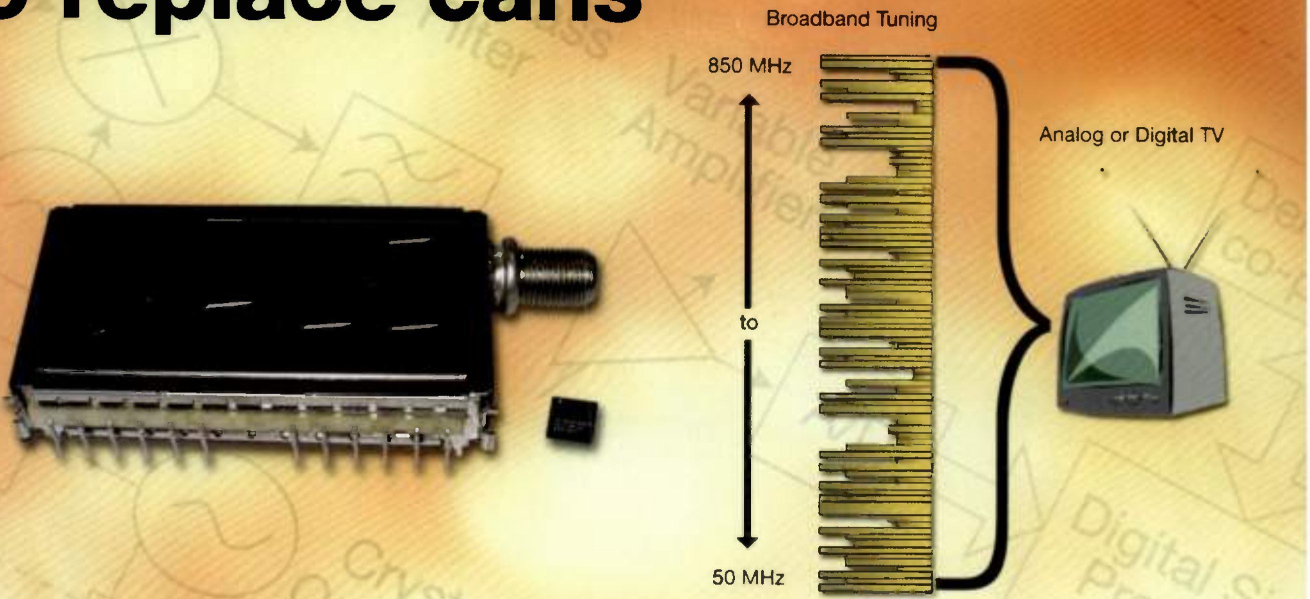
OCTOBER 2005

RFDESIGN

RF AND MICROWAVE TECHNOLOGY FOR DESIGN ENGINEERS

Silicon TV tuners poised to replace cans



Next-Generation Wireless:
DualPath architecture blends optical wireless and RF into high bandwidth, high availability outdoor point-to-point solutions

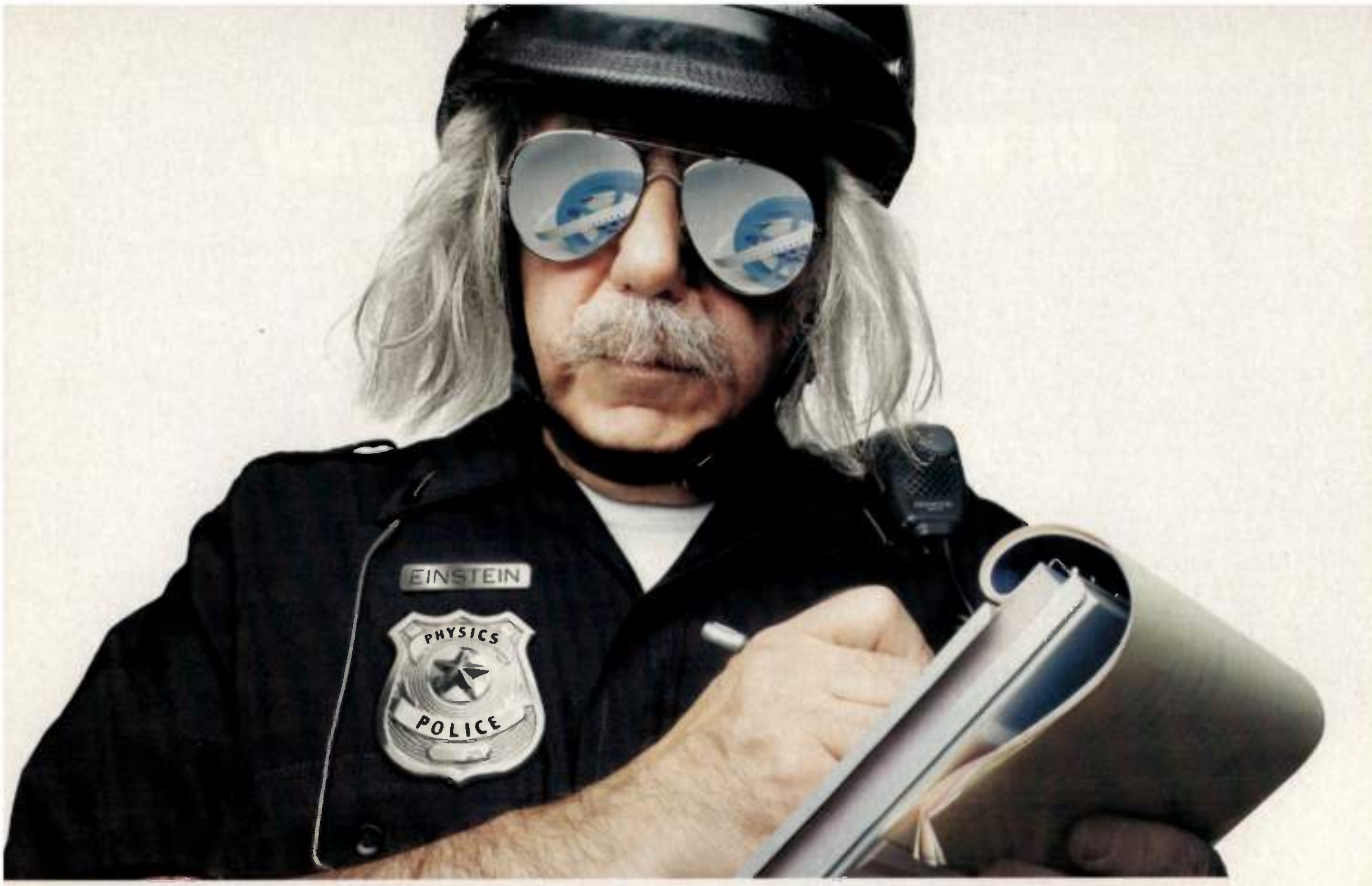
Amplifiers:
Improving amplifier's efficiency using a linearizer in conjunction with adaptive bias modulation

Embedded Technology:
Integrating microcontroller and RF functions on-chip for wireless out-of-box experience

DESIGN TIP

A general measurement technique for determining RF immunity

www.rfdesign.com



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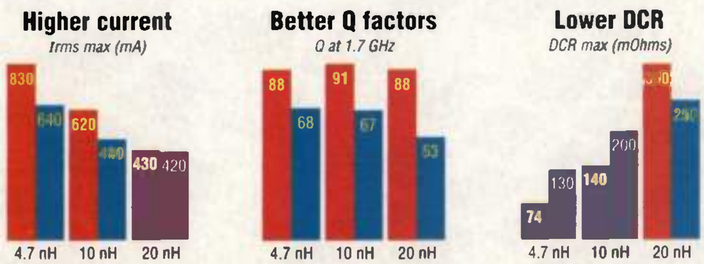

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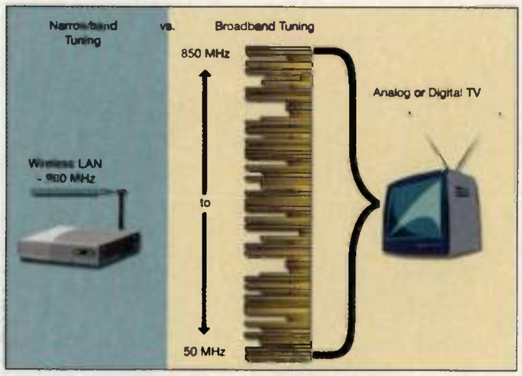

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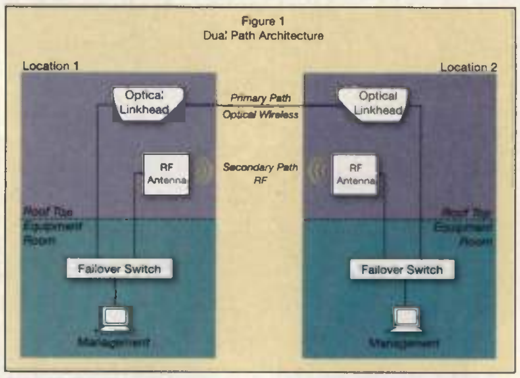

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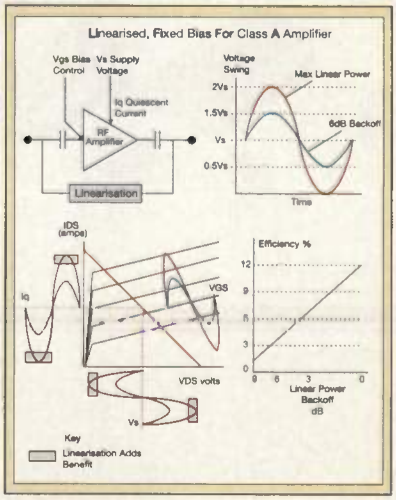

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DIGITAL ATTENUATORS

0.5 to 31.5dB in 0.5 and 1dB Steps

From $2.69 ea. Qty. (1,000)

24 Models To Choose From IN STOCK

- *Choose single +3V or dual +3V, -3V supply voltage @ 100μA*
- *Select 5 or 6 Bit, serial or parallel interface*
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- *Very high IP3 +52dBm, 0.2dB compression @ +24dBm above 1MHz*
- *CMOS programmable start-up and always immune to latch-up*

From world-class performance to very competitive prices, count on Mini-Circuits DAT digital attenuators for the solutions to fit your needs!

Top View Exposed Metal Bottom
Small 4x4mm Package.

DAT SELECTION GUIDE

Specifications Typical at: $T_{AMB} = 25°C$

Model Series	Interface	Z (Ω)	Freq. MHz	Atten. dB	Steps dB	Bits	Price $ea. (Qty.10)
DAT-15R5-P ▲	Parallel	50	DC-4000	15.5	0.5	5	3.55
DAT-15R5-S ▲	Serial	50	DC-4000	15.5	0.5	5	3.55
DAT-15575-P ▲	Parallel	75	DC-2000	15.5	0.5	5	3.55
DAT-15575-S ▲	Serial	75	DC-2000	15.5	0.5	5	3.55
DAT-31-P ▲	Parallel	50	DC-2400	31.0	1.0	5	3.55
DAT-31-S ▲	Serial	50	DC-2400	31.0	1.0	5	3.55
DAT-3175-P ▲	Parallel	75	DC-2000	31.0	1.0	5	3.55
DAT-3175-S ▲	Serial	75	DC-2000	31.0	1.0	5	3.55
DAT-31R5-P ▲	Parallel	50	DC-2400	31.5	0.5	6	3.80
DAT-31R5-S ▲	Serial	50	DC-2400	31.5	0.5	6	3.80
DAT-31575-P ▲	Parallel	75	DC-2000	31.5	0.5	6	3.80
DAT-31575-S ▲	Serial	75	DC-2000	31.5	0.5	6	3.80

▲To specify Supply Voltage:
Add the letter (P) to model number for positive +3 volts.
Add the letter (N) to model number for Dual ±3 volts.
Example: DAT-15R5-PP or DAT-15R5-PN
Patent Pending

DAT test fixture available.

Detailed Performance Specs and Shopping Online at: ***www.minicircuits.com/dsa.shtml***

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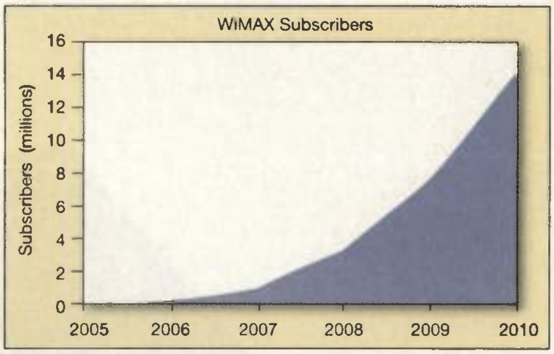

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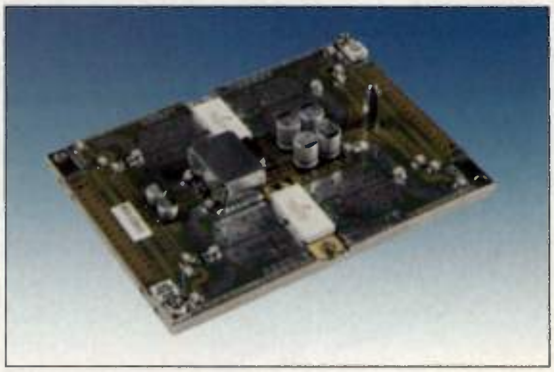

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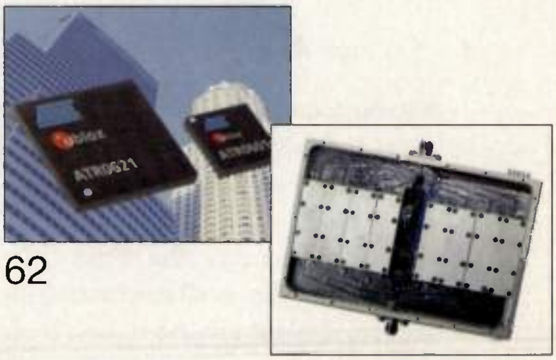

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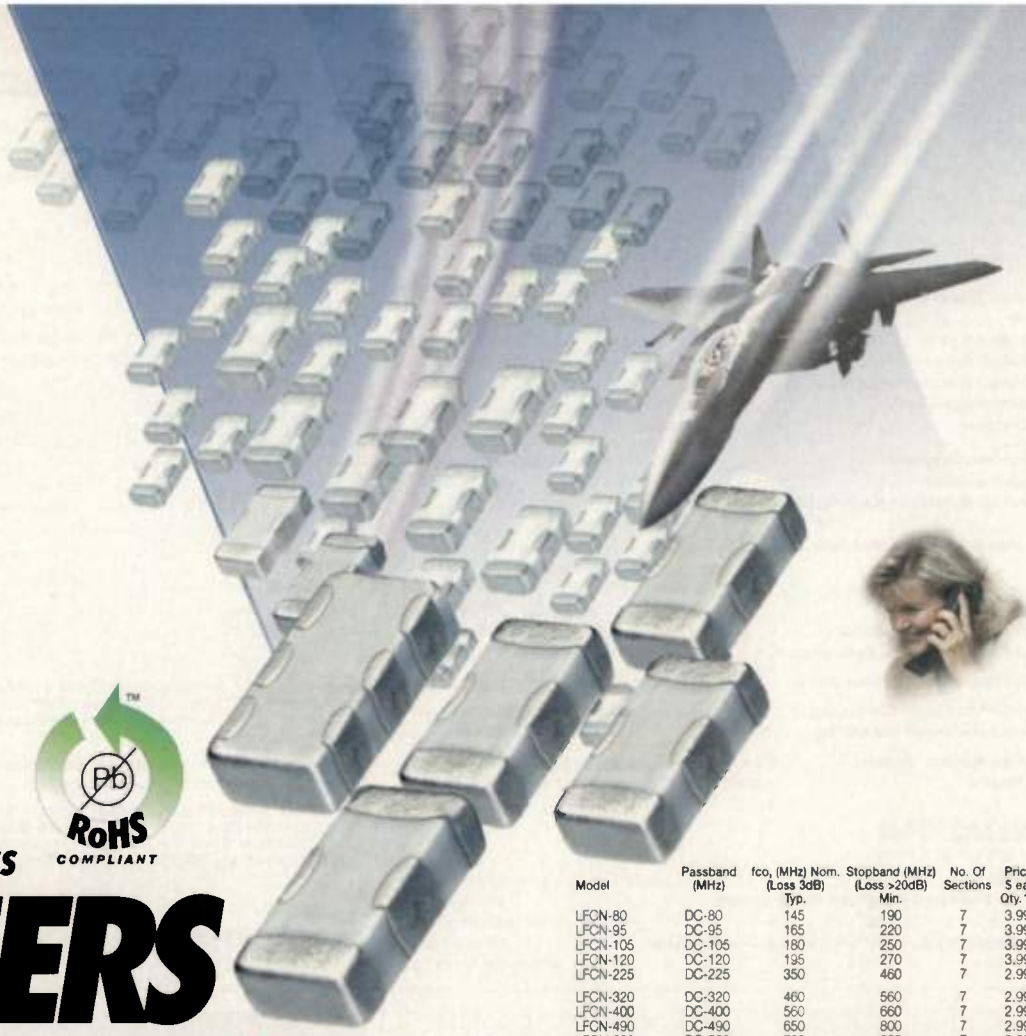

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K1-HFCN Contains 40 Units: Only $79.95
5 ea. HFCN-650, 740, 1200, 1500, 1760, 2000, 2275, 2700

For RoHS compliant requirements, ADD + SUFFIX TO BASE MODEL No. Example: LFCN-80+

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Model	Passband (MHz)	fco, (MHz) Nom. (Loss 3dB) Typ.	Stopband (MHz) (Loss >20dB) Min.	No. Of Sections	Price $ ea. Qty. 10
LFCN-80	DC-80	145	190	7	3.99
LFCN-95	DC-95	165	220	7	3.99
LFCN-105	DC-105	180	250	7	3.99
LFCN-120	DC-120	195	270	7	3.99
LFCN-225	DC-225	350	460	7	2.99
LFCN-320	DC-320	460	560	7	2.99
LFCN-400	DC-400	560	660	7	2.99
LFCN-490	DC-490	650	800	7	2.99
LFCN-530	DC-530	700	820	7	2.99
LFCN-575	DC-575	770	900	7	2.99
LFCN-630	DC-630	830	1000	7	2.99
LFCN-800	DC-800	990	1400	5	1.99
LFCN-900	DC-850	1075	1275	7	1.99
LFCN-1000	DC-1000	1300	1550	7	1.99
LFCN-1200	DC-1200	1530	1865	7	1.99
LFCN-1325	DC-1325	1560	2100	5	1.99
LFCN-1400	DC-1400	1700	2015	7	2.99
LFCN-1450	DC-1450	1825	2025	7	2.99
LFCN-1500	DC-1500	1825	2100	7	2.99
LFCN-1525	DC-1525	1750	2040	7	2.99
LFCN-1575	DC-1575	1875	2175	7	2.99
LFCN-1700	DC-1700	2050	2375	7	1.99
LFCN-1800	DC-1800	2125	2425	7	2.99
LFCN-2000	DC-2000	2275	3000	5	1.99
LFCN-2250	DC-2250	2575	2900	7	1.99
LFCN-2400	DC-2400	2800	3600	5	1.99
LFCN-2500	DC-2500	3075	3675	7	1.99
LFCN-2600	DC-2600	3125	3750	7	1.99
LFCN-2750	DC-2750	3150	4000	7	1.99
LFCN-2850	DC-2850	3300	4000	7	1.99
LFCN-3000	DC-3000	3600	4550	7	1.99
LFCN-5000	DC-5000	5580	6800	7	1.99
LFCN-6000	DC-6000	6800	8500	7	1.99
LFCN-6700	DC-6700	7600	9300	7	1.99
HFCN-650	850-2490	650	480	7	1.99
HFCN-740	900-2800	740	550	7	1.99
HFCN-880	1060-3200	880	640	7	1.99
HFCN-1200	1380-4600	1180	940	7	1.99
HFCN-1300	1510-5000	1300	930	7	1.99
HFCN-1320	1700-5000	1320	1060	7	1.99
HFCN-1500	1850-5500	1550	1250	7	1.99
HFCN-1600	1950-5000	1600	1290	7	1.99
HFCN-1760	2100-5500	1760	1230	7	1.99
HFCN-1910	2200-5200	1910	1400	7	1.99
HFCN-1810	2250-4750	1810	1480	7	1.99
HFCN-2000	2410-6250	2000	1530	7	1.99
HFCN-2100	2500-6000	2100	1530	7	1.99
HFCN-2275	2640-7000	2275	1770	7	1.99
HFCN-2700	3000-6500	2500	1800	7	1.99
• HFCN-5500	6000-11500	5500	4500	5	2.99

LFCN = Low Pass, HFCN = High Pass

LFCN Models: U.S. Patent #6,943,646 except LFCN-800,-1325,-2000 & -2400.

★ For applications requiring DC voltage to be applied to the input or output, *add suffix letter "D" to model number* (DC resistance to ground is 100 megaohms min.) *and add $0.50 to unit price.*

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Model	Passband (MHz)	fco, (MHz) Nom. (Loss 3dB) Typ.	Stopband (MHz) (Loss >20dB) Min.	Model	Passband (MHz)	fco, (MHz) Nom. (Loss 3dB) Typ.	Stopband (MHz) (Loss >20dB) Min.
Low Pass							
VLF-80	DC-80	145	190	VLF-1450	DC-1450	1825	2025
VLF-95	DC-95	165	220	VLF-1500	DC-1500	1825	2100
VLF-105	DC-105	180	250	VLF-1525	DC-1525	1750	2040
VLF-120	DC-120	195	270	VLF-1575	DC-1575	1875	2175
VLF-225	DC-225	350	460	VLF-1700	DC-1700	2050	2375
VLF-320	DC-320	460	560	VLF-1800	DC-1800	2125	2425
VLF-400	DC-400	560	660	VLF-2250	DC-2250	2575	2900
VLF-490	DC-490	650	800	VLF-2500	DC-2500	3075	3675
VLF-530	DC-530	700	820	VLF-2600	DC-2600	3125	3750
VLF-575	DC-575	770	900	VLF-2750	DC-2750	3150	3875
VLF-630	DC-630	830	1000	VLF-2850	DC-2850	3300	4000
VLF-800	DC-800	1075	1275	VLF-3000	DC-3[illegible]	3600	4550
VLF-1000	DC-1000	1300	1550	VLF-[illegible]	DC-5000	5580	6800
VLF-1200	DC-1200	1530	1865	VLF-6000	DC-6000	6800	8500
VLF-1400	DC-1400	1700	2015	VLF-6700	DC-6700	7600	9300
High Pass							
VHF-650	710-2490	650	480	VHF-1760	1900-5500	1760	1230
VHF-740	780-2800	740	550	VHF-1810	1900-4750	1810	1480
VHF-880	950-3200	880	640	VHF-1910	2000-5200	1910	1400
VHF-1200	1220-4600	1180	940	VHF-2000	2260-6250	2000	1530
VHF-1300	1400-5000	1300	930	VHF-2100	2200-6000	2100	1530
VHF-1320	1400-5000	1320	1060	VHF-2275	2450-7000	2275	1770
VHF-1500	1600-5500	1550	1250	VHF-2700	2650-6500	2500	1800
VHF-1600	1650-5000	1600	1290	VHF-5500	6000-11500	5500	4500

U.S. Patent # 6,790,049

★ For applications requiring DC voltage to be applied to the input or output, add *suffix letter "D" to model number* (DC resistance to ground is 100 megaohms min.) *and add $0.50 to unit price. No. of sections: 7 except VHF-5500 is 5.*

*DC-11.5GHz Low & High Pass

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Mini-Circuits VLF Low Pass and VHF High Pass SMA Filters, featuring excellent stopband rejection and passband matching, flat passband response, and sharp rolloff, are unparalleled solutions for RF filtering over a wide range of bandwidths from DC to11.5GHz. Our unique patented Unibody package measures less than 1½" in length and is designed to minimize interconnect losses and improve reliability. Combine that with the temperature stability, performance repeatability, and low cost from our LTCC ceramic technology, and the result is a very rugged, high performance, competitively priced series. These filters are ideal for test set-ups as well as transmitter/receiver filtering in both tactical and commercial applications.

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

For RoHS compliant requirements, ADD + SUFFIX TO BASE MODEL No. Example: VLF-80+

Detailed Performance Specs and Shopping Online for these models, and our full line of .12"x.06" LFCN & HFCN surface mount filters, see ***www.minicircuits.com/filter.html***

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RF/IF MICROWAVE COMPONENTS

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Time to take a closer look at BPL

In the March 24 RF Design Bulletin, an e-newsletter of *RF Design* magazine, I reported a market study on broadband over powerline (BPL) communications conducted by Telecom Trends International, a Falls Church, Va.-based research firm. The BPL market projection and comments from the findings were reported in the bulletin. Of course, the report was one sided because it did not include views and comments of the opposition. In this case, amateur radio operators and ARRL members. The result was a barrage of letters to the editor, all criticizing the editor and the magazine for running such stories and promoting BPL.

But, we are here to disseminate information on new technologies as they evolve. The readers must be informed of the pros and cons of new technology. According to ARRL, BPL is a nuisance to amateur radio operators and ARRL has been complaining for months about interference. Now, ARRL is calling on the FCC to shut down the first BPL service launched in the city of Manassas, Va. this month. It is the first city-wide commercial deployment of BPL technology anywhere in the United States, according to Communication Technologies Inc. (COMTek), the Chantilly, Va.-based company that owns and operates the BPL network in Manassas. The company will serve as the Internet service provider and will provide e-mail and Web hosting services.

As per the ARRL release, the facility has been the source of unresolved interference complaints dating back to early 2004, none of which has resulted "in any action or even interest" on the part of the FCC's Office of Engineering and Technology (OET) staff. In the meantime, interference to local amateur radio stations continues.

"The Manassas system currently causes harmful interference, and it is not compliant with applicable FCC Part 15 regulations," the ARRL said in a 16-page filing to the OET and the FCC's Enforcement Bureau. "Whatever actions either Manassas Power or Communication Technologies Inc. might have taken to relieve the problem, they have not been successful, and it persists to the present time. This is precisely the situation the FCC discussed last October in which the system must be shut down, pending successful resolution of the severe interference."

Meanwhile, COMTek is committed to expanding such services to several other investor-owned utilities, municipal-owned utilities, and other entities around the country. Similar efforts are also in progress in Europe, where the European Commission is making efforts to resolve any issues and open the market to potentially cut the cost of broadband delivery. In fact, dozens of trials are currently under way on all continents

Let's face the fact. Like any new technology, BPL is also going through ups and downs. And it will continue to evolve. Instead of shunning it altogether as a no-good broadband solution, it is time to sit down and look at ways to alleviate the problem. I am sure there are frequency ranges, modulation techniques, power levels, shielding technologies and other methodologies that can be developed to address the interference problem. Just as the innovators have created this broadband technology, I am sure they will also find a solution to eliminate this problem.

It's time to look at this problem more closely and work toward standardizing the BPL technology and service that is interference free. Right now, there is no standard and each operator offers a proprietary technology. Interestingly, at the last Intel Developers Forum, the HomePlug Powerline Alliance announced that it is strengthening its focus on worldwide implementation of HomePlug standards. Toward that end, the alliance is working on a BPL specification based on the established HomePlug AV specifications. It also has created the promoters group to address the Home-Plug BPL standards efforts. Hopefully, this group will ensure that the new standard is interference free.

Ashok Bindra

Ashok Bindra, Editorial Director

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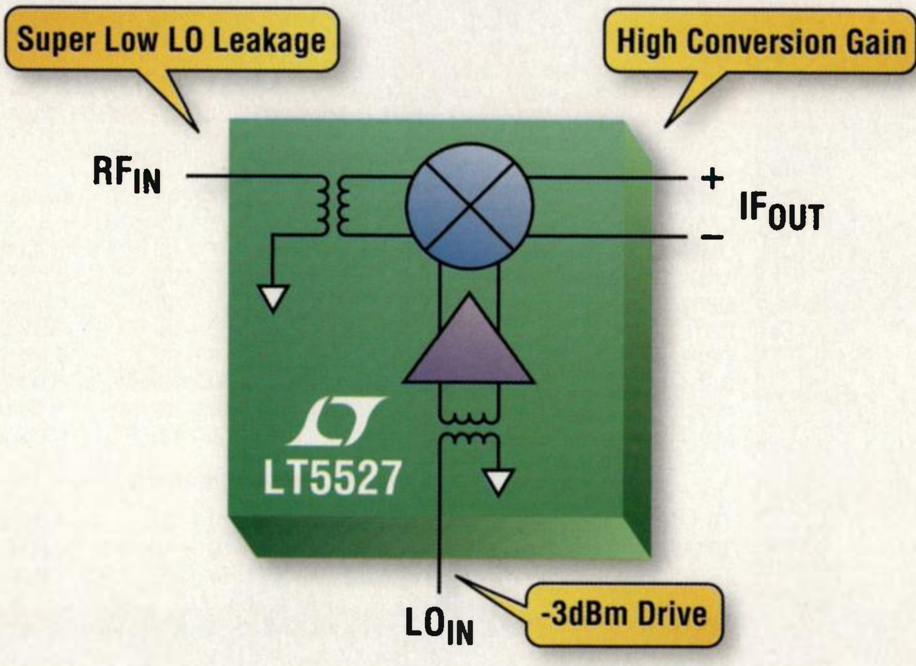

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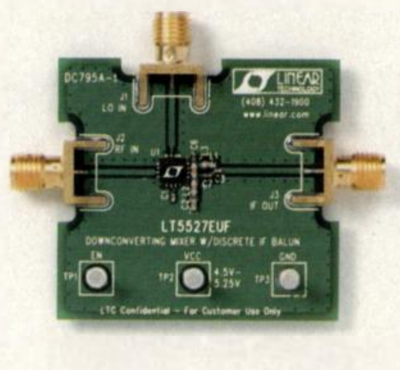

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Model Number	RF/LO Frequency (GHz)	IF Frequency (GHz)	LO Power (dBm)	Conversion Loss (dB) Typ./Max.	LO-to-RF Isolation (dB) (Min.)
DOUBLE-BALANCED VERSIONS					
DM0052LA2	0.5 – 2	DC – 0.5	7 – 13	6.5/8.5	30
DM0104LA1	1 – 4	DC – 1	7 – 13	5.5/7.0	30
DM0208LW2	2 – 8	DC – 2	7 – 13	7.0/8.0	30
DM0416LW2	4 – 16	DC – 4	7 – 13	7.0/8.0	30
DB0218LW2	2 – 18	DC – 0.75	7 – 13	6.5/8.5	22
DB1826LW1	18 – 26	DC – 2	7 – 13	7.5/9.5	20
DB0226LA1	2 – 26	DC – 2	7 – 13	6.5/8.5	20
DB0440LW1	4 – 40	DC – 2	10 – 15	9.0/10	20
M1826W1	18 – 26	DC – 8	10 – 13	9.0/11	20
M2640W1	26 – 40	DC – 10	10 – 13	10/12.5	20
TRIPLE-BALANCED VERSIONS					
TB0218LW2	2 – 18	0.5 – 8	10 – 15	7.5/9.5	20
TB0426LW1	4 – 26	0.5 – 8	10 – 15	10/12	20
TB0440LW1	4 – 40	0.5 – 20	10 – 15	10/12	18

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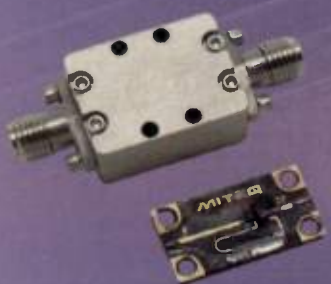

Model Number	Input Frequency (GHz)	Input Power (dBm)	Output Frequency (GHz)	Conversion Loss (dB) Typ./Max.	Rejection (dBc) Fund.	Rejection (dBc) Odd Harm.
DROP-IN VERSIONS						
SXS01M	0.5 – 3	8 – 12	1 – 6	13/16	-20	-25
SXS04M	2 – 9	8 – 12	4 – 18	13/15	-20	-25
SXS07M	3 – 13	8 – 12	6 – 26	13/17	-18	-25
CONNECTORIZED VERSIONS						
SXS2M010060	0.5 – 3	8 – 12	1 – 6	13/16	-20	-25
SXS2M040180	2 – 9	8 – 12	4 – 18	13/15	-20	-25
SXS2M060260	3 – 13	8 – 12	6 – 26	13/17	-18	-25

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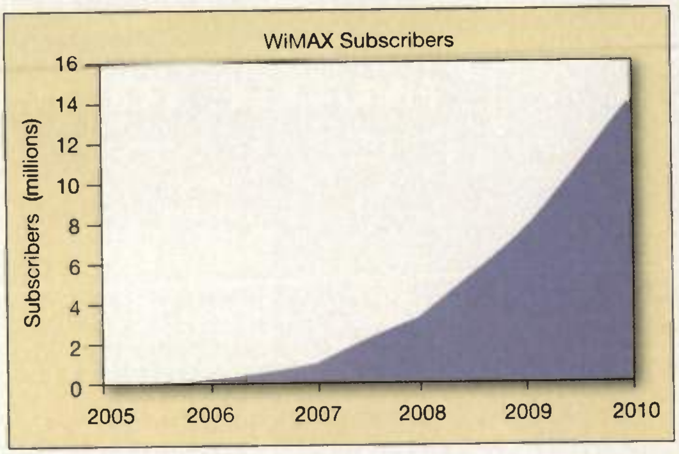
WiMAX opportunities include stationary applications



Although the WiMAX movement continues to focus on mobile opportunities, it is the traditional fixed wireless markets that will remain the technology's main source of revenue through 2009, according to a new report from Visant Strategies. The worldwide wireless broadband audience of five million in 2005 is expected to grow by 40% yearly through 2010 and Visant Strategies believes WiMAX vendors will be perfectly poised to take advantage of this building market. In the report, "802.16/WiMAX: Assessment of Fixed and Mobile Opportunities," Visant Strategies foresees a $3.4 billion annual opportunity for fixed and portable broadband equipment by 2010. The author of the report, Andy Fuertes, predicts that 50% of that market will be accounted for by WiMAX, but that there will be a delay of two to four years before WiMAX is deployed in the mobile network. However, he observed that WiMAX is replacing wire-based broadband access such as cable modem and digital subscriber line at an increased rate. The mobile WiMAX community is faced with political, technical and competitive challenges, the report found, impacting time to market, which is paramount since the 802.16e specification is not finished. Yet, WiMAX will still become a factor in the mobile market in the years to come since most operators will not commit to additional major upgrades prior to 2009 and the standard is gaining support. FLASH-OFDM, TD-CDMA and future revisions of 3GPP and 3GPP2 will also play a role in the fixed and mobile markets. Some of these platforms, especially FLASH-OFDM, already have considerable technical and time to market advantages over mobile WiMAX.

The study provides global and regional forecasts for fixed and mobile 802.16 and BWA base stations and CPE shipments and equipment revenues as well as fixed and mobile 802.16 and BWA subscribers and service revenues through 2010. Estimates for 802.16 chipset shipments and revenues are also provided through 2010.

For more information, visit www.visantstrategies.com

Mobile protocol emulator tests uplinks

Aeroflex has added a high-speed uplink packet access (HSUPA) test capability to its 6401 air interface monitor emulator (AIME) 3G mobile protocol test system. The new capability is initially targeted at engineers with a development test requirement for higher uplink data rates provided by HSUPA. It will be followed by a conformance test capability that will enable the formal certification of HSUPA devices. The HSUPA development test suite runs on Aeroflex's existing 3G mobile protocol test system, the 6401 AIME test system. The flexible system design of the 6401 AIME allows existing users to upgrade their development test systems to include the HSUPA capability without the need for additional hardware. The high-speed downlink packet access (HSDPA) conformance test cases are providing the benchmark for the 3GPP Working Group's formal HSDPA verification and approval process. HSUPA (also referred to as enhanced uplink) is a 3GPP release 6 feature that provides higher uplink data rates and is expected to be offered in parallel with HSDPA. This combination of HSUPA and HSDPA will offer the user bidirectional high-speed, low latency data links that are well suited for services such as voice over Internet protocol (VoIP). HSUPA, as with HSDPA, can be offered at a range of data rates to suit the capability of the mobile device, as well as the prevailing radio conditions. HSUPA devices are grouped in the 3GPP standards in six categories, providing uplink data rates from 729.6 Kbps to 5.76 Mbps. Availability of the HSUPA development test capability is scheduled for the fourth quarter of 2005.

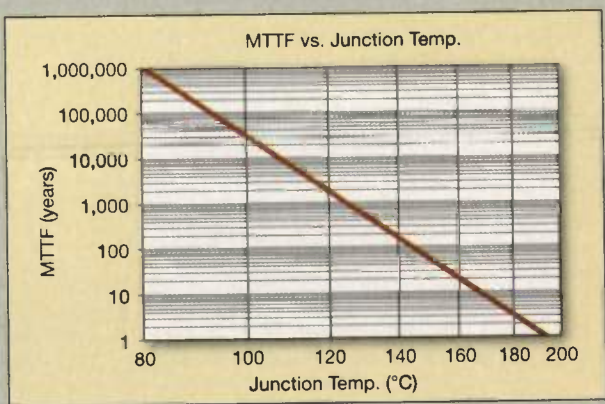
For more information, visit www.aeroflex.com

Integrated RF design environment has new capabilities

Applied Wave Research Inc. (AWR) has announced a new version of its flagship product, Microwave Office design suite. Built on the AWR high-frequency platform with its open design environment and unified data model, Microwave Office design suite offers ease-of-use, powerful technologies, and openness

Correction

Figure 4 in Design Tip on p. 70 of the August issue, was incorrect. The correct Figure 4 is shown below.



and interoperability, enabling integration with best-in-class tools for each part of the design process. With the acquisition of APLAC Solutions, RF simulation technology is now incorporated within the open AWR design environment. The latest product release delivers key productivity improvements to microwave designers.

