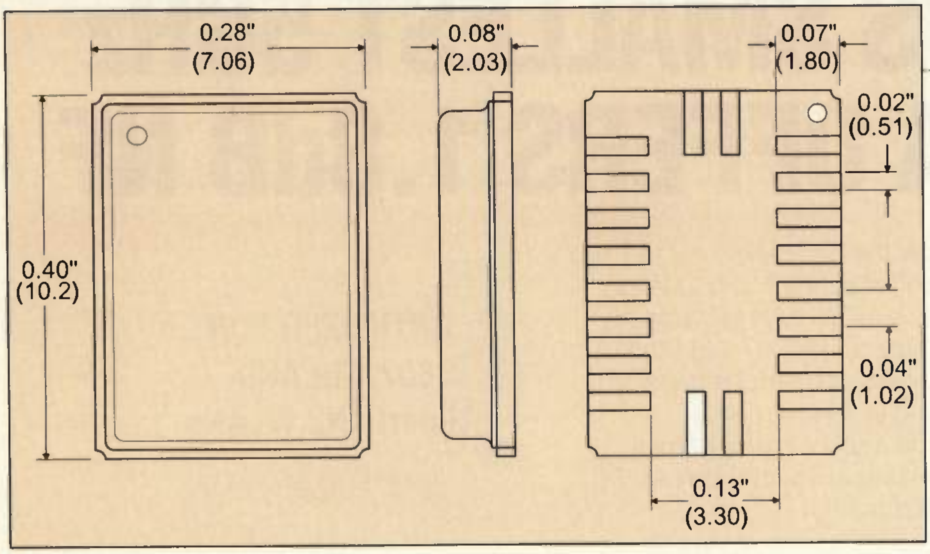

Figure 6. Transceiver footprint.

baseband output.The horizontal axis is in dBm while the vertical axis is linear, so the plot indicates a close approximation to a logarithmic detector.

The second change was in the receiver's gain distribution. The gain in the first RF amplifier, RFA1, was decreased from 50 dB in the original receiver to 35 dB, and the gain in the second amplifier, RFA2, was increased from 30 dB to 50 dB. This change improved the receiver in two areas. The gain increase of 20 dB in RFA2 increased the log detector range by 20 dB over what could be obtained with a 30 dB gain block, and the gain decrease of 15 dB in RFA1 increased the RF input level that could be handled without saturation by 15 dB at the delay line input.

The third change was to include an optional automatic gain control (AGC) system in the new transceiver. The user can choose to either enable or disable the AGC function. Again, referring to Figure 4, a simple stepped AGC was included. When the output level of the final stage of RFA1 is 1 to 2 dB into compression, it sets a flip-flop in the AGC control circuit that changes the gain of RFA1 from 35 dB to 5 dB. This increases the RF input level required to saturate the receiver from –45 dBm to –15 dBm. The AGC circuit resets RFA1 back to full gain when the detected signal level multiplied by 0.8 in the baseband circuit drops below the threshold reference for the "fixed" reference data comparator.

The ability of the new transceiver to work with ASK modulation can be used to greatly reduce the adverse effects of a high-level, amplitude-modulated, in-band interfering signal. The modulation from such an interfering signal appears during the "carrier off" condition with OOK modulation, but is masked when using ASK, because the desired RF carrier is present for all data conditions.

At higher data rates there is also distortion in an ASK signal. This is due to frequency band-limiting by either the filters in the receiver or in the transmitter. It is important that it does not prevent slicing the detected signal at the correct level to get good data reproduction at the output of the data comparator. The logarithmic detector can make band-limiting distortion even worse.

Referring to Figure 4, this type of distortion is handled well in the new receiver with the addition of data slicer, DS2, whose threshold is positioned about 6 dB below the peak of the detected pulse. This is accomplished by using a peak detector to find the top of the pulse and offsetting the thres-hold by 6 dB, using the slope of the logarithmic detector to determine the correct DC offset from the peak. The output of DS2 and the output of the fixed reference comparator, DS1, drive the input to an AND gate. Both comparator outputs must be high before the gate outputs a high. This prevents noise spikes from either of the comparators from appear-ing at the receiver output unless both comparators see them. Once again, the user can either enable or disable the peak detector-referenced comparator.

Finally, to address the issue of low current consumption, the sequencing of the RF amplifiers in the ASH receiver architecture reduces the current consumption by at least 50%. At low data rates, reducing the duty cycle of the RF amplifiers below 50% can reduce the current consumption even further. This is accomplished by decreasing the pulse rate in the pulse generator while maintainin

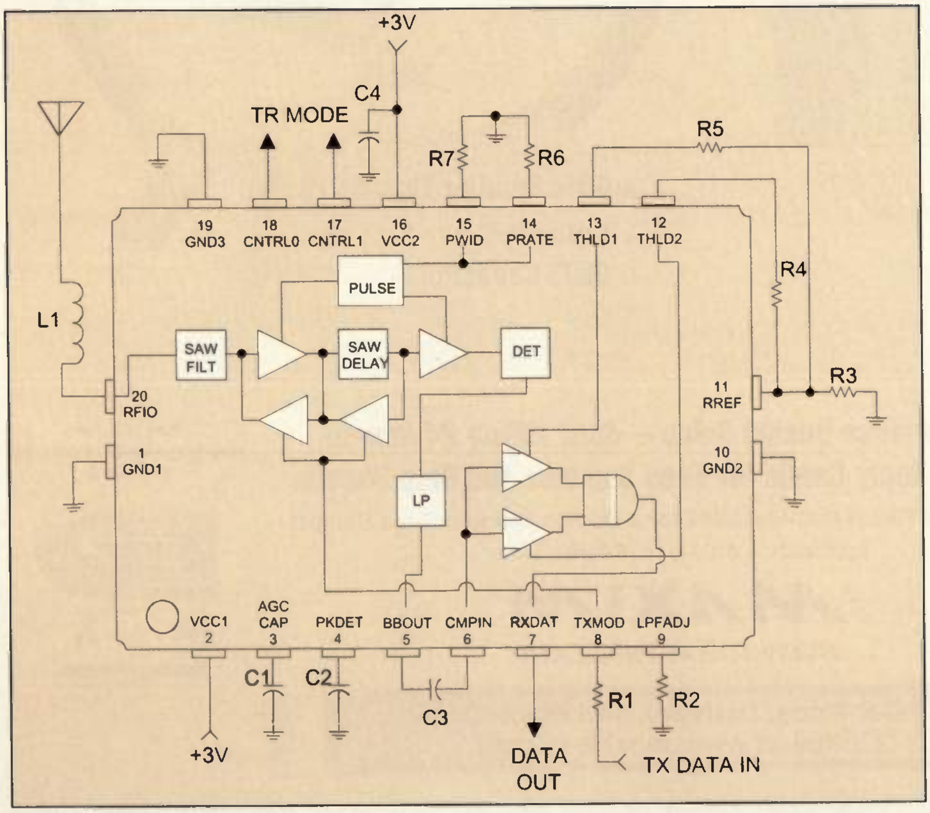

Figure 7. ASH transceiver electrical connections.

RECEIVER	
Data rate	2.4 kp/s
sensitivity	–102 dBm (50% sampling)
Sensitivity	–97 dBm (12.5% sampling)
Out-of-band rejection	100 dB
RF bandwidth	500 kHz (minimum)
Maximum signal	0 dBm
Detector saturation	–45 dBm
Detector saturation w/AGC	–15 dBm
DC voltage	2.4 to 3.5 VDC
DC current	3.0 mA (50% sampling)
DC current	1.6 mA (12.5% sampling)
TRANSMITTER	
Power output	0 dBm
DC voltage	2.4 to 3.5 VDC
DC current	10 mA peak
operating temperature	–40 to +85° C

Table 1. ASH transceiver performance example.

the same pulse width. Second, the new transceiver was designed to have a "power down" mode that is invoked by pulling the CNTRL1 and CNTRL0 ports to a complementary metal-oxide semiconductor (CMOS) low. (See Figure 4). If this mode is used, the receiver can be periodically turned on to see if a recognizable wake-up code is being transmitted.

An example would be turning the receiver on for 10 ms every second. This would reduce the receiver's average current consumption by a factor of 100.

plete 868 MHz transceiver are 10.2 X 7.06 X 2.03 mm. The case outline drawings for the new hermetic package are shown in Figure 6. Figure 7 includes a package outline, simplified block diagram, required external components and external electrical connections for the hybrid transceiver. The components and connections of Figure 7 use every available option. The small size and current consumption of the device make it suitable for applications such as the watch example given.

CR filter	+1 MHz, 19 dB	+2 MHz, 33 dB	+5 MHz, 18 dB		+10 MHz, 29 dB
CR filter	–1 MHz, 30 dB	–2 MHz, 38 dB	–5 MHz, 23 dB		–10 MHz, 38 dB
ETSI Specification		30 dB 35 dB	50 dB	60dB	

Table 2. Original SAW-coupled resonator rejection vs. proposed Class II blocking ratio.

The new receiver typically consumes 1.6 mA of current when set up for a 2.4 kb/s data rate; thus, a reduction by a factor of 100 would reduce the average current to 15 μA. This makes the transceiver useable in watch or ID card applications using lithium coin cell batteries.

Transceiver performance

The performance of the resulting transceiver with a data rate of 2.4 kb/s is included in Table I. The surface-mount package dimensions for a com-

TETRA/ETSI requirements

The spectrum is becoming more and more crowded, as evidenced by the recent problems caused by introducing the new Trans-European trunked radio (TETRA) service in the United Kingdom. The problem in the U.K. was compounded by the presence of a narrow 418 MHz low-power band, located between the TETRA mobile frequencies and the TETRA base station frequencies, that is primarily used for automotive keyless entry. The manufacturers of the receivers used in this low-power application did not anticipate the introduction of such a service, so the receivers were ill-equipped to deal with the interference potential of the TETRA system. Many were LC-stabilized super-regenerative receivers with their inherent poor frequency selectivity.

Earlier this year, superheterodyne receivers equipped with SAW-coupled resonator RF front-end filters demonstrated more than acceptable performance in the presence of simulated TETRA signals when shown to the Radiocommunications Agency.

CR filter	+1 MHz, 19 dB	+2 MHz, 33 dB	+5 MHz, 18 dB		+10 MHz, 29 dB
CR filter	–1 MHz, 30 dB	–2 MHz, 38 dB	–5 MHz, 23 dB		–10 MHz, 38 dB
ETSI Specification		30 dB 35 dB	50 dB	60dB	

Table 3. SAW-coupled resonator rejection vs. proposed Class II blocking ratio.

• *Proposed ETSI requirements*

The new 868 to 870 MHz SRD band has been a topic of much discussion ir light of the TETRA interference problems encountered in the 400 MHz band. ETSI, in conjunction with industry, is rewriting EN 300 220-1 tc include more stringent specifications or SRD transmitters and receivers. Fo example, the present draft includes a transmitter maximum-frequency drif specification of ±100 ppm under the extreme voltage and temperature con ditions of that document. This can be met with SAW-based equipment including the new transceiver.

In the area of SRD receivers, a block ing or desensitization specification ha been added. For Class 1 equipment whose low performance or failure woul result in physical risk to people, th blocking ratio between the desired in band signal and an interfering out-of band signal is specified to be 84 dB starting at a 1 MHz frequency offset For Class 2 equipment, whose low per formance would result in an inconve nience that cannot be overcome by othe means, the blocking ratio is specified t be 30 dB at 1 MHz, 35 dB at 2 MHz, 5 dB at 5 MHz and 60 dB at 10 MHz fre quency offset. For Class 3 equipment whose low performance would result i an inconvenience to persons and whic can simply be overcome by other mean no blocking performance is specified.