This latest version offers an integrated filter synthesis solution using Nuhertz Technologies' filter synthesis technology. High-frequency circuit designers can perform accurate filter synthesis from within the unified AWR design platform. The feature offers complete synthesis capability for passive, transmission line, active, switched capacitor, and digital filters, as well as two graphical user interfaces, one for the highly experienced user who requires advanced options and capabilities, and one for the mainstream user who needs ease of use. EM Socket II, AWR's second-generation electromagnetic (EM) open socket interface, supports visualizations for integrated third-party tools. All EM manipulation and visualization features that were a part of AWR's EMSight technology are now a part of the EM Socket II. This enables EM Socket integrators like Sonnet, Zeland and Optimal, to access current animations and E-field display.

The new features of the design suite include a unified and integrated EM and layout editor, eliminating the need for a separate EM editor by combining EM into schematics and layout. Other features include a new layout architecture for speed and capacity, faster HSPICE with support for larger arbitrary n-port devices, and ERC/DRC enhancements. Users will benefit from the new folder management feature for larger projects, improved reporting of simulation warnings and errors, and a license file-sensitive installer that simplifies administration of features.

For more information on product pricing and availability, visit www.appwave.com

LeCroy unveils protocol solutions for UWB development and testing

LeCroy Corp. has unwrapped an advanced protocol analyzer for radio-based traffic for WiMedia Alliance's ultra-wideband (UWB) common radio platform and certified wireless USB (WUSB) from the USB-IF standards. Called UWBTracer system, it was developed by the company's Protocol Solutions Group (formerly Computer Access Technology [CATC]). Additionally, the company is announcing a UWBTrainer, which acts as signal source for generating test signals.

The UWBTracer analyzer is capable of capturing and decoding WiMedia and certified wireless USB traffic exchanged over the air. The system provides full capture and analysis of MAC and PHY interface traffic between modules or chipsets. The combination of radio-based analysis as well as MPI recording makes the UWBTracer analyzer useful at every stage of product development. Beginning with the initial debug of the MAC PHY communication path, to eventual interoperability testing between different WiMedia-based devices, the UWBTracer analyzer is designed to reduce time to market for certified WUSB chipsets, devices and software. Also, it

will include support for multiple association models as well as encryption.

The UWBTracer features the CATC Trace software that logically organizes and displays the protocol hierarchically all the way from WiMedia-based frames up to WUSB transfer. The analysis and control software, which has become the de facto industry standard, includes powerful triggering and filtering and pop-up tooltips that explain the protocol in context of the captured traffic.

Additionally, the user can isolate specific MPI and WUSB events using the comprehensive search function. Real-time statistics provide additional insight into the product's operation and performance.

The UWBTracer analyzer will begin shipping in the first quarter of 2006, with the UWBTrainer traffic generator following. Wire Line Adapter Decode support for USB customers will become available in this quarter.

Silicon received for first component in UWB chipset

FOCUS Enhancements Inc. has received first silicon for its high-performance 880 Mbps wireless ultra-wideband (UWB) chip. FOCUS Enhancements' analog/RF chip is the first chip of a two-part chipset solution in FOCUS Enhancements' TALARI UWB technology for UWB solutions that will enable wireless video distribution and high-speed data transfer for home and office applications. The company expects tape out of the second chip to occur this month and receipt of silicon of this chip in December. Evaluation kits are to be shipped at the end of 2005. The high-performance radio-frequency analog IC portion of the chipset was manufactured by Jazz Semiconductor. Fujitsu produced the flip-chip ball grid array package for the analog chip. Taiwan Semiconductor Manufacturing Corporation Ltd. will produce the digital baseband/MAC application-specific integrated circuit.

TALARIA UWB Technology from FOCUS Enhancements allows wireless high-definition (HD) and standard definition (SD) video transmission at net data rates up to 880 Mbps at distances of up to eight meters and 37 Mbps at 40 meters. The analog chip is an integral part of FOCUS Enhancements' TALARIA UWB technology, which has been proven to effectively transmit wireless video through a variety of typical in-home obstructions. The company is demonstrating multiple HD streams through various types of walls and line-of-sight SD video streams up to 40 meters in its Hillsboro, Ore., laboratory. TALARIA UWB technology uses WiMedia MB-OFDM for UWB standard interoperability and FOCUS Enhancements' DS-OFDM modulation techniques. With DS-OFDM modulation, TALARIA UWB technology generates more densely packed signals that cover a wider swath of the available UWB spectrum. This makes them ideal for high-speed wireless and video applications throughout a home or small office. The TALARIA UWB technology analog chip will operate between 3.2 GHz and 7.2 GHz. In addition to 880 Mbps, other selectable rate settings include 110 Mbps, 440 Mbps and 660 Mbps. The analog chip uses 0.18 micron silicon germanium process technology to achieve the higher signal-to-noise ratios required to supply reliable, consumer-friendly video distribution.

For more information, visit http://www.FOCUSinfo.com

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Silicon TV tuners poised to replace cans

While the evolution of TV receivers has accelerated on many fronts in the last decade, fully integrated silicon tuner design has lagged behind this evolutionary wave. The silicon TV tuner is now perfected and will rapidly replace traditional can tuners, just as transistors replaced vacuum tubes during the mid-1960s.

By Alvin Wong and Jordan Du Val

The past decade delivered an unprecedented and multifront evolution of TV broadcasts and receivers. These advances include stereo audio, HDTV, flat-screen technology using LCD and plasma displays, and TV receivers integrated into personal computers. The ultimate goal for TV receivers is a fully integrated solid-state TV with a flat-screen LCD or plasma display.

While significant progress has been made toward this goal, tuners have fallen behind in the evolutionary development. This lag, however, is in the process of rapidly changing. Demand for smaller and lower-power televisions, flat-screen miniaturization, and even government standards are driving the development of silicon tuners to the razor's edge. In fact, the Federal Communications Commission (FCC) has set standards requiring all new televisions to incorporate digital tuners within the next two years.

Tuner history

The traditional tuner design for decades has been the "can" tuner, appropriately named because they are housed in metal enclosures to minimize RF interference and cross-talk. Despite the long history of use, can tuners have some major deficiencies.

First, the requisite use of tunable and fixed coils has virtually dictated discrete transistor designs for the tuner. This results in poor temperature characteristics and a physically large, power-hungry module—some as large as two inches by four inches. Perhaps the primary deficit with can tuners though is that each must be tuned individually as part of the manufacturing process. Not only is this a time-consuming step, the tolerance of the passive components results in a relatively broad acceptance standard for can tuner quality control.

As the disadvantages of the can tuner become more evident in today's modern devices, the silicon tuner is poised to unseat the can tuner in virtually all applications, in the same vein as transistors replaced vacuum tubes. Silicon tuners have the potential to offer a number of advantages and capabilities that the can tuner lacks.

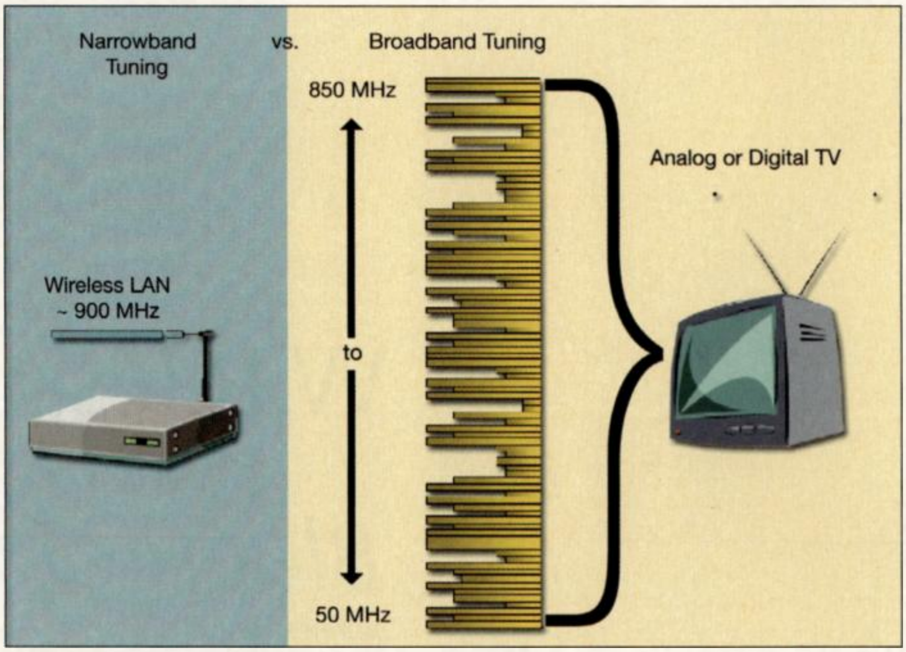

Figure 1. Narrowband vs. broadband tuning.

Highly integrated silicon tuners are much easier to manufacture, and no tuning is required, reducing the overall cost of the tuner. The tuner can also be made extremely small compared to the can tuner because of the high level of integration.

Another notable advantage of silicon tuners is that a single tuner can receive TV signals using any of the several worldwide transmission standards. This means that an international manufacturer need only stock a single, meets-all-standards tuner, instead of one or multiple can tuners for each disparate standard.

Other advantages of silicon tuners include:

- integrated analog and digital tuners;
- multiple tuners in the same package for picture-in-picture and other applications;
- greater reliability;
- superior thermal stability;
- tighter quality control standards; and
- quicker channel lock: ~5 ms vs. ~150 ms.

These advantages, coupled with recent IC design rules and techniques have enabled practical silicon tuners. New IC techniques being used include enhanced BiCMOS processes, silicon-germanium (SiGe) transistors, and 0.18 μm design rules. This design evolution, when added with government dictates, will result in a rapid and universal transition to silicon tuners.

Overcoming physical and integration problems

The fact that development of silicon tuners has lagged behind virtually all other TV developments clearly identifies that silicon tuner technology had difficult challenges to overcome in order to realize a producible tuner. And indeed, a number of difficult hurdles had to be crossed before a practical, manufacturable silicon tuner could be produced at a reasonable cost.

An obvious question at this point might be 'why are tuners even necessary? Why not do it all digitally?' Ideally, such a tuner would be produced with a simple (in concept...extremely complex in design)

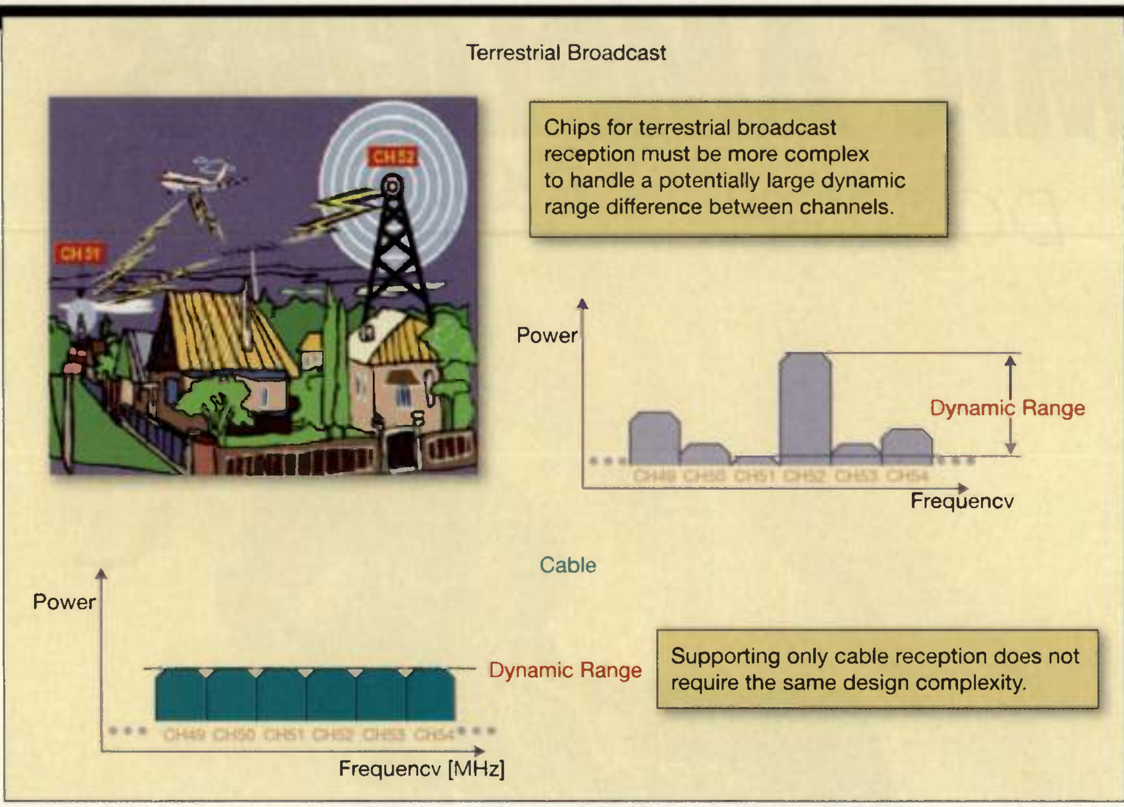

Figure 2. Broadcast signals vs. cable signals.

analog-to-digital converter (ADC), whereby analog TV signals would be directly converted to a digital datastream without tuned circuits, including input and output filtering.

Even a cursory look at TV bandwidths reveals the magnitude of the ADC problem to be overcome. The Nyquist theorem requires nearly two billion samples per second using an ADC converter to sample the analog input signal across the entire 860 MHz TV bandwidth, and with enough bits of resolution to reproduce an HDTV-quality picture. ADC converters with that kind of sampling rate and resolution currently are expensive.

This extreme sampling speed and resolution is necessary because of the very large bandwidth associated with broadcast television. However, if a tuner is used, this broadband input can be tuned to a single, baseband signal that is significantly easier to process with ADCs. Because the tuner simply pushes the difficulty of handling this very large bandwidth from an ADC converter to the tuner, problems dealing with the large bandwidth still had to be solved.

Most receiver designs cover a relatively small frequency range. A couple of examples include 802.11b wireless LANs and cellular phones. The tuner in a cellular phone tunes about 500 kHz of bandwidth. A TV receiver, by comparison, must tune about 860 MHz—three orders of magnitude more bandwidth. The extreme difference in bandwidths results in many proven narrowband design techniques not transferring to TV's wideband requirements. Figure 1 illustrates the magnitude difference in the two receiver applications. New techniques have replaced traditional analog designs to facilitate broadband capability with new silicon tuners.

An even bigger obstacle in the realization of silicon tuners was designing highly integrated circuitry to accommodate the enormous dynamic range required for broadcast TV signals. Signals reaching the receiver are affected by the variable and arbitrary distance from the transmitter. It's not unusual to have signal strength variations of several-thousand-fold.

Cable signals are of relatively uniform signal strength and integrity, which al-

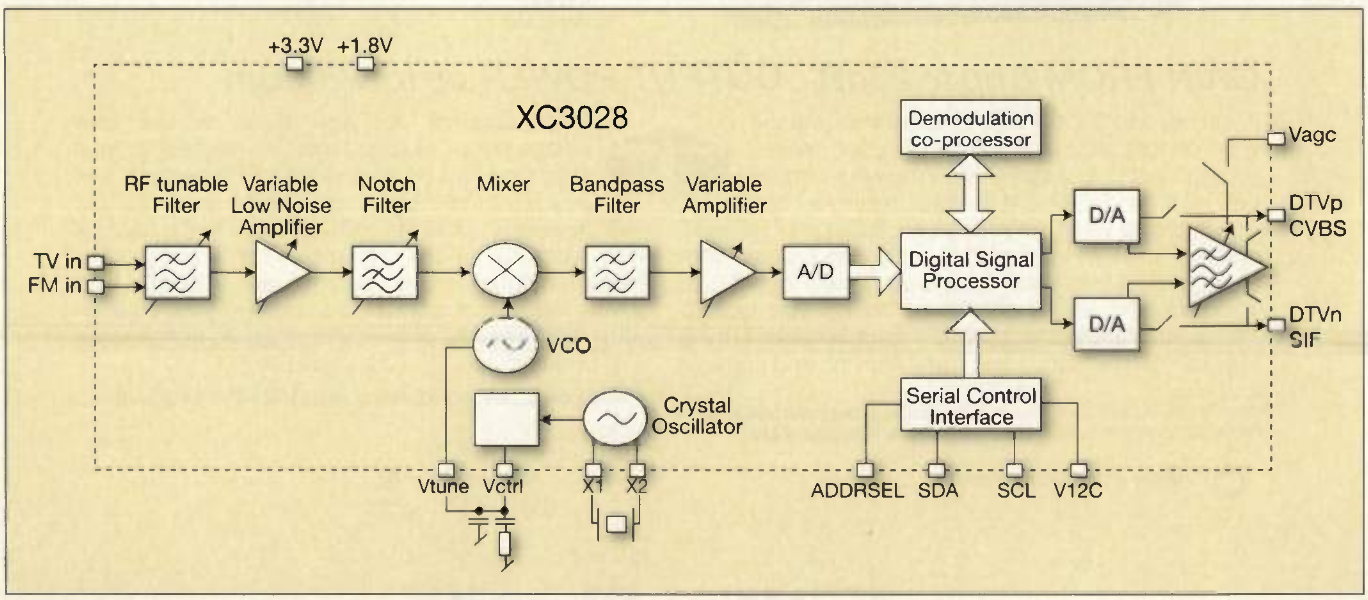

Figure 3. Block diagram of XC3028 analog and digital silicon tuner.

LEADING inside

A series of engineering insights
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Specifying A/D Converters: Considerations for IF-Sampling Applications

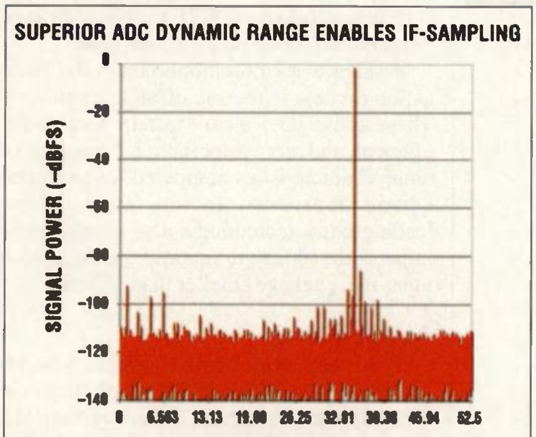
Choosing the ADC with the highest resolution or sampling speed is often not enough to satisfy the performance demands presented by IF-sampling architectures. ADCs for IF-sampling applications must support high input frequencies while also maintaining adequate SNR, SFDR, and SINAD performance. These features enable designers to eliminate one or more mixing stages and simplify filtering, thereby reducing cost and helping to meet end-system objectives.

Wideband signals having complex modulation—such as those used in many wireless communications, instrumentation, and radar systems—can exhibit time-varying bursts and transients. Furthermore, the data carried by these signals is often spread over multiple channels.

The ADC for these types of architectures must have sufficient input bandwidth to adequately capture and digitize this data. The ADC's dynamic range must also be high enough to detect small signals in the presence of blockers or other large signals in the bandwidth of interest.

Dynamic Range and Noise Requirements

In wideband CDMA systems having a base data rate of 3.84 MHz, data converter clock rates of 16×, 20×, 24×, and 32× are viable. A data converter running at 92.16 MSPS provides good noise performance, and 16-bit ADCs that sample at 100 MSPS are available today. If lower sampling rates are used, the SNR required increases by 1 dB for 76.8 MSPS and 2 dB for 61.44 MSPS.



32k point single-tone FFT/ADC: 105 MSPS, 70.3 MHz A_{IN}

The receiver conversion gain and noise figure (NF) sets the ADC's required SNR. At the antenna, the noise spectral density is –174 dBm/Hz, or that of thermal noise. For a conversion gain of 40 dB and a noise figure of 3 dB, the noise spectral density (NSD) at the ADC input will be –131 dBm/Hz (–174 + 40 + 3). If the ADC noise floor is 10 dB below that of the front end noise, it will contribute about 0.1 dB to the overall NF of the receiver. Therefore, a maximum ADC noise floor of –141 dBm/Hz is desirable.

For IF-sampling applications, the total noise of the ADC can be determined by simple integration. For example, a 10 MHz bandwidth signal would have total noise of –71 dBm. This is calculated by adding the effect of the 10 MHz bandwidth [10 log (10 MHz) = 70 dB] to the 1 Hz noise floor of –141 dBm. If the full scale range of the ADC is 4 dBm, the required minimum full-scale SNR for the ADC is then 75 dB.

Selecting the Optimum A/D Converter

What types of ADCs meet the needs of IF-sampling architectures? Typically, they require ADCs with 14 bits to 16 bits of resolution that deliver superior SNR at high input frequencies. Advances in high speed ADC technology offer improved SNR, low additive jitter, higher sampling rates, and increased input frequency capability. These features enable engineers to design more efficient base stations, radar, and measurement equipment.

Additionally, the instrumentation used to validate communications systems must meet even tighter specifications, so as not to mask or distort the end-product's actual performance. These systems allow designers to accurately characterize signals of interest with minimum added distortion from the data converter. The AD9446 16-bit, 100 MSPS ADC from Analog Devices is an example of wideband converter technology that is targeted for IF-sampling applications in communications instrumentation. With a 70 MHz analog input and 100 MSPS sampling rate, the AD9446 provides a spurious-free dynamic range of 83 dB; it provides 82 dB of SFDR with a 100 MHz analog input. For more information on the AD9446 and other data converters for IF-sampling applications, please visit *www.analog.com/PerformanceADCs.*

*Author Profile: **Joanne Mistler** is a marketing engineer with Analog Devices' High Speed Converter Group in Wilmington, MA. She has 22 years of RF/MW experience, focusing on low noise synthesizer design, digital communications, and test and measurement applications.*

PERFORMANCE • EXCELLENCE • INNOVATION • 40 years ADI 1965 2005 lowed some early silicon tuner designs to work in that environment. However, only recently have silicon tuners achieved the dynamic range required to reliably reproduce a quality TV picture and audio (Figure 2). Silicon tuners, such as Xceive's XC2028 and XC3028 have a dynamic range of 80 dB, more than enough to handle the challenge of broadcast signal quality.

The large dynamic range also demands that the receiver be extremely sensitive to receive very weak signals—yet not prone to front-end overload caused by very strong signals. New active filter designs have produced the sensitivity required, while remaining immune to overload induced by strong, local signals. This results in a superior sensitivity of –83 dBm or better.

Silicon tuner solutions

Several manufacturers have full or partial silicon tuner solutions. We have produced a one-design-fits-all-TV-standards analog tuner IC. While XC2028 is a complete analog RF-to-baseband tuner, the XC3028 is a complete analog and digital RF-to-baseband tuner. Both these chips are based on a systematic, iterative design approach to optimize highly integrated functions in traditional and non-traditional ways. The basic block diagram of the silicon tuner is shown in Figure 3. This design is significantly more sophisticated than a can tuner, incorporating substantial digital processing circuitry in addition to the RF signal conditioning and tuning front end. For instance, the XC3028 integrates on-chip wideband tunable filters, image rejection filter, programmable channel filter, and wideband voltage-controlled oscillator (VCO).

Not only are silicon tuners a significant improvement over can tuners in the areas outlined above, they have a much tighter QC acceptance tolerance due to eliminating high-tolerance passive components. Figure 4 shows the frequency response of two individual Xceive EVK4 silicon tuners vs. two high-quality can tuners. Note how little variation exists in the silicon tuners compared to can tuners.

To further illustrate this point, several can tuners were tested separately. It was observed that 1 dB to 2 dB of variation across the frequency range is normal. In addition, each tuner has a slightly different transfer characteristic, resulting in slight variations in the picture quality of the completed TV receiver.

In addition, the designers have extensively analyzed the sources of non-linear signal degradation to further enhance dynamic range over the full TV bandwidth. Each non-linear degradation was cancelled with an inverse-acting non-linear source. Another advancement is that no external low noise amplifier (LNA) is required with Xceive's silicon tuners. Other solutions may require external LNAs to achieve the -83 dBm sensitivity of the Xceive design (ATSC signal).

A final factor in physically being able to integrate the full tuner function was the fabrication of the IC itself. The fabrication took advantage of improvements in the BiCMOS process, as well as benefiting from small, 0.18 μm architecture. Both factors contribute to speed and low power consumption.

Perhaps even more important in the fabrication process is the use of SiGe transistors. These active devices are faster, more power efficient, and more important, have improved noise characteristics compared to traditional silicon transistors. Incorporation of this leading edge technology also significantly impacts the ability to incorporate the silicon tuner in a package smaller than a dime.

Applications

There are many obvious applications for silicon tuners—they will replace can tuners in virtually every consumer TV set within just a few years. Beyond that, however, the reduction in size and power requirements opens a new and diverse universe of applications.

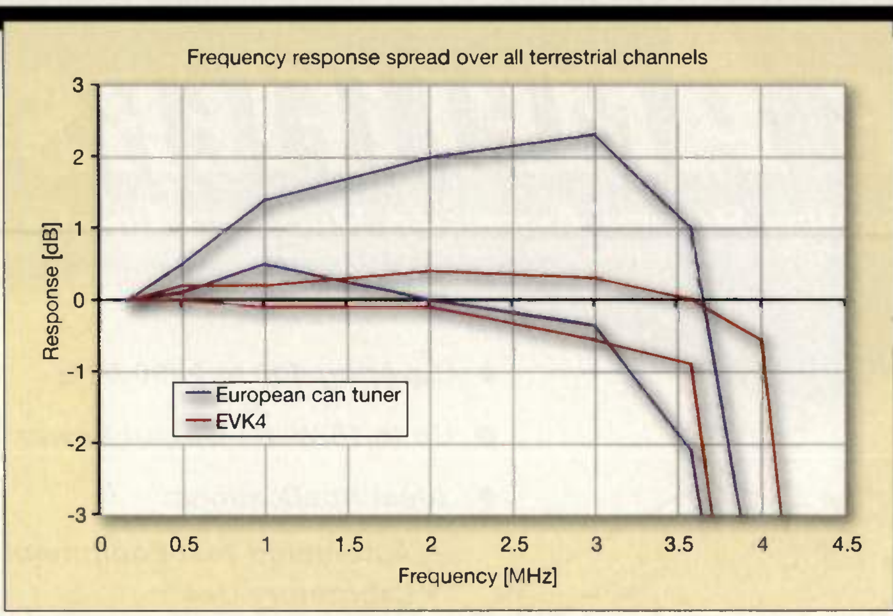


Figure 4. Superior tolerance of silicon vs. can tuners.

■ **Tuners for PCs:** The demand for TV receivers integrated with PCs already exists. New silicon tuners will make them significantly more practical. For example, Compro has designed a USB 2.0 compatible TV receiver based on the XC3028. This tiny device (VideoMate U880) is about the same size as a USB flash drive.

■ **Flat panel TVs:** Another market that will get a boost from silicon tuners is picture-in-picture. Because of the low-power design and adjacent-channel interference rejection, multiple silicon tuners can be incorporated into a single design, allowing instant access to several broadcasts.

■ **Cellular phone/PDA:** The size of silicon tuners, with their stingy use of battery power, allow for TV reception in a cell phone or PDA.

The TV broadcast industry has been in the midst of sweeping changes over the last 10 to 15 years. One of the last components to experience this sweeping evolution is the tuner.

Only recently have tuner designs caught the innovation wave. Newly designed silicon tuner chips, integrating the full tuner function have performance, packaging and power advantages over traditional can tuners.

ABOUT THE AUTHORS

Alvin K. Wong is vice president of marketing for Xceive Corp. He joined Xceive in December 2004, bringing 16 years of management experience in the semiconductor industry. Most recently at Infineon Technologies, Wong was the vice president of marketing, responsible for building strategies and running operations in North America for the wireless division.

Jordan Du Val is vice president of sales for Xceive Corp. He joined Xceive in January 2002. He was formerly president and CEO of SpotNet. He holds a Bachelor degree in commerce, with Honors from Carleton University, Canada and holds four patents in interactive TV architecture and systems.

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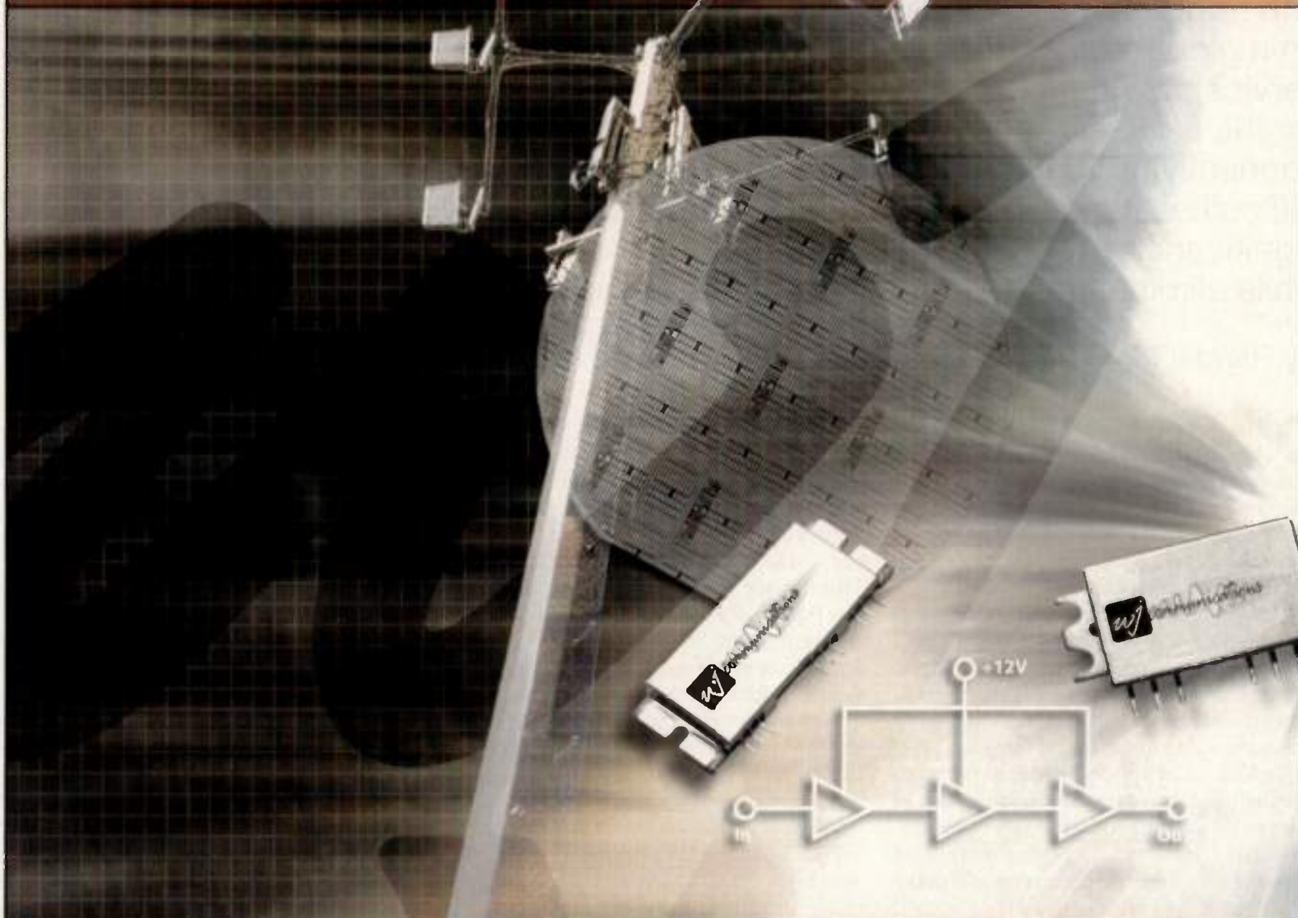

Introducing a new family of 12V power amplifier modules featuring high efficiency and linearity. These devices were developed using InGaP/GaAs HBT process technology for the 2.5/3G, PCS and UMTS markets and include internal matching for 50 ohm operation.

Model	Frequency Range (MHz)	Modulation Type	P1dB (dBm)	Power Gain (dB)	Channel Power @-45 dBc ACP	Voltage (V)	Operating Current (mA)	PAE* (%)	Package Size
AP501	1930-1990	IS-95A	+36	30.5	+30.5	12	520	16	29 x 13 x 4 mm
AP502	2110-2170	W-CDMA	+36	28	+27	12	410	10	29 x 13 x 4 mm
AP503	1805-1880	CDMA2000	+36	31.5	+30.5	12	460	17.5	29 x 13 x 4 mm
AP504	1710-1785	CDMA2000	+36	33	+30.5	12	460	17.5	29 x 13 x 4 mm

All parameters are shown for their performance at the specified output channel power level with the specified signal modulation type.

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DualPath architecture blends optical wireless and RF into high bandwidth, high availability outdoor point-to-point solutions

Today, the use of wireless technologies for connecting buildings, campuses and remote locations rapidly and cost-effectively has become commonplace on a global scale. Businesses throughout the world—including enterprises or service providers, small-to-medium businesses or mobile carriers—are opting for the flexibility, installation ease and cost savings associated with wireless connectivity. To that end, they avoid the licensing, leasing and/or installation difficulties typical of wired or leased lines. Outdoor wireless also provides a significant performance improvement over standard E1/T1 leased-line speeds while eliminating the rights-of-way hassles of trenching.

By Randel Maestre

Of the various wireless technologies available today, optical wireless (commonly referred to as free space optics or FSO) and radio-frequency (RF) have emerged as the two preferred options for customers seeking a high performance, yet easy-to-deploy outdoor wireless point-to-point connectivity solution.

With data rates in excess of Gigabit speeds and full-duplex operation, optical wireless provides more than enough bandwidth to meet the capacity requirements of the most network-intensive applications including streaming video and medical imaging. And, through its use of invisible and narrow beams of light, optical wireless is viewed as one of the most secure forms of wireless communications today. However, increasingly stringent network availability requirements make optical wireless best suited for shorter building-to-building links (two to three kilometers) with true line-of-sight. Blockage of the optical beam transmission path by trees, fog or smog can restrict the performance of optical wireless systems as well as their effective transmission range.

RF technology, on the other hand, is a reliable yet longer-distance outdoor wireless connectivity solution that has its own set of challenges and considerations. While weather-related problems are not as prevalent in outdoor RF implementations, RF links pale in comparison to optical wireless from a performance perspective. Optical wireless products, with speeds up to 1.25 Gbps full duplex, have far greater capacity than RF products (54 Mbps to 72 Mbps half-duplex raw data rates) and, therefore, are more ideal for handling the network load required of building-to-building links. Issues such as security breaches, interference and spectrum saturation also can potentially compromise RF data.

The bottom line for today's bandwidth-hungry organizations is that a blend of these proven outdoor wireless technologies yields the optimal capacity and availability. In order to achieve the proper balance of performance, distance and availability in outdoor wireless implementations, a system combining high-bandwidth optical wireless and high-availability RF technologies is required. This unique and highly innovative mix of technologies will deliver unprecedented bandwidth and network availability to satiate the most bandwidth-hungry applications.

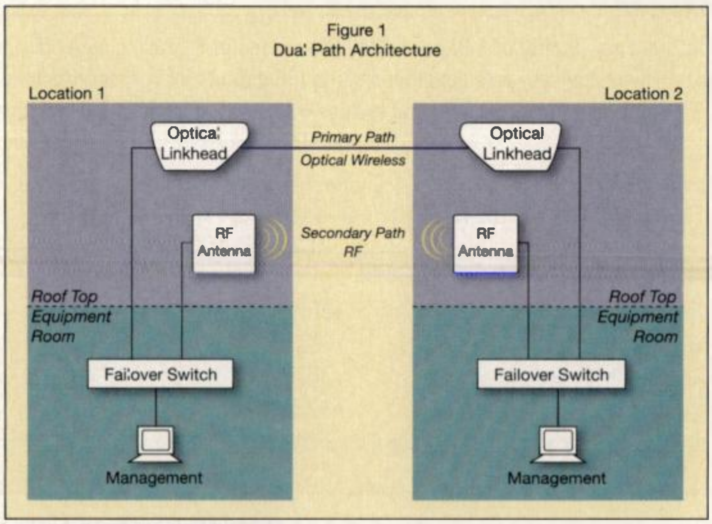

Figure 1. DualPath architecture.

The need for bandwidth and availability

The need for high-speed networking is driven by several factors including the growth of the Internet, the proliferation of mobile computing, the increase in computer processing power and the development of enterprise-wide applications such as voice-over-IP (VoIP), video and imaging. Network computer users have come to expect low latency, sub-second response times and near-instantaneous access to information even in these bandwidth-intensive applications. Even worse, some of today's network-driven applications will actually stop working if the network infrastructure does not support specific bandwidth and latency requirements. To meet these requirements, businesses have traditionally relied on high-speed wired connections such as optical fiber or Gigabit Ethernet switching technology.

But, bandwidth and low latency alone are not sufficient when facing the challenge of real-time information access. Network availability, or uptime, must also be considered. As consumers and enterprises become more reliant on information, network failures and service outages become critical. While 100% availability is ideal (but also unrealistic due to the

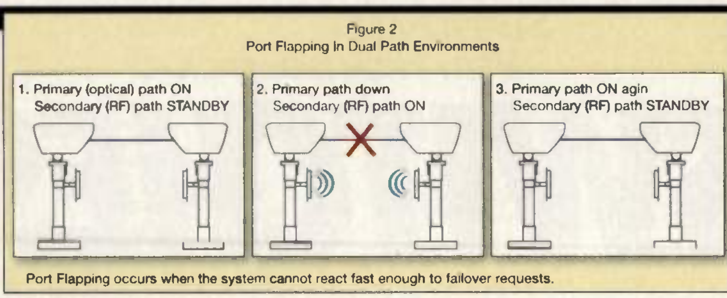

Figure 2. Port flapping in DualPath environments.

potential issues with network component or data path failure), most high-availability networks strive to achieve "five nines" or 99.999% availability. This translates into roughly five minutes of downtime over the course of a year. For many companies, especially those with mission-critical applications, even this 0.001% of network downtime poses harsh economic penalties. The end result is the need to design high-availability networks with built-in redundancy, thereby maximizing data flow while minimizing disruptions.

The challenge with any network design is balancing bandwidth with availability, which is not a trivial undertaking when dealing with wireless networks. While optical wireless provides more than adequate bandwidth, it falls short of the availability requirements of most enterprise customers, especially in inclement weather conditions. And while RF provides higher availability in these weather-impacted environments, its bandwidth falls short of many networks' needs. An RF system operating in half-duplex mode at a 54 Mbps to 72 Mbps raw data rate generally results in only 20 Mbps to 30 Mbps of actual network data throughput. This restricted throughput can be quite adequate for a limited period of time (for example, as a back-up path or in a failover scenario), but is simply insufficient to regularly handle remote LAN traffic. Additionally, it falls short of satisfying the ever-growing needs of users running bandwidth-intensive network applications.

Optical wireless—A brief history

To better understand the complementary relationship between optical wireless and RF, it is important to trace the roots of these proven connectivity solutions. Optical wireless technology was first demonstrated by Alexander Graham Bell in the late 1800s as a method of transmitting voice signals by beams of sunlight. It was not until the 1960s during the Cold War that optical wireless products were used as secure and tap-proof outdoor wireless communications for military field use. Highly classified military information and troop movement strategies could be transmitted without fear of interception, due to the fact that the beams of light were confined to a narrow cone of free space and were immune to RF jamming or interception devices.

For the past decade, optical wireless products have continually improved in performance. Today's modern and feature-rich optical wireless solutions are commercially used to carry mission-critical information including financial data, healthcare and patient records, corporate communications and voice traffic. These products operate in the worldwide unlicensed terahertz frequency range, also referred to as "near infrared" spectrum. Furthermore, the vast majority of today's state-of-the-art optical wireless systems are Laser Class 1M certified, making them completely eye safe.

RF—From indoor use to outdoor deployment

Since its first use in World War II military applications more than 50 years ago, wireless local area networks (wireless LANs) have evolved into a mainstream technology used for a variety of in-building and outdoor implementations. This, however, was not always the case. Initial wireless LAN implementations were proprietary—operating at only 1 Mbps to 2 Mbps, primarily in the 902 MHz to 928 MHz industrial, scientific, medical (ISM) frequency bands. This 900 MHz band, as it is more commonly referred to, was one of three unlicensed bands allocated by the Federal Communications Commission (FCC) in the early 1980s for license-free spread spectrum devices—the other two were at 2.4 GHz to 2.483 GHz and 5.725 GHz to 5.85 GHz.

In June 1997, the Institute of Electrical and Electronic Engineers (IEEE) ratified the first wireless LAN standard thereby paving the way for wireless LAN's widespread adoption and usage. IEEE 802.11 set the guidelines for wireless LANs to operate at the 2.4 GHz frequency with data rates of 1 Mbps to 2 Mbps. In September 1999, due to increased pressure to ensure wireless LAN data rates remained on par with wired Ethernet speeds, IEEE 802.11b and IEEE 802.11a standards were defined in the 2.4 GHz and 5.8 GHz frequency bands, respectively.

IEEE 802.11b defined the rules for an 11 Mbps wireless LAN solution. IEEE 802.11a, on the other hand, provided a broader frequency band capable of supporting data rates of 54 Mbps and potentially higher. Wireless LANs were suddenly a viable networking option with data rates meeting or exceeding traditional enterprise network speeds of 11 Mbps up to 54 Mbps. And the WiFi world as we know it today was born.

Historically, wireless LANs were focused on in-building applications such as retail, warehousing and portable computing where an 11 Mbps network pipe is adequate. An outdoor RF link, however, requires much more bandwidth for handling the traffic of multiple remote LANs and potentially hundreds or thousands of users. The majority of outdoor RF links are simply outdoor implementations of WiFi, which use specialized bridges, routers and antennas to reach distances of 10 miles or beyond in some cases. Still, even a 54 Mbps half-duplex data rate may not be enough to handle the traffic load of two or more networks. This is especially the case in today's typical network environment where the evolution from 10 Mbps (Ethernet) networks to higher speed 100 Mbps (Fast Ethernet) and 1.25 Gbps (Gigabit Ethernet) networks has driven the need to dramatically increase data throughput of building-to-building LAN connectivity solutions.

To meet the higher bandwidth requirement for outdoor RF links, the latest outdoor wireless solutions have focused on modified versions of the IEEE 802.11a standard to reach even greater network speeds. Most have implemented a modified orthogonal frequency-division multiplex (OFDM) encoding and modulation scheme to achieve greater data rates (up to 72 Mbps) and increase network efficiency. OFDM uses multiple overlapping carrier signals instead of just one signal. By using multiple signals just far enough apart to avoid interference, data is no longer compromised by radio anomalies, whereas in a single signal mode a problem can result in a lost link.

Even with OFDM implementations, however, outdoor wireless links typically support a maximum raw data rate of 72 Mbps (or 30 Mbps real network data throughput in half-duplex operational mode), which represents only a portion of the capacity of an optical wireless link. Optical wireless products, which support 100 Mbps to 1.25 Gbps full-duplex data throughput rates, are more than capable of handling the network load required of a building-to-building link. Still, weather conditions, including fog, do not impact RF signals to the extent that they may impact an optical wireless solution. Simply put, the opportunity to combine optical wireless and RF results in a high-performance, high-availability outdoor wireless solution. This integration of distinct, yet synergistic, technologies has resulted in the creation of a patented DualPath architecture focused primarily on meeting the needs of outdoor point-to-point connectivity.

DualPath architecture

A DualPath approach to outdoor wireless point-to-point connectivity consists of four key components (configured as shown in Figure 1):

- primary path (optical wireless);

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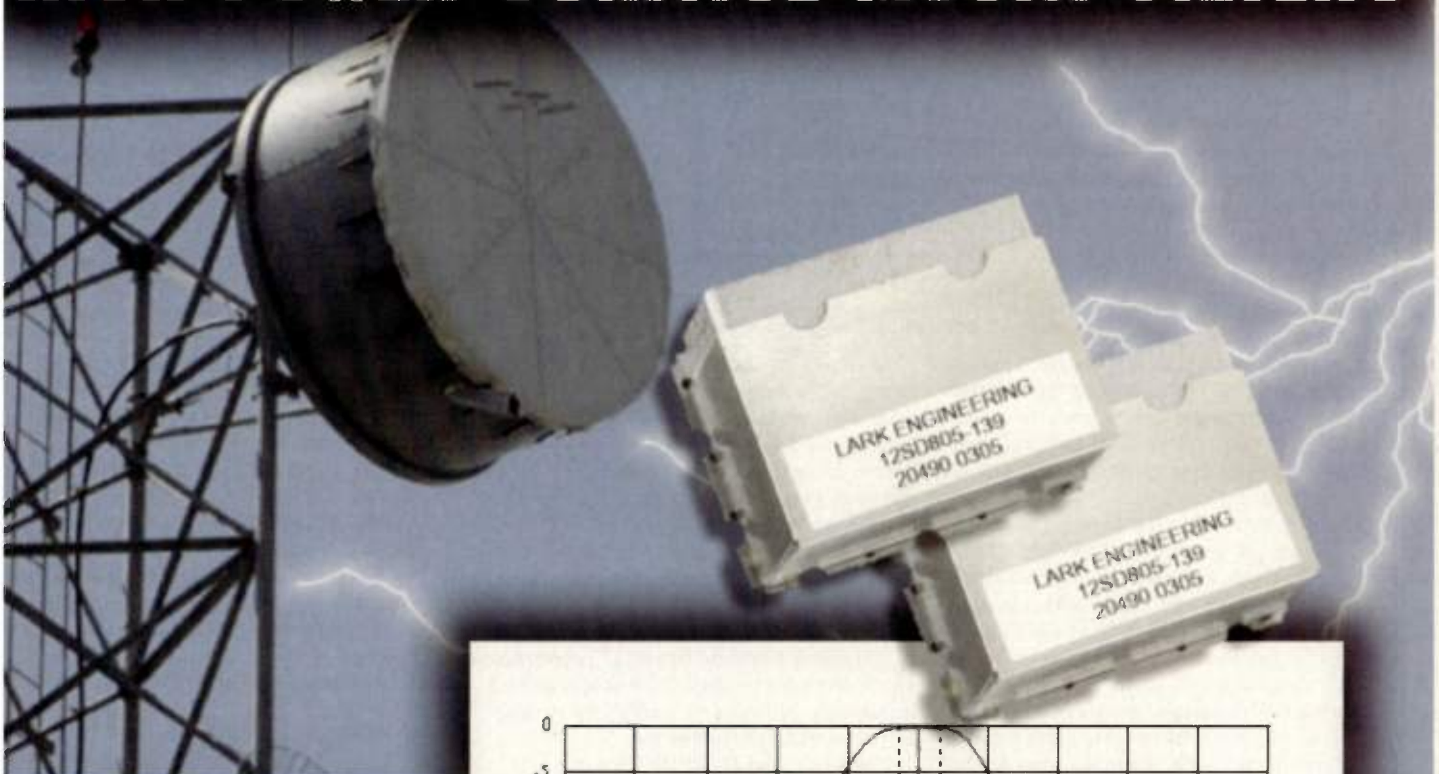

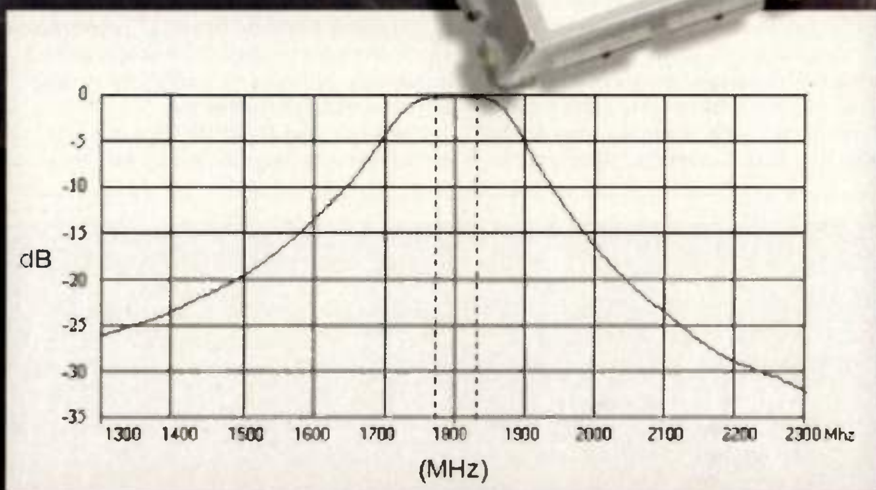

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- secondary or failover path (RF);
- intelligent switching; and
- configuration and management.

The primary path, or the optical wireless path, is the main transmission medium in this architecture design. Since this path will be operational the majority of the time, it needs to be the most robust in terms of performance and speed. Of course, answering the question of how often the failover mechanism from the optical path to a secondary RF path will be triggered is a challenge. The most appropriate way to look at this is by using availability statistics of an optical wireless path in different geographical regions of the world. Although uptime projections can vary widely, depending on weather, distance and other environmental conditions, optical wireless availability is typically calculated at 99.9% availability, which translates into just a little more than eight hours of downtime per year or an average of 11 minutes per week or 1.5 minutes per day. This downtime figure, while low, may not be suitable for mission-critical applications.

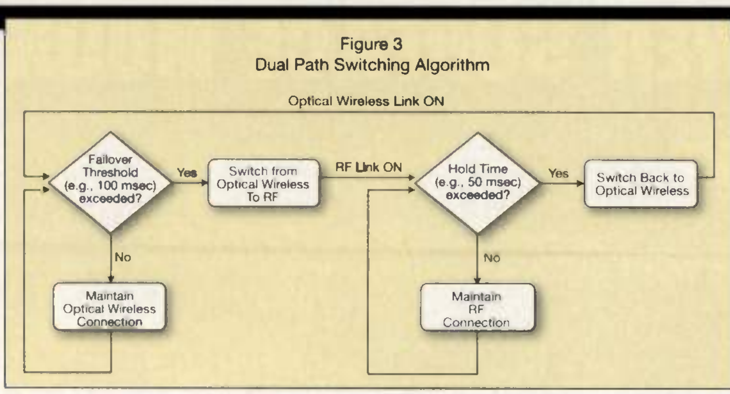

Figure 3. DualPath switching algorithm.

Maximizing network uptime in these stringent environments requires an automatic failover strategy. Relying on a single communication path causes a single point of failure. Even using multiple paths of a single transport media (e.g., two optical fibers) does not automatically guarantee 99.999% availability. With DualPath architecture, a fully redundant, automatic failover path switches seamlessly between optical wireless and RF, using different transport mechanisms with complementary physical properties. This combination of optical wireless and RF technology provides the ultimate wireless network redundancy strategy.

The key to the DualPath approach lies in the failover switching mechanism from the primary to the secondary path and vice versa. This becomes apparent in real-time applications or VoIP environments where excessive failover times, latency delays and jitter (variation in delay) may degrade voice quality. Typically, this delay should be no more than 150 milliseconds to get acceptable voice quality. Therefore, an ideal failover would result in seamless, sub-second (less than 150 millisecond) switching between paths resulting in no service disruption. Standard off-the-shelf switches or basic fault redundant transceivers have been known to take from 10 seconds up to several minutes to switch between primary and optical wireless links, depending on the switching protocol used. While these switching delays may be sufficient for data transmission, they are unacceptable in voice or similar real-time applications. For optimal performance and to minimize network disruptions, a DualPath switching algorithm takes these switching delays into consideration.

In addition, an issue known as port flapping can be resolved if a proper switching algorithm is designed into a DualPath system.

As shown in Figure 2, flapping occurs in unstable environments where rapid switching between primary and secondary links takes place (think of a foggy optical wireless environment where signal levels can change in an instant depending on the density of the fog). A system can "hang" if the switch cannot react fast enough to these failover requests. Furthermore, too many failovers in a short time period can result in certain switch ports being completely shut down.

The key to resolving flapping is to specify a minimum "failover threshold" and to implement a "hold time" into the switch (Figure 3). The failover threshold defines the minimum amount of time the optical wireless link must be broken before switching to the secondary backup. This helps to eliminate what has been called the "bird effect" (a bird flying through an optical wireless path normally takes less than 50 ms so a failover threshold is usually set at 100 ms or more). In the event that the primary (optical wireless) link fails and the secondary (RF) link takes over, the hold time determines when to revert to the primary link. A hold time of 50 seconds, for example, will require the optical wireless link to be stable for a full 50 seconds before switching from the RF backup, providing reliable and intelligent switching while alleviating flapping issues. The DualPath architecture is designed to handle these events automatically and transparently, which can be cumbersome and difficult to control with standard off-the-shelf switch/radio combinations.

The final piece of the DualPath architecture is configuration and management. One of the negatives to developing homegrown optical wireless/RF back-up solutions is the cumbersome nature of configuration. Since each component (optical wireless link head, RF radio, switch) is typically sourced from multiple vendors, each must be individually configured with multiple installation CDs or separate instruction guides. Integrated configuration software will allow each device to be configured and managed from a common interface, which simplifies management while streamlining overall operation.

Management of these devices should allow for the tracking of failovers and other important network features such as signal strength, power levels and overload. An ideal DualPath network management solution would support not only the visual tracking of these features, but the ability to create simple network management protocol (SNMP) traps and alarms for online problem notification. Traffic management also can be a value-added DualPath benefit. In the long run, the ability to perform load balancing or load sharing across the optical wireless link and the RF link can improve performance considerably.

Optical wireless and RF: Blending the best of both worlds

While optical wireless and RF technologies are making inroads as de facto standards for outdoor point-to-point connectivity, the reality is that, as stand-alone solutions, neither can simultaneously meet the high bandwidth and high availability requirements of today's network user. A DualPath approach to network design that blends each technology, intelligent switching and configuration/management will be critical to ensuring that information is available in the enterprise network and beyond. RFD

ABOUT THE AUTHOR

Randel Maestre is director of product management at LightPointe Communications, a provider of outdoor wireless products. He was instrumental in growing the wireless LAN market during a decade-long tenure with AT&T and Lucent where he led various sales, product and marketing initiatives, including the launch of WaveLAN, the first wireless LAN product. Maestre can be reached at www.lightpointe.com.


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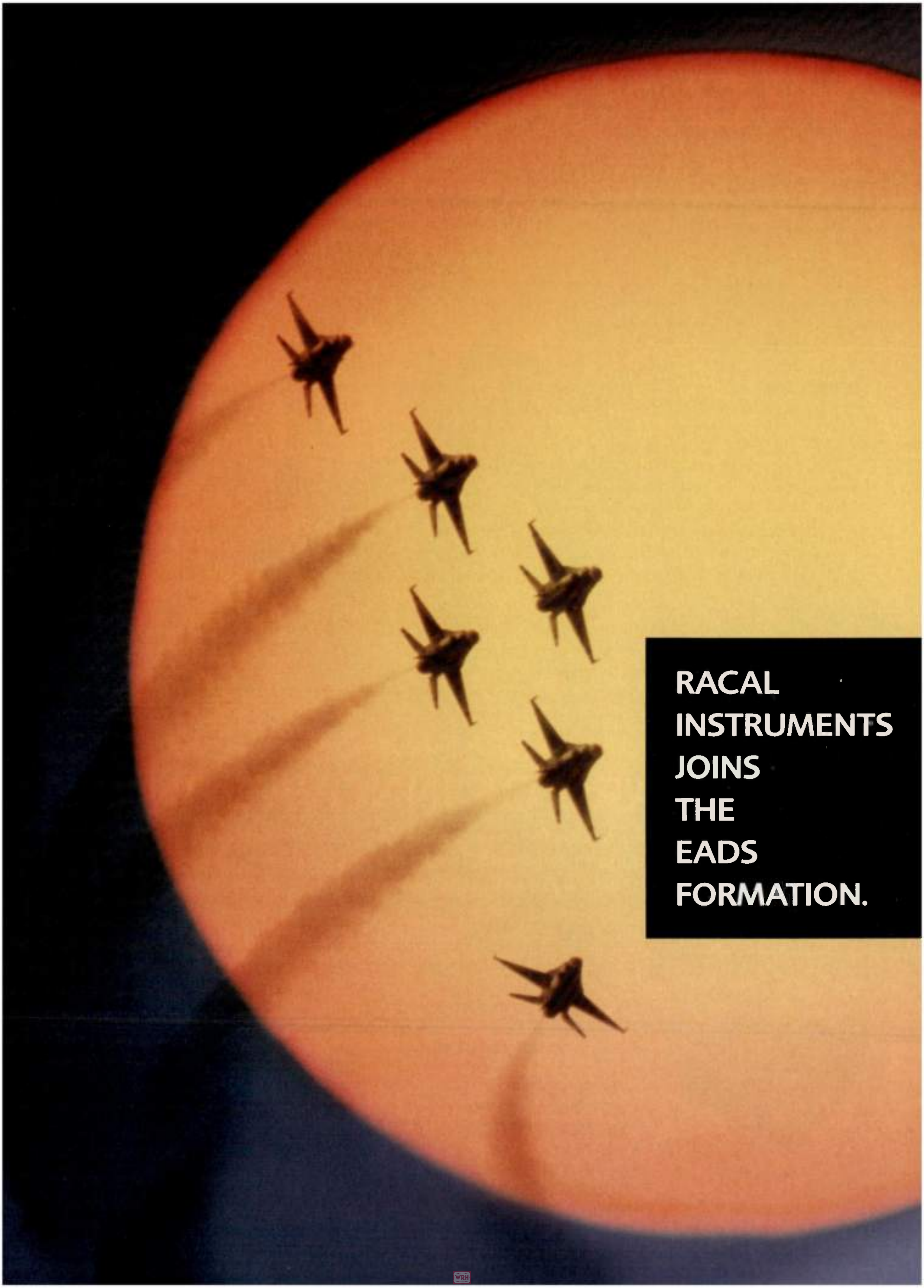
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Improving amplifier's efficiency using a linearizer in conjunction with adaptive bias modulation

By combining the benefits of a linearizer with adaptive bias techniques, an amplifier's efficiency can be significantly improved over a wide range of RF powers.

By Tim Fergus

With the introduction of the 3G standards, the implementation of the analog radio transceiver circuitry has become easier with much of the channelization and filtering being performed within the digital domain. This has not been the case for the power amplifier design—the introduction of higher-order modulation schemes (3G, EDGE), the linearity of the power amplifier has been a key area of interest. With GSM, power amplifier design was simplified by the fact that the modulation scheme employed had a constant RF envelope. This allowed GSM to achieve low distortion, high-efficiency power amplification. This is not the case for 3G applications where high linearity and low distortion are necessities—impacting heavily on efficiency. In such situations circuits known as linearizers are employed that assist the power amplifier to achieve higher power and efficiency for the same level of distortion.

The main goal of the power amplifier is to produce the highest RF power possible while maximizing efficiency—with any resultant distortion products within acceptable limits.

The problem with this approach is most amplifiers in mature networks operate at less than the maximum-rated RF power. For example, in a mature GSM network, the power amplifiers may be backed off by 3 dB from full power. This is likely for emerging standards such as EDGE and 3G where the deployment of infrastructure will be initially at full power and later reduced as more cells are added to support extra capacity. In addition, engineering margins need to be added to ensure that the equipment will be compliant at full-rated power over all conditions. Finally, the RF power required during quiet periods of the day (early hours of the morning) is likely to be much lower than that required at peak periods.

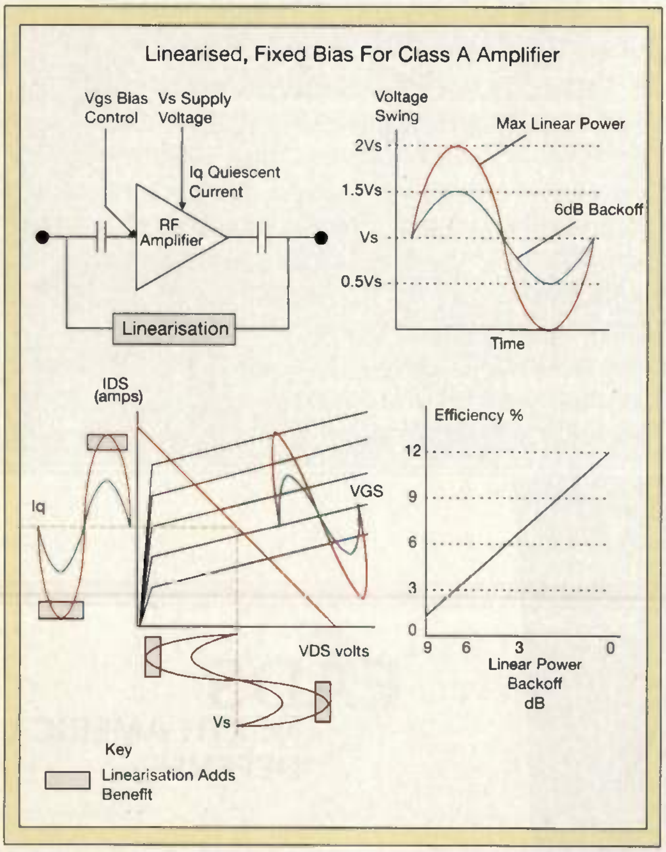


Figure 1. Load-line representation of Class A amplifier.

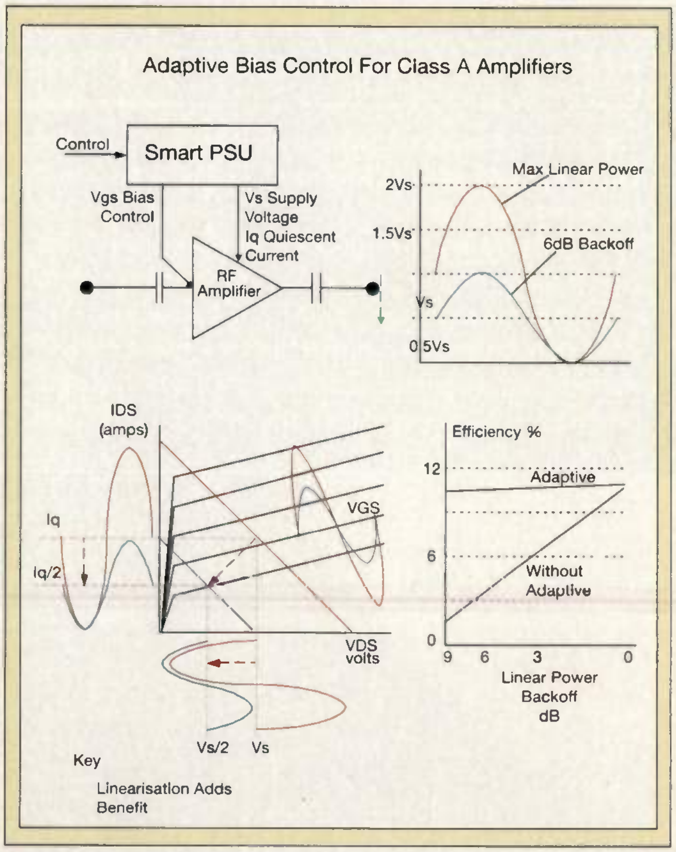
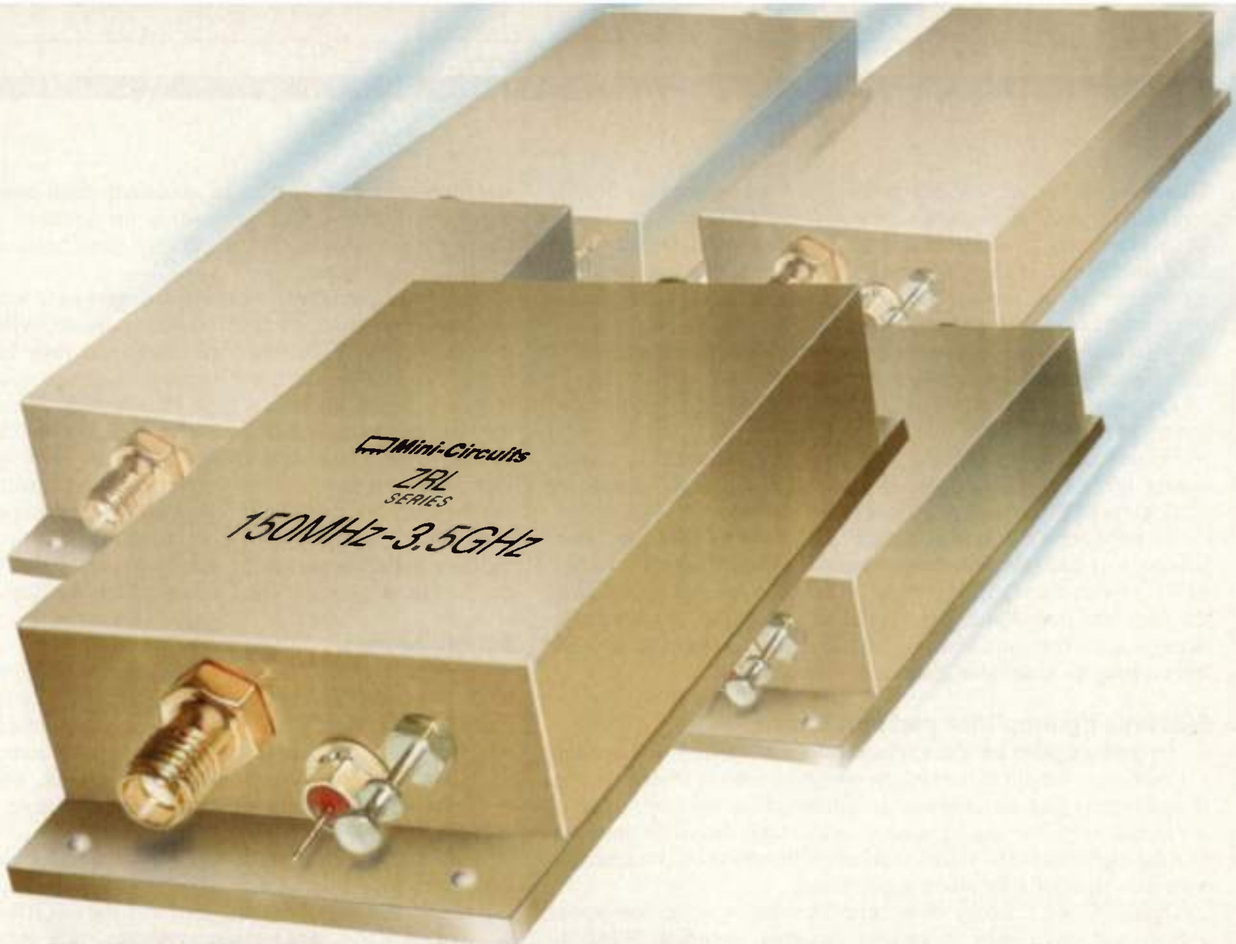


Figure 2. Adaptive bias control for Class A amplifier.



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Therefore, the average amplifier power delivered may be significantly less than the maximum rated.

Unfortunately, linearizers that work best at maximum-rated power, offer little benefit at lower RF powers. This results in power amplifier efficiencies that are lower than expected in operation with a significant overhead of redundant linearization circuitry.

What can be done to improve efficiency for lower RF powers below the maximum rated for the power amplifier?

The answer is to ensure that the linearizer provides good benefit over a range of powers. This can be achieved using adaptive bias techniques. These can vary the quiescent current and supply voltage across the power amplifiers in sympathy with the average or instantaneous RF power requirements.

By employing a hybrid combination of adaptive bias and linearization, it is possible to improve amplifier efficiencies over a range of RF powers for a varied type of modulation scheme. In addition, the linearizer provides an error signal indication that can be used to determine the optimum bias conditions for the power amplifier while maintaining an acceptable distortion.

Maximizing amplifier performance

For most amplifier technologies and architectures, the linearizer adds the maximum benefit at the highest operating powers where inherent distortions are greatest. Depending on the amplifier type, up to 3 dB of additional RF power can be realized for the same distortion products. For the higher-order modulation schemes linearization is a common approach especially for macro applications.

Generally, the linearity of an amplifier improves for low-power signals and this results in smaller distortion products. When an amplifier is backed off from its maximum-rated power, the effect of any linearization is much less hence, linearization in general, does not provide improvements in amplifier performance for low-power operation. (See Figure 1.)

It is clear from Figure 1 that the linearizer adds benefit at the upper and lower excursions of the RF signal envelope. When the RF signal is backed off by 3 dB from maximum rated there is no real benefit from linearization. As the RF power is further reduced efficiency drops. Although linearizers offer little benefit at lower RF powers, they can be used to indicate the level of distortion occurring.

For linearizers using negative feedback, there will be an error signal that relates to the error induced in the power amplifier. This can be used to determine if the bias is too high or two low for the particular application. For 3G applications, closed loop linearization is a significant challenge given the wide loop bandwidths required. Some of this functionality would need to be performed in the digital domain.

Adaptive bias

In situations where the power amplifier is operating at significantly lower power than maximum, there is another option of using adaptive bias and power supply modulation to improve efficiency. Assume that a 3G WCDMA class amplifier produces 12% efficiency for maximum RF power. If we wish to produce an RF output, which is a quarter of maximum, the dc dissipation remains the same with efficiency dropping to 3% (0.25 * 12).

With adaptive bias for Class A, for an amplifier 6 dB below maximum RF power, this would result in a halving of bias current and supply voltage when compared with the full RF power case.

Figure 2 shows this technique can maintain amplifier efficiency

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COMPRESSION, P1dB	+18	+19		dBm	
VSWR			1.5/1 2/1		16 TO 32dB GAIN <1 TO 15dB GAIN
IMPEDANCE		50		OHMS	
ATTENUATION RANGE	0		31	dB	
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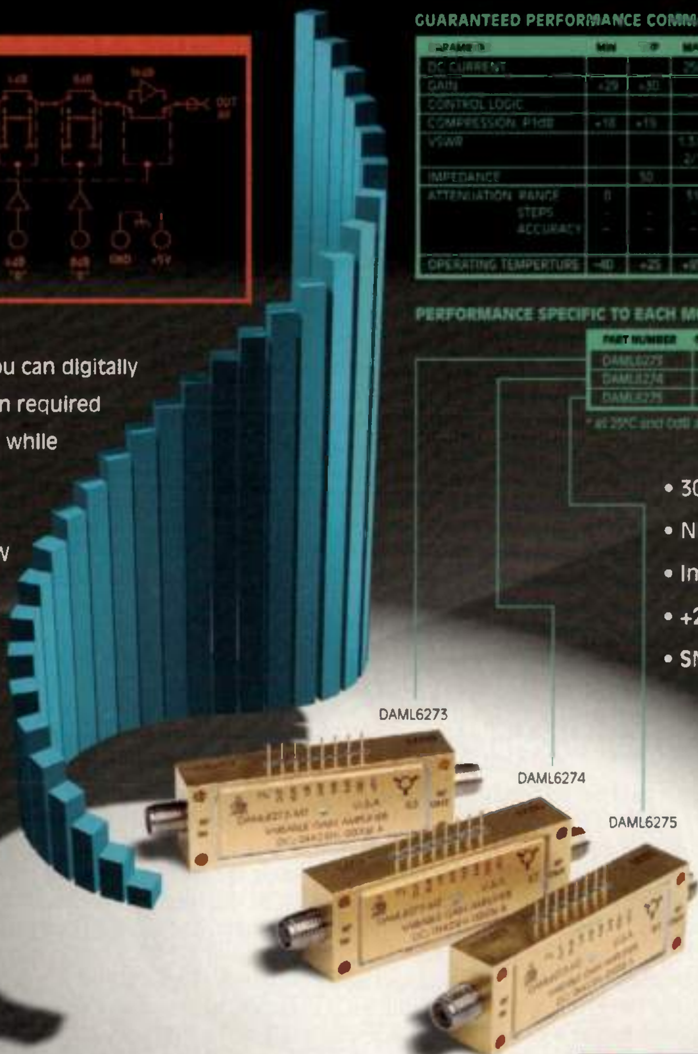

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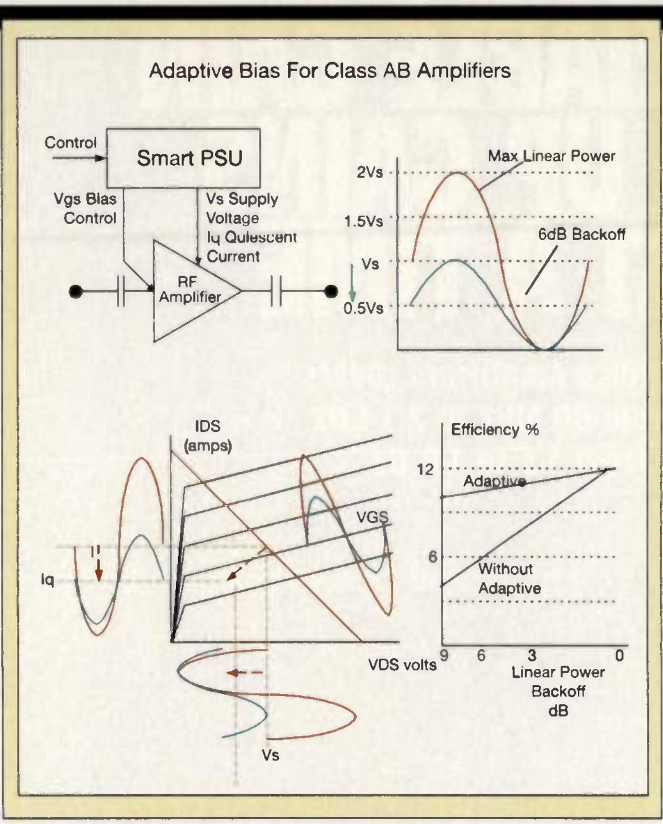

Figure 3. Adaptive bias for Class AB amplifier.

over a range of powers. This approach is of benefit if the RF power amplifier is only expected to run at full-rated power for a short time during a 24-hour period. The bias circuitry needs some knowledge of the RF power requirement in order to adjust itself. The benefit to be realized depends on the amplifier characteristics. For example, a device operating in Class A could realize the full benefit.

A device operating in Class AB would potentially have less benefit as the quiescent current varies with RF power automatically. The bias current does need to be modified to track temperature changes.