• *Present transceiver*

The present 868 MHz transceive uses a SAW-coupled resonator for th front-end RF bandpass filter whose fre quency response is shown in Figure 8 This filter is a two-pole structure with bandwidth of about 700 kHz and a cen ter frequency of 868.35 MHz. The filte ultimately reaches >60 dB of rejectior but, as can be seen in Figure 8, th

INDUSTRY'S SMALLEST 2.4GHz LNA INCREASES BLUETOOTH RECEIVER SENSITIVITY TO -90dBm

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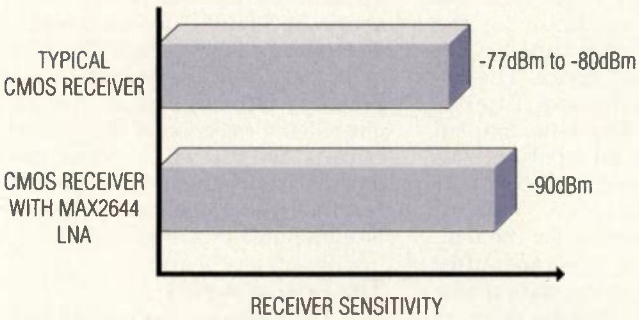

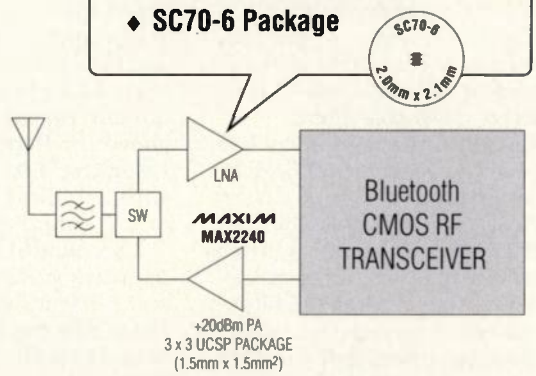

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NEW	MAX2644	2450	16	2.0	-3	Yes	Bluetooth, 802.11, HomeRF™, WCDMA, satellite radio, MMDS
NEW	MAX2654	1575	15	1.5	-7	—	GPS
NEW	MAX2655	1575	14	1.7	+3	Yes	GPS in cellular phones
NEW	MAX2656	1960	13.5	1.9	+1.5	Yes	PCS, DCS, WLL

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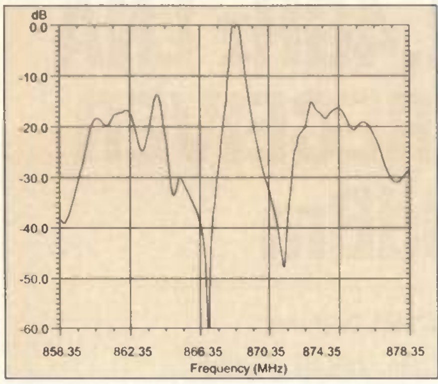


Figure 8. Present SAW-coupled resonator filter response.

device has close-in spurious responses that affect the receiver's blocking performance at the frequency offsets of 2, 5 and 10 MHz. The rejection of the coupled resonator at the ±1 MHz points is limited by the 12 dB/octave roll-off rate, characteristic of a two-pole filter.

The bandwidth of the SAW delay line second filter in the receiver is 1.5 MHz, and the filter response is close to that of a six-pole linear phase Bessel filter. As a result, the coupled resonator filter must provide the majority of the receiver selectivity needed to meet the blocking requirement. The rejection of the coupled resonator filter, derived from the plot of Figure 8, is shown in Table II for each of the specified frequency offsets versus the Class 2 proposed blocking ratio specifications. This filter does not meet the proposed blocking requirements for a Class 2 system. Thus, the present receiver would be suitable for Class 3 equipment, but not Class 2 with the proposed blocking requirement.

• *Proposed new transceiver filter*

A new 868 MHz SAW-coupled resonator filter is being designed for the transceiver that would meet the proposed blocking requirements for Class 2 equipment. The form factor for the upgraded transceiver would be the same as for the present device. The frequency response of the new filter is shown in Figure 9. The new coupled resonator filter is a four-pole device with a typical bandwidth of 620 kHz and a center frequency of 868.35 MHz.

This bandwidth accounts for the temperature variations of the transmitter and receiver, as well as the data-modulation side bands. The ultimate rejection is about 70 dB, and the close-in spurious responses of the present filter have been eliminated. The rejection of the new filter, derived from the plot of Figure 9, is shown in Table III for each of the Class 2 frequency offset points. The filter provides the needed selectivity to meet the proposed blocking ratios. The ultimate out-of-band rejection of the entire transceiver (>100 dB) will be about the same as that obtained using the present filter, but the close-in spurious responses will be eliminated by the new filter.

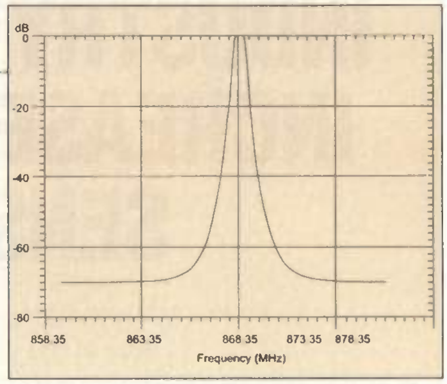


Figure 9. New SAW-coupled resonator filter response.

The final analysis

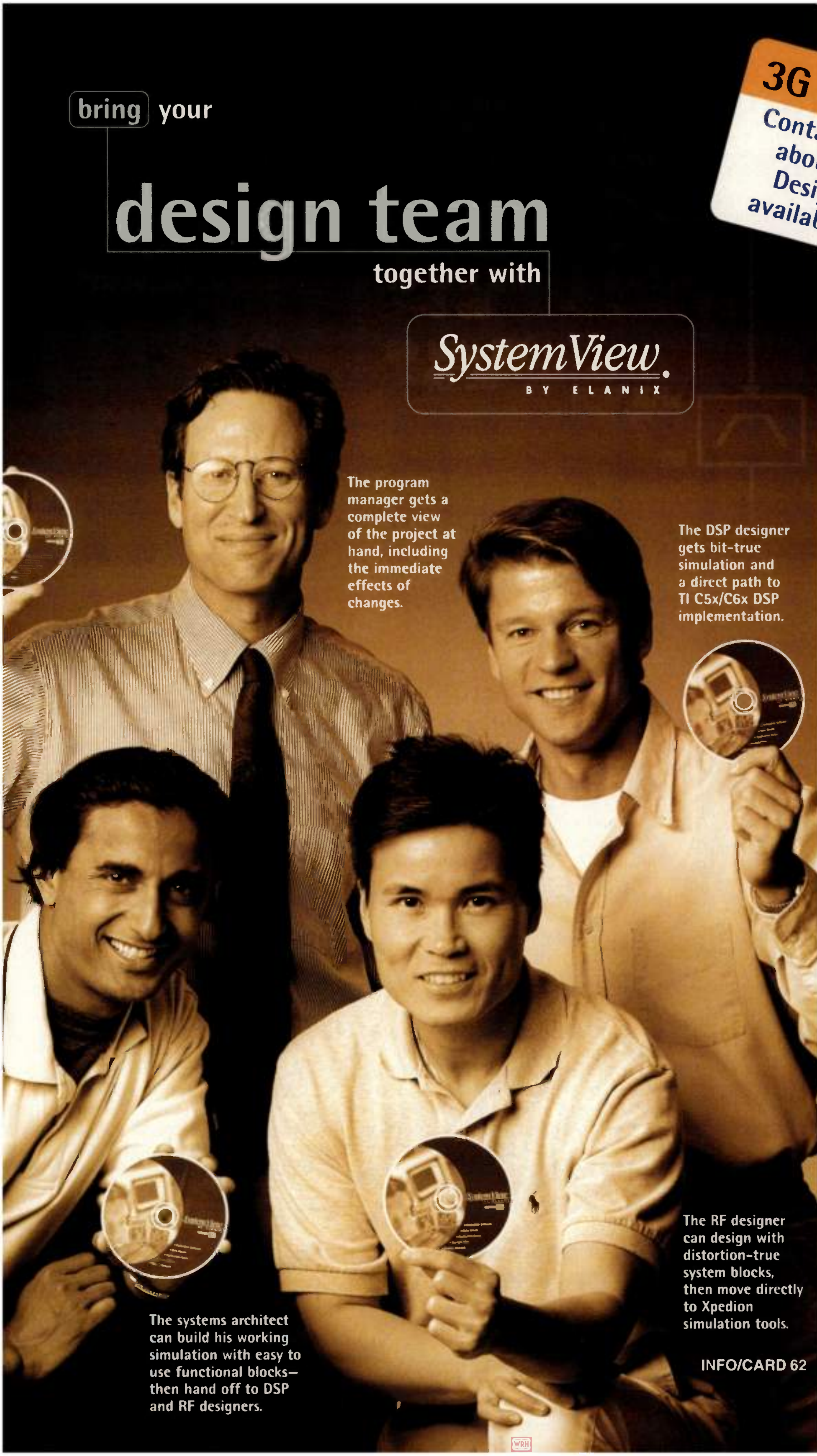
A new transceiver design has been developed around the capability of

SAW devices. The delay of a SAW delay line was used as a storage element to create a time diversity receiver while using its amplitude characteristics to perform a filtering function. The same delay line's phase characteristics were then used to create the transmitter oscillator. On the antenna port, a SAW-coupled resonator filter was used as a preselector filter on the receiver input, and it was used to filter out harmonics on the output of the transmitter. The use of the same two SAW devices in both the receiver and the transmitter, in conjunction with a custom IC for the active functions, made it possible to include the entire transceiver in a 10.2 X 7.06 X 2.03 mm surface-mount package. This small size, in combination with low power consumption, low cost and excellent radio data link performance, make the new transceiver suitable for wireless SRD applications involving watches, ID cards, hand-held apparatus, computers, computer peripherals, tags and many more applications.

RF

About the author

Darrell Ash is senior vice president and CTO of RF Monolithics. He received his BSEE from the University of Evansville and then was awarded a National Science Foundation Fellowship to attend Brigham Young University where he received his MSEE, magna cum laude. Ash co-founded RF Monolithics where he served as vice president of engineering until 1995. Since that time, he has served as Sr. VP and chief technical officer working on new technologies, including the new miniature RF transceiver. Ash has 32 years of experience in the design of radio frequency filters, circuits, RF hybrids and systems. He has had 12 patents issued in his name on the application of SAW devices to circuits and systems. He has presented numerous technical papers on his work and is presently a senior member of the IEEE. He can be reached at 972/789-3845. The author would like to thank Darren Ash for his invaluable assistance in putting this paper together. *This paper first presented at the Low Power Radio Association's Radio Solutions conference in Birmingham, England in 1999.*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INFO/CARD 62

On The Web

Revised catalog, interactive Web site

Berkeley Nucleonics announces Version 1.5 of the company's Web site. The site now offers user-specific online training seminars on nuclear spectroscopy systems, new product and application content, and a fast-link to the customer service department.

Berkeley Nucleoincs
INFO/CARD 115

Redesign includes Invensys links

Fasco has completed a major redesign of its Web site. The new site design mirrors the Invensys Web site structure for seamless navigation. It includes options for online ordering through the FAStore icon, where distributors can locate any of Fasco's stock products either directly by model number or through search menus using product specifications. Visitors to the site can access product information for all the Invensys companies directly from the Fasco homepage. A product search can be initiated by entering a keyword and indicating whether the search should be limited to Fasco products or products from all Invensys companies. The redesigned Web site also continues to showcase its distributor locator feature, which finds the nearest Fasco distributor by entering a ZIP code and mile radius.

Fasco
INFO/CARD 116

Catalog covers EMC components

A new 256-page EMC components catalog from Schaffner EMC provides detailed technical data on a range of filters, chokes, and feedthrough components. The catalog covers noise-suppression circuits, current-compensated chokes, rod-cored chokes, saturating chokes, PCB filters, IEC-inlet filters, single-phase filters, three-phase filters, output filters, feedthrough capacitors, and filter input-output connections. Product information includes current ratings, IEC compliance, differential and common-mode attenuation, optional versions and installation instructions. Insertion loss diagrams are provided, as well as mechanical schematics. The catalog also provides an EMC primer covering technical and compliance issues and a product selection flow chart to expedite the ordering process.

Schaffner EMC
INFO/CARD 117

Special edition CD-ROM aids in compiler choice

Microchip Technology has released a special-edition version of the MPLAB-Integrated Development (IDE) "SE" CD-ROM. Providing technical and sales information at the fingertip, this resource allows current and future Microchip users to test-drive C compiler demos to determine which compiler options fit their needs. Users can also look up PICmicro components for design purposes and find development tool sources. The special edition CD-ROM also contains a complete copy of the most current release of Microchip's MPLAB-IDE software. A Windows-based development platform for the Microchip Technology PICmicro microcontroller MCU families, MPLAB-IDE offers a project manager and program text editor to communicate editing and debugging information via a user-configurable toolbar.

Microchip Technology
INFO/CARD 118

TETRA primer details specifications, test

IFR Systems announces its new primer on Terrestrial Trunked Radio, titled *Introduction to TETRA: Capability, Specifications and Measurement*. The primer presents TETRA, the international digital radio standard, in an easy-to-read format. It describes the benefits of TETRA over conventional PMR/PAMR standards for mobile radio systems used in public safety applications. It also examines TETRA's specifications and the basic test requirements demanded of both TETRA transmitters and receivers.

IFR Systems
INFO/CARD 119

Text covers transmission line devices

Networks and Devices Using Planar Transmission Lines, by Dr. Franco Di Paolo, is a single text that incorporates the theoretical principles and practical aspects of planar transmission line devices. The author examines striplines, microstrips, slot lines, coplanar waveguides and strips, phase shifters, and hybrids. For each type of structure, a complete and self-contained treatment is provided for geometric characteristics, electric and magnetic field lines, solution techniques for the electromagnetic problem, analysis methods, design equations, attenuation, and practical consideration. Of particular interest is the author's treatment of planar ferrimagnetic devices such as phase shifters, isolators and circulators. The book contains thousands of formulas, hundreds of figures, and references. Eight appendices are included, providing the theoretical background needed to fully understand all of the devices analyzed.