Generally, the linearity of an amplifier improves for low-power signals and this results in smaller distortion products.

However, the significant change would be modulation of the supply voltage. This is shown in Figure 3 (based on real measurement).

In the case of a Class AB amplifier, the efficiency with adaptive bias does decrease with falling drive as Class AB transistor are sensitive to external biasing arrangements and efficiencies fall away more rapidly than theory would suggest. Under these conditions, the adaptive biasing can set the correct quiescent current for a particular supply voltage to ensure optimum linearity. This is often referred as the sweet spot and maximizes the device efficiency for the given operating conditions.

This can be taken a step further where the adaptive bias is dynamic and tracks the modulation envelope in real time. It is possible to use dynamic modulation of the power supply to track the signal but this generates distortion products with the systems that are problematic (alteration of the bias and power supply results in unwanted modulation of the RF signal). In addition, a significant safety margin is required to ensure that the amplifier can deliver the RF power required at that instance that degrades efficiency.

Therefore, dynamic power supply modulation cannot achieve the low distortion products required for most modern communication systems.

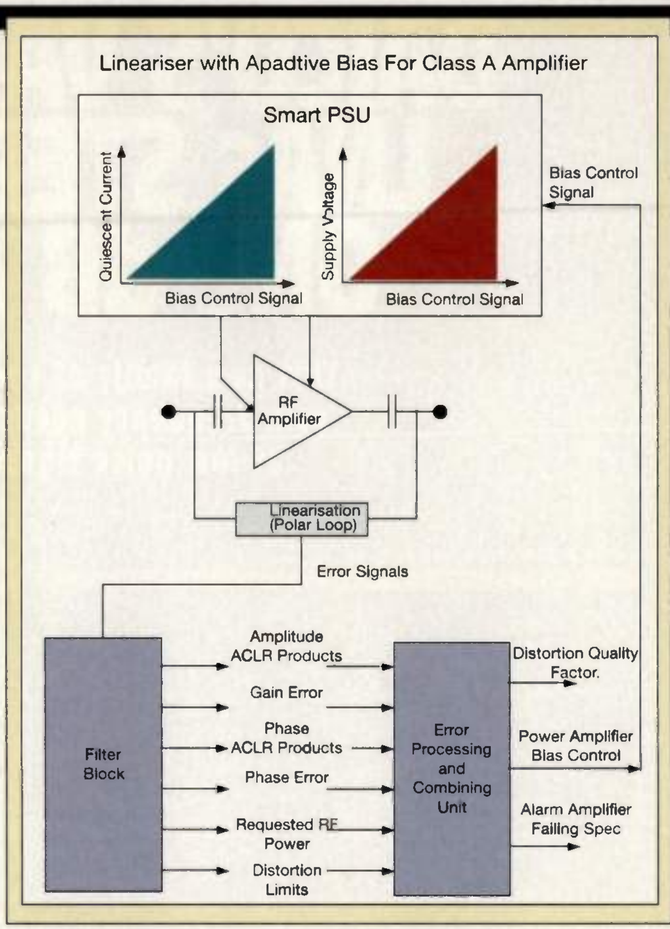

Figure 4. Polar linearizer with adaptive bias.

It should be noted that a power supply unit (PSU) capable of dynamic voltage adjustment is a significant challenge. Care needs to be taken to ensure the PSU maintains high efficiency and stability while achieving rapid change in output voltage.

Hybrid approach

However, by combining linearization and adaptive bias, one can optimize amplifier efficiency over a range of RF powers. In this hybrid application, both adaptive bias and linearization are included. Figure 4 shows such an arrangement.

Both systems are wrapped around a power amplifier, which could be a single or multistage unit. The areas of interest are the linearizer and adaptive bias system. Such a system is possible for narrowband systems such as GSM or EDGE. Nonetheless, different linearization strategies would be required to meet the signal bandwidth for 3G.

In this design, the linearizer is a negative feedback system (for example, a polar loop) comparing the amplitude and phase distortions caused in the PA. These comparisons are used to derive error signals, which drive modulators that oppose the distortions occurring within the amplifier. The operation of the polar loop linearizer is discussed in[1].

For adaptive bias, the power amplifier block (two stage) is connected to an active power supply that can alter its output voltage in a dynamic manner. The bias control block sets the quiescent current for the amplifiers. For a Class A amplifier, both of these can vary in sympathy to maintain the correct load line for different RF power requirements.

Theory of operation

The novel part of this implementation is that the amplifier bias conditions are determined from the error signals within the closed loop system. For the polar loop case, these are the phase and

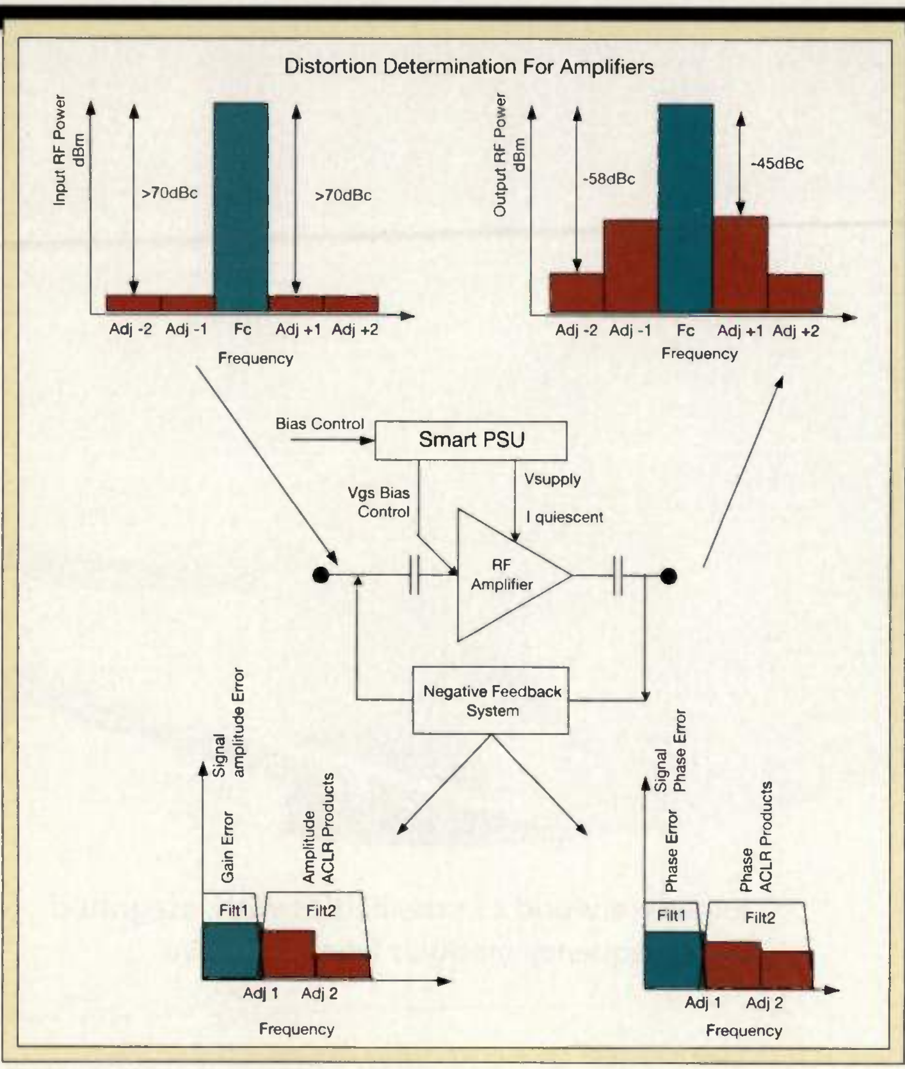

Figure 5. Distortion products from linearization.

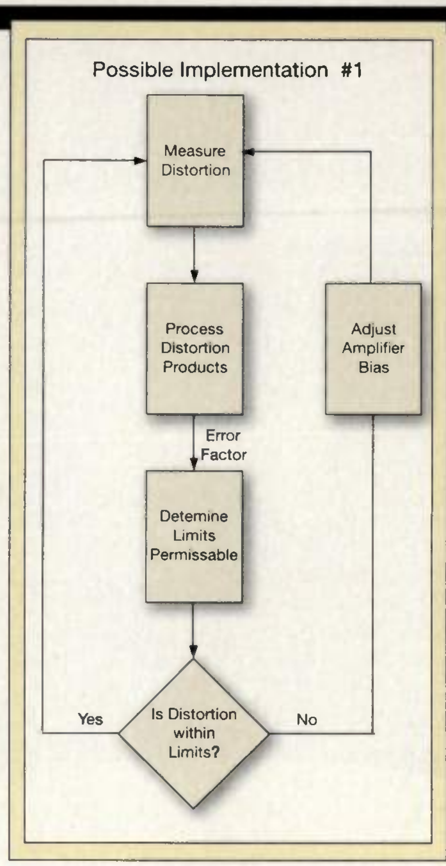

Figure 6. Bias adjustment algorithm.

amplitude error signals from the detectors. This error signal can be related to the distortions in the amplifier. For example, the phase error relates to error-vector magnitude (EVM) while the amplitude error relates to adjacent-channel power modulation (ACPM). By processing the magnitude of these errors (by analog or digital methods), it is possible to determine the distortion products generated within the amplifier. When these error signals fall outside the predefined window the biasing arrangements for the amplifier is not optimum and need to be adjusted. Therefore, these error signals can be used to determine the amplifier dc bias conditions. It is assumed that the ac load line is also maintained within reasonable limits.

Figure 5 shows a simplified 3G waveform along with the distortion artifacts following amplification (these are the red blocks). These artifacts occur as a result of phase and amplitude distortions within the amplifier, which results in a spreading of energy into the adjacent channels. To provide correction for these distortions, the linearizer will produce a comparison signal following downconversion to a low frequency. The algorithm in Figure 6 show this comparison signal, which results from comparing input reference and output signals.

Assume that the power amplifier is required to deliver a certain power with a predefined EVM and ACPM distortion. Initially, the quiescent and supply voltages are too low to deliver the RF power required so the amplifier produces excessive distortion that fails specification. The linearizer error signal will exceed the predefined limit indicating that the distortion is outside specification. This error signal is monitored as the supply voltage and quiescent current are increased for the amplifier. When the error signal falls within the permitted range, the bias is then correct. In practice, this happens dynamically resulting in the best efficiency over a wide range of RF powers for varied modulation types.

Conversely, if the quiescent current and supply voltages are high for the required RF power, the amplifier will produce minimal distortion and the error signal from the linearizer will be too small. This error signal is monitored as the supply voltage and quiescent current are decreased for the amplifier until the error signal lies within the predefined window (Figure 6).

Under these conditions the linearizer is working at full capacity over a range of RF powers. Returning to the load line, the improvement is clear with reference to the load line where constant efficiency is maintained.

From Figure 7 it can be seen that the benefits of linearization are maintained while the RF is backed off. In addition, the amplifier efficiency is constant over a 10 dB RF power range. These figures are based on a Class A gallium arsenide (GaAs) amplifier.

Benefits of hybrid combination

The hybrid combination of adaptive bias and linearization offers significant efficiency benefits including:

- Optimum efficiency over a wide range of RF output powers for different signals.
- Near constant efficiency over a range of powers with slow or dynamic bias adaptation.
- Provides a method for determining acceptable distortion artifacts so that the adaptive bias can be optimally set.
- Linearizer reduces the potential for modulation due to distortions occurring from adaptive bias techniques.
- Potentially permits the supply voltage and quiescent current of the amplifier to preserve the load line in accordance with the processed error signals.

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MwT-PH7	12	6.0	80	N/A	13.5	24.0
MwT-9	12	7.0	180	N/A	8.5	25.0
MwT-PH9	12	7.0	240	N/A	11.0	27.0
MwT-17**	8	6.5	560	0.8	10.0	29.5

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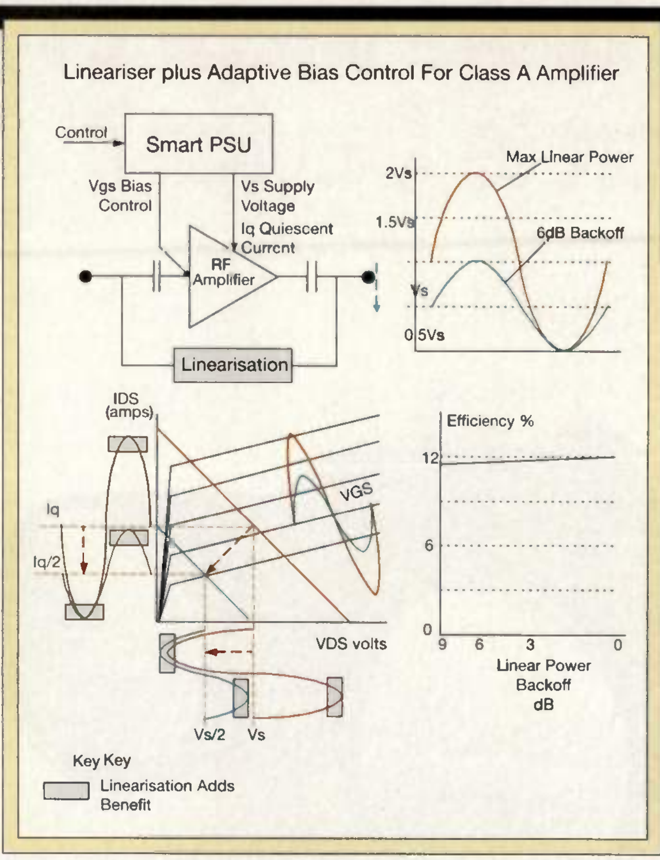

Figure 7. Linearization and adaptive bias.

■ No need for significant engineering margins to be built into the design. RFD

Acknowledgments

I would like to thank all my colleagues in the Wireless Technology Practice for their assistance and helpful comments during this research.

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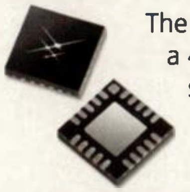

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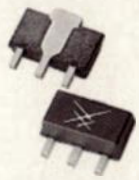

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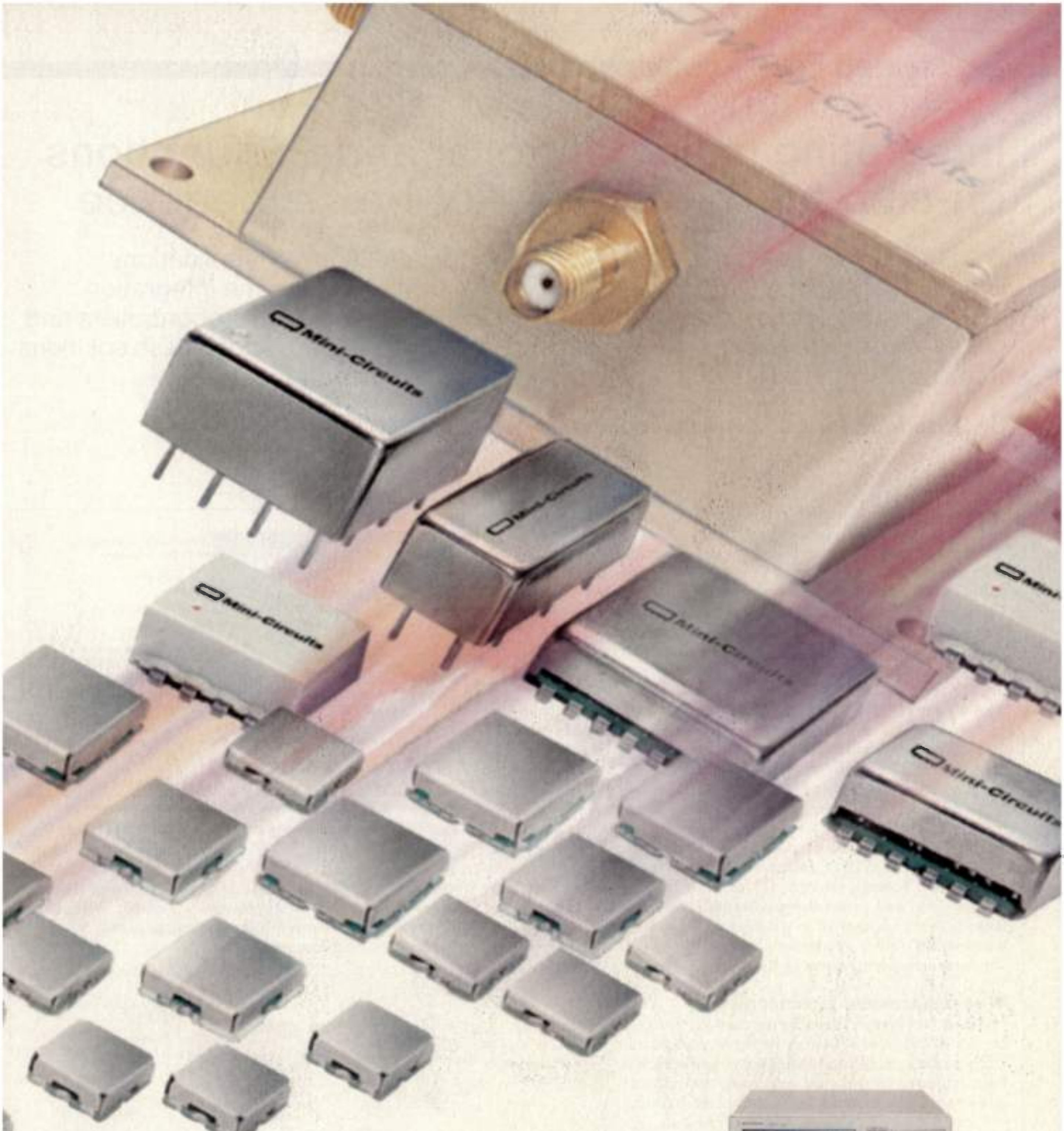
Mini-Circuits

Integrating microcontroller and RF functions on-chip for wireless out-of-box experience

Wireless is a broad technology encompassing a multitude of applications with different costs and complexity. This article will focus on the integration of Bluetooth, wirelessUSB, and Zigbee radios into eight-bit microcontrollers and mixed-signal arrays to create low-power, low-cost, single-chip wireless solutions that enable interdevice communication without the need for cables.

By Deepak Sharma and Ryan Woodings

As Meg takes the turn to her street in her SUV, she pushes the button on her garage door opener and her garage door opens, the main hallway light comes on, the central alternating current (AC) kicks in to her desired level, the plasma TV comes on to her favorite channel and her automatic blinds come down to provide comfortable viewing. This may sound far fetched, but with today's wireless technologies this scenario is easily within the realm of possibility.

Wireless is a broad technology encompassing everything from extremely low-power, low-cost radio frequency identification (RFID) tags to wireless metropolitan area networks using WiMax and ultra-wideband (UWB) as illustrated in Figure 1. This article will focus on the integration of Bluetooth, wirelessUSB and Zigbee radios into eight-bit microcontrollers and mixed-signal arrays to create low-power, low-cost single-chip wireless solutions that enable interdevice communication without the need for cables.

While 802.11 has made its mark in wireless local area networking, the next revolution is occurring in the areas of wire replacement and sensor networks. Wire replacement covers short-range wireless applications such as keyboard, mouse, presenter tools, in-home light management systems, simple sensor networks, garage door openers, car key fobs, and personal computer (PC) headsets. The heart of these systems consists of a wireless radio (usually Bluetooth or wirelessUSB) and a microcontroller (usually eight bit) along with various external components on the board.

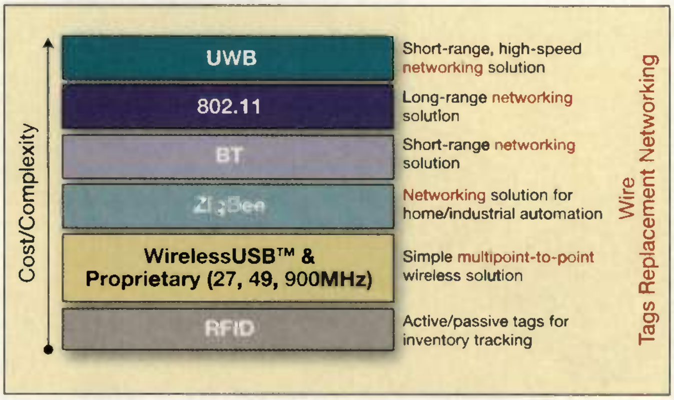

Figure 1. Wireless technologies by application vs. cost/complexity.

Wire replacement technologies

Sensor networks are becoming popular with the recent creation of Zigbee, which has been designed as a standardized solution for sensor and control networks. Zigbee has been optimized for mesh and cluster-tree networks that allow peer-to-peer communication. Most Zigbee devices are extremely power sensitive (thermostats, security sensors, etc.) with target battery life being measured in years. The focus of Bluetooth is ad-hoc interoperability between cell phones, head sets and personal digital assistants (PDAs). Bluetooth is also used as a cable replacement solution for wireless computer peripherals. Most PDAs and high-end cell phones today contain an integrated Bluetooth solution. WirelessUSB is built upon the premise that a complex networking protocol is not required for simple point-to-point applications like PC mice, keyboards, and basic sensor networks.

Bluetooth, wirelessUSB, and Zigbee all operate in the 2.4 GHz industrial scientific and medical (ISM) band. (Zigbee can also operate in the 900 MHz band.) There are several benefits to the 2.4 GHz ISM band compared to other license-free bands:

1. 2.4 GHz is an ISM band and is available worldwide; many other license-free bands are not consistent worldwide. While the end consumer may not care, it is a big advantage to consolidate supply chain logistics for manufacturers.

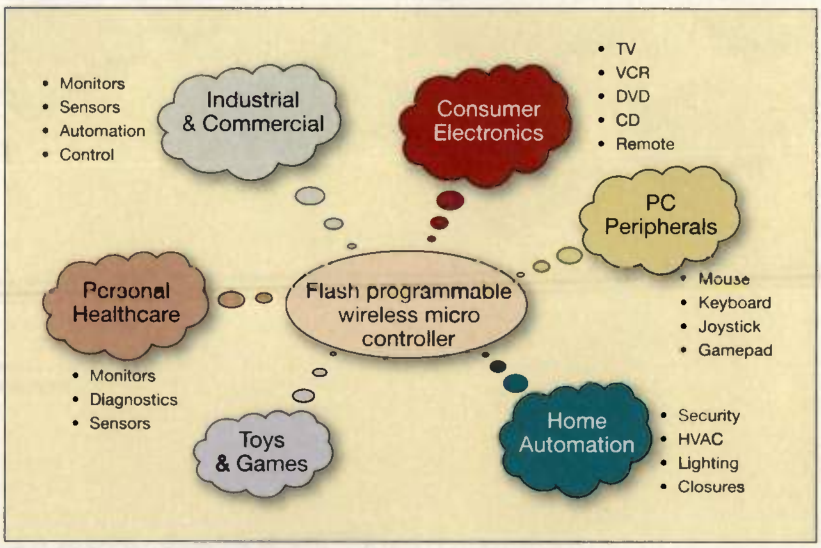

Figure 2. Explosion of applications for a wireless microcontroller.

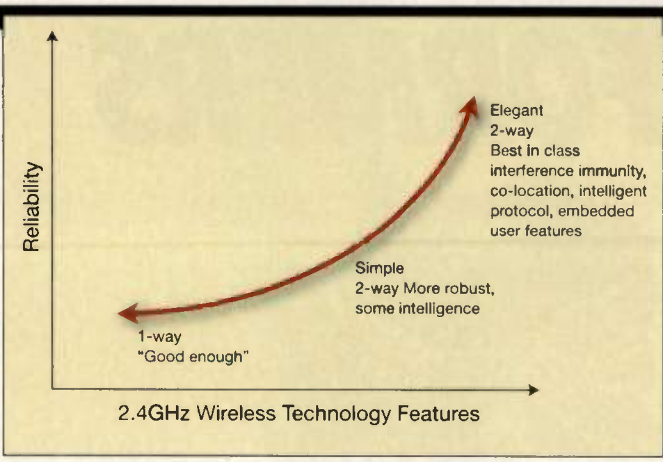

Figure 3. Reliability spectrum for wireless technologies.

2. High bandwidth—27 MHz systems suffer from bandwidth limitation and co-location issues. 2.4 GHz has several channels and combined with intelligent coding schemes can offer virtually unlimited co-location properties.
3. Spread spectrum—Devices using the 2.4 GHz band have to use a spread spectrum technique, either frequency-hopping spread spectrum (FHSS) similar to Bluetooth or direct-sequence spread spectrum (DSSS) similar to Wi-Fi, to enable high interference immunity and rejection. This results in highly robust solutions.
4. Low cost—With the mass adoption and ability of semiconductors to move down the technology curve, we are almost reaching a point where the cost delta between a 27 MHz system and 2.4 GHz system is negligible and the benefits far outweigh the slightly higher cost for designers and marketing groups.

Microcontroller integration

As microcontrollers become smaller and cheaper, the functionality of many external components is being integrated directly into the microcontroller. Eight-bit microcontrollers come in a variety of package sizes, random access memory (RAM) and read-only memory (ROM) sizes, serial communication buses, and analog inputs and outputs, enabling engineers to select a microcontroller that matches their design requirements and cost constraints. Some microcontrollers integrate the microcontroller and almost all related analog and digital peripheral circuits typically found in an embedded design, such as: analog to digital converter (ADC), digital to analog converter (DAC), pulse width modulation (PWM), amplifiers, timers, counters, universal asynchronous receiver-transmitter (UART), small computer serial interface (SCSI), SCSI parallel interface (SPI), intelligent interface controller (I^2C), and USB. This mixed signal integration allows customers to significantly reduce the number of components they have to use, greatly improving system quality and reliability and drastically lowering bill of materials. With this continued integration of external components into the microcontroller it was only a matter of time before the integration of reliable radio technology and advanced mixed-signal array microcontrollers occurred. The result of this integration is the potential to unlock value (read profits for manufacturers and ease of use for end consumers) across a myriad of applications in the consumer world as shown in Figure 2.

The issue now is figuring out the right wireless technology and microcontroller to integrate together. If the right microcontroller is merged with the right radio the resulting technology will enable designers to significantly decrease development time, component count and system cost while improving operating range, power consumption and latency. Besides benefits to the design engineer, the integration also simplifies supply chain logistics by significantly reducing the numbers of components in the device.

So what is the impact on end applications? The biggest impact is in two areas: ease of use and installation costs. Integration leads to a lower learning cycle and complexity level of implementation. By going 'wireless' you are able to carve out huge costs of installation. For example, using a wireless solution to set up carbon dioxide detectors in an existing building enables installation in days and does not require any breaking down of walls or expensive wiring.

However, you have to be cautious and intelligent about choosing the right solution. Let's begin with the wireless technology. The first step is deciding what kind of system you are building: is the system a high-end consumer electronic (light control system in a house) or a low-end commodity ($12 wireless mouse)? This would help in deciding between a one-way wireless protocol and a two-way wireless protocol. You could move along the reliability spectrum of wireless technology as shown in Figure 3.

Finally, the wireless protocol should be as simple as possible to enable an easy learning curve and implementation in a reasonably sized code space. You should also be evaluating intelligent binding schemes and security algorithms. (You don't want your garage door opener to be a gateway into your PC at home.)

Choosing a microcontroller

The next step is the microcontroller choice. The first thing is to find one that has integrated the wireless radio in it. Beyond that there are several factors to consider:

- **Microcontroller scalability.** Preferably you want to choose a family that allows you to scale both up and down in terms of flash size, inputs and outputs (I/Os), and various analog and digital components. It would be wise to choose a mixed signal array in case you are also looking at temperature sensing and voltage sequencing in your application. (For example, temp sensing in a server farm could trigger fans for the servers and at the same time send a wireless signal to a hub to record data for analytics at a later stage. The analytics could help in energy conservation and optimize power payments.)
- **Toolset integration.** The ideal scenario is to have the wireless radio be a user module/library that would simplify radio communications development in the design environment. The designer software development environment should be GUI based with simple point and click options. It should provide flexibility to code in either C or assembly language and use event triggers and multiple break points in debugging the design.
- **Design time reduction.** A nice to have feature is a toolset witha higher level of abstraction, enabling design at a level

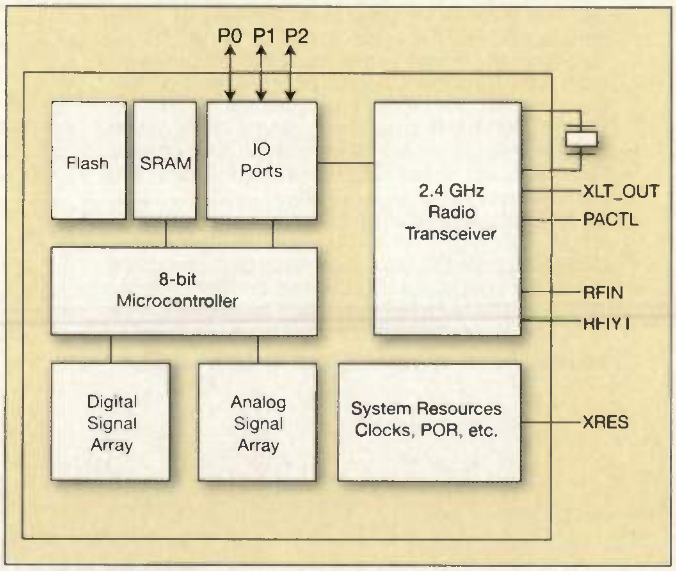

Figure 4. Block diagram of microcontroller with integrated radio.

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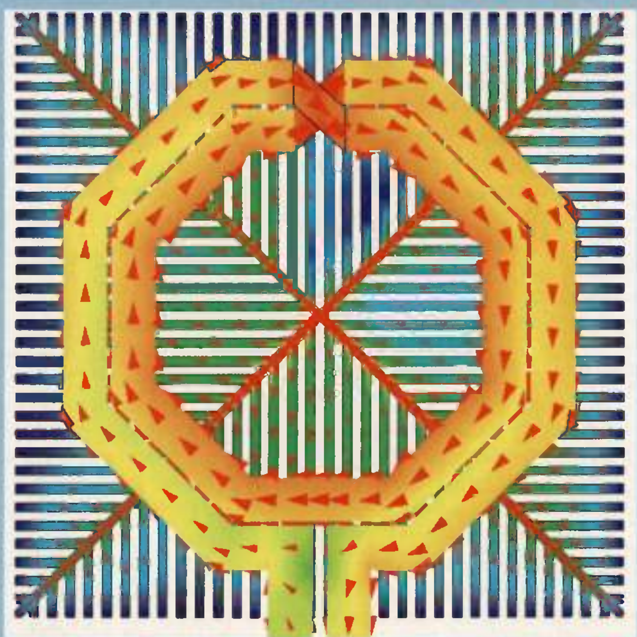
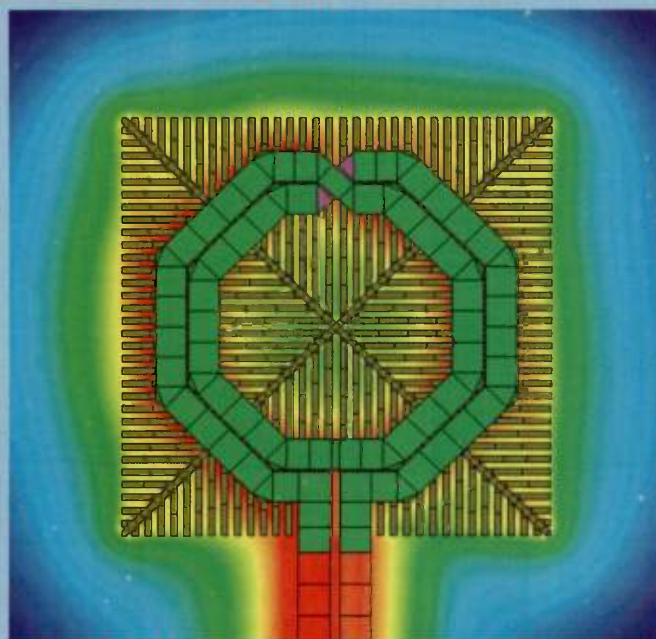
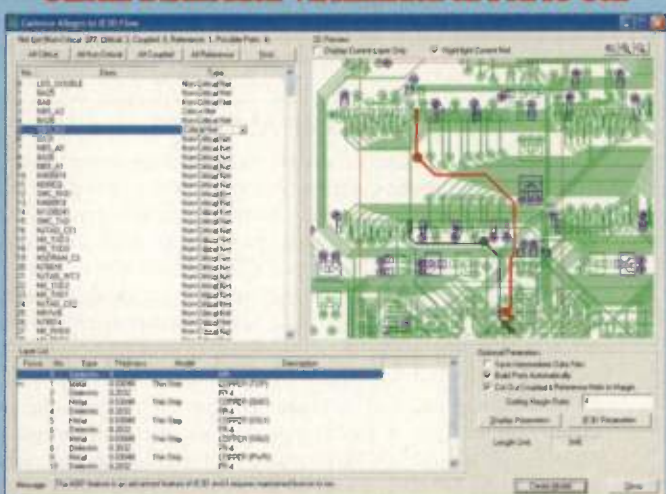


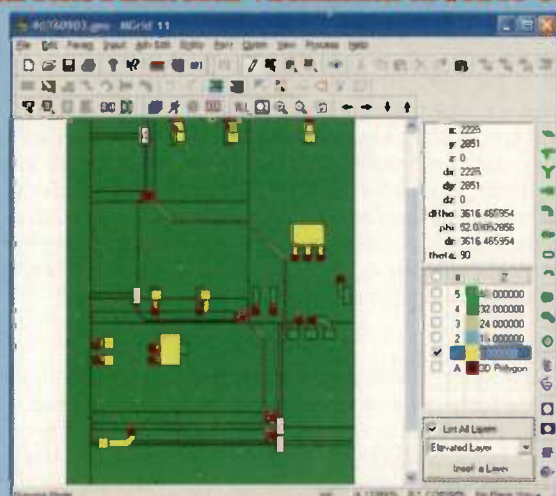
Current Distribution Visualizstion on a RFIC Cell



Near Field Distribution Visualization on a RFIC Cell



Critical Nets and Reference Nets Defined on a PCB Layout



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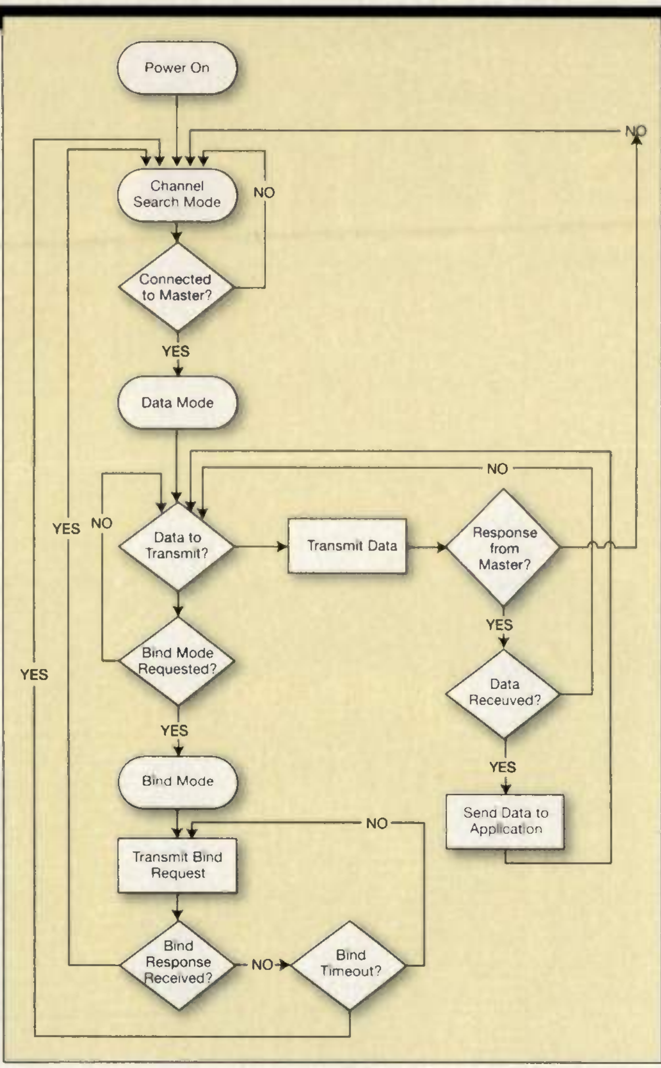

Figure 5. Example protocol state machine.

not requiring C or assembly language. This enables designers to focus on application expertise and create a custom solution using a system similar to choosing from a catalog and linking the parts in a logical manner. There would be an additional bonus if the tool could create datasheets, schematics and bill of materials to reduce total design cycle time to hours instead of weeks or months. Some of this may not appeal to the 'die-hard' engineers who prefer to hand code assembly and debug it using logic analyzers, but most modern engineers welcome tools that will reduce design time and increase the reliability of their product.

It is clear from a business and technology perspective that the time for integrating reliable 2.4 GHz radios with flexible mixed signal array microcontrollers is here. The rest of this article will explore an application example of a garage door opener and describe some of the real world design issues faced in implementing this using an integrated solution such as PRoC from Cypress Semiconductor Corp. vs. a discrete multichip solution.

Hardware

A discrete multichip solution typically requires additional external components in addition to separate microcontroller and radio chips. This adds additional size and cost to the design. By using an integrated solution, the design can be extremely small, consume less power, cost less, and take less time to develop. Figure 4 shows a block diagram of an eight-bit microcontroller with an integrated 2.4 GHz radio. Observe that due to the integration of the two chips the interface between the microcontroller and the radio is completely internal, which reduces the number of external pins required or frees external pins to become generic I/O pins instead of being dedicated to the radio interface.

Firmware

Integrated solutions are able to take advantage of the tight coupling between the microcontroller and the radio to create an easy-to-use firmware library for radio access. Some solutions even provide a complete protocol stack that provides a robust two-way link between devices. Depending on the target application the right protocol may be Bluetooth, wirelessUSB or Zigbee. By providing a complete protocol stack customized for the specific radio and microcontroller these solutions make it easy to create a connection between two or more devices. A simple API, such as the one shown below, is used to interact with the radio. After creating the connection the protocol will send packets to the target device, retransmitting the packets if an error is detected. If a connection is lost to the target device the protocol will re-establish the connection or find another route to the target device.

```
protocol_init()
protocol_create_connection()
protocol_send_packet(int packet_length, char* packet)
protocol_get_packet(int max_packet_length, char* packet)
```

Figure 5 shows an example of a protocol state machine that handles creating a wireless connection, and provides guaranteed packet delivery and interference immunity, without requiring additional design effort by engineers. This allows the engineers to treat the wireless link like a wired serial bus such as SPI, UART or I^2C.

System

With the integration of radio and microcontroller it is now trivial to create small wireless temperature sensors that can be placed in each room of the house, with each sensor periodically reporting its temperature to the main thermostat in order to more accurately control the heating and air conditioning in the home. A floodlight that lights up the driveway can now be connected to additional motion detectors covering the front walkway and side of the house so that the floodlight turns on when you walk out the door instead of requiring you to walk in darkness to the driveway before it turns on.

As Meg pulled into her garage, she smiled as she looked forward to watching her favorite show on her new plasma TV and wished that somehow her intelligent garage door opener would also heat up the TV dinner in a microwave and serve it on her table! Not a reality yet, but dream on since now is the time to bring those dreams to reality. RFD

ABOUT THE AUTHORS

Deepak Sharma is senior product marketing manager-wireless for Cypress. He joined the company in 1998 as a marketing engineer and has progressed over the years to manage several products. He managed PLDs, datacom and video products in the DCD division. In early 2005, he moved into the CCD division to take over the wireless portfolio. His expertise is in marketing and brand strategy for hi-tech products with experience in organizational and business strategy. He holds an M.B.A. from Rochester Institute of Technology (NY) and a B.Tech from B.I.T.S. (Pilani), India.

Ryan Woodings is a staff software engineer at Cypress Semiconductor, specializing in short-range wireless protocol design for the company's wirelessUSB products. He has six years experience in short-range wireless technologies including IrDA, Bluetooth and wirelessUSB. Woodings holds a B.S. and M.S. in Computer Science from Brigham Young University.

Next-generation wireless components

LDMOS UHF pallet amplifiers

Richardson Electronics Ltd. has announced two LDMOS UHF pallet amplifiers designed and manufactured by its European design and production center. The LDU401C provides 350 W at 1 dBcp and 90 Wrms for digital video broadcast applications. The LDU501C is rated at 450 W at 1 dBcp and 120 Wrms for DVB-T. Both products feature Motorola RF power devices and are mechanically compatible with Motorola's MRFA2604. Both also operate from a supply voltage of 35 Vdc, within a frequency range of 470 MHz to 862 MHz and have a value of 50 Ω for input and output impedance.

Richardson Electronics Ltd.
(800) 348-5580
www.rell.com

Package-on-package solution

Spansion LLC, the Flash memory venture of Advanced Micro Devices (AMD) and Fujitsu Limited, is shipping package-on-package (PoP) Flash memory samples to customers that will enable them to deliver sleek, feature-rich wireless phones, PDAs, digital cameras and MP3 players. Spansion's PoP solution vertically combines discrete logic and memory packages for board space savings, lower pin-count, simplified system integration and enhanced performance. As a result, handset manufacturers can accommodate the growing demand for advanced features in their wireless products without having to increase their size and weight.

The PoP solutions measure approximately 1.4 mm in height and vertically combine a system memory package with a logic chipset package. PoP solutions enable a high degree of flexibility for designers, allowing virtually any POP-enabled memory package to be combined with any PoP-enabled logic chipset in a matter of weeks. PoP solutions also enable high yield use of logic and memory, and simplified test to help reduce time to market and maximize cost efficiency.

Spansion has the capability of delivering eight-die solutions in a 128-ball, 12 mm x 12 mm package with a 0.65-mm pitch. PoP's short trace lengths and low bus capacitance also help to overcome the signal integrity and timing issues associated with emerging 133 MHz dual-data rate (DDR) memory solutions. The company's approach reduces pin count and eliminates printed circuit board (PCB) routing between logic and memory, for reduced design complexity. The PoP solutions include the inherent benefits of its two-bit-per-cell MirrorBit technology. With the future availability of the ORNAND architecture, the company plans to extend the benefits of MirrorBit technology and believes it will be able to respond to the demand for mass storage solutions in wireless handsets and complement application processors with an optimized code and data storage solution.

Samples of 12 mm x 12 mm and 15 mm x 15 mm Flash memory PoP solutions are available for wireless phones and will vary in pricing depending on logic/memory densities and combinations.

Spansion LLC
(408) 962-2500
www.spansion.com

Low-power ADC

Maxim Integrated Products has announced the MAX19586, a 16-bit 80 Msps analog-to-digital converter (ADC) that achieves 80 dB or greater signal-to-noise ratio (SNR). The MAX19586 is suitable for high-performance broadband applications. Examples include cellular base-station transceiver systems (BTS), multicarrier and multistandard communication receivers, E911 location receivers, antenna array processing, and high-end test and measurement instrumentation. The spurious-free dynamic range (SFDR) performance eases filtering requirements, and less expensive filters reduce system costs. The large dynamic range can also be used to simplify system design by eliminating the need for variable gain attenuators (VGA) or automatic gain control (AGC) blocks in the receiver. This is especially important in systems where the receiver is expected to digitize both weak (far) and strong (near) signals. With more than 80 dB of dynamic range, the system can capture both signals without having to change gain ranges.

The MAX19586 is a 3.3 V ADC with a fully differential wideband track and hold (T/H) and a 16-bit converter core. Designed for excellent operation in the second Nyquist region, the MAX19586 is also optimized for use with high-IF input frequencies. This makes the part ideal for high-performance digital receivers. The part has a 1.8 V digital supply voltage and a 2.56 Vp-p full-scale input range. Power dissipation is 1.1 W. The MAX19586 also offers a noise floor of -82 dBFS and 96 dBc SFDR at an input frequency of 10 MHz (-2 dB input amplitude). This ADC can also sample input frequencies beyond 170 MHz. In subsampling applications, the MAX19586 offers superior performance at high IF (77.2dB SNR at an input frequency of 168MHz). The MAX19586 is packaged in a space-saving 56-pin QFN-EP. Pricing is $59.25 each for 1000-unit quantities.

Maxim Integrated Products
(408) 737-7600
www.maxim-ic.com

Single-chip mobile VoIP processor

Broadcom Corporation has announced a second-generation mobile voice-over-Internet protocol (VoIP) processor, the BCM1161, designed specifically for WiFi phones that feature advanced multimedia and telephony capabilities. This single-chip VoIP processor enables a new class of multimedia voice and video applications such as video streaming, digital cameras, video conferencing and data connectivity, all not available from the typical cordless phones used in homes today. Today's WiFi phones are beginning to leverage the convergence of VoIP and WLAN, enabling the handsets to not only provide leading-edge performance and features, but also to interoperate with new home entertainment appliances. To enhance VoIP phones, Broadcom chips feature advanced compression techniques for a superior audio experience.

The BCM1161 focuses on low-power and advanced multimedia functions, including polyphonic ring tone support, a two-Megapixel digital camera, voice record/playback and video clips record/playback. A variety of advanced telephony features are also supported, such as three-way conferencing, speakerphone support and high-fidelity voice capabilities through the use of Broadcom's BroadVoice technology. The new single chip integrates an ARM9-based CPU, analog voice codec with a direct microphone and high-output speaker interface, 262 k color LCD interface and a USB 2.0 interface. Broadcom's BCM1161 mobile VoIP processor is available.

Broadcom Corporatoin
(949) 450-8700
www.broadcom.com

WiMAX demo network

TeleCIS Wireless Inc. has deployed a "triple play" WiMAX demonstration network in Santa Clara, Calif. TeleCIS built the network to demonstrate the performance gains made possible by its advanced, standards-based (802.16-2004) WiMAX chip

design, which will enable service providers to achieve critical objectives for a profitable business model—namely, non-line-of-sight deployment and "self-installed" customer-premises equipment (CPE). In addition, the low power, small size and high performance of the TeleCIS solution based on the current standard will be built into laptops and PC cards, enabling the portable, or "nomadic," WiMAX market in the near future. TeleCIS installed a WiMAX base station on the top of its office building and equipped a van with VoIP phones, a video monitor and laptop PCs to create a triple play environment that represents both fixed CPE and portable devices. During "test drives," TeleCIS shows simultaneous, uninterrupted DVD-quality streaming video, high-speed Internet connection and VoIP telephony capability while moving within the demo network service area. During the demonstration, TeleCIS Rx Technologies performance enhancing features are "turned off" and comparisons can be seen between the TeleCIS solution and the WiMAX mandatory implementation.
TeleCIS Wireless Inc.
(408) 844-8040
www.telecis.com

Wireless chipsets

The next-generation picoArray series of flexible products for WiMAX and WCDMA infrastructure from **picoChip** will incorporate the ARM926EJ-S processor from ARM Limited, creating a single-chip, software-defined solution for advanced wireless systems. Combining ARM processor technology and picoChip's fully programmable signal processing array in an advanced 90 nm device reduces the cost of WiMAX deployment without compromising the flexibility essential for standards compliance and system performance enhancement. The cost-effective solution will enable carriers to build-out their infrastructure based on the current 802.16d WiMAX standard and quickly upgrade their equipment to support mobility once the new 802.16e standard is complete. WiMAX implementations are power-intensive and currently require increasing numbers of DSP or FPGA devices, with a consequent escalation of costs. With the ARM-powered picoChip offering, carriers will be able to bring mobile WiMAX services online in the shortest time frame possible. This will enable customers to maximize the benefit from the WiMAX standard with ubiquitous broadband Internet access and enhanced mobile multimedia services.
picoChip
(408) 467-3866
www.picochip.com

ZigBee protocol stack

Microchip Technology Inc. has announced its free ZigBee Protocol Stack now supports the Uniband Electronic Corporation (UBEC) uz2400 ZigBee/IEEE802.15.4 2.4GHz RF transceiver. Embedded systems designers can now use Microchip's ZigBee Stack with the UBEC uz2400 RF transceiver or the Chipcon CC2420 transceiver, providing increased design flexibility. Microchip offers the smallest and only free ZigBee stack, enabling lower development and system costs. Microchip has upgraded its ZigBee stack to version 3.3 to meet ZigBee specification version 1.0. The ZigBee standard is an industry protocol for wirelessly networked control and monitoring applications. To make it easy for engineers to design with the ZigBee protocol, Microchip features the PICDEM Z development platform based on Microchip's PIC18 high-performance microcontroller family, which supports ZigBee applications. Microchip's ZigBee stack is the only stack small enough to fit into a 16 Kbyte microcontroller, enabling low-cost sensors. The stack is sized at 33.7 Kbytes for a coordinator and 14.4 Kbytes for reduced-function devices. Microchip's PICDEM Z platform accelerates customer designs by providing hardware and a free ZigBee protocol stack that can be easily integrated into wireless products. Microchip offers more than 63 PIC18 eight-bit microcontrollers that support the ZigBee stack. Microchip's ZigBee Stack is available at no cost on the company's Web site. The PICDEM Z demonstration board is available for $199 each.
Microchip Technology Inc.
(480) 792-7200
www.microchip.com

Bluetooth stereo headphones

CSR's BlueCore3-Multimedia chip provides the Bluetooth connectivity behind Motorola's new feature-rich HT820 Bluetooth stereo headphones. The recently launched HT820 is planned for worldwide distribution in the second half of 2005 and will enable users to listen to stereo audio streamed wirelessly from a range of different devices, while remaining connected to a mobile phone for hands-free voice calling. The Motorola HT820 removes the need to carry headphones for listening to music and a separate mono Bluetooth headset for hands-free voice communication by integrating a microphone into the Bluetooth stereo headphones for use with voice calling. The advanced DSP technology within the BlueCore3-MM chip significantly reduces background noise and echo, and allows the headset to switch between paired devices. The headphones can receive music from any Bluetooth-enabled device that supports the new Advance Audio Distribution Profile (A2DP), thus widening the range of potential music sources.
CSR plc
(972) 238-2300
www.csr.com

WCDMA power amplifier family

Anadigics Inc. has introduced the AWT6272, the AWT6276 and the AWT6277. These three wideband CDMA (WCDMA) power amplifiers (PAs) offer power efficiency to extend battery life in mobile handsets and WCDMA-enabled notebook PC cards. The new high-efficiency-at-low-power (HELP) PAs offer full compliance with high-speed downlink packet access (HSDPA) requirements, while maintaining compatibility with Universal Mobile Telecommunications System (UMTS) data services to support the growing demand for mobile high-speed Internet services. Each amplifier covers a specific frequency band. The AWT6272 covers the 824 MHz to 849 MHz range. The 1850 MHz to 1910-MHz frequency band is covered by the AWT6276, and the AWT6277 operates from 1920 MHz to 1980 MHz.

Anadigics' HELP WCDMA PAs use the company's InGaP-Plus technology, which integrates bipolar and field-effect transistor (FET) structures on the same InGaP GaAs die. The HELP WCDMA PAs offer quiescent currents of 16 mA or lower, provide leakage currents of less than 1 μA, and are optimized for all output power levels to deliver 50% less average power consumption.
Anadigics Inc.
(908) 668-5000
www.anadigics.com

ATTENUATORS

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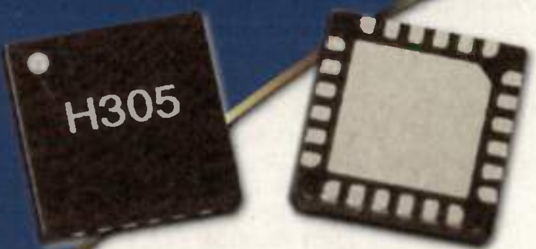
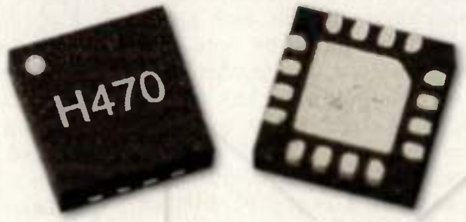
Serial Control



+52 dBm Input IP3

- 0.5 dB LSB Steps to 15.5 dB
- CMOS Serial Data Interface
- +/- 0.3 dB Typical Bit Error

Parallel Control



Covers RF & IF, DC - 3 GHz

- 1 dB LSB Steps to 31 dB
- 5 Bit TTL/CMOS Control
- +/- 0.3 dB Typical Bit Error

A SELECTION OF OUR DIGITAL IC ATTENUATORS

	Part Number	Function	Frequency Range (GHz)	Attenuation Range (dB)	Input IP3 (dBm)
NEW!	HMC541LP3	1 Bit	DC - 5	0.25 to 7.75	+50
	HMC291 (SOT26)	2 Bit	0.7 - 4.0	4 to 12	+54
	HMC468LP3	3 Bit	DC - 6	1 to 7	+50
NEW!	HMC540LP3	4 Bit	DC - 5.5	1 to 15	+50
NEW!	HMC470LP3	5 Bit	DC - 3	1 to 31	+45
NEW!	HMC271LP4	5 Bit, Serial Control	0.7 - 3.7	1 to 31	+48
	HMC273MS8G	5 Bit	0.7 - 3.7	1 to 31	+48
NEW!	HMC305LP4	5 Bit, Serial Control	0.7 - 3.8	0.5 to 15.5	+52
NEW!	HMC539LP3	5 Bit	DC - 4	0.25 to 7.75	+50
	HMC306MS10	5 Bit	0.7 - 4.0	0.5 to 15.5	+52
NEW!	HMC472LP3	6 Bit	DC - 3	0.5 to 31.5	+45
	HMC425LP3	6 Bit	2.4 - 8.0	0.5 to 31.5	+40
	HMC424LP3	6 Bit	DC - 13.0	0.5 to 31.5	+32

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Active Components

Switch for tri-mode phones

M/A-COM has announced an RoHS-compliant SP3T Tx/Rx switch for tri-mode mobile phones (GSM, CDMA, GPS). The MASWSS0144 switch offers versatility with a low insertion loss and is configured to enable switching from a common antenna port to dual-band GSM, CDMA, cellular, PCS and GPS receive ports.

The design of the switch is asymmetric and has dedicated paths for each mode. This allows each path to be optimized for the assigned mode of operation. It is designed for the following key typical performance characteristics at 1.0 GHz, 2.7 V control voltage, and PIN of +34 dBm: insertion loss of 0.6 dB, high isolation of 30 dB, cross modulation of -102 dBm for the CDMA path, and third harmonics greater than 72.5 dBc for the GSM path.

The MASWSS0144 is packaged in a surface-mount 3 mm PQFN-12. It is fabricated on a 0.5-micron gate-length GaAs process with full passivation added.

The MASWSS0144 is available from stock.

M/A-COM
(800) 366-2266
www.macom.com

Amplifiers

Low-noise gain block amplifier

Mimix Broadband Inc. has released a gallium arsenide (GaAs) two-stage low-noise gain block amplifier that has a self-biased, single supply design. Using 0.25 μm optical etch-stop pseudomorphic high electron mobility transistor (pHEMT) device model technology, this low-noise gain block, identified as CMM1100, covers the 2 GHz to 18 GHz frequency bands and provides 3.5 dB noise figure and 18 dB gain, delivering 16 dBm P1dB.

This low-noise gain block amplifier offers a combination of low-noise figure and broadband output match by employing a unique feedback stage to provide a good noise figure that does not exist in typical distributed low-noise designs. Integrated bias coils and on-chip dc blocking are all inclusive in the compact chip measuring 1.550 mm x 1.600 mm x 0.100 mm.

Engineering samples are available.

Mimix Broadband
(281) 988-4600
www.mimixbroadband.com

WCDMA power amplifier

Anadigics Inc. has introduced three wideband CDMA (WCDMA) power amplifiers (PAs) that offer power efficiency to extend battery life in mobile handsets and WCDMA-enabled notebook PC cards.

The HELP WCDMA PAs use the company's InGaP-Plus technology, which integrates bipolar and field-effect transistor (FET) structures on the same InGaP GaAs die. The HELP WCDMA PAs offer quiescent currents of 16 mA or lower, provide leakage currents of less than 1 microamp, and are optimized for all output power levels to deliver 50% less average power consumption. The PAs are offered in a 10-pin 4 mm by 4 mm by 1.1 mm surface-mount package designed for applications that require European Union's Restriction of Hazardous Substances (RoHS) solutions.

The AWT6272, AWT6276 and AWT6277 are priced at $2.46 in quantities of 10,000 units.

Anadigics
(908) 668-5000
www.anadigics.com

Broadband driver amplifier

WJ Communications Inc. has announced a 1 W, high-linearity driver amplifier targeted for mobile infrastructure, CATV/DBS, VHF/UHF broadband, and defense and homeland security applications. The AH202 covers the 50 MHz to 2200 MHz frequency range, is available in a 6 mm x 6 mm 28-pin QFN SMT package and is lead-free/RoHS compliant.

This device is broadband and operates over a 50 MHz to 2200 MHz frequency range while providing its P1dB and OIP3 performance when biased at +11 V; it can also be biased as low as +9 V for lower power applications. Thermal design allows the product an MTTF of more than 100 years at a mounting temperature of +85 °C. All devices are 100% RF and dc tested. The AH202 is targeted for use as a driver amplifier for a variety of applications including mobile infrastructure, CATV/DBS, VHF/UHF broadband, and defense and homeland security applications where high linearity and medium power are required.

Fully assembled evaluation boards and loose samples are available.

WJ Communications Inc.
(408) 577-6342
www.wj.com

Analog and RF Front Ends

480 Mbps USB 2.0 switch

Fairchild Semiconductor's FSUSB23 is a single-port USB 2.0 high-speed (480 Mbps) analog switch in a MicroPak chip scale package (CSP). Its compact packaging, combined with low power consumption of less than 1 μA and wide bandwidth of greater than 720 MHz, make it applicable for multifunctional cell phones. The FSUSB23's ability to switch high-speed USB signals allows it to pass the eye diagram compliance for ac and dc performance to meet the USB 2.0 high-speed standard. It also retains complete USB 1.1 full-speed (12 Mbps) reverse compatibility for use in a range of applications.

The FSUSB23 complements Fairchild's line of high-performance USB switch solutions. Other USB-compliant products include the FSUSB22, a low-power two-port analog switch also for high-speed USB compliance, and the FSUSB11, a low-power, single-port full-speed USB switch.

The lead (Pb)-free FSUSB23 meets or exceeds the requirements of the joint IPC/JEDEC standard J-STD-020B and is compliant with European Union requirements.

Fairchild Semiconductor
(207) 775-8100
www.fairchildsemi.com

Broadcast/Satellite Communications

Set-top box chips

STMicroelectronics has announced silicon devices to implement secure video processor (SVP) technology. The STB5525 STB decoder, which is also ST's single-chip solution to support dual TV and dual DVR requirements in standard-definition STBs, and the STB5524, which targets the growing DVR market, are intended for use across satellite, cable and terrestrial TV services.

The STB5525 and STB5524 devices offer a glueless interface to ST's range of demodulator chips, enabling them to be used with a range of sources to provide a solution for delivering digital content to two TV sets or two digital video recorders. They include a SATA interface for connecting hard disk and recordable DVD drives, plus two 480 Mbps USB2 ports for home networking and for the simple addition of peripherals.

The integrated CPU of the STB5525 and the STB5524 is a 300 MHz ST231 core, the ST processor to be used in an STB chip. This core is a member of the EEMBC-certified ST200 very long instruction word (VLIW) series, which was designed specifically for video and audio streaming, including MPEG-2 and MPEG-4, in digital consumer applications where high performance, low silicon costs and low power consumption must be combined with rapid development to ensure the minimum time-to-market.

The STB5525 and STB5524 decoders will be available in sample quantities in the third quarter of 2005, with volume production

scheduled for the first quarter of 2006 and when purchased in volumes of 10,000 units, are priced at $15 and $14, respectively.
ST Microelectronics
(781) 861 2650
www.st.com

PC-TV demodulator

Zarlink Semiconductor has introduced a terrestrial demodulator for PC-TV, portable and handheld digital TV equipment. The ZL10354 device offers a unique "diversity enabled" maximum ratio, combining architecture that allows portable TV equipment manufacturers to link two or more chips.

Access Devices Inc., a manufacturer of digital TV equipment, is designing the ZL10354 into its PC-TV products. The mobile products target the European and Asian terrestrial markets, where free-to-air digital TV, radio, and interactive multimedia services are fueling demand for portable DVB-T electronics products. Zarlink's diversity-enabled MRC design allows two or more ZL10354 demodulators to be linked together via a simple interchip bus that also manages the diversity signal control. This bus is cascaded from chip to chip, adding signal quality improvement at each stage. Two devices deliver a sufficient improvement for most applications and consume less power than most diversity alternatives due to the low power consumption of the ZL10354 demodulator—less than 300 mW (milliWatts) in a typical application.

The ZL10354 demodulator complies with the NorDig Unified 1.0.2 and other global terrestrial DTV standards. The device includes an integrated digital IF (intermediate frequency) filter that eliminates the need for switched bandwidth surface acoustic wave (SAW) filters in the tuner design. The chip also contains an RF signal strength indicator, allowing download and reading of the TV signal strength directly at the receiver box.

The chip is pin- and feature-compatible with the ZL10353 and ZL10355 demodulators. All Zarlink demodulators feature a "blind scan and auto re-acquisition" function, built on a hardware-based state machine that automatically scans the entire broadcast band much faster than software-based channel-scanning algorithms.
Zarlink Semiconductor Inc.
(613) 592 0200
www.zarlink.com

GPS receiver

MMT has announced the availability of its MN1010 module, a GPS receiver. The ultrasmall design is packaged into a 10 mm x 10 mm x 1.8 mm, RF-shielded 36-pin package. It draws less than 75 mW. It is a complete 12-channel GPS receiver that only requires power and an antenna to operate. The 12-channel receiver allows all satellites in view to be tracked, providing a solution to minimize position jumps caused by individual satellite blockage. The GPS chipset integrated into the MN1010 is from u-Nav microelectronics and features the uN1008 CMOS RF front-end and the highly integrated uN8130 baseband processor.

The MN1010 is supported by an evaluation kit, which includes software and references designs to reduce time and cost for the OEM development.
MMT
(65) 6745 8832
www.micromodular.com.sg

GPS software

u-Nav Microelectronics has announced the availability of its Orion Navigation and SDK software package.

Orion is a powerful and versatile GPS navigation software package designed to support u-Nav's family of GPS chipsets across multiple frequency plans. The software is responsible for all GPS functions such as signal acquisition, tracking, data extraction and GPS navigation. Orion's message-based architecture supports self-contained as well as hosted applications. The compay provides industry-standard NMEA and u-Nav binary protocols. This versatile GPS navigation package supports autonomous operation and multiple-assisted operating modes, including 3GPP, 3GPP2, and IS-801 that are required by GSM, WCDMA and CDMA cellular networks. Unlike many competing A-GPS solutions in the market, u-Nav's approach allows simultaneous operation of GPS without interruption of a user's cellular call.

The Orion software development kit (SDK) provides developers the freedom to customize and add functional software blocks to meet application-specific requirements. In addition, this user-friendly SDK allows users to modify operating parameters of the navigation software and develop custom applications to run on the internal DSP of u-Nav's GPS chipsets. The SDK also provides a complete set of performance analysis tools and support for production flashing of the Orion software.

Orion GPS navigation software is in beta release, with full production release in the fourth quarter of this year.
u-Nav Microelectronics
(949) 453-2727
www.unav-micro.com

Satellite tuner

Zarlink Semiconductor has launched the ZL10037 satellite tuner for SD and HD digital satellite television receivers used in PayTV systems.

The ZL10037 direct-conversion tuner, coupled with the ZL10313 satellite demodulator, offers a high-performance, low-power solution for QPSK satellite receivers. The ZL10037 tuner also delivers HD-compliant performance when used with an 8-PSK demodulator.

Zarlink's ZLE10542 reference design, targeted primarily at PayTV QPSK satellite receiver systems, is a complete front-end solution that combines the ZL10037 tuner with the ZL10313 demodulator. The demodulator provides strong performance across the entire satellite 1 Msps to 45 Msps DVB-S symbol rate range.

The ZLE10542 two-chip RF subsystem consumes less than 1 W of power in full operation. An integrated sleep pin reduces power consumption 1,000-fold in stand-by mode.

The ZL10037 tuner is in full production and is supplied in a 28-pin 5 mm x 5 mm QFN (quad-flat-no lead) package. The ZLE10542 reference design is available to qualified customers.
Zarlink Semiconductor
(613) 592 0200
www.zarlink.com

AGPS/GPS module for mobile devices

Fujitsu Media Devices (FMD) and **Fujitsu Microelectronics Europe** (FME) have introduced a AGPS/GPS module suitable for mobile devices.

The device measures 10.9 mm x 9.1 mm x 1.4 mm, with a power consumption of 180 mW in search mode, or 0.1 mW in deep sleep mode (when TCXO is turned off). Receiver sensitivity of less than –150 dBm has been achieved through Fujitsu proprietary techniques in conjunction with e-Ride Inc., a provider of GPS/AGPS IP, AGPS servers and GPS reference networks.

The module can operate in autonomous, MS-assisted (mobile station-assisted) and MS-based (mobile station-based) operating modes. It functions in the temperature range of -20 °C to +85 °C.
Fujitsu
www.fujitsu.com

GPS receiver

Atmel Corporation and **u-blox AG** have announced the availability of their latest GPS technology and product generation, ANTARIS 4. The ANTARIS 4 architecture combines low power consumption with up to -158 dBm tracking sensitivity.

Enabled by Atmel's advanced 0.18-micron CMOS technology for the ATR0621 baseband and RF-proven BiCMOS technology for the RF front-end IC ATR0601, power consump-

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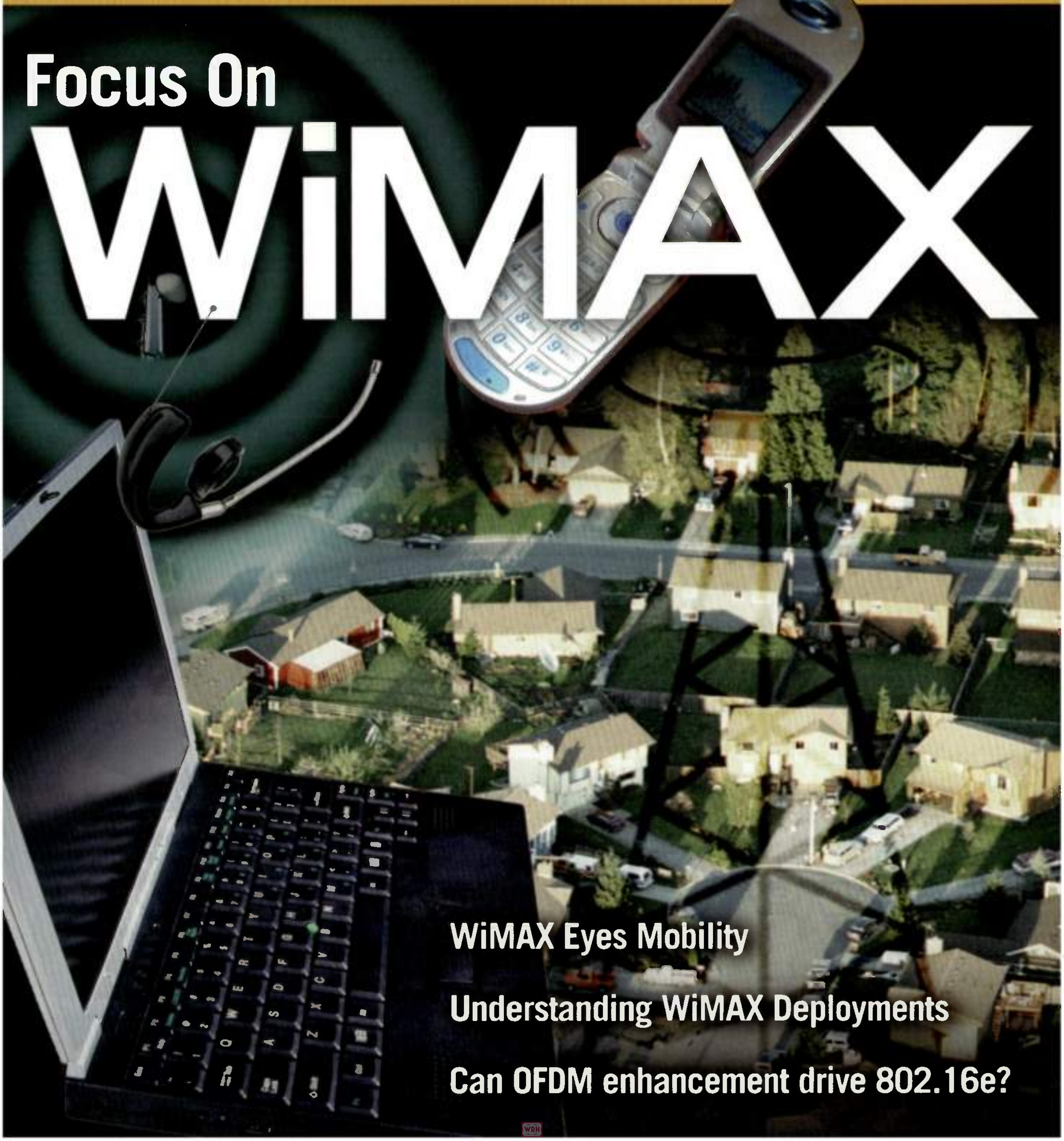
www.rfdesign.com
October 2005

Focus On WiMAX



WiMAX Eyes Mobility

Understanding WiMAX Deployments

Can OFDM enhancement drive 802.16e?

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The RF5163 enables up to twice the effective access-point-to-client range compared to any competitor power amplifier IC on the market. Ultra linear amplification also allows more users per access point while high efficiency enables operation using Power over Ethernet (PoE).

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RF5163 High Power Amplifier

- RF P_{OUT} of +26 dBm @ 1.8% EVM RMS (-35 dB relative constellation error) typical @ 54 Mbps is Universe class
- Lowest EVM and relative constellation error measurements in the WLAN industry
- RF P_{OUT} of +28 dBm @ 4% EVM RMS (-28 dB relative constellation error) maximum @ 54 Mbps is "Best in Class"
- High efficiency allows operation using Power over Ethernet (PoE) IEEE802.3af™
- Provides ultra linear amplification with +3.3 Vdc input
- Wide range of operating voltages - Operates from +3.3 Vdc to +6 Vdc input
- QFN 16-pin, 4x4mm package provides small footprint and lowest cost PCBA cooling
- "With Driver" options provide 32 to 45 dB gain with "Universe Class" linearity, small PCBA footprint and low BOM cost
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By Cheryl Ajluni, *Editor*

WiMAX asks *"Can you hear me now?"*

WiMAX is a compelling sell these days for many reasons. The main one is its ability to make broadband wireless access (BWA) cheaper and easier to deploy. It requires few truckrolls due to good non-line-of-sight protocols and offers lots of ratcheting in bandwidth for discrete services. Some analysts caution though that any cost savings is dependent on the ability of WiMAX providers to bundle wireless broadband services with voice over Internet protocol (VoIP). By doing so, customers should be able to reap the reward in terms of a lower monthly bill, despite the initial investment in upgrading from dial-up Internet access to broadband. Add the element of mobility to the WiMAX/VoIP combination and you have an even more compelling sell.

Integration with VoIP makes good sense for WiMAX. If the technology only supports data, there is little compelling reason to justify build-outs. Voice provides the impetus to make providers more interested in the technology and for consumers to want to try it. But will the creation of a so-called "WiMAX-enabled wireless phone network" be as straightforward as it sounds?

The simple answer is no. But some promising first steps have been taken. Earlier this year the fixed-wireless provider NextWeb (www.nextweb.net) teamed with VoIP facilitator CommPartner (www.commpartners.us) to rollout a wireless VoIP over pre-WiMAX network. It delivers phone service to small and medium-sized businesses in select areas of Northern California. Because the network relies on a fixed wireless connection, it's not actually mobile VoIP, but with work on the mobile version of WiMAX (802.16e) almost complete, that may not be too far out in the future.

WiMAX-based VoIP delivery took another step forward with the certification of Broadsoft's (www.broadsoft.com) BroadWorks VoIP application platform with Soma Networks' (www.somanetworks.com) SIP-based VoIP, paving the way for VoIP application delivery over WiMAX. More recently, TowerStream (www.towerstream.com) struck a deal to sell Vonage (www.vonage.com) VoIP in a bundle with its Internet access. In what may be the first of many deals to come, it will allow TowerStream customers to use their VoIP access at WiMAX hotspots.

At each turn, the industry edges closer to the realization of WiMAX-enabled wireless VoIP. Make no mistake, the task ahead is a difficult one, but if successful, the benefits will be many. Wireless VoIP networks, for example, are less expensive to setup and install than wired ones. They are also considered more secure in the face of natural disasters like Hurricane Katrina where the "last-mile" of wired solutions may be physically damaged or destroyed.

Perhaps the biggest benefit though of WiMAX-enabled wireless VoIP will be the added mobility it grants to people on the move. Today, WiFi hotspots allow mobile consumers to check e-mail or surf the web while drinking a morning cup of coffee. But walk out the door and your connection is lost. If WiMAX-enabled wireless VoIP can be implemented successfully, this will one day be a thing of the past. One thing is for sure, with the rollout of WiMAX in progress, the shape of the communications industry will never be the same again.

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WiMAX eyes MOBILITY

While the communications industry looks to 802.16e as a way to make high-speed Internet connectivity mobile, the fixed version of WiMAX continues its steady deployment.

By Cheryl Ajluni, Editor

These days the standard garnering the lion's share of attention in the communications industry is the Worldwide Interoperability for Microwave Access (WiMAX) specification (IEEE 802.16). WiMAX provides a high-throughput broadband connection at speeds of up to 75 Mbps over a distance as far as 30 miles. On average a WiMAX base-station installation will likely cover three to five miles. The technology can be used for a variety of applications including a "last mile" broadband connection, hotspot and cellular backhaul, and high-speed enterprise connectivity for businesses. While some believe that WiMAX is destined to become as widely used as digital subscriber line (DSL) and cable modem Internet access technologies, others feel that its true potential lies in its mobility. Existing cellular operators could use WiMAX networks to supplement their networks in metropolitan areas, while new operators might deploy the technology to compete with the cellular networks.