CRC Press
INFO/CARD 120

Guide provides advanced AC-to-DC converter info

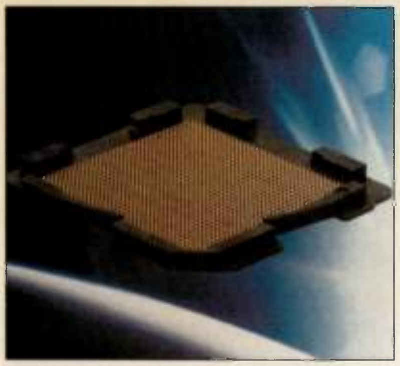
Applying UFM500/UFM1K AC to DC Converters, from Powercube, provides design engineers information for applying front-end modules (UFMs) to their applications. Used with most industry standard DC to DC converters, including various Powercube models, UFMs offer a high-density, small, off-line power switching solution. A complete schematic with input filter, input fuse, transient protection and appropriate hold-up capacitors is described in this application note.

Powercube
INFO/CARD 121

RF product focus — interconnect/interface

Solderless interconnect for µPCs

Teledyne Interconnect Devices introduces the MicroConn connection for land grid array (LGA) applications. The products offer OEM designers a reliable and economical solderless interconnect for microprocessors, ASICs and other large packages. It is suitable for computer, server, workstation and test instrument applications. The MicroConn design features a liquid crystal polymer (LCP) plastic matrix containing high-density metal contacts (up to 1.00 mm contact spacing). Short contact length delivers low inductance at high frequencies, and a positive stop prevents overstressing of contacts. This results in a robust, low-profile flush mount connector.



Teledyne Interconnect Devices
INFO/CARD 122

Waterproof circular connector

Hirose introduces the addition of the HR3O outdoor circular connector to its product line. The HR3O is a push-pull latched circular connector designed to meet 1P67, enabling it to withstand submersion for as long as 30 minutes when mated. This miniature circular connector has an outside diameter of 12.6 mm, housing six contacts in a lightweight plastic that is resistant to corrosion. Both the plug and receptacle use gold-plated solder cup contacts, rated at 2 amps. HR3O mis-insertion can be avoided due to its five-key polarization system. The HR30 is also designed to withstand 1000 cycles. Behind the plug's collet-style cable strain relief is a 10 mm long gasket to seal the cable; these features are integrated when the shell is screwed into position onto the insulator and is achieved without special tools.

Hirose Electric (U.S.A.)
INFO/CARD 123

5W attenuators for DC to 18 GHz

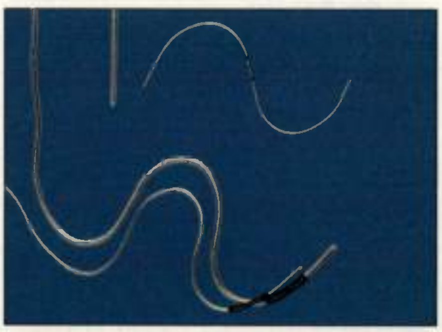
Mini-Circuits introduces a 5 W precision attenuator series displaying tight tolerances from DC to 18 GHz. The SMA

male/female connectorized BW series contains 15 models with nominal attenuation from 1 to 10 dB, in 1 dB steps, plus 12, 15, 20, 30, and 40 dB values. Model number is BW-SXW5 substituting X with desired attenuation value. At 25°C, accuracy is ±0.40 dB for the 1 through 6 dB models, ±0.60 dB for 7 to 20 dB units, and ±0.85 dB for the 30 and 40 dB attenuators. Accuracy specifications include power and frequency variations up to 12.4 GHz (above 12.4 GHz add 0.5 dB). And with a VSWR of 1.15:1 typical, these precision attenuators can be calibrated out easily so as not to affect the device under test. Operating temperature range is –55°C to +100°C, as is storage temperature when stored with mated connector. At 25°C ambient, the devices have a power rating of 5 W average (derate linearly to 2W at 100° C), 125 W peak with 5 µs pulse width, 100Hz PRF.

Mini-Circuits
INFO/CARD 124

Alternatives to semi-rigid and flex cables

MICRO-COAX introduces the UTiFORM family of tin-dipped microwave cables. The cables offer an



alternative to semi-rigid and flexible cables. The cables feature suitable attenuation and VSWR, and also have a higher temperature rating than semi-rigid cables and an equivalent bend radius. They accept standard semi-rigid connectors, can be cut and stripped with standard semi-rigid machines, and require no tooling. The cables offer 100% shielded electrical characteristics, and a 50 Ω impedance from DC to 95 GHz. Capacitance is either 27 pf/ft or 29 pf/ft, depending on the cable. Signal delay is either 1.45 ns/ft or 1.32 ns/ft, depending on the cable. Completely hand-formable, the UTiFORM cables don't require complicated bend specifications and can be reformed with no damage. They have bend radius as tight as 0.100."

MICRO-COAX
INFO/CARD 125

Flex-speed, matched-impedance interfaces

Samtec introduces the QTHI/QSH series 5 mm (.0197") pitch Flex-Speed Interfaces. The matched-impedance

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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
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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.

Mini-Circuits®

US 90 INT'L 91
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The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 CERTIFIED

F 295 Rev C

micro interfaces are available with a choice of 60, 120, 180, 240, and 300 I/Os. The discrete ground plane between rows is surface-mounted for a 100% SMT system that eliminates the need for through-hole penetrations. These high-speed interconnects are fully tested for 50 Ω systems for impedance, VSWR, attenuation, crosstalk and propagation delay at frequencies from 10 MHz to 1 GHz. They provide a low-profile board-to-board spacing of only 5 mm (0.197").
Samtec
INFO/CARD 126

EMI/RFI flexible conduit

Electri-Flex announces three types of flexible electrical conduits offering EMI/RFI shielding. They are designed to protect sensitive electronic circuits in applications such as communications, radar and data transmission. The shielding effectiveness ranges from 126 dB at 1.0 MHz to 120 dB at 1.0 GHz. The conduit is available in three types for various applications. Type EMS offers a temperature rating of –55°C to +105°C, a flexible core constructed of a helically wound interlocked strip of bronze, an all-temperature PVC jacket, and, when assembled with liquidtight fittings, results in a sealed, water-proof raceway. Type EMSP is identical to EMS, except for the addition of a tinned copper shielding braid under the flexible jacket, to further enhance the shielding characteristics. Type LAS provides a UL Listed version. Conforming to UL 360, Type LAS is a flexible steel conduit with a galvanized steel core, over which a tinned copper shielding braid is applied. The outer jacket is flexible PVC with a temperature rating of –20°C to +60°C.
Electri-Flex
INFO/CARD 127

High-voltage coaxial connectors

A line of C-Series RF coaxial connectors designed for high-voltage semiconductor, wafer processing, sputtering, and research applications is now available from Tru-Connector. The connectors feature overlapping Teflon dielectrics to provide a longer electrical leakage path that allows them to handle up to 3 kV peak. Male and female designs for both semi-rigid and flexible cables are available in straight, right-angle, and bulkhead configurations.
Tru-Connector
INFO/CARD 128

FCC-compliant adapters and connectors

In response to requirements of FCC Part 15.203, RF Connectors has

developed a line of specialized interface adapters and connectors. The connectors achieve compliance in three ways: reverse polarity, or gender; reverse, or left-banded threads; and the use of metric rather than Unified Standard threads. The RT-1227, TNC male-to-TNC female right-angle adapter, is one of the devices of the line. It features left-hand or reversed threads at both ends, nickel-plated body, gold-plated contact and pin, and Teflon insulation.
RF Connectors
INFO/CARD 129

Copper fiber channel cable assemblies

Methode Technical Components announces a new line of high-performance cable assemblies for copper fiber channel applications. The assemblies are suitable for high-speed serial datacom systems and are equipped with HSSDC, DB9 or IX3 connectors. Three families are available, including basic cables with DB9 connectors on both ends, high-speed serial data interconnection cables with DB9 and/or HSSDC connectors, and internal drive adapter cables with DB9 and/or IX3 connectors. They are manufactured in accordance with ANSI X3.303-1998 Fibre Channel FC-PH-3 specifications.
Methode Technical Components
INFO/CARD 130

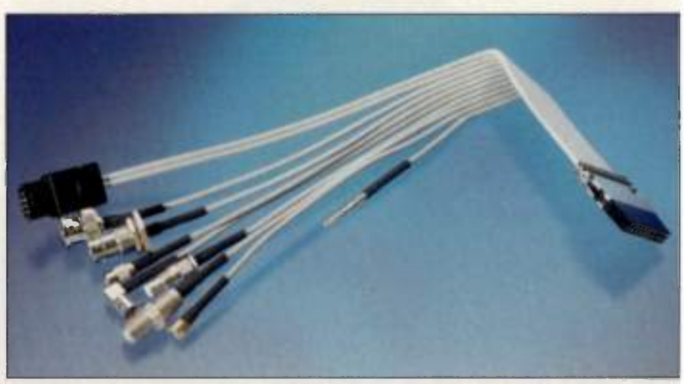
High-density edge card connectors

Sullins Electronics announces a new series of high-density 0.050" edge card connectors. The parts are now available with right-angle bends and with or without mounting ears. This will allow for higher density applications versus the traditional 0.100" and 0.156" products. The connectors are available in all common architectures (PCI, MCA, etc.), as well as in a wide variety of sizes; from 6 position (2 X 6 contacts) to 110 position (2 X 110 contacts). The high-reliability/high-cycle hairpin bellows contact allows for multiple insertions and withdrawals. The connectors are available in a variety of insulator materials, including reflow-compatible parts, molded in PCT, and longer than usual contact tail lengths, allowing these parts to be used on both standard PCB's (0.062", 0.093", 0.125"), and almost any custom board thickness.

Sullins Electronics
INFO/CARD 131

Transition RF adapters and ribbon cable assemblies

Tyco Electronics announces the availability of its Between Series RF adapters, designed to provide convenient transitions between popular series coaxial connectors. These adapters allow designers to use one type of connection and adapt to other interface types on a range of equipment, including medical, instrumentation and test & measurement equipment. The adapters are constructed of stainless steel or brass with several plating finishes. Basic platings on adapters are passivated finish, nickel-plated brass and gold-plated brass. Also available from Tyco is a series of coaxial ribbon cable assemblies. Tyco coaxial ribbon cable assemblies consist of individual coaxial cables encased in a PVC jacket, making up a standard flat-ribbon cable configuration. Each coaxial lead has a solid conductor and a foil shield with a drain wire. This design allows the wire to be mass-stripped and terminated. The connector styles avail-



able for termination to coaxial ribbon cable are BNC plugs, BNC jacks, COAXICON connectors, SMA and 5 MB connectors for test instrumentation, medical electronics and aerospace and defense. The cables are available in either 50 or 75 Ω versions. The 50 Ω version has a nominal capacitance of 31 pf/ft and impedance of 50 ±3 Ω. The center conductor is 28 AWG copper and centerline spacing is 0.100". The 75 Ω version has a nominal capacitance of l7 pf/ft and impedance of 75 ± 4 Ω. A 30 AWG copper center conductor is used. Centerline spacing on the 75 Ω version is 0.100". An alkaline enamel insulation coating is used with a PVC jacket on both versions. Cable assemblies with center polarization are available in 4, 5,10, 13, 17 and 20 positions. Jack-screw cable assemblies are available in 10, 13, 17,20 and 25 positions. Dual-polarization cable assemblies with detents are available in 4, 5, 8, 1O, 13, 16, 17, 20 and 25 positions.

Tyco Electronics
INFO/CARD 132

Power dividers from 0.5 to 26.5 GHz

A new broadband matched-line directional divider from Krytar offers high isolation and low insertion loss. The Model 6010265 (two-way) operates over the entire frequency band of 1 to 26.5 GHz. VSWR is 1.60:1 max, insertion loss is 1.6 dB max and isolation is 19 dB Min. Amplitude tracking is less than 0.3 dB and phase tracking is less than 10°. The unit provides better specifications when used in the 1 to 18 GHz band. The four-way models are offered with similar specifications. Applications include power and frequency monitoring, as well as summing of output power from multiple-power amplifier inputs.

Krytar
INFO/CARD 133

SHV series of coaxial connectors

Ceramaseal announces a new addition to the current offering of SHV coaxial connectors. The connector is constructed using Ceramaseal's ceramic-to-metal sealing technology and is designed to mate with a standard 10 kV SHY plug. The smaller diameter of the connector does not compromise the 10 kV voltage rating. The receptacles have a temperature range of –269° C to +450° C. They can handle currents up to 2 amps and voltages up to 10 kV. The connector is also non-magnetic and provides more flexibility due to the decreased size. The weldable receptacle is made of 304 stainless steel and high-purity alumina ceramic. The connector can also be supplied on conflat flanges, quick flanges, or custom flanges. SHV connectors feature an improved interface over MHV connectors by maintaining connector ground through the center contact mating cycle.