Of course, cellular operators aren't sitting idly by waiting for that to happen. Instead, they are looking to the flurry of emerging 3G standards like CDMA2000 1xEV-DO and EV-DV (data and voice) or the WCDMA high-speed download packet access (HSDPA) and high-speed uplink packet access (HSUPA) overlays to give them the range, throughput and flexibility they need to remain competitive and keep consumers happy (Table 1). WiMAX proponents claim that in the long run, it will be cheaper and faster to deploy than cellular. Using the licensed 2.5 GHz band, for example, they expect the upfront costs of mobile WiMAX to be less for the same coverage. And, since these same proponents plan to deliver WiFi speeds with cellular range, at 700 MHz WiMAX might cover the same range with one-third the number of towers.

While 3G cellular technologies stand ready to forge new territory in terms of performance, many in the industry are counting on the fact that WiMAX will deliver on its vision of mobility. The question that remains to be answered is if WiMAX's ability to deliver this broadband wireless performance, on a mobile basis, will really turn the market in its favor. Or, will the market remain faithful to existing modem and cellular technologies, if for no other reason than that they work just good enough to get the job done?

Table 1.

Wireless Technologies

	Wi-Fi	Wi-Fi	Wi-Fi	WiMAX	WiMAX	Edge	CDMA2000/ 1xEV-DO	WCDMA/ UMTS
Standard	802.11a	802.11b	802.11g	802.16d	802.16e	2.5G	3G	3G
Usage	WLAN	WLAN	WLAN	WMAN Fixed	WMAN Portable	WWAN	WWAN	WWAN
Throughput	Up to 54Mbps	Up to 11Mbps	Up to 54Mbps	Up to 75Mbps (20MHz BW)	Up to 30Mbps (10MHz BW)	Up to 384Kbps	Up to 2.4 Mbps (typical 300-600Kbps)	Up to 2Mbps (Up to 10Mbps with HSDPA technology)
Range	Up to 300 feet	Up to 300 feet	Up to 300 feet	Typical 4-6 miles	Typical 1-3 miles	Typical 1-5 miles	Typical 1-5 miles	Typical 1-5 miles
Frequency	5GHz	2.4GHz	2.4GHz	Sub 11GHz	2-6GHz	1900MHz	400, 800, 900, 1700, 1800, 1900, 2100MHz	1800, 1900, 2100MHz

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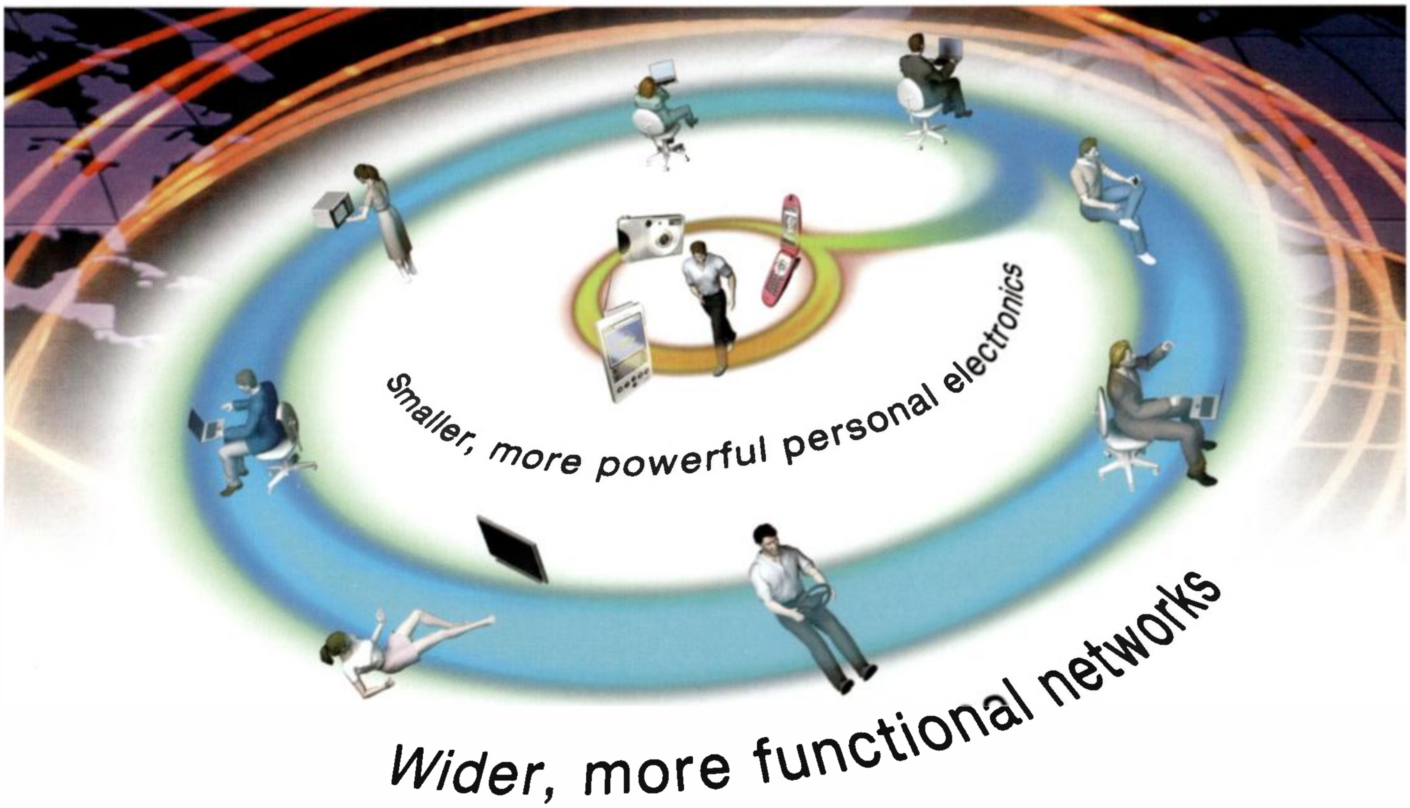

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Understanding mobile WiMAX

The mobile version of the WiMAX standard, 802.16e, would allow WiMAX technology to be built into notebooks and other mobile devices so that people could communicate while walking or riding in cars. This specification is an extension of 802.16-2004—the fixed version of WiMAX—that provides transmission to stationary devices using the 2 GHz to 11 GHz frequencies. Higher frequencies require line of sight. 802.16-2004 enables the creation of high-speed, fixed wireless broadband networks, which provide Internet connectivity, Internet protocol (IP) and TDM voice capabilities and IP-based real-time video at high speeds.

The 802.16e specification is expected to be ratified before the end of 2005 and will quickly be followed by product samples, certification, and volume rollout. Helping in that regard will be the WiMAX Forum (www.wimaxforum.org); an industry-led organization formed in 2001 to promote and facilitate the deployment of broadband wireless networks, based on the IEEE 802.16 standard, by certifying compatibility and interoperability of broadband wireless products. Certification will take place via the WiMAX Forum certified testing and certification program. As of July, the organization officially began testing products for WiMAX Forum certification at the Cetecom Labs in Spain.

With certification now under way, chipset makers have focused their attention squarely on the 802.16e specification and the question of which modulation scheme it should employ. While orthogonal frequency-division multiplexing (OFDM) was chosen as the modulation scheme for 802.16 fixed applications, the modulation scheme for 802.16e is still up for debate. The frontrunner, scalable OFDM access (OFDMA), is being touted by companies like Intel (www.intel.com) who feel it can handle the fourfold increase in complexity over fixed WiMAX, different power and coverage requirements, and higher link budgets that are all specific to 802.16e.

In contrast, Wavesat (www.wavesat.com) feels that OFDM 256 Fast Fourier Transform (FFT) will provide the much needed backward compatibility to 802.16. By serving as the physical layer in both fixed and mobile WiMAX systems, future base stations should be able to recognize and operate both fixed and mobile applications; assuming, of course, that the physical layer has, at minimum, the same number of carriers (256) and FFTs.

The choice of a modulation scheme for 802.16e is a crucial decision because it will surely impact the operators' desire to implement WiMAX. Choosing a scheme that provides them the assurance of backward compatibility to fixed WiMAX solutions, while also allowing them to preserve their initial 802.16 investment, will be key.

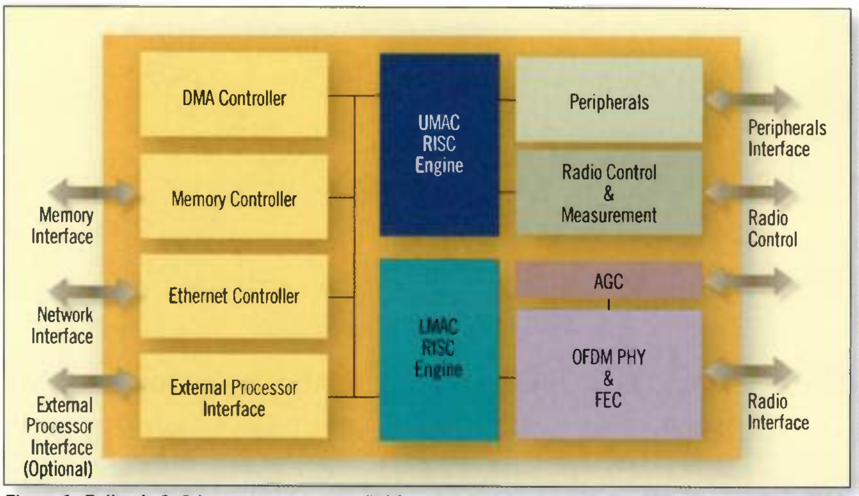


Figure 1. Fujitsu's SoC incorporates a main RISC engine that implements the 802.16 upper-layer MAC, scheduler, drivers, protocol stacks, and user application software, as well as a secondary RISC/DSP that functions as a co-processor. A multichannel DMA controller handles high-speed transactions among agents on a high-performance bus.

The big picture

Despite the questions of modulation schemes and uncertainty about the direction of mobile WiMAX, progress on the fixed WiMAX front is continuing at a steady pace. In order for any technology specification to be successful these days it requires, at minimum, three basic components: an officially standardized specification, an industry organization to promote the standard and vendors to build equipment compliant to the standard. Today, the 802.16-2004 fixed WiMAX specification has each of these components covered.

The last component came earlier this year when industry giants, Intel and Fujitsu (www.fujitsu.com), introduced WiMAX solutions. The Intel product, PRO/Wireless 5116, is a highly integrated, IEEE 802.16-2004 compliant system on chip (SoC) for both licensed and license-exempt radio frequencies. The processor's radio features an OFDM physical layer with support for channel bandwidths up to 10 MHz, an integrated 10/100 media access controller, inline security processing, and a time-division multiplexing controller interface for handling applications such as voice over Internet protocol (VoIP). It also features adaptive modulation (BPSK, QPSK, QAM16 and QAM64) and offers a programmable architecture that makes it easier for equipment makers to add additional applications on top of the chip.

Fujitsu's solution, the MB87M3400 WiMAX SoC, is also 802.16-2004 compliant and was designed to enable deployment of BWA equipment for both base stations and subscriber stations in licensed or license-exempt bands below 11 GHz (Figure 1). It uses an OFDM 256 PHY that supports channels from 1.75 MHz to 20 MHz, and can operate in time division duplex (TDD) or frequency division duplux (FDD) modes with support for all available channel bandwidths. A programmable frequency selection generates the sample clock for any desired bandwidth. When applying 64 QAM modulation in a 20 MHz channel and using all 192 subcarriers, the SoC can sustain raw peak data speeds up to 75 Mbps; uplink subchannelization is also supported.

Of course, the first company to introduce an 802.16-2004-compliant WiMAX chip was WaveSat with its DM256 baseband IC. Today, the company offers a family of products built around DM256 for licensed and license-exempt radio frequencies. The Evolutive DM256 family features 5 bits/sec/Hz spectral efficiency, adaptive modulation, programmable channel bandwidth up to 10 MHz, and support for TDD, half FDD (HFDD) and FDD duplexing modes.

A handful of start-ups are also now making a play for the WiMAX space. One such company is Sequans Communications (www.sequans.com). Its SQN1010 and SQN2010 SoCs provide system vendors with comprehensive, integrated baseband solutions to build subscriber stations and base stations, respectively, for next-generation BWA networks.

Filling out the WiMAX ecosystem are announcements from companies like picoChip (www.picochip.com), which is now readying its next-generation flexible picoArray chip, with integrated ARM 926EJ-S processor, for availability next year. This 90 nm, CMOS device will allow carriers to build-out their infrastructure based on the 802.16-2004 WiMAX standard, as well as upgrade their equipment to support

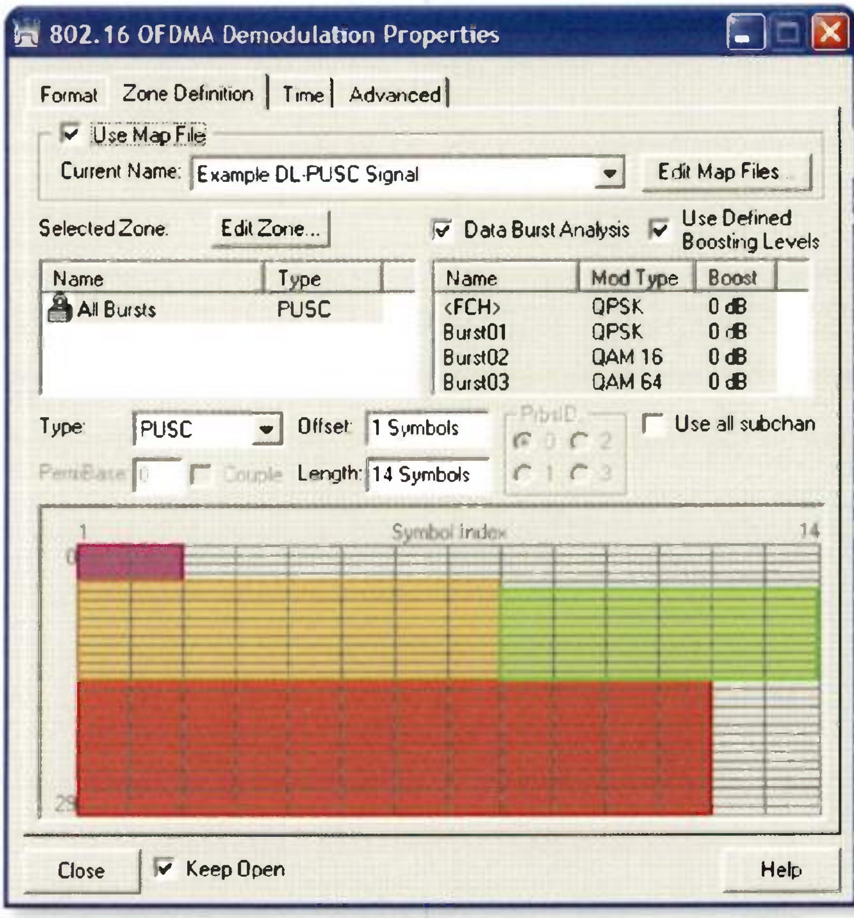


Figure 2. The 89600 B7Y solution from Agilent Technologies allows designers to capture WiMAX signals using a logic analyzer instead of the conventional spectrum analyzer or digitizer. Designers can now take a significant step forward in understanding their systems, as they can, for example, see what comes out of the A/D converters feeding their DSP.

mobility once the 802.16e standard is complete.

In addition, the company just released a family of reference designs, including a PHY, MAC and RF radio with antenna, for both subscriber stations and base stations. The reference designs are aimed at fixed 802.16-2004 WiMAX, mobile WiMAX and WiBro; Korea's version of the WMAN standard. The new reference designs include PC6530 (for 802.16e base stations) and PC6620/6630 (for 80216d/80216e subscriber stations). The designs are compatible with all aspects of WiMAX specifications and are fully upgradable for new versions of the standard, as well as for advanced features such as the active antenna system (AAS) and multiple input, multiple output (MIMO) system.

Even test and measurement vendors, like Agilent Technologies (www.agilent.com), have gotten onto the WiMAX bandwagon (Figure 2). Its digitizers, spectrum analyzers and Advanced Design Systems (ADS) simulation tools help designers cut through the complexity of the WiMAX specification and better understand where and how problems may arise (see "Library speeds design of BWA applications," p. 15). To help designers maximize their success in WiMAX, the company hosted an e-seminar entitled "From fixed WiMAX 802.16d to mobile 802.16e: RF and digital baseband testing." The event featured information on the new measurement and test/troubleshooting approaches that will be needed to deal with the added layers of complexity 802.16e creates. The contents of the seminar can still be accessed at www.get.agilent.com/vmx_link.cgi?site=nammo_edm&code=3390_reg&ref=3390_eSem_Sept15_OFDMA_FE_reg_E.

Add to these announcements the fact that manufacturers like Airspan, Alvarion, Proxim, Redline Communications and SR Telcom, have plans to announce WiMAX devices. Couple this with the work this year by service providers to begin commercial WiMAX trials and it's easy to understand why the WiMAX standard has, and will continue, to gain momentum in the months and years ahead. EWT

Understanding WiMAX deployments

Three options exist for WiMAX base-station deployments in support of self-installable indoor customer terminals. Choosing the right deployment option requires careful consideration of the trade-offs between channel capacity and base-station infrastructure and terminal costs.

By Doug Gray

The ability to support the deployment of indoor customer-installable end-user terminals can provide operators with significant cost savings that can greatly enhance the business case for a WiMAX fixed broadband wireless network. For the same operational performance, indoor terminals will be less expensive since they do not need to be hardened to deal with the more stringent requirements of out-door environments. Also, they can be designed as a single-box solution, thus eliminating extensive cabling and the need for multiple packages. More important, indoor units do not require professional rooftop installation. The net savings in customer premise equipment (CPE) costs for the operator can amount to several hundred dollars per customer. This CPE cost savings, however, does not come without other offsetting infrastructure costs that must be considered when making network deployment decisions. Consequently, various trade-offs need to be considered to help assure a winning business case when planning and deploying a WiMAX fixed wireless network with indoor self-installable customer terminals.

Projected CPE cost

Recognizing the need for low-cost residential customer terminals, WiMAX vendors are aggressively pursuing designs and manufacturing approaches that are intended to drive down prices. Since WiMAX solutions are based on the worldwide IEEE 802.16 standard, ASICs and other critical components will be available at costs that will quickly decline with increasing volume. For the purpose of this discussion, outdoor terminal prices are assumed to be about $350 and indoor terminals about 30% less. With growing volumes and increased manufacturing efficiencies, these prices are projected to decline about 20% per year and 30% per year, respectively.

Installation costs for operator-installed outdoor terminals requiring a truck-roll can vary considerably from region to region depending on local labor rates, installation complexities, and roundtrip travel times. Figure 1 provides a forward-looking summary of projected average selling prices (ASPs) for residential WiMAX terminals and projected cost savings for self-installed indoor terminals. It assumes an installation cost differential of $150 in 2005 growing at 5% per year in future years. The net cost differential of approximately $250, as opposed to the absolute terminal pricing is the key variable in quantifying the trade-offs between the various deployment options.

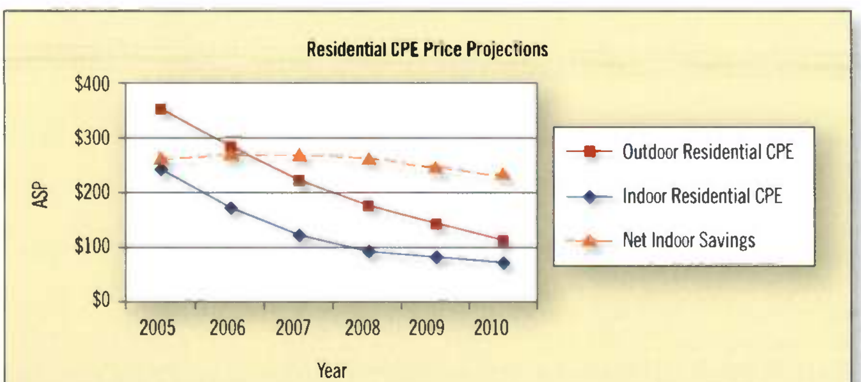


Figure 1. This graph represents residential terminal projected prices.

Performance factors

From the end-customer's perspective, the functionality of indoor and outdoor terminals will be the same. However, due to reduced system gain and increased path losses the range capability of indoor terminals will always be less than the range capability for outdoor terminals. Professionally installed outdoor terminals will be mounted on a rooftop or under the

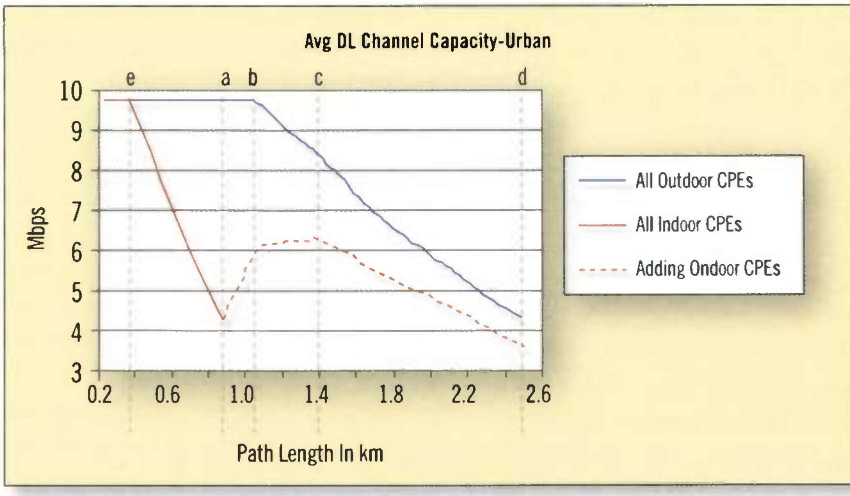


Figure 2. Shown here is the average downlink channel capacity.

eaves. These units will have a high gain, narrow beamwidth antenna and when mounted, will be strategically located on the customer premises and carefully aligned so as to maximize received signal strength and minimize the effects of interference.

Indoor residential terminals on the other hand will be subject to the following limitations:

- Indoor units will have lower antenna gain (wider beamwidth) to reduce the size of the unit and to facilitate self-installation. This results in a reduced system gain of approximately 6 dB.
- Signals will have to pass through one or more walls or windows. Signal loss through walls and windows is caused by a combination of signal reflections and signal attenuation as it passes through the medium and is more significant at shorter wavelengths. At frequencies in the 2.5 GHz to 5.8 GHz range these losses can be significant.
- Self-installable indoor terminals are subject to customer-by-customer installation variations that will not always be optimal. With some installations, for example, the height of the terminal relative to the height of the base station antenna will result in an installation that is off bore-sight to the base station antenna in the elevation plane.

Based on the current WiMAX channel model and terrain type; a 6 dB reduction in system gain and the anticipated excess path losses for indoor units will result in a range reduction compared to installation with outdoor units of 65% to 75%. As a result, in both capacity-limited and range-limited deployments, the use of indoor terminals will require additional base-station infrastructure to make up for the reduced channel capacity and/or range. The cost of this additional network infrastructure must be taken into consideration when making deployment decisions.

The operator has the following deployment alternatives from which to choose:

- Deploy base-station infrastructure to support 100% outdoor residential terminals only.
- Deploy base-station infrastructure to support 100% indoor residential terminals only.
- Deploy base-station infrastructure assuming a mix of indoor and outdoor terminals.

Channel and base-station capacity

To quantitatively evaluate the relative trade-offs between the three deployment options it is necessary to understand the relationship between downlink (DL) channel capacity of a WiMAX base station and the coverage area or range over which the base station is expected to operate. Since fixed WiMAX deployments use adaptive modulation and adaptive coding, the effective DL channel capacity is dependent on the mix of modulations and the distribution of active users over the coverage area. For the purpose of this discussion a WiMAX-compliant solution with the characteristics summarized in Table 1 will be assumed. The most important parameters, system gain and BW efficiency, are consistent with the mid-performance WiMAX-compliant solutions, based on IEEE 802.162004, that are expected to be available in the near future.

Based on these characteristics, and

WiMAX Radio Characteristics for Downlink Range and Capacity Estimation	
Frequency Band	3.5 GHz
Duplexing	Frequency Division Duplexing (FDD)
Channel Bandwidth	3.5 MHz
Adaptive Modulation	BPSK, QPSK, 16 QAM, 64 QAM (COFDM)
BW Efficiency	2.8 bits per HZ (net of PHY and MAC overhead)
Downlink User Data Rate	9.7 Mbps at 64 QAM to 1.1 Mbps at BPSK
Propagation Conditions	100% of Users Non-Line-of-Sight (non-LOS), uniformly distributed over the base station coverage area
Downlink System Gain for Outdoor CPEs	164 dB at BPSK
Downlink System Gain for Indoor CPEs	158 dB at BPSK
Excess Path Loss for Indoor CPEs	14 dB

Table 1. Base-station radio characteristics.

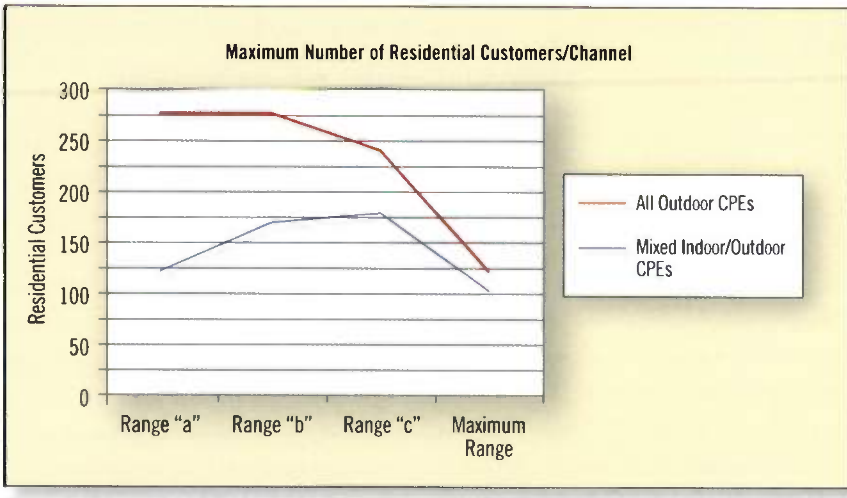


Figure 3. This graph highlights residential customer capacity per channel.

Range Notation	Description
"a"	Range limit for deployments comprised solely of indoor self-installable terminal.
"b"	Range at which modulation/code rate changes from 64 QAM-3/4 to 64 QAM-2/3 for outdoor terminals. Deployments with all outdoor terminals limited to this range will assure maximum DL channel capacity.
"c"	At this range there is a secondary peak in the channel capacity for the mixed deployment scenario. This is the point at which the mix of indoor and outdoor terminals distributed over the coverage area is "optimal."
"d"	This is the maximum range for fixed outdoor terminals. Most fixed wireless metro deployments will be capacity-limited rather than range-limited unless the operator has a significant amount of spectrum.
"e"	Deployments limited to this range or less assures that all users are operating at 64 QAM-3/4 code rate, even if all are indoor terminals, thus achieving maximum downlink channel capacity. Deploying base stations with this range limitation is generally not a viable deployment option since the combination of household density and the market penetration is unrealistically high.

Table 2. Description for range notations.

Service	DL Data Rate	Overbooking Factor
Residential Internet Access	384 kbps Average	20:1
Residential VoIP	128 kbps	4:1
Customer Breakdown	50% Internet Access Only 50% Internet Access plus VoIP	

Table 3. Residential service definition.

assuming a uniform distribution of active non-line-of-sight users over the coverage area, it is possible to determine the effective base-station downlink channel capacity for the three CPE deployment options: all outdoor, all indoor and mixed indoor and outdoor. This is shown in Figure 2 with range projections based on a typical urban environment (terrain category "A"). The range notations used in Figure 2 are described in Table 2.

Converting the downlink channel capacity to the number of potential customers that can be supported provides additional insight as to the infrastructure cost implications. For a residential-only customer base using the service characterization summarized in Table 2, the channel capacity can be expressed in terms of the number of supportable customers per channel as shown in Figure 3 for ranges, "a," "b," "c," and "d," "d" denoting maximum range.

The service definitions in Table 3 convert to an average data rate of 35 kbps per residential customer or approximately 28 residential broadband customers per megabit of channel capacity. When deploying with indoor CPEs, Figure 3 suggests that a mixed deployment of indoor and outdoor CPEs, at ranges "b" or "c" will provide greater revenue potential per channel or alternatively, a lower base-station infrastructure cost per subscriber.

Conclusion

Limiting the base-station range in order to support lower-cost indoor self-installable customer terminals necessitates a higher investment for base-station infrastructure, but the terminal savings more than offsets these costs in a majority of deployment scenarios. In areas with high subscriber densities, generally encountered in urban and many suburban environments, a cost-effective deployment can support 100% indoor CPEs with a significant net savings in capital expenditure (CAPEX) per subscriber. In less populated areas with lower subscriber densities, limiting the range sufficiently to support a high percentage of indoor CPEs will not always be the most cost-effective approach.

If capacity-dependent or variable base-station costs dominate the infrastructure cost, a deployment that supports 100% indoor CPEs will often be the more cost-effective deployment alternative. However, if fixed base-station costs dominate, a mixed indoor/outdoor deployment may prove to be the more cost-effective approach. EWT

ABOUT THE AUTHOR

Doug Gray works as a telecommunications consultant focusing on strategic planning and business development in the area of broadband wireless networks. He is currently working on various assignments on behalf of the WiMAX Forum with primary emphasis on business case studies. Gray holds an MSEE degree from Stanford University and a BSEE from the Polytechnic Institute of New York.

Can OFDM enhancement drive WiMAX mobility forward?

Today's operators require a smooth path to mobility. OFDM with subchannelization, a solution that drives strong value differences in today's broadband mobility market, offers a cost-effective solution to their fixed to basic mobility business model.

By Vijay Dube

WiMAX covers a wide range of fixed and mobile applications. Analysts predict roughly 20 million subscribers for fixed services by 2009, while mobility figures vary between 15 million and 40 million subscribers by the end of the decade (Figure 1). With the adoption of the 802.16 WiMAX fixed protocol late last year, attention has now turned to development of the 802.16e WiMAX mobility protocol. This standard is expected to be completed in 2006. Upon its completion, the WiMAX mobility protocol will provide two primary areas of opportunity for the industry: basic, or urban mobility, which covers fixed to nomadic and portable applications; and full mobility, which addresses the emerging broadband cellular market (see the sidebar, "The WiMAX opportunity").

For the purpose of this discussion, "fixed" is defined as a solution in which it is not possible to use the service from more than one location. "Mobility" covers different levels of services including nomadicity (using a service in different locations), portability (basic mobility without soft hand-off) and full mobility (high vehicular speed and seamless hand-off between cells).

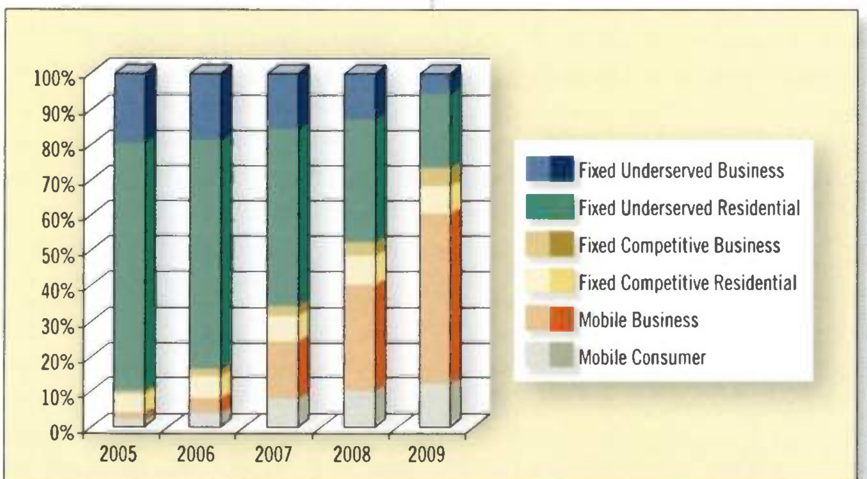


Figure 1. The higher cost of first-generation WiMAX products (due to relatively limited production and potential interoperability adjustments) mandates that early WiMAX applications will favor high revenue-generating applications, as well as underserved service areas such as backhauls and rural DSL extension.

Like its predecessor 802.16-2004, or 802.16d as it is more commonly known, the WiMAX mobility protocol will employ a form of orthogonal frequency-division multiplexing (OFDM). Whereas 802.16d addresses fixed wireless applications only and uses OFDM256, the emerging 802.16e standard can serve the needs of fixed, nomadic and fully mobile networks. Although it is generally perceived as the mobile version of the WiMAX standard, in reality it serves the dual purpose of adding extensions for mobility and including new enhancements to the orthogonal frequency-division multiplexing access (OFDMA), or multi-user OFDM, physical layer. This new enhanced 802.16e physical layer is referred to as scalable OFDMA (SOFDMA) and includes a number of important features for fixed, nomadic and mobile networks.

OFDMs path to urban mobility

In recent years, Intel's strong support of WiMAX and its characterization as a disruptive technology for low-cost broadband connectivity, earned the standard a high degree of visibility in the telecommunications industry and contributed to its hype;

even before anyone had an opportunity to experience a real WiMAX network implementation. A lot of pressure is now riding on WiMAX to deliver on that hype. Despite the recent shift in attention to the OFDMA mobility standard, motivated by the large potential of the broadband mobility market, WiMAX's path to mobility may not be as smooth as the industry once expected.

Many industry players worry that shifting the focus of the WiMAX community singularly to scalable OFDMA at this stage of the game, may induce severe penalties in terms of cost and implementation schedule. By the time the mobile version of SOFDMA user equipment is available in high volume and from a number of diverse suppliers, advanced 3G data networks using 1xEV-DO and WCDMA may be already available from a well-established ecosystem.

Building on existing OFDM256 capacity to fulfill the fixed to basic mobility market space needs may be the best way to eliminate these concerns. It would provide the market window needed for WiMAX applications such as laptop connectivity and other portable devices, while highlighting the value difference between it and existing 3G technologies and WiFi serving the basic/urban mobility market.

The advantages of using OFDM256 to address the fixed to basic mobility market are numerous. In fact, many of the same OFDMA strengths are present in OFDM256. Both OFDM and OFDMA, for example, share the same basic advantages over other single-carrier mobile technologies in that they are highly suitable for NLOS environments. Here, the symbol period for each subcarrier is much greater than the maximum delay spread, which simplifies equalization and optimizes FEC correction to tolerate the deep fades caused by multipath on multiple subcarriers.

Other important features included in OFDMA can also be supported in OFDM256 with less complexity in the physical (PHY) and the media-access control (MAC) layers. Some of the advantages and limitations of OFDM are:

- Scalable FFT. OFDM does not support scalable FFT, but rather a fixed 256 FFT structure. However, 256 FFT can offer as much granularity (carrier spacing) for most applications, as a 2.5 MHz system bandwidth is a popular scenario in a typical 1:3 re-use pattern in a multisector cell design. On the other hand, OFDMA offers more flexibility in system design and scalability while keeping the same performance and the fixed equipment subcarriers spacing.
- OFDMA boasts theoretically superior system gain performance, but remains unproven in real implementation.

OFDMA offers high system gain performance by introducing uplink and downlink subchannelization. OFDM256 optionally supports uplink and downlink subchannelization, which allows link budget improvement by concentrating the transmit power on a subset of the total OFDM subcarriers, which translates into coverage (indoor penetration), capacity and power consumption benefits. In OFDMA this feature, referred to as advanced modulation and coding (AMC) is aiming at additional diversity gain through adaptive subcarrier allocation.

With regard to subcarrier permutation scheme, OFDM uses a less complex pattern of permutations. Its subchannels are distributed over frequency as with OFDMA but they are fixed in time for any given allocation. Consequently, if the OFDM subchannel falls on bad channel conditions (at least until the BS allocates a new subchannel), the advantage goes to OFDMA.

The bottom line is that OFDMA is well suited for full mobile applications, while more simple subcarrier permutations, fixed in time for a given subchannel allocation, are well suited for fixed, portable or low mobility environments.

The WiMAX opportunity

The 802.16e WiMAX mobility protocol is often looked at in terms of the market opportunity for basic mobility and full mobility. WiMAX basic mobility is the natural evolution of the 802.16-2004 version of the WiMAX standard, which uses the OFDM256 modulation scheme. It adds subchannelization to improve indoor performance and subscriber coverage flexibility in terms of throughput vs. distance. OFDM256 basic mobility targets simple standard profiles and low-cost terminals. Fast time to market and backward compatibility with fixed applications are also retained as key values.

By comparison, WiMAX full mobility will follow a much more complex technical and challenging market path that may result in a larger market potential, but in the process puts it directly in the path of 3G. Based on scalable OFDMA (SOFDMA), WiMAX full mobility promises to deliver the performance and operational improvements required for cellular deployment, such as high-speed mobility and hand off, which would allow in-vehicle users to switch from one base station to another seamlessly. These improvements, however, come at the expense of a more complex PHY and MAC layer, an extensive inventory of profiles and lack of compatibility with existing OFDM256.

- Potentially better frequency re-use in favor of OFDMA.

OFDMA's more complex subcarrier permutation is aimed at better frequency reuse and easier cell planning (minimizing the probability of hits between adjacent sectors/cells by reusing subcarriers). OFDM offers a similar feature in the scheduler

(MAC), although it is less systematic.

- Similar space diversity features for downlink.

The OFDMA space-time-code (STC) mode and AAS are supported as options for OFDM in the downlink segment.

Why OFDM?