Ceramaseal
INFO/CARD 134

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"

When it comes to your RF design, come to the source.
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INFO/CARD 105

RF2460

RF Micro Devices announces the RF2460 LNA mixer – a complete receiver front-end chip for the PCS CDMA market. Based on silicon germanium (SiGe) technology, the device is a low-current receiver front-end solution for PCS CDMA handsets. The device offers a high level of performance in a small package. The subsystem can be used as a stand-alone product for single-mode PCS handsets, or as a companion to the previously released RF2461 cellular CDMA receiver front end for use in dual-band handsets. The device is a 3.0 VDC complete receiver front end with gain, noise figure and IIP3 specifications designed to be compatible with the IS-98B standard for CDMA PCS handsets. The IC amplifies and downconverts RF signals while providing 29 dB of stepped gain control range. It features digital control of LNA gain, mixer gain and power-down mode. Another feature of the chip is its adjustable IIP3 of the LNA and mixer using an off-chip resistor. In maximum gain mode, the cascaded performance of the subsystem is 25 dB of gain. It has a 2.2 dB noise figure that draws 26 mA of current. The subsystem is designed to meet or exceed the requirements for U.S. and Korean PCS CDMA handsets. It can also be used for other downconverter applications in the 1.5 to 2.2 GHz frequency range, such as W-CDMA. The RF2460 is manufactured using a SiGe HBT process and is offered in a small, 4 x 4mm, MLF-20 leadless plastic package.

RF Micro Devices
INFO/CARD 135

Front-end receiver SoC for PCS CDMA markets

Be able to select the performance you need. Engineers will go to great lengths to find an edge in accuracy. With Agilent Technologies' complete family of network analyzers, you'll no longer have to.

There's a full range of frequencies from 10 Hz to 110 GHz, so you can get the precise level of performance for any application. That means you won't have to pay for features like S-parameters or highest accuracy if you don't need them. And, if it's dynamic range you want, the new RF PNA Series offers up to 143 dB without compromising on speed. It's a new standard in performance to help you stay ahead in a competitive environment.

Call us, or visit our web site to find out more. We'll rush you a network analyzer selection guide, and a component manufacturing brochure, *Ramp up to Higher Yields Fast.* Because you deserve performance that's perfectly on par with your needs.

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Agilent Technologies

Innovating the HP Way

INFO/CARD 7

RF products

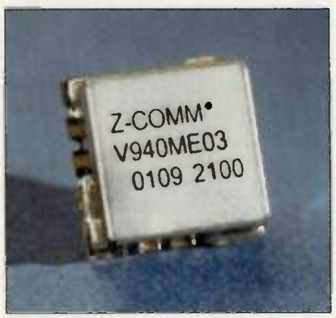
Lightweight, compact, fully functional handheld spectrum analyzer

Anritsu announces a lightweight, fully functional handheld spectrum analyzer that provides field engineers and technicians with unprecedented measurement flexibility in field environments and applications requiring mobility. Featuring a rugged, lightweight battery-operated design, the instrument weighs four pounds and is powered by a lightweight NiMH battery. It is an improved alternative that allows accurate, reliable, and repeatable measurements to be made anywhere, anytime. Covering the 100 kHz to 3 GHz frequency range, the instrument is suitable for cellular, data, paging, PCS, satellite, SMR, wireless Internet, and WLAN/WPBX. It offers a broad range of functions and narrow resolution bandwidths down to 10 kHz. The instrument features a menu-driven interface and requires little training before operation. A save setup feature allows as many as 10 test setups to be stored in the spectrum analyzer's nonvolatile memory. All results are shown on the large, high-resolution LCD display that makes viewing easy under a variety of lighting conditions. Additionally, the instrument offers high-end specifications featuring 65 dB dynamic range, ±1.5 dB amplitude accuracy, and a full-span noise floor of 97 dB or better.

Anritsu
INFO/CARD 136

Low-noise, compact VCO

Z-Communications is announcing the V940ME03 VCO for broadband fixed wireless and U-NII band applications. Delivering low phase noise performance in a low-profile package, the VCO covers the 5.725 to 5.875 GHz frequency range within only 0.5-4.5 VDC of



control voltage. The VCO offers spectral purity of –109 dBc/Hz, typically, at 100 kHz from the carrier and 1.1:1 linearity over frequency and temperature. It suppresses the second harmonic to better than –30 dBc, while drawing only 27 mA, and provides 0+3 dBm of output power into a 50 Ω load.

Z-Communications
INFO/CARD 137

High-precision ratio voltage divider

California Micro Devices announces a new precision voltage divider. The PRN105 features a tight

ratio tolerance, tight TCR, and a wide range of resistor values. This device provides a high degree of stability, low noise and the proven reliability characteristic of Tantalum Nitride. The device's tight tolerances result from manufacturing two thin-film resistors at the same time with the same material on the same substrate. The device is also available in custom values and configurations.

CMD
INFO/CARD 138

Tx-DAC digital-to-analog converter

Analog Devices announces a performance-enhanced member of the company's Tx-DAC family of transmit digital-to-analog converters. The AD9772A features a 7 dB improvement in noise floor, a 10 dB incremental increase in IMD performance, and a 6 to 8 dB reduction in PLL noise. Additionally, wideband DAC features 14 bit 2× interpolating DAC with allowable input data rates up to 160 MSPS. The AD9772A's en-

hanced on-chip circuitry improves overall signal quality and channel capacity, making the device well-suited for multi-carrier IS54/136 and multi-mode (GSM/EDGE, IS136/EDGE) systems, as well as for 3G (cdma2000, WB-CDMA) cellular basestations.

Analog Devices
INFO/CARD 139

High-speed wireless link technology

The Communications Research Centre offers a new type of speed wireless link technology operating in the 5.2/5.8 GHz unlicensed bands. The WEB terminal is a wireless Ethernet IEEE 802.3X compatible bridge capable of providing links over distances

of up to six km at data rates of 32 Mb/s. As many as 90 Mb/s are achievable using low-cost off-the-shelf DVBS technology. The terminal is based on the ETS 300-421 modulation standard. Using adaptive antenna and other beam-forming techniques, a significant increase in the carrying capacity of the system is possible, making the 5.2/5.8 GHz spectrum an attractive alternative to LMDS and MMDS solutions.

CRC Research
INFO/CARD 140

NEW PRODUCTS

NO. 79

RF/IF MICROWAVE COMPONENTS

J-LEAD

FROM $21.95

5V VCO HAS LOW PHASE NOISE IN ISM BAND

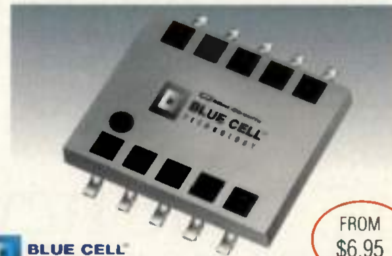
Mini-Circuits has introduced a broad band 2050 to 2700MHz surface mount voltage controlled oscillator with flat 46-56 MHz/V (typ) tuning sensitivity. Typically, the JTOS-2700V operates with high 8dBm power output and features low -134dBc/Hz SSB phase noise at 1MHz offset, -25dBc harmonic suppression (speced to 4th), and 0.5 to 18V (min. to max.) tuning voltage. Solder plated J leads provide superior mechanical integrity over temperature. Excellent price-performance value.

FEATURED PRODUCT

FROM $16.95

818 TO 853MHz MIXERS PERFORM WITH VERY HIGH IP3

Mini-Circuits HJK/HUD family of frequency mixers are breaking new ground by achieving the highest IP3 commercially available...this level 17 (LO) HJK-9H model displays +33dBm typical. Targeting 818 to 853MHz (RF) cellular applications, these low cost passive mixers require no DC biasing and boast 6.7dB (typ) conversion loss. The 1dB RF compression point is 20dBm typical, or 3dB higher than the power level of the LO signal, and LO to RF isolation is tightly controlled at 35dB (typ).



BLUE CELL TECHNOLOGY

FROM $6.95

1500 TO 2200MHz 90° HYBRID IS .250"x .300"x .050" SOLUTION

Mini-Circuits patented QBA-20W 2way-90° power splitter has been developed for high isolation (23dB typ) and low insertion loss (0.41dB typ, avg. of coupled outputs less 3dB) within the broad 1500 to 2200MHz band. As a splitter, these Blue Cell™ hybrid's are capable of handling 25W (max.) power input and are housed in a low profile 0.050" ceramic package providing good heat dissipation and incorporating solder plated leads for excellent solderability.

FROM $4.95

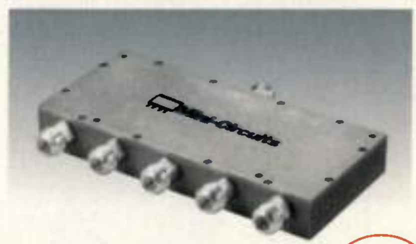
.05 TO 400MHz TRANSFORMERS PROVIDE 4:1 IMPEDANCE MATCHING

Broad bandwidth TTCM4-4 surface mount RF transformers from Mini-Circuits operate from 0.5 to 400MHz with 4:1 impedance ratio. Referenced to midband loss (0.6dB typ), insertion loss is 1dB from 5MHz to 100MHz, 2dB in the 1.3 to 160MHz range, and 3dB band wide. Typically, amplitude unbalance is 0.1dB and phase unbalance is 1 degree. Open case design has plastic base with solder plated leads.

DC TO 4GHz MMIC AMPLIFIERS HAVE GOOD DYNAMIC RANGE

DC to 4GHz ERA-51SM amplifiers are part of Mini-Circuits family of "ERA" amplifiers using InGaP technology and custom designed temperature simulation software to deliver the next generation of high reliability. Typically at 1GHz (25°C), this low cost model provides 17.4dB gain, 18.1dBm (max.) power output (typ. at 1dB comp.) and 4.1dB NF with 33dBm IP3 for good dynamic range. See our web site for S-parameter data, grounding, and biasing techniques.

FROM $1.72



FROM $144.95

5WAY-0° SPLITTER/COMBINER UNVEILED FOR UHF TRANSMITTERS

A high power 5way-0° power splitter/combiner for the 450 to 920MHz band has been introduced by Mini-Circuits. The ZB5CS-920-10W is a tough built Type-N Female coaxial unit with very low 0.4dB typical insertion loss, high 26dB (typ) isolation, and 0.10dB amplitude/2 degrees phase unbalance typical. Maximum power input is 10W as a combiner and 20W as a splitter when operated within -55°C to +55°C (above 55°C, max. power rating is reduced). Value priced.

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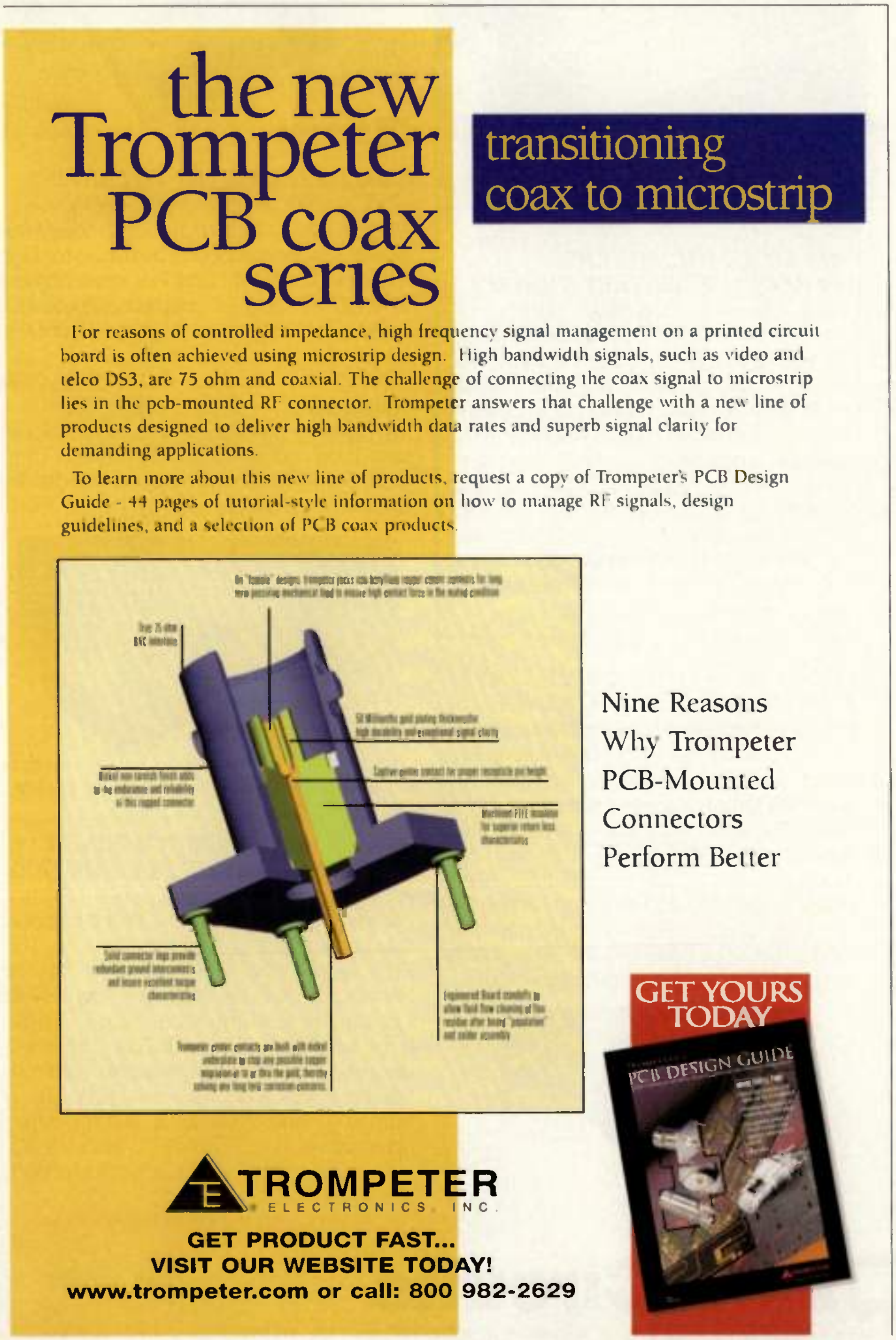
AMPLIFIERS

Power amplifier supports 3G applications

The RF2186 high-power linear amplifier for hand-held systems is designed for use as the final RF amplifier in 3 VDC CDMA2000 and WCDMA/UMTS handsets, spread-spectrum systems and other applications in the 1.920 GHz to 1.980 GHz band. The amplifier is backward-compatible with existing 2G and next-generation 2.5G systems. Operating from a single 3 VDC supply, the self-contained device delivers 27 dBm linear output power, 31 dB linear gain and 35% linear efficiency. The amplifier's 50 Ω input can be matched to obtain optimum performance characteristics exceeding the recommended supply voltages.

RF Micro Devices
INFO/CARD 141



INFO/CARD 51

GaAs MMIC power amps work in 17.5 to 31.5 GHz

Fujitsu Compound Semiconductor is expanding its GaAs MMIC power amplifier line with four millimeter-wave, high-power MMIC amplifiers covering the 17.5 to 31.5 GHz frequency band with output ranging from 26 to 31 dBm. These devices are designed for point-to-point or point-to-multipoint radio link and LMDS applications. With the use of the 0.25μm gate-length pHEMT process technology and input/output 50 Ω matching, these devices can ease the customer's design implementation. The FMM5803X is a high-gain, wide-band three-stage MMIC amplifier designed for operation in the 27.5 to 31.5 GHz frequency range with a 30 dBm output, a 12/14 dB power gain and a 20% N_{add}. The 5805 is for operation in the 17.5 to 20 GHz frequency range with a 31 dBm output, a 21 dB power gain and a 30% N_{add}. The 5806 is a two-stage amplifier for operation in the 25 to 27 GHz frequency range with a 26 dBm output, a 9.5 dB power gain and a 25% N_{add}. The 5807 is a three-stage amplifier for operation in the 21 to 27 GHz frequency range with a 29/30 dBm output, a 14 dB power gain and a 20% N_{add}.

Fujitsu Compound Semiconductor
INFO/CARD 142

SUBSYSTEMS

Transceiver offers serial I/O

The TR400 transceiver is designed for low-cost, short-range, medium-data-rate communications between two (or as many as 15) devices having serial I/O and requiring remote control of a process–whether in a safe or hazardous area. The transceiver is available in a commercial or intrinsically safe plastic housing that mounts anywhere, inside a sanitary metal case or in an explosion-proof-approved enclosure. The device stores as many as 72 characters and automatically trans-

mits the data via the 916.5 MHz ISM unlicensed band. As a remote wireless controller, the device accepts a wireless command from the master to turn on its open collector transistor for local control. A PC-compatible terminal connected to the master can take action, log alarms or command the sending unit to control a local load via its open collector transistor.
OTEK
INFO/CARD 143

Counter includes transmitter/receiver

The FS-counter consists of an RF transmitter and receiver set. The transmitter transmits a fail-safe (check-in signal) every minute and should the receiver fail to receive it, it will alarm the user by blinking its LED and intermittent buzzer. The transmitter accepts TTL or dry contact pulses and transmits them to the receiver, which accumulates the count and makes it available at its "jack" and six-digit counter. The counter operates in the 315 MHz band and requires no FCC license. Range is over 100 feet for indoors and over 300 feet for line of sight. The set operates from AC power with battery backup or just battery for mobile remote applications. Applications include wireless event counters of production parts, illegal entry, traffic counting and volume/flow from hazardous to safe areas.
OTEK
INFO/CARD 144

TEST EQUIPMENT

Switching modules expand measurement capability

The Agilent 3499A/B switching modules allow test engineers to choose from 26 switching and control modules and two mainframes as they configure test systems. Engineers can choose from 26 plug-in modules to switch 1310/1550 nm optical signals, as well as electronic signals from DC to 26 GHz, 1 mV to 1 kV, and 1 mA to 8 A. New modules include the N2266A multiplexer module with a scan speed up to 350 channels-per-second that will increase component manufacturing test throughput (capacitors, resistors) up to 100%. The N2268A module is designed for low insertion loss, high isolation and VSWR performance that makes it suitable for RF signal measurements with spectrum analyzers, network analyzers and GSM/CDMA test sets.
Agilent Technologies
INFO/CARD 145

Transmitter extends frequency range

A dual-band transmitter for testing in cellular and PCS frequency bands has been enhanced to extend its frequency range to 805-894 MHz and 1.850 to 1.990 GHz. A model is also available to cover the GSM (925 to 960 MHz) and DCS (1.805 to 1.880 GHz) frequency bands. The transmitter gen-

ANNOUNCING A NEW PRODUCT LINE!

HBT AMPLIFIERS WITH InGaP GaAs Technology

- DC TO 7 GHz PERFORMANCE
- 10 dB to 20 dB GAIN
- +12 dBm to 24 dBm OUTPUT 1dBcp
- LOW COST, HIGH RELIABILITY InGaP GaAs HBT PROCESS

Performance Table

Part Number	Freq. Range (GHz)	Vcc (V)	Icc (mA)	Output P1dB (dBm)	Output IP3 (dBm)
HMC313	DC - 6.0 DC - 6.0	5.0 7.0	47 82	13.6 19.3	28.9 33.0
HMC314	0.7 - 4.0	5.0	185	18.0	29.5
HMC315	DC - 7.0 DC - 7.0	5.0 7.0	31 50	12.0 16.5	26.8 31.0
HMC323 & HMC324	DC - 3.0	7.5	57	16.8	30.0
HMC326MS8G	3.4 - 3.6	5	125	24	36.0

HBT Darlington Amplifier

16 dB Gain

HMC313

HBT Amplifier w/ Power Down

10 dB Gain

HMC314

HBT Darlington Amplifier

12 dB Gain

HMC315

HBT Driver & Dual Driver Amplifier

11 - 12 dB Gain

HMC323 & HMC324

HBT Driver Amplifier for WLL

20 dB Gain

HMC326MS8G

COMPLETE DATASHEETS & 7 ADDITIONAL NEW AMPLIFIERS FOR 802.11, UNII, & HipeRLAN RADIO PLATFORMS AVAILABLE ONLINE.

INFO/CARD 52

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VISA We Accept

TÜV

erates a CW signal with a manually adjustable output level −10 to +10 dBm. The unit is suitable for in-building use. Signal coverage can be fully tested before final transmitter installation. Frequency is set through the serial port of a PC or laptop. Units are battery-powered for field use, providing four to six hours of operations. The compact unit is about 4" X 7" X 2".
Praxsym
INFO/CARD 146

PASSIVE COMPONENTS

Resonator features small package

The SSR-DR ultraminiature ceramic chip resonators measure 2.5 mm X 2.2 mm X 1.0 mm. The resonators feature an operating frequency range of 20 to 60 MHz (±0.5%) with several standard frequencies available. The resonant impedance is 60 Ω for 20 to 30 MHz and 100Ω for 30.1 to 60 MHz, with a temperature stability of ±0.3% over the operating temperatures of −20°C to +80°C.
AVX
INFO/CARD 147

SEMICONDUCTORS AND ICs

IC performs clock recovery

The Extractor 1000 is a receiver clock recovery IC. The IC provides an interface between RF Monolithics' RX and TR series ASH radios and a low-cost host controller. The IC performs clock recovery and start symbol detection, eliminating the need for the customer to develop RF UART functions. The IC also allows the receiver to run at zero threshold (open squelch). This feature permits the receiver to run at maximum sensitivity without burdening the real-time processing power of the host microcontroller. The microcontroller can run in a low-current (sleep) mode while the IC1000 is searching for a start symbol. Only when a start symbol is detected and incoming data are present will the IC wake up the host microcontroller.
RF Monolithics
INFO/CARD 148

SIGNAL SOURCES

TCXOs offer Stratum 3 stability

C-MAC MicroTechnology has introduced a versatile range of TCXOs operating at any output frequency between 1.0 and 80 MHz. Based on C-MAC's Pluto temperature compensation IC, the CFPT-9050 series can fulfill the stability and frequency requirements of SDH/SONET clock requirements up to and including Stratum 3. The TCXO comes in an FR4-based 14 X 9 mm surface-mount package with a footprint compatible with industry-standard six-pad SOJ-20 devices. This small device can achieve Stratum 3 stability even at 77.76 MHz output because of circuitry within the Pluto IC, which allows either

the crystal's fundamental frequency or its third overtone to be selected.
C-MAC MicroTechnology
INFO/CARD 149

Oscillators feature low-jitter voltage

The Panther miniature surface-mount VCXOs exhibit clean, low-jitter properties. This product (model 333) is packaged in a standard 9 X 14 mm hermetically sealed SMT ceramic package. The fundamental oscillators (models 333L and 333S) operate on +3.3 VDC or +5.0 VDC, respectively. The oscillators use CTS' high-frequency fundamental crystal technology and are available in frequencies such as 77.76 MHz and 155.52 MHz. Because the fundamental crystal frequency is the same as the output, no frequency multiplication is required, thus eliminating excess noise and subharmonics that typically result from the frequency multiplication process using PLL or multiplication techniques.
CTS
INFO/CARD 150

VCXOs available at 1.024 MHz to 170 MHz

The J-type voltage-controlled crystal oscillators provide low jitter and are available at frequencies from 1.024 MHz to 170 MHz. Features include +3.3 VDC or +5 VDC options, small 14 X 9 mm package and CMOS or PECL outputs. Typical jitter performance is less than 0.5 ps rms (12 kHz to 20 MHz) at the output frequency for the CMOS version and less than 1 ps rms for the PECL option. The oscillators are suitable for clock smoothing and frequency translation in SONET/SDH, ATM, DSLAM and other telecommunications applications.
Vectron International
INFO/CARD 151

PLL modules combine VCXO, VCO techs

The CTR1000 series combines high-frequency VCXO and VCO hybrid and crystal technologies. The device starts with a stable low-reference frequency that can be generated into a stable high-frequency output. Output frequencies are available from 1.544 MHz to 2.488 GHz (OC-48). Each portion of the module can be customized to attain specific designer objectives for the entire device. Other features include laser-trimmable thick-film capacitors in the VCXO portion that adjust nominal calibration frequencies and set overall modulation sensitivity. Specifiable parameters include output frequency, loop bandwidth, lock time, phase noise, phase error and jitter. High-frequency, low-noise references allow lower scale-up multiples, reducing overall noise and generation.
Champion Technologies
INFO/CARD 152

Clock oscillators cover 3 MHz to 125 MHz range

The R-series oscillators surface-mount clock oscillators cover the 1.544 MHz to 125 MHz frequency range. The standard frequencies are 25, 44.726, 50, 75, 100, and 125 MHz. The oscillators are available with frequency accuracy from 20 ppm to ±100 ppm, over the 0°C to 70°C range. The oscillators are built in a miniature 5 X 7.5 X 2 mm surface-mount package with large solder pads with 60 mil gold plating for enhanced solderability. The oscillators are available on tape and reel and are compatible with double-sided PCB production. Solder pads extend up the sides of the oscillator–referred to as castellations–and draw solder during reflow soldering operations.
MF Electronics
INFO/CARD 153