While OFDMA has the potential to offer more performance and scalability than OFDM for urban mobility, from an operational perspective it is not the ideal solution. From a market strategy perspective alone, use of OFDM for covering both fixed as well as simple mobility applications provides a way to put WiMAX on the map substantially faster than waiting for OFDMA. Its value in the market is already known. Plus it gives WiMAX supporters a way to take advantage of the transition from fixed to basic mobility now, as it happens, while the window of opportunity to branch into wireless laptop, handheld devices and related applications still exists.

Further strengthening OFDM's position as the solution for urban mobility is that it features low-cost CPE, profile and engineering simplicity, market availability and upgradability as well as backward compatibility (a single path from fixed to basic mobility). These features are essential for building fast traction in an emerging WiMAX market, as well as for growing low-cost CPE volume shipments to reach the market commodity phase. Some of OFDM's most notable strengths are:

- **Standards and profile simplicity.**

OFDM supports 256 FFT, which simplifies profiles with sufficient granularity for most allocated spectrum; assuming the usual cell frequency reuse pattern is employed. To date, WiMAX certification has faced delays due to equipment availability even in the limited profiles. Adding a myriad of profiles, as expected in scalable OFDMA, will only serve to make the certification much more complex and time consuming.

- **Fast time to market.**

The 802.16-2004 WiMAX protocol has already been published and 802.16e for OFDM is near completion. Minimal work needs to be done to cover the basic mobility requirements. Fast time to market is extremely important for an emerging market where addressing the window of opportunity with a low-cost product can make all the difference. Given the current market opportunity, WiMAX would provide the best product fit for wireless laptop and handheld devices; a segment in which 3G lacks cost-effective throughput and reliability and where WiFi offers limited coverage, a lack of security features and no carrier-grade MAC.

- **Low cost, proven technology.**

OFDM, as defined in 802.16e, is far less complex than scalable OFDMA. It guarantees low-cost terminals and infrastructure to fit the emerging WiMAX markets in term of scalability and application flexibility. Such low-cost terminals can open a wider range of applications, which in turn accelerates market traction and the ability to quickly reach mass production.

Since the OFDM standard is based on a number of proven solutions that have been successfully implemented in many wired and wireless applications, it is highly probable that it will achieve its targeted performance. Scalable OFDMA, on the other hand, tries to incorporate a wide variety of proposed technologies, some more proven than others. Since there has been only modest justification of proposed features on the basis of performance data, and since the final composition of these technologies is not yet completely determined, it is difficult to know whether a given feature will enhance performance.

- **Upgradability and backward compatibility.**

Upgradability is mandatory to protect customer investment as the WiMAX market evolves in terms of applications, operator diversity (including ISP, WISP, green field and infrastructure based, new and incumbents) and business case profiling. Without a path to mobility and the security of upgradability and backward compatibility, many industry players, especially Tier 1 companies, will adopt a standstill position toward WiMAX. While Tier 1 players are

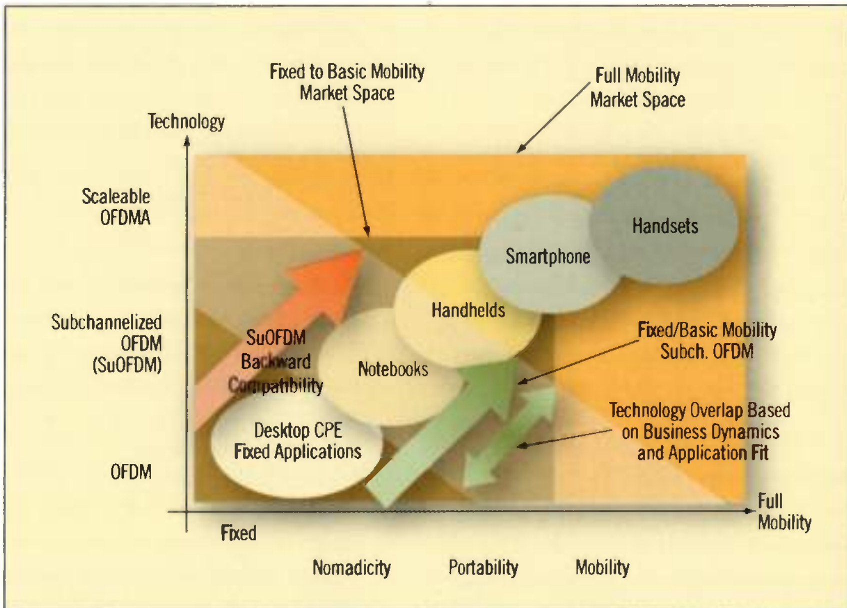


Figure 2. As shown in this graph, WiMAX basic mobility is covered by a range of overlapping technologies.

notoriously slow movers in an emerging market, their presence is absolutely essential to reach volume shipments.

Conclusion

In contrast to OFDMA, OFDM has already gone through the definition stage and is now heading to full implementation. Today, a growing number of chip manufacturers, as well as original design manufacturers (ODMs) and equipment makers, are developing their solutions based on OFDM256 WiMAX technology. This technology is field proven making it a safe choice for current and future deployments. By the end of 2005, many manufacturers will benefit from low-cost CPE packaging, such as miniPCI and other high-volume manufacturing formats, providing broadband service providers access to cost-effective solutions.

OFDM 802.16e highlights the operator's need for a smooth path to mobility; one that provides a future-proof solution, protects their investment and provides a sound business case. For the operator who is deploying fixed wireless access solutions today, and who wants to offer nomadic or mobile services in the future, OFDM256 is the only choice.

As shown in Figure 2, there is a technology overlap covering basic mobility. The technology of choice depends on the application, the carrier (a fixed carrier interested in basic mobility only), the size of the network (such as a low-density network in poorly deserved areas or a small specialized carrier for vertical applications), and the best cost efficiency for the application.

A strong polarization toward full mobility at this stage of WiMAX development may not be the best tactic or positioning to face direct competition from 3G. Many believe that WiMAX' sweet spot starts with the fixed to basic mobility market where current wireless technologies are not offering the throughput, affordable cost for high data-rate usage, security or reliability customers demand.

Once the first market steps for the transition from fixed to basic mobility have been successfully completed and the WiMAX ecosystem is backed by customer confidence, OFDMA will be in a prime position to help forge the path for WiMAX full mobility. Backed by a completed standard and certification, and building on the successes of OFDM256, OFDMA will be well equipped to face the full mobility challenge where entrenched leaders have already made tremendous progress in technology development and network deployments. EWT

ABOUT THE AUTHOR

Vijay Dube is the vice president of marketing & business development at Wavesat. He is a seasoned executive with nearly 25 years of extensive experience in the global semiconductor industry working for such companies as Atsana Semiconductor Corporation and Dipix Systems Limited.

IN THE NEWS

Alvarion Ltd.

Alvarion Ltd. (www.alvarion.com) has successfully completed beta trials of BreezeMAX PRO—an OFDM-based WiMAX-ready, cost-effective customer premises equipment (CPE) that uses the Intel PRO/Wireless 5116 broadband interface chip. Alvarion is now fulfilling orders for the BreezeMAX PRO in volume production quantities for commercial deployments. Its release marks the culmination of a joint development effort with Intel (www.intel.com) that began in 2003.

picoChip

picoChip (www.picochip.com) and the Korean Electronics and Telecommunication Research Institute (www.etri.re.kr/), or ETRI, are jointly developing software-defined radio (SDR) technology for wireless code-division multiple access/high-speed download packet access (WCDMA/ HSDPA) and WiMAX. This cooperative effort will include development and research into future wireless technologies and also involves a team from ETRI working at picoChip's Bath headquarters for a year.

WiMAX Forum

WiMAX Forum (www.WiMAXForum.org) certification testing is ongoing at Cetecom labs in Spain. The first WiMAX Forum Certified products; those that are certified as conformant to the standard, interoperable with other vendors' products, and able to support metropolitan broadband fixed, portable and mobile applications; are expected to be available in the November/ December time frame.

ArrayComm

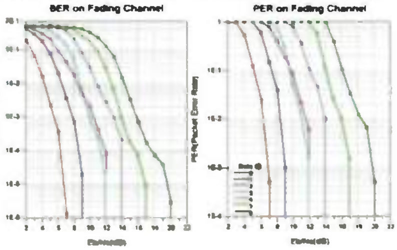
ArrayComm (www.arraycomm.com) and Intel (www.intel.com) are working to incorporate key requirements into the 802.16 standard that will improve its ability to support smart antenna technology. As part of this collaboration, ArrayComm will develop IEEE 802.16-compliant smart antenna solutions. For its part, Intel plans to support ArrayComm's solution with its future Institute for Electrical and Electronics Engineers (IEEE) 802.16e WiMAX client device chipsets; yielding large improvements in overall system range, capacity, and coverage quality for 802.16 networks.

The agreement was signed by Guillaume d'Eyssautier, President and CEO of picoChip and Dr Yim Chu-Hwan, President of ETRI in London, UK.

Library speeds design of BWA applications

A WiMAX design exploration library is available for use with Agilent Technologies Advanced Design System (ADS2005A) electronic design automation (EDA) software. With its fully coded bit-error rate (BER) analysis, this library helps wireless systems designers and verification engineers speed development of communications products for broadband wireless access (BWA) applications. Designers can identify DSP and analog/RF integration problems early; thereby avoiding overspecification. Because system designers can analyze a system's performance before all of its components have been designed and any system integration problems can be eliminated early in the design cycle, significant cost savings can be realized.

The WiMAX design exploration library provides preconfigured simulation setups, signal sources and fully coded BER analysis for simulation of the circuitry used in BWA designs. It works within the ADS environment and with the Agilent Ptolemy simulator to streamline the design and verification of orthogonal frequency-division multiplexing (OFDM)-based, last-mile service designs. ADS offers a complete set of front-to-back simulation and layout tools, as well as instrument links, for RF and microwave IC design in a single, integrated design flow. The Ptolemy solution is a system-level simulation and design environment within ADS and is based on a hybrid of data flow and timed synchronous technologies. It facilitates analog/RF and digital signal processing co-design.



To aid in large-scale RF/mixed-signal IC design, the WiMAX design exploration library from Agilent Technologies can be imported into the company's RF design environment that integrates the RF simulation technologies from ADS into the Cadence analog and mixed-signal design flow.

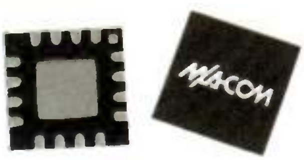
Agilent Technologies, www.agilent.com

Tri-mode phone switch is RoHS-compliant

The MASWSS0144 RoHS-compliant SP3T T/R switch from M/A-COM offers excellent versatility and a low insertion loss to maximize system performance while reducing design complexity. Configured to enable switching from a common antenna port to dual-band GSM, CDMA, cellular, PCS and GPS receive ports, it is targeted for use in tri-mode mobile phones.

The MASWSS0144 switch is fabricated on a low-cost 0.5-micron gate-length GaAs process with full passivation added for robust reliability and features an asymmetric design. It has dedicated paths for each mode, which allows each path to be optimized for the assigned mode of operation. At 1.0 GHz, 2.7 V control voltage, and PIN of +34 dBm, the component features low insertion loss of 0.6 dB, high isolation of 30 dB, cross modulation of -102 dBm for the CDMA path, and third harmonics greater than 72.5 dBc for the GSM path.

It comes packaged in a surface-mount 3 mm PQFN-12, making it well suited for cost-sensitive, space-constrained applications. It is available from stock and is priced at $0.45 in quantities of 100K.



M/A-COM, www.macom.com

Software-defined solution powered by ARM

A 90 nm single-chip, software-defined solution for advanced WiMAX and WCDMA applications is available from picoChip. Powered by the ARM926EJ-S processor from ARM and combined with a fully programmable signal-processing array, this cost-effective solution significantly reduces the cost of WiMAX deployment without compromising the flexibility essential for standards compliance and system performance enhancement. As a result, carriers can build-out their infrastructure based on the 802.16d WiMAX standard, while being able to quickly upgrade their equipment to support mobility once the 802.16e standard is complete.

WiMAX implementations are power intensive and require increasing numbers of DSP or FPGA devices. Unfortunately, this can lead to a rapid escalation of cost. The 90 nm synthesizable ARM processor used in the picoChip next-generation wireless solution helps mitigate these concerns through its small size and exceptional power efficiency. It enables the picoChip solution to flaunt a lower cost bill of materials, while also providing a standardized software development platform for a fast path to WiMAX certification and productization. With the ARM-powered picoChip offering, carriers can bring mobile WiMAX services online in the shortest time frame possible. In turn, customers can maximize the benefit from the WiMAX standard with ubiquitous broadband Internet access and enhanced mobile multimedia services.

picoChip, www.picochip.com
ARM, www.arm.com

Mesh networking comes to WiMAX

A WiMAX mesh networking solution from Skypilot is bringing sophisticated mesh networking to WiMAX deployments. It provides multihop, multilink, multipath, and multi-base-station connectivity with a breadth of coverage, performance, and fault-tolerance capabilities that are not available with point-to-multipoint deployments. The end result is an interoperable, carrier-class solution that boasts tremendous benefits for network operators.

Skypilot's WiMAX mesh network is based on a sectorized antenna architecture that mirrors the benefits of point-to-multipoint topologies. At the same time, it can deliver the benefits of mesh networking, which include close proximity via "picocells" for increased subscriber performance, non-line-of-sight operation via mesh routing around obstructions, easily expandable coverage areas, scalable network capacity, and fault tolerance with failover routing. The highly flexible design of the mesh network also demonstrates load balancing and traffic segmentation, subscriber mobility throughout mesh, and automatic discovery for lower operating expenditure (OPEX.)

The WiMAX mesh network leverages Skypilot's synchronous mesh protocol and uses the Fujitsu MB87M3400 WiMAX system-on-chip to provide WiMAX mesh networking infrastructure solutions for the 2.3 GHz to 2.7 GHz, 3.3 GHz to 3.8 GHz and 5.x GHz frequency bands. The MB87M3400 SoC uses an OFDM 256 PHY that supports channels from 1.75 MHz up to 20 MHz, and can operate in TDD or FDD modes, with support for all available channel bandwidths. A programmable frequency selection generates the sample clock for any desired bandwidth. When applying 64 QAM modulation in a 20 MHz channel and using all 192 subcarriers, the SoC's data rate can go up to 75 Mbps. Uplink subchannelization is also supported.

Skypilot, www.skypilot.com
Fujitsu, www.fujitsu.com

WiMAX: On Course and set for deployment

By Keith Horn

With this year's introduction of the first WiMAX system-on-chips (SoCs), the process of moving this standardized technology into full-scale deployment has begun. Systems manufacturers and equipment suppliers are engaged in vital compliance and interoperability testing via plug test events and official labs established by the WiMAX Forum.

To maintain the momentum WiMAX has gathered in 2005, several important events must take place. First, WiMAX-compliant SoCs must move into full production, as they are doing. The compliance program must stay on track with vendors submitting WiMAX-compliant systems to plug test events. Governments and their regulators around the world must ensure the availability of spectrum. It will be the job of WiMAX supporters to encourage and facilitate government endorsements for that spectrum. Finally, trial network deployments, slated for late this year, will be needed to boost industry confidence that WiMAX can deliver robust, high-quality broadband wireless access at costs below the expensive, proprietary services that exist.

WiMAX's objective is interoperability of equipment based on the 802.16d or HiperMAN standards. The WiMAX Forum has chosen to support the 256 OFDM mode exclusively. To ensure worldwide interoperability, the forum will only certify equipment supporting that PHY mode. Certification testing began in July with initial tests at the Certecom site in Malaga, Spain, and at proof-of-concept sessions in Vancouver, Canada. The results have been good and the testing process will continue at a steady pace through the remainder of this year.

The forum is certifying equipment in the 3.3 GHz to 3.8 GHz and 5.7 GHz to 5.8 GHz bands. Along with member companies, it has developed system profiles to address the 5.8 GHz license-exempt band and the 2.5 GHz and 3.5 GHz licensed bands. The forum is working with service providers and equipment manufacturers to expand the frequency allocation to cover the key spectrum identified as interesting to potential WiMAX service providers.

Governments around the world have begun allocating more spectrum for WiMAX. Japan, for example, has allocated the 4.9 GHz to 5.0 GHz band after 2007, while the 5.47 GHz to 5.725 GHz band is being considered for future use. The former allocation will require a license for base-station deployment and support 5 MHz, 10 MHz and 20 MHz bandwidths. The latter allocation may not require a license and could support 20 MHz bandwidths.

In North America, interest lies in deploying WiMAX in the 4.9 GHz broad-spectrum public safety band. Lower-frequency bands, such as the 800 MHz licensed and 915 MHz ISM unlicensed bands, could also be useful.

WiMAX deployment will begin gradually as the compliance and interoperability process proceeds. Certified systems should begin shipping later this year, with demand growing exponentially on a global basis in 2006 and 2007. Initial deployments are likely to occur in China, India, South Asia, a handful of locations in South America, and selected sites in Europe (Spain and Portugal) and North America (specifically western Canada).

These deployments will likely be non-cellular data-networking applications, led by suppliers marketing proprietary OFDM systems. Service providers in metropolitan areas will use WiMAX in place of DSL and cable modems. Rural service providers in developed and developing countries may need to introduce WiMAX base stations for new customers and provide the customer premise equipment to subscribers directly.

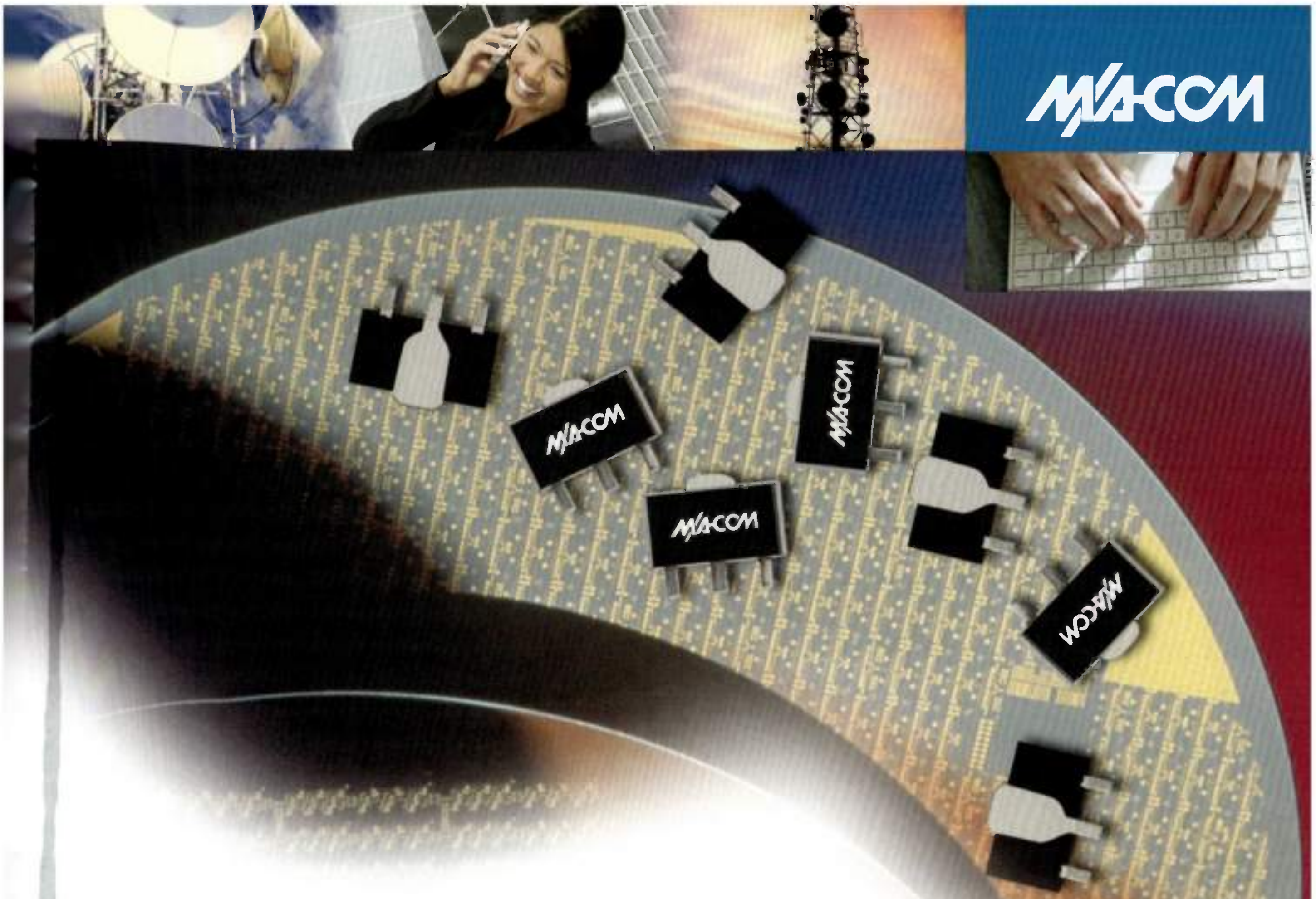
As deployment rolls along, WiMAX and WiFi (802.11) are expected to coexist and become increasingly complementary. Theoretically, WiMAX supports a coverage radius of 30 miles and a data rate of up to 75 Mbps, while WiFi supports a shorter radius and lower data rates.

By leveraging their existing sales channels, WiFi vendors can incorporate WiMAX into their products as a way to backhaul hotspot traffic to the public WAN. But because WiMAX deployment requires the push of service providers, vendors must work with providers for product launch. Pure-play CPE companies will partner with base-station companies that have service provider ties or solicit service providers to evaluate their products.

Over the next few years, 802.16 and 802.11 capabilities will be available in end-user devices ranging from laptops to PDAs. Both will also deliver wireless connectivity directly to the end user—at home, in the office and on the move.

In the midst of deployment, another development is pending; the ratification of the WiMAX mobility specification, 802.16e, which is expected early next year. It is easy to see how mobile WiMAX could converge with 3G cellular, WiFi and other similar broadband wireless technologies to yield multimode, multiband cellular handsets capable of seamless, network-to-network roaming. This may be just one of the benefits of this interoperable broadband wireless access technology.

Keith Horn is the senior vice president of Fujitsu Microelectronics America, www.fujitsu.com.



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MAAMSS0050	SOT-89	2100	13	30	43 24 dBm/Tone – 1 MHz	420
New Introductions – Fall 2005						
MAAMSS0056	SOIC-8EP	2100	24	27	40 1dBm/Tone – 1 MHz	190
MAAMSS0057	SOIC-8EP	2100	23	30	45 24 dBm/Tone – 1 MHz	500
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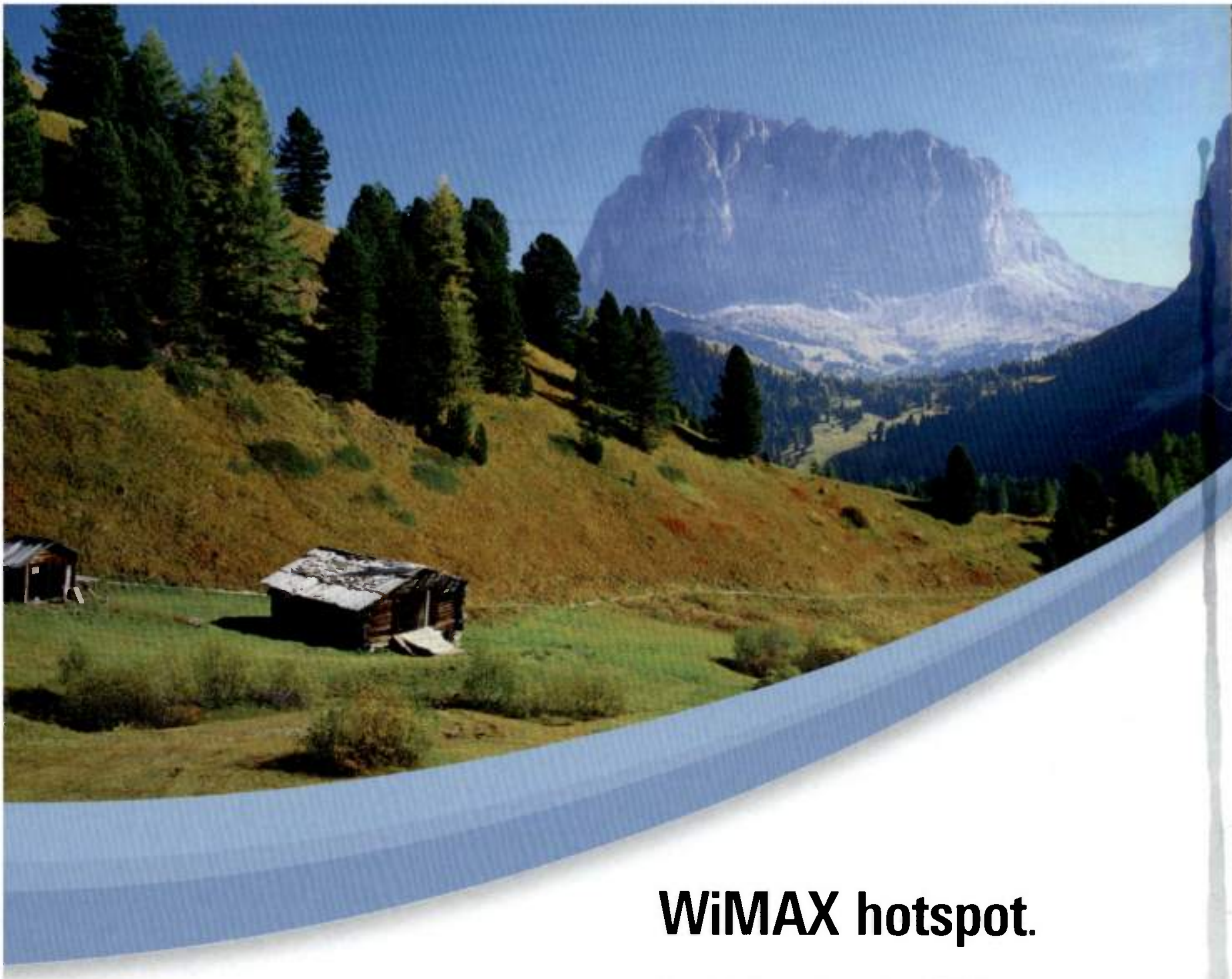

tion levels of 62 mW during 1 Hz update rate in continuous tracking mode are achieved. This means a power consumption reduction of 40% compared to the previous chipset generation. The power consumption can be further reduced with the FixNow power saving mode. ANTARIS 4 also requires fewer external components, allowing for more space and cost-efficient designs and modules. Like its predecessor, the 16-channel ANTARIS 4 engine will feature u-blox SuperSense-enabled indoor GPS, assisted-GPS (A-GPS) and full support of WAAS and EGNOS satellites.

As an optional extension to the ANTARIS 4 chipset, the ATR0610, a fully integrated low-noise amplifier manufactured using Atmel's Silicon-Germanium (SiGe) process is available to cope with challenging reception environments and enable cost-sensitive antenna designs. For the advanced 16-channel GPS baseband, the ATR0621, a pin-compatible replacement of the ATR0620, can be used. The complete GPS firmware is integrated into the ROM, and no external Flash is required for stand-alone applications. Flash memory can be used for advanced features like dead reckoning software.

The u-blox LEA-4P is the first ANTARIS 4 module available. Measuring 17 mm x 22 mm, the LEA-4P has the same functionality as the TIM-LP and additionally features a USB port and a FLASH memory, all packed into a module 40% smaller than its predecessor.

Atmel Corporation
(408) 441-0311
www.atmel.com

Consumer Electronics

Twin-eye laser sensor

Philips Laser Sensors has developed a generation of ultrasmall position/velocity sensors based on Philips' twin-eye laser technology. The highly integrated and smart laser sensor can meet the price levels needed for use in consumer products such as computer mice, identification devices, printers or mobile phones. The company's first implementation of this technology in a commercial product is the company's PLN2020 twin-eye laser sensor.

This PLN2020 was developed in close collaboration with Logitech for use in the Logitech V400 laser cordless mouse for notebooks. The 11-pin 3.85 mm high twin-eye laser sensor has a printed circuit board footprint of 6.8 mm x 6.8 mm and incorporates lenses for its two lasers in the package assembly. These lenses project two orthogonal laser beams for X-Y position sensing. Working together, they can also simultaneously detect Z-axis movements.

The SiP also contains a dedicated application-specific integrated circuit, which performs all the necessary digital and analog signal processing for displacement calculation and laser power saving and eye-safety management functions.

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The **Jabra** BT350 is an over-the-ear Bluetooth headset with advanced features and modern design providing versatility for the perfect hands-free mobile experience.

The Jabra BT350 features a vibrate function that alerts users of incoming calls. The headset includes an intuitive "one-touch" call answer/end button and volume control. A multicolored LED indicates Bluetooth connection, battery life and charging status. It delivers up to seven hours of talk time and 200 hours of standby time.

True to Jabra form, the Jabra BT350 is lightweight (0.63 ounces) and designed for hours of comfortable use. The headset supports easy charging from either a PC via USB cable or ac adapter and is Bluetooth 1.2-compliant with wireless connection up to 30 feet.

The Jabra BT350 will be available with a suggested retail price of $79.

Jabra
(630) 442-6900
www.jabra.com

Design Software

EM design simulation software

Flomerics' Version 7 of its MicroStripes electromagnetic design simulation software for microwave and antenna design increases the speed with which users can tune their designs. The version automatically runs a series of simulations while varying one or more design parameters over a user-specified range.

The automatic meshing algorithm in the new version automatically mimics what experienced users do when they manually fine-tune the mesh. The result is that the new version eliminates the need for fine tuning, allowing automatically generated meshes to be used for nearly all simulations. The accuracy of the results produced by automatically generated meshes is equivalent to that produced by hand-tuned meshes in the majority of cases.

MicroStripes electromagnetic analysis software differs from other electromagnetic simulation software in that it uses the transmission line matrix (TLM) method for solving Maxwell's equations. A key advantage of the TLM method when applied to antenna design is that it solves for all frequencies of interest in a single calculation and, therefore, captures the full broadband response of the system in one simulation cycle. A further advantage is that the TLM method creates a matrix of equivalent transmission lines and solves for voltage and current on these lines directly. This uses less memory and CPU time than solving for E and H fields on a conventional computational grid.

MicroStripes 7 is available for all 64-bit Windows editions (x64 and Itanium). On these platforms, it comes with a 64-bit solver capable of solving problems requiring more than 2 Gbytes of memory.

Flomerics
+44 (0)20 8487 3000
www.flomerics.com

EMPiCASSO Version 4.0

EMAG Technologies Inc. has released EMPiCASSO Version 4.0. EMPiCASSO is a simulation tool for analysis and design of planar antennas and microwave circuits. The new version builds on the strengths of the previous versions and features a point-and-click layout editor, a 2.5D method of moments (MoM) simulator, a model-driven network simulator and parametric sweep and optimization utilities. It also features a faster and more accurate MoM engine, new network models using Agilent's Touchstone format, expanded geometrical objects, smart data graphs using the Touchstone format, an enhanced periodic simulator and expanded finite array capabilities.

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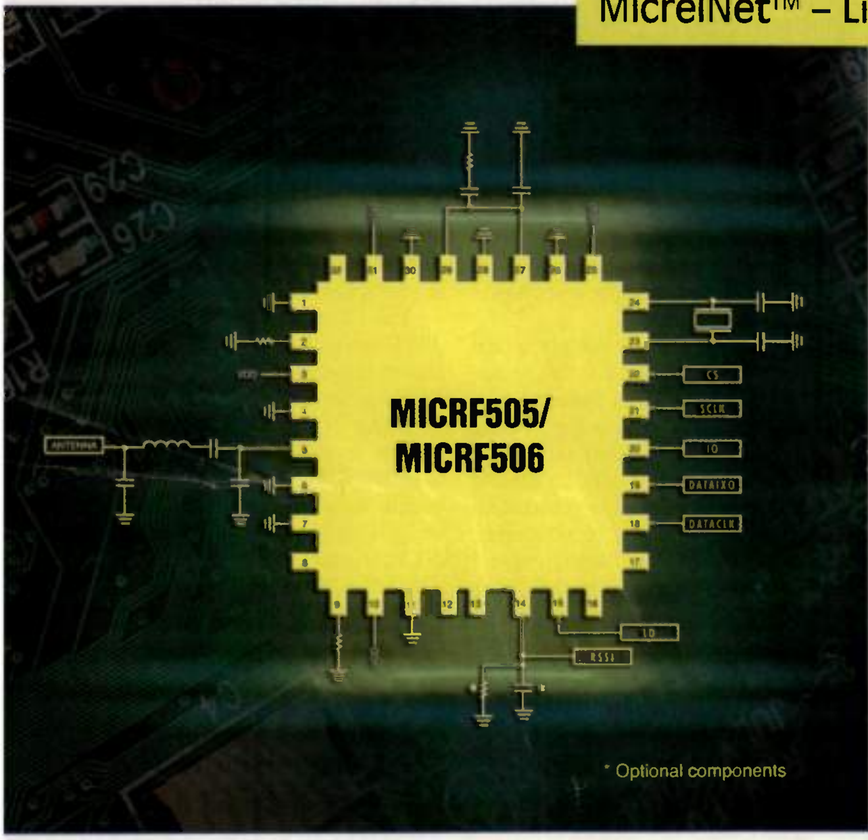

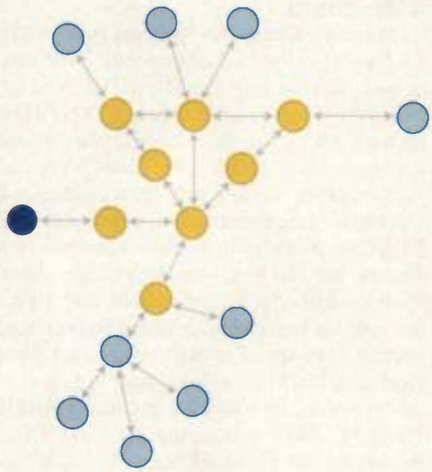

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Embedded Technology

VME board

Mercury Computer Systems Inc.'s VME host board supports dual PowerPC 7448 processors and the RapidIO fabric (VITA 41.2), or a PCI Express interconnect (VITA 41.4) on the VXS multigigabit P0 backplane fabric connector. The Momentum series VPA-200 will combine host, signal processing, and I/O carrier functionality in a single slot. The VPA-200 provides a flexible, multifunction feature set for price-sensitive, entry-level military embedded applications and paves the way for higher-end implementations that require high-speed backplane interconnects made available by the VXS standard.

The VPA-200 will support dual Freescale PowerPC 7448 processors at 1.267 GHz, delivering 10 GFLOPS each for floating-point operations. The high-speed backplane interface is based on the Xilinx Virtex family FPGA, which can be configured with different IP cores to support RapidIO for distributed computing applications that require true fabric functionality or PCI Express for bridged I/O and processing clusters. VME 2eSST support running faster than 300 MB/sec will be provided by the Tundra TSi148 VME bridge chip. Off-the-shelf PCI mezzanine cards may be configured on two PMC sites.

The VPA-200 is expected to be available for $7000 in OEM quantities.
Mercury Computer Systems
(800) 229-2006
www.mc.com

ZigBee reference design

Texas Instruments Inc. has introduced an MSP430 MCU-based reference design for ZigBee and 802.15.4-ready systems that will allow the incorporation of Airbee Wireless's free, four-node ZigBee-ready protocol stack. A hardware evaluation board from SoftBaugh will also be available and includes Chipcon's 802.15.4 radio, transceiver and PCB antenna. TI's MSP430 MCU offers current consumption at 1.1 micro amps standby and 300 microamps active.

Based on the MSP430F161x MCU with a Chipcon 802.15.4 radio for receiving and transceiving, TI's reference design will include an example application note and PCB layout files. The free four-node ZNS-Lite software for MSP430 devices will be available via the Airbee. The software stack includes a "getting started" guide and a programmer's reference manual.
Texas Instruments
(972) 644-5580
www.ti.com

Integrated multimedia platform for handsets

Skyworks Solutions Inc. has expanded its EDGE portfolio with the introduction of its three-chip complete system solution that reduces board space and enables multimedia features including a high-resolution camera interface, MP3 and MPEG. Skyworks' Lynx architecture combines its next-generation ARM 9 processor and StarCore DSP baseband engine, an integrated analog mixed-signal and Helios direct conversion receiver, and a power amplifier module.

Lynx also delivers a system-optimized EDGE Class 12 protocol stack that incorporates a flexible multimedia framework to enable a wide range of features for globally distributed handsets. With the addition of its system solution, Skyworks' complete EDGE portfolio can be tailored to meet custom OEM and ODM integration requirements, ranging from a standalone Intera front-end module (FEM) to a Helios radio, to a complete Lynx system.

Skyworks' GSM/GPRS/E-GPRS product families go through interoperability testing (IOT) and field testing, operating on more than 100 networks in 50 countries throughout the Americas, Europe, Asia and the Middle East. Skyworks provides an experienced customer production engineering team to support board layout, system software integration, and full type approval, up through production ramp.