VCO for portable data terminals

The CLV0925E voltage-controlled oscillator is geared for portable data applications. The VCO generates frequencies between 896 to 959 MHz within a control voltage range of 0.3 to 4.7 VDC, making it suitable for quick integration into PLLs where the error voltage can be taken directly from the IC's charge pump circuitry. Also, the VCO exhibits a spectral signal of −114 dBc/Hz, typically, at 10 kHz offset. The oscillator draws only 12 mA, typically, while operating from a 5 VDC source.
Z Communications
INFO/CARD 154

RF software

CAD import modules allow extrusion

Remcom's 3D Solids and layered CAD import modules are for importing Autocad DXF files and SAT solid objects into its XFDTD electromagnetics software. Complicated objects described either as 3D solids or layers can be imported into XFDTD and automatically meshed. The layered CAD import module allows extrusion so that 2.5D objects can be imported, while the 3D Solids Importer meshes any collection of 3D solids. By eliminating the need to draw objects in XFDTD, this capability can enable end-users working with CAD software to use XFDTD more efficiently and save time.
Remcom
INFO/CARD 155

Easy-to-use, measurement-specific, graphical program

Agilent Technologies' VEE OneLab, a graphical PC programming environment for stand-alone research and development applications, incorporates Mathworks MATLAB Script and features from the MATLAB Signal Processing Toolbox. VEE OneLab offers a robust measurement programming environment that contains significant features from VEE Pro 6.0, including capabilities from The Mathworks. Three features characterizing the Agilent VEE OneLab are built-in analysis, new standards-complementary functions, and new tutorials. It is especially suitable for design characterization, design verification, data acquisition and experimentation in single-test-stand applications.
Agilent Technologies
INFO/CARD 156

Analog, mixed-signal circuit simulation system

Intusoft announces a new SpiceMod data modeler and new IntuScope5 graphical waveform analyzer within its ICAP 8.x.8 version. The SpiceMod program has a new Library Manager, which creates templates to make it easy to manipulate and save models. The waveform analyzer has been redesigned from the ground up to enhance waveform selection, scaling, viewing and math operation. The data sheet modeling program and waveform analyzer are part of Intusoft's ICAP package, which also includes an IsSpice4 circuit simulator and SPICE model libraries with more than 13,000 analog and digital parts.
Intusoft
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RF Design Online!

For more information on companies noted in the software column, check out the *RF Design* Web site at **www.TelecomClick.com** for direct links to company Web sites.

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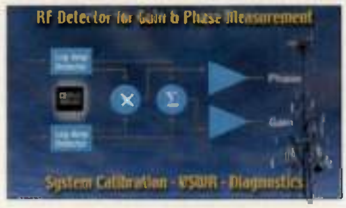
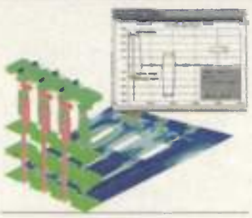


The A8302 enables users to measure the gain and phase of a signal with excellent accuracy over temperature up to 2.7GHz, which makes it suitable for all cellular standards (GSM/CDMA/TDMA/W-CDMA). The AD8302 integrates two wide dynamic range log amps that are closely matched in their characteristics and operating range.

ANALOG DEVICES
www.analog.com



Ansoft is the market leader in full-wave finite element electromagnetic simulation software. Ansoft HFSS enables engineers to design 3D HF structures such as microwave components, antennas and interconnect found in cellular telephones, broadband communications, and microwave circuits. Version 8.0 contains Full-Wave Spice technology.

ANSOFT CORPORATION
www.ansoft.com

New! Free trial version!

Now you can acquire the new student or evaluation version of APLAC RF design and simulation tool for free!

APLAC Solutions has released the new student and evaluation versions of its famous RF design and simulation tool, APLAC 7.60.

APLAC
www.aplac.com

AR announces DITO, a low-cost, portable electrostatic (ESD) discharge simulator offering up to 16.5 kV air and 10 kV contact discharge. DITO offers low-fatigue, one-hand testing, stored in a lightweight wand. A menu-driven LCD and keys on the wand itself lets users choose standard, user-definable,"easy zap" or "quickstart" test routines.

AR
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CAD Design Software's RF Designer Suite is a complete intelligent wireless layout system. Complex geometries, intelligent RF parts creation, Netcheck and DRC of RF components (NO alternate part replacement!).

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DoveBid test and measurement group is one of the largest, most reliable dealers of reconditioned microwave hardware and electronic test and measurement equipment in the nation. We offer the most advanced instrumentation from most major manufacturers and also purchase used late model equipment.

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Elanix announces the latest software tools for third-generation (3G) wireless system design and test. The 3G Design Suite provides the highest performance simulation and testing environment available today for complete physical layer design and test, including unique RF design capabilities that provide interactive simulation between processing gain and RF headroom analysis while maintaining simulation performance.

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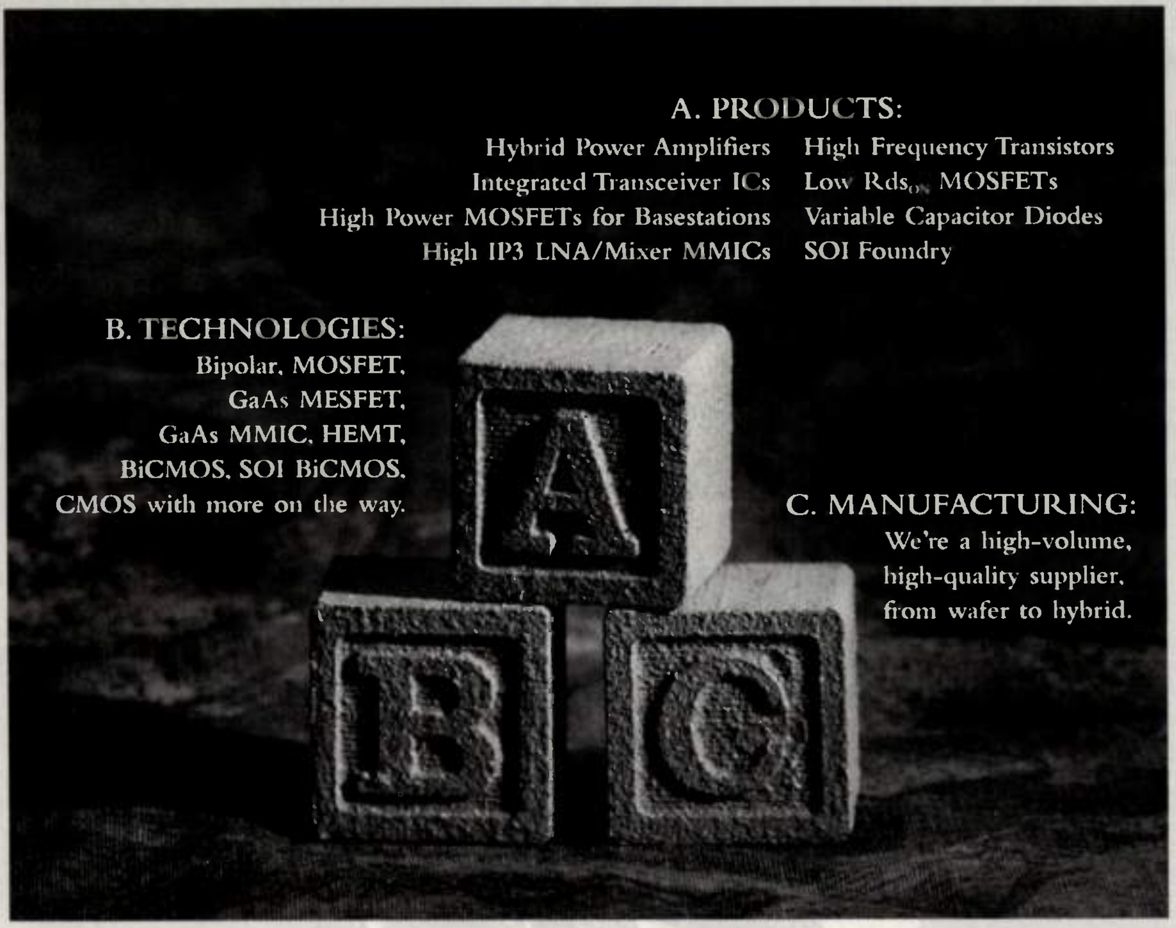

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INFO/CARD 72

DIRECTIONAL COUPLERS

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LOW COST DIRECTIONAL COUPLERS

Introduction

Ever expanding applications of RF and Microwaves for Wireless and Cable applications have revived the development efforts of components at these frequencies. There is a continuing demand to reduce the cost and increase the performance and quality at the same time. Mini-Circuits is working to satisfy these goals and has introduced a new Directional Coupler series to satisfy the demands of the market. These couplers are designed to need only commercially available low-cost off-the-shelf chip resistors as external components, and are designed for automated manufacturing to achieve low overall cost.

What Constitutes a Directional Coupler

Fig 1 is the block schematic of a Directional Coupler. The heart of the coupler is supplied by Mini-Circuits as a component. When used with one external chip component, a resistor R, a complete coupler is realized. Mini-Circuits has released a series of couplers for both 50 and 75 ohm applications. These couplers have prefix "TCD" in their model number.

Performance of the Coupler

Mini-Circuits has introduced 9 couplers covering the frequency range of 5 to 1000 MHz. TCD-13-4 for example, is a 13 dB coupler designed for 50 ohms, and TCD-13-4-75 is a 13 dB coupler with 75 ohm characteristic impedance. ***Fig 2*** is a photograph of the coupler and ***Table 1*** gives the specifications. Also shown in Table 1 are the specifications for couplers having other coupling values. ***Fig 3*** shows the insertion loss of TCD-13-4-75. The insertion loss of the coupler is typically 0.9 dB over the band. ***Fig 4*** shows the directivity vs. frequency, which is typically 15 dB over the band. ***Fig 5*** shows coupling vs. frequency, which is typically 13 dB. ***Fig 6*** shows return loss vs. frequency at all three ports, which is typically 20 dB (VSWR, 1.22:1). Circuit board layout plays an important part in the performance of the coupler. In order to minimize parasitic effects, the suggested layout shown in ***Fig 7*** should be used. This series needs only an external resistor of 0805 size. The chip resistor should have a nominal value of 75 and 50 ohms for TCD-13-4-75 and TCD-13-4 respectively. Actual data for other couplers shown in table 1 can be viewed instantly at http://www.minicircuits.com.

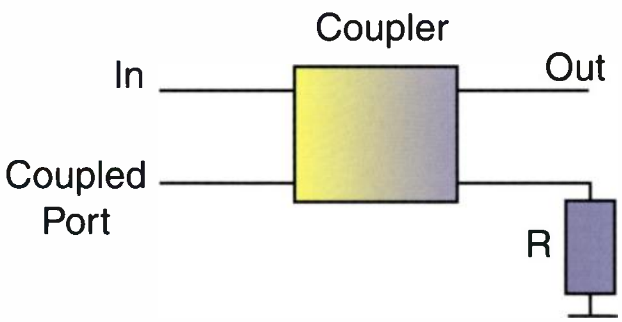


Fig.1 Block Schematic of a Directional Coupler

Fig. 2

Construction of the "TCD" device

TCD-series couplers use one magnetic core transmission line transformer to realize a directional coupler. The base of the device is plastic with embedded leads, which makes the construction very rugged. The leads are solder plated for excellent solderability. All connections from the transformers to the header are made by welding. This helps to ensure preciseness of the assembly, with resulting high performance repeatability, as well as preventing any disconnection during reflow.

Conclusion

Nine couplers have been introduced to operate over 5-1000 MHz. Due to all-welded connections the couplers are very rugged. The product has been designed to be fabricated in automated set-ups which helps lower the cost. Further cost reduction is obtained by designing the unit to work with a low-cost off-the-shelf chip resistor used as external component. These units are designed for automated pick and place manufacturing.

Mini-Circuits® P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661
For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE

ELECTRICAL SPECIFICATIONS Table 1

MODEL NO.	FREQ. RANGE (MHz) f_L-f_U	COUPLING (dB) Nom.	COUPLING (dB) Max Flatness	MAINLINE LOSS (dB) L Typ.	L Max.	M Typ.	M Max.	U Typ.	U Max.	DIRECTIVITY (dB) L Typ.	L Min.	M Typ.	M Min.	U Typ.	U Min.	RESISTOR, R1	VSWR (:1) Typ.	POWER INPUT, W L Max.	MU Max.	CASE STYLE	Price $ ea. Qty. (10-49)
TCD-9-1W	5-750	8.9±0.5	±0.5	1.2	2.1	1.2	1.8	1.5	1.9	21	17	17	10	15	-	50	1.30	0.5	1	DB714	5.95
■ TCD-9-1W-75	5-500	8.9±0.5	±0.5	1.3	2.1	1.2	1.8	1.3	1.9	21	17	17	10	12	-	75	1.30	0.5	1	DB714	5.95
TCD-10-1W	10-750	10.3±0.5	±0.8	1.3	2.1	1.2	1.6	1.4	2.0	22	17	18	14	15	-	50	1.30	0.5	1	DB714	5.95
■ TCD-10-1W-75	10-750	10.5±0.5	±0.7	1.6	2.1	1.4	1.9	1.5	2.0	22	17	18	14	14	-	75	1.30	0.5	1	DB714	5.95
TCD-13-4	5-1000	13.0±0.5	±0.6	0.7	1.3	0.7	1.3	0.8	1.5	21	17	18	12	15	-	50	1.20	0.5	1	DB714	5.95
■ TCD-13-4-75	5-1000	13.0±0.5	±0.9	1.0	1.8	0.8	1.3	1.1	1.5	22	17	15	-	12	-	75	1.20	0.5	1	DB714	5.95
TCD-18-4	5-1000	17.9±0.5	±0.6	0.7	1.3	0.7	1.1	1.0	1.4	22	11	20	15	18	-	50	1.20	1	1	DB714	5.95
■ TCD-18-4-75	10-1000	18.0±0.5	±0.9	0.9	1.3	0.7	1.2	0.8	1.3	20	15	22	15	18	-	75	1.20	1	1	DB714	5.95
TCD-20-4	5-1000	20.0±0.5	±0.8	0.3	0.9	0.4	0.8	0.7	1.1	20	11	21	15	15	-	50	1.20	1	1	DB714	5.95

■ Denotes 75 ohm model L=low range [f_L to 10 f_L] M=mid range [10f_L to f_U/2] U=upper range [f_U/2 to f_U]

TCD-13-4-75 INSERTION LOSS

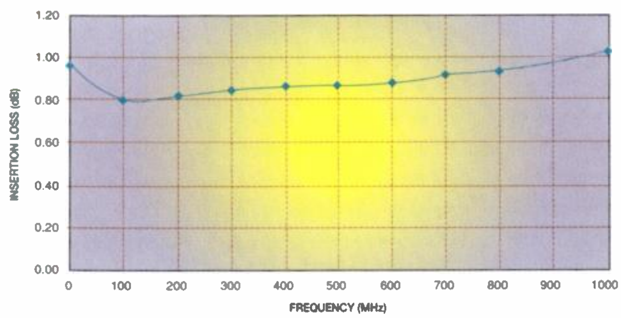


Fig. 3

TCD-13-4-75 DIRECTIVITY

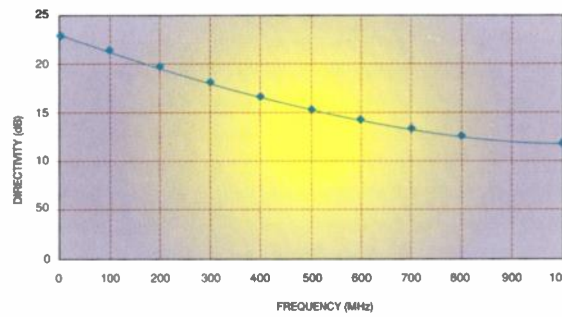


Fig. 4

TCD-13-4-75 COUPLING

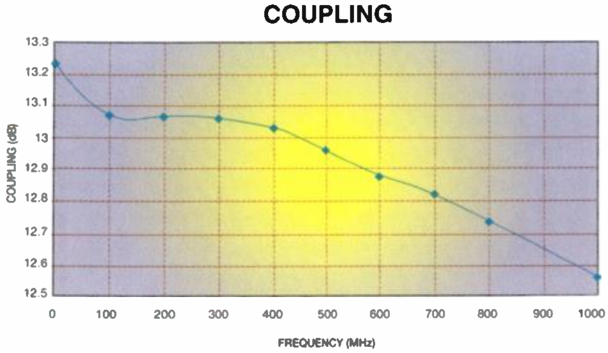


Fig. 5

TCD-13-4-75 RETURN LOSS

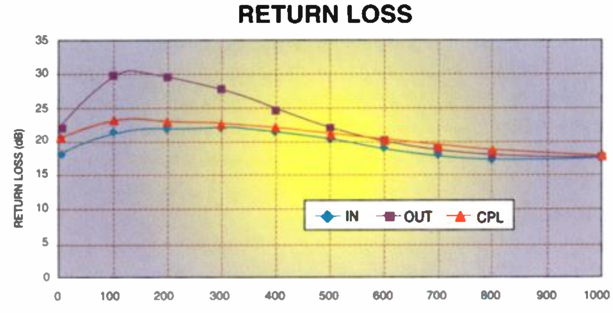


Fig. 6

DO-IT-YOURSELF

DIRECTIONAL COUPLERS

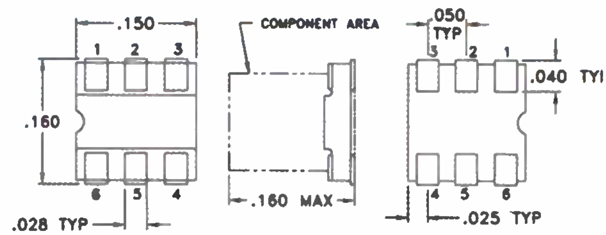
Mini-Circuits

Typical Performance Data - TCD-13-4-75

Frequency (MHz)	Insertion Loss (dB)	CPL (dB)	DIRECTIVITY (dB)	RL-IN (dB)	RL-OUT (dB)	RL-CPL (dB)
5	0.96	13.23	22.93	18.39	22.11	20.63
100	0.8	13.07	21.46	21.56	29.75	23.23
200	0.82	13.07	19.9	22.09	29.67	22.99
300	0.84	13.06	18.25	22.15	27.88	22.67
400	0.86	13.03	16.68	21.58	24.86	22.04
500	0.86	12.96	15.34	20.44	22.11	21.08
600	0.87	12.88	14.27	19.08	19.99	20.15
700	0.91	12.82	13.42	17.97	18.61	19.42
800	0.93	12.73	12.75	17.33	17.64	18.67
1000	1.02	12.56	11.88	17.83	17.63	17.78

CASE STYLE DRAWINGS & DIMENSIONS (INCH)

CASE STYLE DB714



WT GRAMS: .15

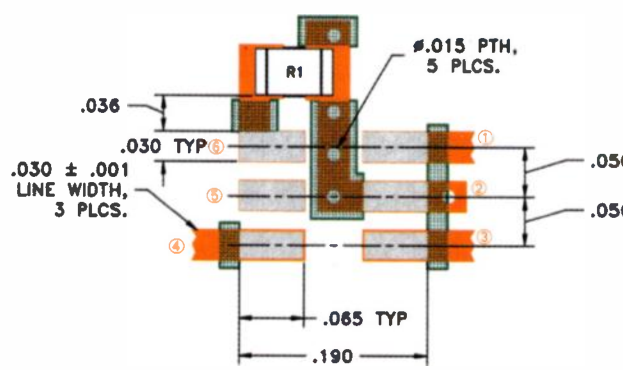
PIN CONFIGURATION

PORT	
INPUT	3
OUTPUT	4
COUPLED	1
GND	2
50/75Ω TERM (EXTERNAL)	6
NOT USED	5

MAXIMUM RATINGS

OPERATING TEMPERATURE	-20°C to 85°C
STORAGE TEMPERATURE	-55°C to 100°C

SUGGESTED PCB LAYOUT FOR TCD COUPLERS



DENOTES METALLIZATION

DENOTES SOLDER MASK

DENOTES METALLIZATION FOR DEVICE SOLDERING

RECOMMENDED MATERIAL: ROGERS R04350, DIELECTRIC
THICKNESS: .030 ± .002
COPPER: 1/2 OZ. EACH SIDE
RESISTOR R1: 0805 SIZE, REFER TO TABLE 1 FOR VALUE.

Fig. 7

GET THE DATA NOW

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Synergy Microwave	61	79
T-Tech	22	85
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Temex	68	81
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Trilithic	31	83
Trompeter Electronics	86	51
Ultra RF	35	56
Valpey-Fisher	40	86
Vancomm	80	53
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Product Showcase

The VCXO-C series is a tight-stability, voltage-controlled crystal oscillator. The frequency can be pulled a minimum ±100PPM by applying a voltage between 0.5V & 4.5V to pin 1. This oscillator is designed for use in applications requiring a general-purpose VCXO with excellent cost vs. performance characteristics.

FOX ELECTRONICS
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An economic way of upgrading an analog signal generator to a vector modulated signal generator, the 2029 offers a high performance solution for 2G, 2.5G and 3G radio systems. The 2029 covers the frequency range 800MHz to 2.51 GHz.

IFR
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The Model 12951 Solid State Matrix is an 8 in x 12 out x 2 wire state matrix switching module. The unit is designed to switch balanced RS-422 data pairs and is a non-blocking, full fanout matrix, allowing an input to be simultaneously connected to any combination of outputs.

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Noise Com's NC 302L is a member of our diode family and a building block of all noise systems. The NC302L is designed for specific microwave applications in which 50-ohm impedance is required. Typical small impedance of the NC302L is 10-20 ohms when a diode is turned on.

NOISE COM
www.noisecom.com

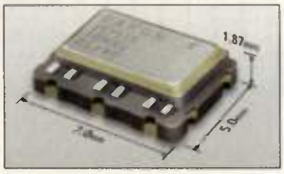
StatMat, a powerful, comprehensive engineering statistical analysis tool by Nuhertz Technologies, performs fast, accurate, and easy-to-use statistical processing of your engineering field data on your PC. StatMat supports probability plots, histograms, and linear and curvilinear regressions and interpolations.

NUHERTZ
www.nuhertz.com/statmat

Precision Tube's new catalog describes its broad line of semi-rigid cables, delay lines, and flexible cables. Semi-rigid cables are produced with outer jacket materials of aluminum, copper or stainless steel. Cable sizes range from .020" to .500" with impedances from 10-to-100 Ohm. Cable types include solid dielectic, air-articulated, cryogenic/lossy, MIL-C-17 types and "soft-form" units.

PRECISION TUBE
www.precisiontube.com

Product Showcase

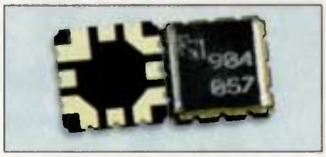


Rakon's new IT7500 and IVT7500 oscillators lead the way for a new generation of products. The 7500 series features an analogue IC for temperature compensation. This analogue IC has no erratic frequency jumps. The unit can operate on any supply voltage between 2.7 and 5.5 volts, and consumes only 1.2mA typically. Clipped Sinewave frequency output ranges from 10MHz to 26MHz.

RAKON
www.rakon.com

RF Micro Devices introduces a complete W-CDMA single-mode chip set solution including a front end (RF2469), power amplifier (RF5176), modulator/AGC (RF2690), AGC/demodulator (RF9678), upconverter (RF2638), and driver amplifier (RF2377).

RF MICRO DEVICES
www.rfmd.com



Sawtek introduces a next-generation cellular RF SAW duplexer that turns "wish list" specs into reality. It is 74% smaller than first-generation SAW duplexers and 95% smaller than ceramics. Sawtek's monolithic approach speeds time to market and slashes costs, while still providing outstanding isolation and Tx/Rx amplitude response.

SAWTEK
www.sawtek.com

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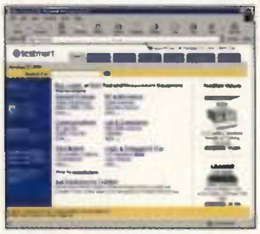
TEMEX
www.temex-components.com



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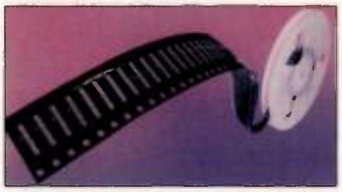
TEST MART
www.testmart.com

Trompeter Electronics announces the latest innovation in BNC connector design, a 75 ohm BNC separable circuit board jack for interconnecting mother and daughter boards. This connector assembly is ideal for launching high-frequency signals directly from the edge of a PCB through the motherboard into a coax cable.

TROMPETER ELECTRONICS
www.trompeter.com

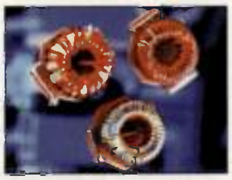
New spindle block light from T-Tech on its complete line of Quick Circuit rapid prototyping systems illuminates the cutting tool when the spindle is in operation. Dubbed the "Funkengrooven", the illumination is now a free standard feature on all systems. Upgrade kits for systems in the field are available.

T-TECH
www.t-tech.com



Gore introduces GORE-SHIELDÒ SMT EMI gaskets, high-performance EMI shielding gaskets that can also be used as a RF grounding pad or interconnect. The parts come in several different sizes and are shipped to the customer in standard tape-and-reel configuration that is compatible with surface-mount pick-and-place machinery.

W.L. GORE & ASSOCIATES
www.gore.com/electronics



J.W. Miller introduces the surface-mount style PM2110 and PM2120 Series High Current Torid Inductors, suited for a variety of space-conscious applications requiring high-current, high-frequency and high-density circuit designs. Featuring a cost-effective, low-loss iron powder core, the series ensures high reliability and low contact resistance for high-current requirements.

J.W. MILLER
www.jwmiller.com

Continued on page 112

Broadband RF and Microwave

LOGARITHMIC AMPLIFIERS

FEATURES

- MIC Technology
- High Sensitivity
- Fast Rise Times
- Small Size

The MLS series is the newest edition to MITEQ's line of high-performance logarithmic amplifiers. Utilizing the latest MIC (microwave integrated circuit) technology, these logarithmic amplifiers achieve exceptional performance in packages as small as 1.8 square inches. The design uses low-noise gain blocks and the same proprietary detection circuitry as the MLIF series to achieve ultrawide operational bandwidths. Increased sensitivity and video rise times as fast as 2 ns are available.

Model Numbers	Operational Frequency Range (MHz)	Input Dynamic Range (dBm)	Tangential Sensitivity (dBm)	Video Flatness (dB)	Rise Time (ns)	Fall Time (ns)	Recovery Time (ns)
MLS-375/250-70	250 to 500	-70 to 0	-75	±1.0	15	30	40
MLS-550/500-70	300 to 800	-70 to 0	-73	±1.5	10	25	35
MLS-1000/500-70	750 to 1250	-67 to ±3	-70	±1.5	10	25	35
MLS-2000/1000-70	1500 to 2500	-67 to ±3	-70	±1.5	15	30	40
MLS-3000/2000-70	2000 to 4000	-65 to +5	-68	±2.0	10	25	35
MLS-5000/2000-70	4000 to 6000	-65 to +5	-68	±2.0	10	25	35

For additional information, please contact Boris Benger at (631) 439-9402, fax (631) 439-9540 or e-mail bbenger@miteq.com

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INFO/CARD 50

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
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
FEM – finite-element method
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
ISM – industrial, scientific, and medical

Continued on page 110


SPIRENT
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Communications


HOT
1999
INTERNET TELEPHONY
PRODUCT OF THE YEAR
2000
WINNER
BEST OF SHOW
WINNER
BEST OF SHOW
2000
INTERNET TELEPHONY
BEST TEST
2001

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
XDSL – another name for an ISDN BRI channel

Product Showcase

Vancomm Inc. has released its expanded 2001 Wireless Infrastructure Products and Services Catalog; you will find 80 pages of information for one of the most comprehensive sources of wireless site infrastructure materials in the industry today.

Vancomm's catalog will provide you with integrated solutions that will help you develop and select products to fit any site specific application.

VANCOMM
www.vancomm.com

New 4 X 2 GaAs RFIC Switch from CEL.

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www.cel.com.

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INFO/CARD 35

RF Literature/Product Showcase

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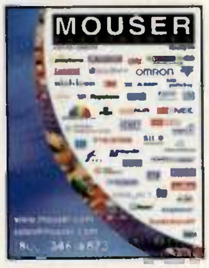

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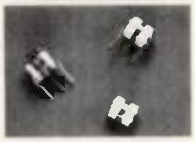

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  - ±1.50 dB @ 40dB
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- Transfer Function Accuracy:
  - 0 - 10 dB @ ±0.25 dB Max
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  - 30 - 50 dB @ ±1.0 dB Max
  - 50 - 60 dB @ ±1.5 dB Max
- Switching Time: 500 nS Max
- Operating RF Power: 100 mW CW/Peak
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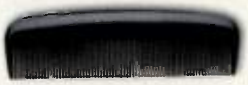

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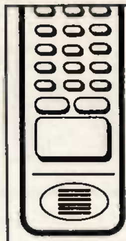

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Sr. Scientist SAW Devices: Responsible for the research and development of new or modified process formulations and equipment, requirements and specifications in the manufacturing and evaluation of Surface Acoustic Wave (SAW) devices. Conceive, plan and execute projects involving understanding, defining, and selecting new concepts and approaches for new or improved processes in SAW devices. PhD/MS.

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RF Design Engineer Design of RF transceivers used in digital radios in the 2-6GHz frequency range. BSEE minimum, MSEE preferred. 3+ years of board-level RF and analog circuit design experience. Experience with amplifiers, filters, mixers, PLLs and their integration into radio transceivers.

Active Components Engineer: Design discreet RF active components for RF systems. BSEE with at least 2 years experience in designing LNAs required. Experience with high power amplifier design is a plus.

Sr. Filter Design Engineer: 3 plus years experience in the design and development of RF/Microwave filters for the wireless industry. Experience with ceramic, cavity, combline, stripline, low pass, band pass filters a plus. All Filter Designers are encouraged to apply.

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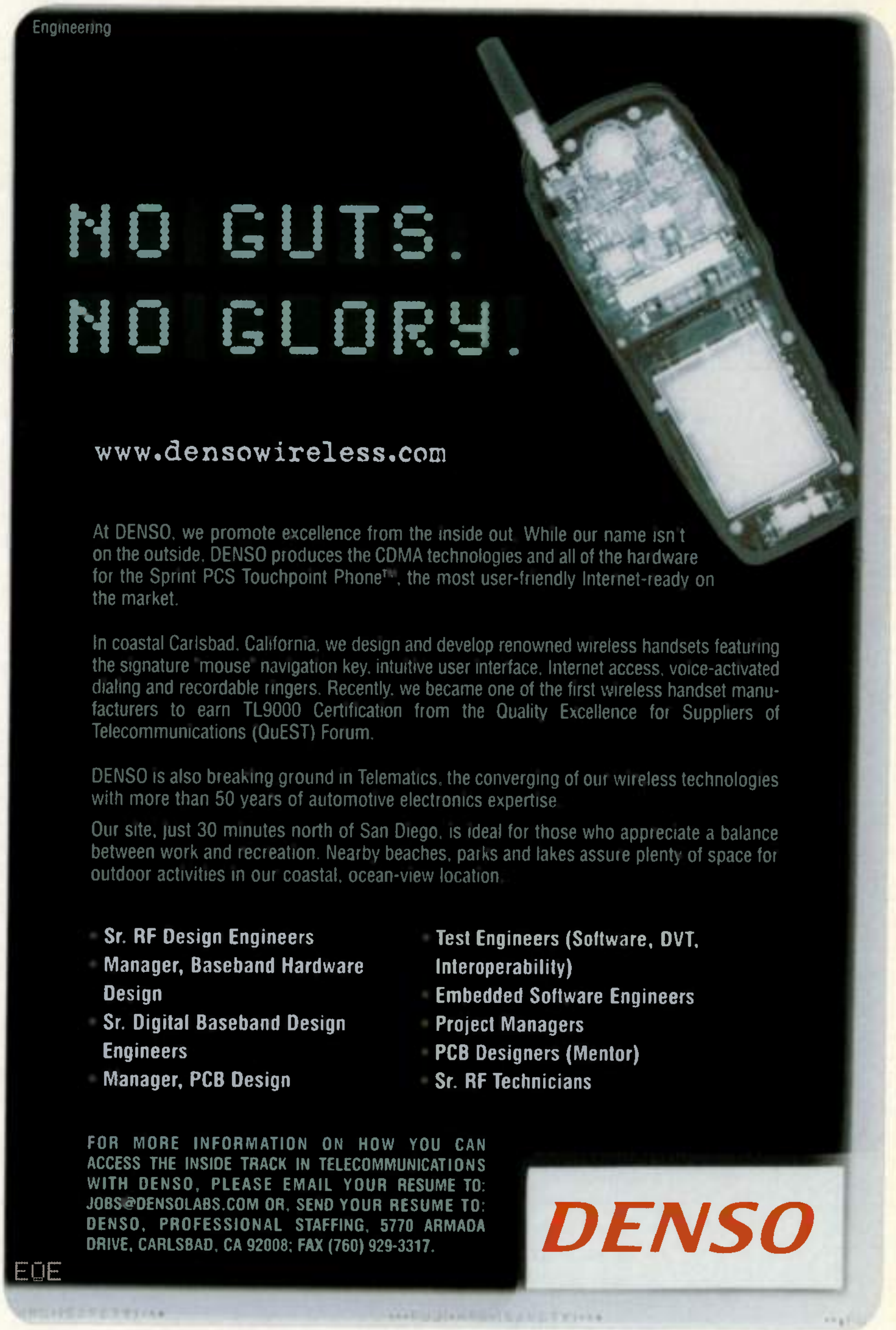

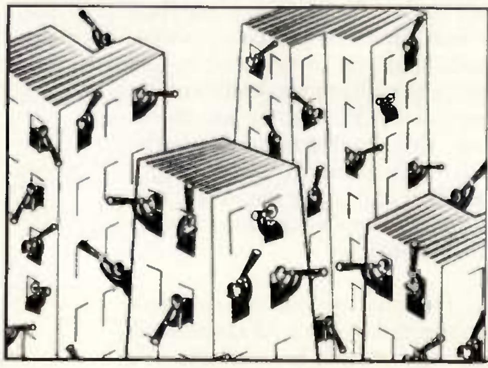

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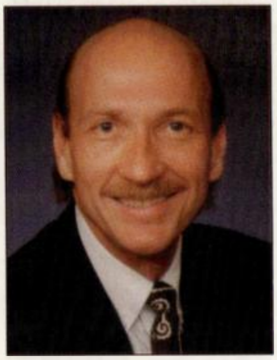

by Ernest Worthman
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Every now and then I come across an interesting tidbit of science (or science fiction) that we eclectic types find extremely interesting, and to which the rest of the world simply yawns. A few months ago, while lazily reading *USA Today* on a flight home, I found such a tidbit.

Call me geeky, but to me this is quite fascinating. In a recent experiment, Dr. Lijun Wang and other scientists at the NEC Research Institute in Princeton, NJ succeeded in getting a brief pulse of laser light to move 310 times as far in a given time as it would have traveled at the normal, absolute speed of light in a vacuum (186,000 miles per second).

Wow! When I heard this, my mind immediately started conjuring up dozens of scenarios; some of which cracked me up.

Seriously, for a moment — If, indeed, this turns out to be grounded in reality, rather than a one-shot, heavily weighted, esoteric experiment, or a trick (remember all the excitement over supposed successful cold fusion not too long ago?), this could make science fiction science fact. It seems to finally support (to a limited degree) the theory that we really can exceed the speed of light.

The scientists say that the pulse of laser light was sent through cesium vapor and traveled so quickly that it left the chamber before it had even finished entering. Previous experiments have been conducted in which light also appeared to achieve such so-called superluminal speeds, but the light was distorted, raising doubts as to whether scientists had really accomplished such a feat. In this case, however, the scientists claim that the laser pulse in the NEC experiment exits the chamber with almost exactly the same shape, but with slightly less intensity. The scientists say that the leading edge of the light pulse has all the information needed to produce the pulse on the other end of the chamber, so it doesn't have to wait for the whole enchilada to reach the end before being reconstructed.

Whoa, horsey — Hmmm...as can be expected, such a noteworthy moment will have its detractors. Some claim that this may not have been a bona-fide experiment. One scientist, a physicist at the University of Toronto, questions whether the light particles coming out of the cesium chamber were the same ones that entered. There is further speculation that the kind of chamber in Wang's experiment is normally used to amplify waves of laser light, not speed them up. In the usual arrangement, one beam of light is shone on the chamber, exciting the cesium atoms. Then a second beam passing through the chamber soaks up some of that energy and gets amplified when it passes through them. But the amplification occurs only if the second beam is tuned to a precise wavelength. By cleverly choosing a slightly different wavelength, Wang induced the cesium to speed up a light pulse without distorting it in any way. So, if that's the case, then we're back to square one.

It could happen — Even if it turns out to be bogus, it's a start. This is the kind of stuff that eventually promotes true leaps in technology. Think of the wonderful improvements to humanity such a breakthrough would provide. We've long dreamed of being able to move faster than light, and some of the applications for doing so (other than time travel) are compelling.

For example, I could know what our editor, Roger, is getting ready to say to me with the first word, and I could have the right answer all the time. Also, missed magazine deadlines would be a thing of the past, and we could have the right answer for our significant others every time as well (this alone is worth throwing billions of dollars at).

For the RF industry, if we could apply the properties of such an experiment to RF energy, think of the savings in bandwidth. We could get all of the information before it left the sender, needing no bandwidth at all.

If, eventually, we could get physical atoms to exhibit the properties of light waves (hey, they do it in *Star Trek*), we wouldn't have to wait for the rest of our bodies to catch up. The tip of our nose hits the destination and, boom, we get an automatic rebuild all the way back. (Maybe we could order a few changes during the process?)

OK, I've had some fun with this. The reality is that modern physics works, and we're bound to accept that. But we have the dreamers, and dreams sometimes change reality. Be thankful for the dreamers. Because of them, someday we will move faster than the speed of light – and I can't wait.