Skyworks' Lynx complete system solution incorporates a multimedia framework that delivers next-generation functionality and services on a single ARM 9 core architecture. The multimedia playback engine supports a number of audio (MIDI 64-tone, XMF, MP3, WMA, AAC, AMR), still image (JPEG, GIF), video (MPEG, H.263, H.264), and 2-D/3-D graphics formats. With an integrated multi-megapixel camera interface and on-chip image signal processing (ISP), Lynx can process and encode high-resolution still image (JPEG) and video (3GPP and MP4) formats. Multiple peripheral interfaces are supported including USB 2.0 OTG, MMC/SD, IrDA, and Bluetooth. The platform comes pre-integrated with Java JTWI 1.0 and supports a number of JSRs and other data services.

The L9100 represents the first system in the platform series and provides a two-megapixel camera plus ISP, USB 2.0 OTG, MMC/SD, and IrDA interfaces, along with support for Bluetooth, GPS, WiFi and other peripherals. The Lynx L9100 is available and sampling to qualified customers worldwide.
Skyworks Solutions Inc.
(949) 231-3000
www.skyworksinc.com

ST7Lite MCU family

STMicroelectronics has announced a series of eight-bit Flash microcontrollers within the ST7Lite family, which add embedded peripherals to the established ST7Lite feature set. The ST7FLITE3 MCUs introduce an enhanced 12-bit auto-reload timer and a master/slave LINSCI asynchronous interface into the 20-pin package and mark a significant step forward in communications and control functionality for real-time, industrial, consumer and motor control applications.

The 12-bit timer offers four independent PWM (pulse width-modulated) output channels with programmable dead time generation, intended for use in half-bridge driving mode in motor control applications where PWM signals must not be allowed to overlap; a 2 kHz to 4 MHz frequency range; programmable duty cycles; polarity control; and programmable output modes.
STMicroelectronics
(781) 861 2650
www.st.com

Industrial Automation

Automated test and validation software

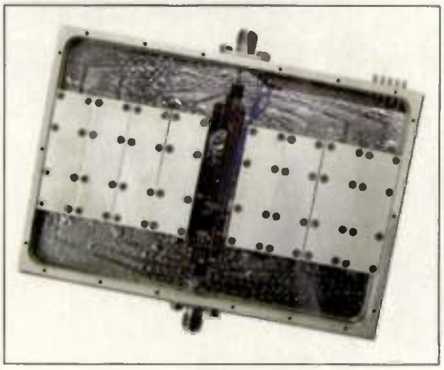
Tektronix Inc. has added the TDSVNM application for efficient testing and debugging of low-speed serial buses including controller area of network (CAN) and local interconnect network (LIN) networks. Tektronix' TDSVNM is available on the TDS5000B and the TDS7000B series digital phosphor oscilloscopes (DPO), both featuring the MyScope customizable user interface.

Through integrated timing analysis with protocol information, designers can use TDS5000B and TDS7000B series oscilloscopes to isolate the problems to either physical layer or data link layer. Oscillator tolerance and propagation delay measurements brings out synchronization problems whenever a new CAN/LIN node is added to the network. An ability to simultaneously decode CAN and LIN messages using two channels enables designers to monitor different segments of the network for locating communication problems across gateways. Measuring a CAN Eye diagram enables the designer to observe the noise content in the CAN message.

The TDSVNM software is available for purchase from Tektronix and the trigger module is available for purchase from Crescent Heart Software or Tektronix distributors.
Tektronix
(800) 833-9200
www.tektronix.com

Microwave/ Millimeter-wave Technology

Eight-channel switch bank



Lorch Microwave's 8IFA-1340/2440-SR is an eight-channel switch bank that covers the frequency range from 1340 MHz to 2440 MHz. The unit features a 4.8 x 3.3 x 0.50 package with SMA-female connectors. The bank uses MMIC switch technology for minimum size and maximum electrical performance. Supply voltage is specified as +5 V at 10 mA. Attenuation points are specified as 35 and 65 dB with a VSWR of 2.0:1 standard.
Lorch Microwave
(800) 780-2169
www.lorch.com

Bias-tee

The BT-2/18-S from **Lorch Microwave** is a bias tee that covers 2 GHz to 18 GHz. The unit features 1.0 dB maximum insertion loss from 2 GHz to 4 GHz and 1.8 dB from 4 GHz to 18 GHz. The VSWR is specified as 1.8:1 from 2 GHz to 18 GHz. The package is 0.75 x 0.75 x 0.62 excluding connectors and pins.
Lorch Microwave
(800) 780-2169
www.lorch.com

Next-generation Wireless

Licensable 802.11b/g WLAN platform

Redpine Signals Inc. has unwrapped a licensable 802.11b/g wireless LAN (WLAN) platform labeled Pine1-LP. Drawing less than 170 mA [377 mW] for the complete SDIO/SPI-based WLAN reference design during a 54 Mbps FTP download, it is the lowest power licensable 802.11b/g platform, claims Redpine Signals. For VoIP calls, it draws only 12.5 mA [35.6 mW].

The Pine1-LP low-power 802.11b/g platform is a complete standards-compliant solution for low-power mobile applications. It includes a baseband MAC, analog front end, an 802.11b/g RF transceiver and power amplifier, as well as SDIO and SPI host interfaces. While the RF transceiver and PA are on a single chip supplied by Taiwan's Airoha Technologies, the AFE is integrated with the baseband MAC. The baseband MAC chip is expected to be available toward year's end.

The SDIO interface is specifically designed to support full 54 Mbps 802.11g data rates. The Pine1-LP MAC, which supports the new 802.11i and 802.11e standards, is based on a programmable packet engine, which off-loads WLAN packet processing and TCP checksum calculations from the host resulting in lower power and increased system performance. Furthermore, the Pine1-LP platform supports Bluetooth coexistence in the 2.4 GHz band with popular Bluetooth chips.
Redpine Signals
(408) 748-3385
www.redpinesignals.com

802.15.4 wireless microcontroller

Jennic has announced that its JN5121 single-chip IEEE 802.15.4 wireless microcontroller is available and in production in volume quantities. It is designed for power-efficient control within wireless sensor networks based on the IEEE 802.15.4 and ZigBee standards.

The JN5121 combines a 32-bit RISC core, fully compliant 2.4 GHz IEEE802.15.4 transceiver and integrated 64 KB ROM and 96 KB RAM memory blocks, all in a single 8 mm x 8 mm 56-lead QFN chip package.

Manufactured on IBM's 7RF low cost RF CMOS process, which is designed for RF and low-power wireless applications, the wireless microcontroller from Jennic provides a versatile general-purpose solution for a diverse range of low-power sensor network applications ranging from simple point-to-point to complex mesh requirements in home, building and industrial control and automation systems.

The device is controlled via the SPI or UART interfaces, whereas debug is achieved via a second UART port. Jennic also provides IEEE802.15.4 protocol software, coordinator and endpoint device evaluation boards and software development tools.
Jennic
+44 (0) 114 281 2655
www.jennic.com

Bluetooth silicon

CSR plc has launched its fifth generation of BlueCore, the Bluetooth hardware and software solution. It has also released its BlueMedia enhancements using DSPs embedded inside the IC to bring both improved audio performance and added radio functionality.

BlueCore5-Multimedia includes a doubling of the processing power of the DSP co-processor to 64 MIPS. The on-chip memory in BlueCore5-Multimedia has also been upgraded to 156 Kbytes SRAM, and improvements to the internal stereo analog Codecs now provide up to 90 dB signal to noise ratio. In addition, the BlueMedia enhancements are sized to run a range of digital music compression and decompression Codecs including MP3+, AAC, WMA3, and ATRAC, as well as new additional audio functions including voice recognition, text-to-speech synthesis and 3D-postitional surround sound.

BlueCore5-ROM features the fifth-generation Bluetooth core as a stand-alone IC, and is targeted for those applications, including the mobile phone, that already include a separate DSP co-processor. In this case, CSR can provide the BlueMedia DSP software to run on the separate IC optimized to run in conjunction with CSR ICs.

BlueMedia on-chip DSP enhancements are also used in its BlueCore5 ICs to offer other non-Bluetooth radios for broadcast reception. The first of these will be BlueCore5-FM, with FM radio embedded in the Bluetooth silicon. This IC is targeted at those applications that are looking to reduce the cost, size and power consumption of existing broadcast receivers at the same time as upgrading to include Bluetooth.

BlueCore5-Multimedia and BlueCore5-ROM will start sampling from the fourth quarter of 2005. BlueCore5-FM will start sampling in early 2006. Prices for the BlueCore5 range from $3 to $5.
CRS
+44 (0)1223 692000
www.csr.com

Passive Components

Flexible Adaptenuators

Mini-Circuits' new line of Adaptenuators are simply attenuators with different input and output connectors. The benefits of using Adaptenuators are improved impedance matching and eliminating the hassle of stocking all different types of adapters to fit your attenuators. Based on the attenuation value required, the attenuator with the right connector needed can be selected. The Adaptenuators are designed with an ultra-wideband frequency response, usable to 4 GHz with a super flat frequency response. Durably built with solid unibody construction.

In stock, from $19.95 ea. (Qty.1-24).

Mini-Circuits
(718) 934-4500
www.minicircuits.com

Rollabout BNC tool kit

Trompeter has upgraded all of its full-size "suitcase"-style tool kits with the replacement of the previous "suitcase"-style container with the Rollabout tool kit case. The Rollabout tool case provides users a [illegible] wheels and equipped with smooth [illegible] foam features retractable handle [illegible], a hard layer [illegible] three layers [illegible], a soft layer to [illegible] for tool placement and an "egg-cushion" [illegible] lateral [illegible] the interior of the crate size" [illegible]. It is fully lockable lid for vertical [illegible] and waterproof. It replaces the medium and large [illegible] in Trompeter's line of The R[illegible] products. Each kit can be [illegible] installed with an array of tools [illegible], the mainstream [illegible] As [illegible] telco central office [illegible] is to [illegible] 002 D10C1420, and it includes the [illegible] coax cable cutter, the 010-[illegible] contact crimp tool, a battery-powered rechargeable coax stripping tool, two cutter [illegible] that tool (one for 735 cable and [illegible] 34 cable), a CD3-19 flip flop dieset, [illegible] crimp tool, a 010-0133 test unit (for [illegible] y and pin height), the RT11 BNC [illegible] tool, and the Rollabout case.

[illegible] g on this particular kit in quantity [illegible] 847.00.

[illegible] ter
([illegible]2-2629
www.trompeter.com

[illegible] Inductance MLCC

[illegible] X Corporation has expanded its low-inductance MLCC family of IDC technology to include an additional case size and increased number of terminals per device.

[illegible] development of additional termination technology has allowed AVX to reduce the ESL to approximately 25 pH for the 0306 case size with a typical capacitance of 1 mF. This technology also provides the ability to increase the number of terminals per device.

Pricing typically starts at $0.10 with a lead time of eight to 10 weeks.

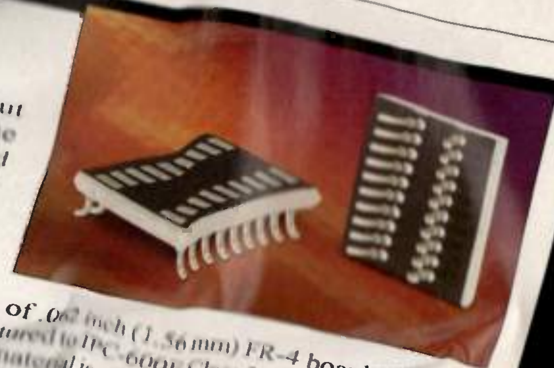
AVX
(843) [illegible]6-0414
www.avxcorp.com

Adapters

Aries Electronics Inc. has introduced two Correct-A-Chip adapters that permit the use of SOIC D package 150 mil body chips to be used on boards designed for SOIC DW package 300 mil body chips and vice-versa.

The series 666000 adapters accept narrow-body SOIC D package devices while mounting on boards designed for wide-body SOIC DW package footprints. Series 665000 adapters accept wide-body SOIC DW package devices while mounting on boards designed for narrow-body SOIC D package footprints.

Both designs are available in pin counts from eight through 24 pins, and are constructed



of .062 inch (1.56 mm) FR-4 board manufactured to IPC-6001 Class 2 standards. The FR-4 material is glass filled and V-0 rated, with one ounce of copper [illegible] nickel plating. The male pins are brass with 200 [illegible] Correct-A-Chip adapters are [illegible] inspected using IPC-[illegible]

All Aries [illegible] manufactured [illegible] and are available [illegible] Custom platings [illegible] suit specific [illegible].

Pricing for a 24-pin adapter starts at $7.25 per unit in quantities of 100. Delivery [illegible] to four weeks ARO.

Aries Electronics
(908) 996-6841
www.arieselec.com

Semiconductor Technology

Silicon carbide substrate and epitaxy materials

Cree Inc. can take orders for 100 mm (4-in) n-type silicon carbide (SiC) substrate and epitaxy material. The current Cree standard for SiC is 3-inch diameter material.

SiC is a high-performance semiconductor material used in the production of a broad range of power, light and communications components, including power switching devices, light-emitting diodes (LEDs) and RF power transistors for wireless communications. Cree's ability to produce single crystal SiC in the larger 100 mm format allows customers to potentially double the number of devices produced per wafer compared with current production on three-inch material.

Cree
(919) 313-5300
www.cree.com

Signal Processing

IP core generator

Actel Corporation has introduced CoreFFT, an intellectual property (IP) core generator that produces optimized fast Fourier transform (FFT) cores for use with Actel's flash- and antifuse-based families of field-programmable gate arrays (FPGAs). CoreFFT produces FPGA-optimized modules that perform FFTs to convert a signal from the

300MHz-12GHz

LTCC MIXERS

from $3.95 ea. (Qty.1000)
IN STOCK

For Commercial, Military, and Industrial Use, Mini-Circuits proudly introduces the MCA1 series of Low Temperature Co-fired Ceramic (LTCC) frequency mixers. Highly reliable, only 0.080" in height, and "tough as nails", these patent pending mixers have all circuitry hermetically imbedded inside the ceramic making them temperature stable and impervious to most environmental conditions. The process also gives you high performance repeatability and very low cost. There's a variety of broadband models and LO power levels to choose from, so you can use these mixers in a multitude of designs and applications. And MCA1 mixers are ideal for the COTS program! Just check all the specs on our web site. Then, choose the model that best fits your needs. Our team is ready to handle your requirements with quick off-the-shelf shipments, custom designs, and fast turn-around/high volume production.

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

New Blue Cell™ LTCC
164 Page Handbook...FREE!

Model	LO Level (dBm)	Freq. Range (MHz)	Conv. Loss (dB)	LO-RF Isol. (dB)	Price $ ea. (Qty. 10)
MCA1-85L	4	2800-8500	6.0	35	9.45
MCA1-12GL	4	3800-12000	6.5	38	11.95
MCA1-24	7	300-2400	6.1	40	5.95
MCA1-42	7	1000-4200	6.1	35	6.95
MCA1-60	7	1600-6000	6.2	30	7.95
MCA1-85	7	2800-8500	5.6	38	8.95
MCA1-12G	7	3800-12000	6.2	38	10.95
MCA1-24LH	10	300-2400	6.5	40	6.45
MCA1-42LH	10	1000-4200	6.0	38	7.45
MCA1-60LH	10	1700-6000	6.3	30	8.45
MCA1-80LH	10	2800-8000	5.9	35	9.95
MCA1-24MH	13	300-2400	6.1	40	6.95
MCA1-42MH	13	1000-4200	6.2	35	7.95
MCA1-60MH	13	1600-6000	6.4	27	8.95
MCA1-80MH	13	2800-8000	5.7	27	10.95
MCA1-80H	17	2800-8000	6.3	34	11.95

Dimensions: (L) 0.30" x (W) 0.250" x (H) 0.080"

For RoHS compliant requirements,
ADD + SUFFIX TO BASE MODEL No. *Example: MCA1-85L+*

Detailed Performance Data & Specs Online at: ***www.minicircuits.com/mixer2.html***

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

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385 Rev G

time domain to the frequency domain to show the spectral content of the signal.

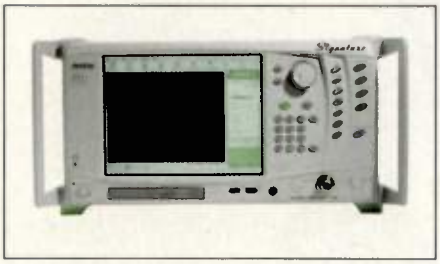
The CoreFFT RTL generator produces modules that can compute 256-, 512- or 1024-point complex forward or inverse decimation-in-time (DIT) FFTs. The core's DIT Radix-2 implementation has been optimized for Actel devices. The module's input and output data are represented as 32-bit words comprising 16-bit real and imaginary parts.

Actel's CoreFFT generator is now available. The core is $500 for a multiple-use RTL generator.

Actel
(650) 318-4200
www.actel.com

Test and Measurement

Signal analyzer update



Anritsu Company has introduced version 2.0 of the Signature (MS2781A) signal analyzer that features up to 30 times faster operation speed, increased demodulation bandwidth, improved IQ vector output and improved amplitude accuracy. Signature is now compatible with Anritsu's MG3700A vector signal generator.

The signal analyzer provides digital modulation analysis over the 100 Hz to 8 GHz frequency range. The version of Signature has demodulation bandwidth of 50 MHz. The signal analyzer also has improved amplitude accuracy of 0.65 dB.

Signature can output up to 10 Msamples of IQ vector data to MATLAB in a few seconds. It delivers high-end performance for spectrum analysis and vector signal analysis. The analyzer has intermodulation distortion (TOI) of +23 dBm, displayed average noise level (DANL) of less than -147 dBm in a 1 Hz bandwidth, and amplitude accuracy of less than 0.65 dB. For digital modulation analysis, Signature has measurements for error vector magnitude (EVM), carrier leakage, and I/Q imbalance without a separate computer. It has less than 1.25% EVM for many common QAM and PSK signals.

It is priced at $49,500. Delivery is four weeks.

Anritsu Company
(800) 267-4878
www.anritsu.com

Time and Frequency

GPS timing clock

Temex Time has announced a jumpstart, plug-and play GPS/Rubidium timing designer kit. The designer kit comes with a GPS receiver, antenna and related cable accessories, and a smart GPS-disciplined SRO-100 Rubidium SynClock+.

The SRO's SmarTiming+ technology also disciplines the GPS auto-adaptively at leading-edge 1 ns resolution, while modeling the stability-affecting temperature range of the SRO at 1 degree Celsius resolution.

The kit comes with a Windows iSync+ software application to control and monitor a complete suite of time and frequency features as well as timing and holdover performance.

Temex Time
+41.32.732.16.66
www.temextime.com

Tx/Rx Technology

WCDMA front-end module

Skyworks Solutions Inc. has launched its Intera front-end modules (FEMs) for wideband code division multiple access (WCDMA) applications with support for high- speed downlink packet access (HSDPA). The Intera FEMs integrate the load insensitive power amplifier, a duplexer, power detector and filters into a 5 mm x 8 mm package. The SKY77413 and SKY77414 are matched 22-pin surface-mount modules that meet the spectral requirements of WCDMA up to 24.8 dBm and 23.9 dBm output powers. Different control pins are available to enhance the performance of the FEMs at different power levels.

By optimizing the efficiency of the InGaP HBT PA monolithic microwave integrate circuit (MMIC) and reducing the RF loss between the integrated components, the SKY77413 FEM achieves current as low as 450 mA, and the SKY77414 FEM achieves current as low as 470 mA at maximum output power (24.8 dBm for SKY77413 and 23.9 dBm for SKY77414).

The SKY77413 (for frequencies that range between 824 MHz to 849 MHz) and the SKY77414 (for frequencies that range between 1850 MHz to 1910 MHz) are available for sampling and priced at $4.50 each in quantities of 10,000.

Skyworks Solutions Inc.
(949) 231-3000
www.skyworksinc.com

GaAs MMIC chipset

Mimix Broadband Inc. has introduced GaAs MMIC subharmonically pumped receiver and transmitter devices, which integrate an image reject subharmonic anti-parallel diode mixer, an LO buffer amplifier and a low-noise amplifier for the receiver, and an output amplifier for the transmitter.

The image reject mixer eliminates the need for an image bandpass filter after the amplifier to remove thermal noise at the image frequency. Using 0.15-micron gate-length GaAs pseudomorphic high electron mobility transistor device model technology, these devices cover the 18 GHz to 25 GHz frequency bands. The receiver has a noise figure of 2.5 dB and 15 dB image rejection across the band. The transmitter has a +20 dBm output third-order intercept point (OIP3) and 15 dB image rejection across the band.

This receiver and transmitter pair, identified as XR1006 and XU1002, are suited for wireless communications applications such as millimeter-wave point-to-point radio, local multipoint distribution services, SATCOM and VSAT applications.

Mimix Broadband Inc.
(281) 988-4600
www.mimixbroadband.com

Parabolic antenna

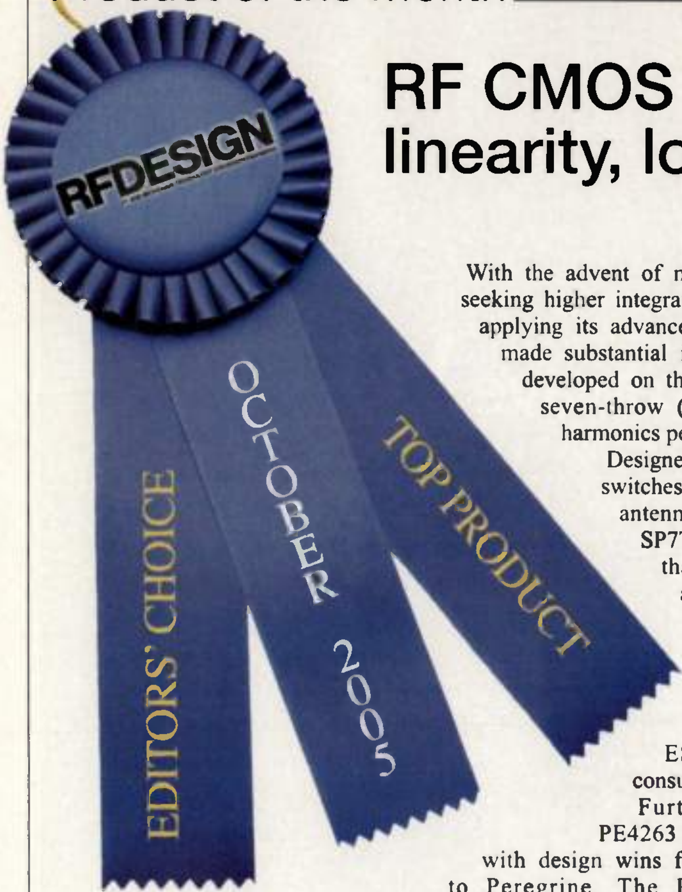
Pacific Wireless has released an all 900 MHz grid dish antenna. The GD9-15 features high gain and low wind loading with a patented wire grid design. The NLOS series grid dish antenna system is constructed of heavy-duty galvanized welded steel with light gray powder coat paint overcoat. These antennas have front-to-back performance to minimize external interference. They come standard with a 30-inch LMR240 pigtail cable terminated with an N female connector.

Pacific Wireless
(801) 572-3024
www.pacwireless.com

Power dividers

The 50PD-559 and 50PD-560 power dividers have been introduced by **JFW Industries**. Their 800 MHz to 2400 MHz frequency range, 5 W power-handling capabilities, and 20 dB minimum isolation make them appropriate for many wireless applications. The two-way configuration is $59 and the four-way version is $79 (1-99 pieces).

JFW Industries Inc.
(317) 887-1340
www.jfwindustries.com



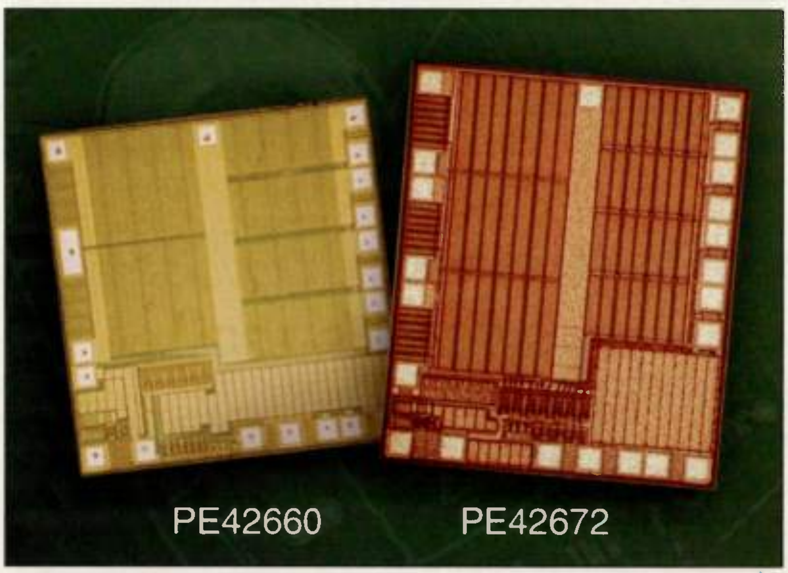
RF CMOS switches deliver higher linearity, lower harmonics

With the advent of multiband multistandard mobile communications systems, designers are seeking higher integration in the front-end modules. **Peregrine Semiconductor Corporation**, applying its advanced UltraCMOS process featuring HaRP technology enhancements, has made substantial improvements to its RF switches. Consequently, the first two devices developed on this process, the single-pole six-throw (SP6T) PE42660 and single-pole, seven-throw (SP7T) PE42672 RF switches, provide unprecedented linearity and harmonics performance.

Designed for quad-band GSM and GSM/WCDMA handset applications, these switches provide for an ever-increasing number of RF paths to connect to the antenna through a single CMOS device. Also, the PE42672, a monolithic SP7T switch with onboard CMOS decoder, is a highly integrated solution that simplifies and lowers the cost of RF designs by reducing overall parts count by as many as six devices and 13 wire bonds. Both devices deliver high RF performance and exceptional linearity. For instance, PE42672 offers second- and third-harmonic distortion of -85 dBc and -79 dBc. While PE42660 offers second- and third-harmonic distortions of -88 dBc and -85 dBc, respectively. Other features include IP3 better than +70 dBm; world class 1.5 kV ESD tolerance, 2.75 V operating voltage and ultra-low-power consumption.

Furthermore, PE42660 switch is drop-in compatible with the PE4263 GSM handset switch released last fall, and is now in production with design wins from major antenna switch module (ASM) manufacturers, according to Peregrine. The PE42660 has two high-power transmit (Tx) ports and four high isolation receive (Rx) ports. The Tx ports are symmetric and designed as paths for the 850 MHz, 900 MHz, 1800MHz or 1900 MHz bands. Likewise, the Rx ports are also symmetric and can be assigned to any of these frequency bands. The 2.75 V device has a switching time of less than 2 µs, and typical and maximum operating currents are 13 µA and 20 µA, respectively.

In addition, the two UltraCMOS-based RF switches deliver transmit-receive (Tx-Rx) isolation of 44/48 dB at 900 MHz and 38/40 dB at 1900 MHz; P1dB compression point of +41 dBm; and 0.55 dB of insertion loss at 900 MHz. On-chip CMOS decode logic facilitates both 1.8 V and 2.75 V three-pin CMOS control inputs, while no blocking capacitors and on-chip SAW filter overvoltage protection devices ensure ease of integration. The PE42672 is priced at $0.70 ea. (25K units) and the PE42660 is priced at $0.60 ea. (10K units).



UltraCMOS with HaRP technology enables multithrow RF switches with unprecendented linearity and harmonics performance.

Peregrine Semiconductor Corp.
San Diego, Calif.
(858) 731-9400
www.psemi.com

A general measurement technique for determining RF immunity

By Arpit Mehta

The presence of the radio-frequency (RF) environment is steadily progressing due to the ubiquitous usage of cell phones. An electronic circuit under such RF environments can give distorted results owing to the circuit's poor RF rejection capability. In order to have the electronic circuits working satisfactorily it becomes imperative to test for its RF immunity.

This article describes a generalized technique to measure the RF immunity of a circuit. It defines a standard and structured test methodology aimed at establishing adequate repeatability of the test results for qualitative analysis. The test results thus obtained aids in astute selection of ICs and developing circuits that are less prone to RF noise.

The RF susceptibility can be tested by placing the DUT near the cell phone. But to have accurate, comparable and efficacious test results the DUT needs to be tested in consistent and repeatable RF fields.The RF anechoic test chamber produces such RF fields that are accurately controlled and comparable to that generated by a typical mobile phone. The RF immunity test procedure was carried on MAX4232 and competitor's parts (Part X) and its results were compared.

The circuit diagram in Figure 1 shows the circuit board connections to the dual op-amp under test in the RF setup. The op-amps are configured as an ac amplifier. With no ac signal, the output sits at 1.5 Vdc (with a supply voltage of 3 V). The inverting input is shorted to ground using 1.5-inch loop of wire to emulate the actual trace of wire to the input signal. This loop incorporates the effects of the actual trace, which could probably be acting as an antenna at the working frequency, collecting the RF signal and demodulating it. The RF noise immunity of the op-amp is measured and quantified by connecting a dBV meter at the outputs of the op-amp.

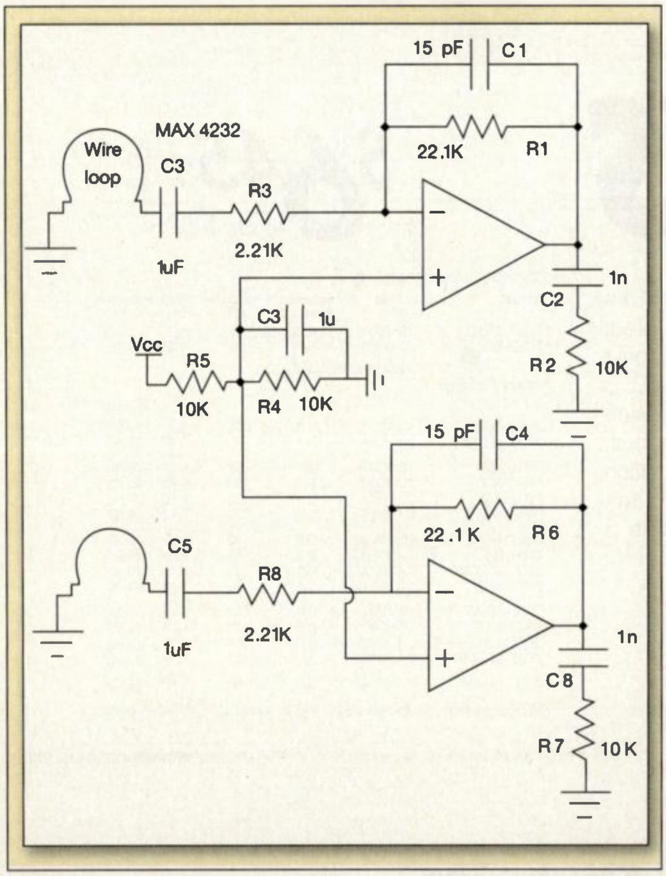


Figure 1. RF noise immunity test circuit.

Figure 2 shows the RF anechoic test setup system that emulates the RF field environment necessary for RF immunity testing. This test chamber is similar to a "Faraday's Cage" and has a shielded body. The chamber has access ports for connecting supply voltages and output monitors. The setup is formed by concatenation of the following equipment:

- Signal generator: SML-03, 9 kHz to 3.3 GHz (Rhode & Schwarz);
- RF power amplifier: 800 MHz-1 GHz/20 W (OPHIR 5124);
- Power meter: 25 MHz to 1 GHz (Rhode & Schwarz);
- Parallel wired cell (Anechoic chamber);
- Electric field sensor;
- Computer (PC); and
- dBV meter.

The signal generator generates the RF signal of the desired frequency and modulation and is fed to the power amplifier. The amplifier output is measured and monitored with a directional coupler in conjunction with a power meter. The computer controls the range of frequencies applied from the output of the signal generator, its modulation type, modulation percentage and its power from power amplifier output so as to generate the desired RF field. This field is radiated inside the chamber using an antenna (planer).

To perform the immunity test on MAX4232 vs. Part X, the DUT is placed inside the shielded anechoic chamber, which serves best to produce uniform, accurately calibrated and consistently repeatable electric fields.

The RF field experienced by a DUT placed near a typical cell phone is around 60 V/m at about 4 cm from the radiating antenna of the phone and decreases as one moves the DUT away from the phone (around 25 V/m at a distance of 10 cm from the phone). A

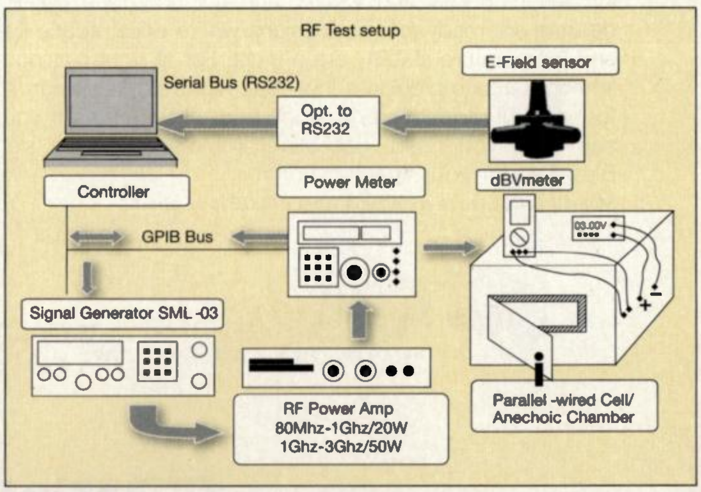


Figure 2. RF noise immunity test method.

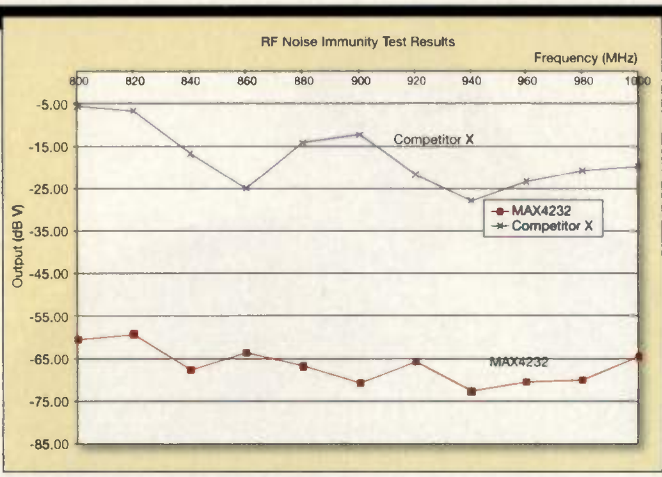


Figure 3. RF noise immunity test results.

uniform field strength of 60 V/m is generated to emulate the actual RF environment experienced by a DUT. Also, 60 V/m is low enough to keep the receiving devices below the clipping level and avoid measurement errors. A RF sine wave whose frequency is varied between the cell phone frequencies of 800 MHz to 1 GHz is modulated with an audio frequency of 1000 Hz with 100% modulation. Modulation with 217 Hz would have produced similar results but a more common 1000 Hz audio frequency is chosen. The access ports on the side of the chamber serve to provide power to the DUT and also to connect the dBV meter, which is set to give dBV (dB's relative to 1 V) readings. Furthermore, the RF field can be accurately calibrated by locating the position of the DUT using the field sensor.

Figure 3 depicts an average output of MAX4232 and Part X. Under the RF frequency variation from 800 MHz to 1 GHz with a uniform electric field of 60 V/m, MAX 4232 shows –66 dBV (500 µV rms with respect to 1 V) and that of Part X is –18 dBV (125 mV rms with respect to 1 V). In the absence of any RF signal, the dBV meter shows –86 dBV.

Thus, MAX4232 output changes by only –20 dB [(-86 dBV)–(-66 dBV)] or goes from 50 µV rms to 500 µV rms under the influence of RF environment. We can say that the output of MAX4232 changes by only a factor of 10 under the selected RF environment. Hence, it can be concluded that MAX4232 has excellent RF immunity of –66 dBV and would not produce any major noticeable distortion at the output.

However, the average reading of Part X is only –18 dBV, which means that this part under RF influence shows 125 mV rms with respect to 1 V rms, a major perceptible increase by 2500 times than the normal expected 50 µV rms. Thus, part X can be said to have a poor RF immunity of –18 dBV and is more likely to cause problems in close proximity to cell phones and other RF sources.

Hence for applications that need the processing of audio signals such as headphone amplifiers, mic amplifiers, op-amps with high RF immunity are better suited. RFD

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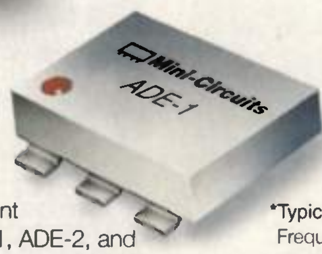

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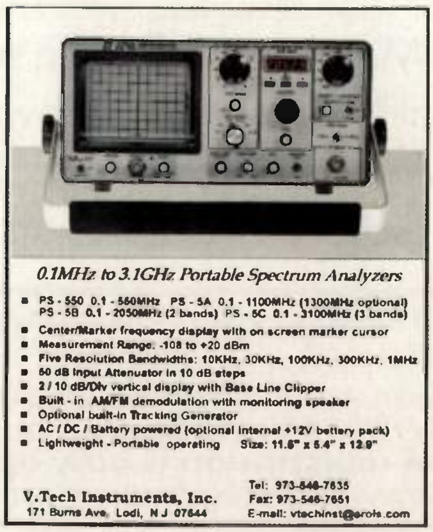
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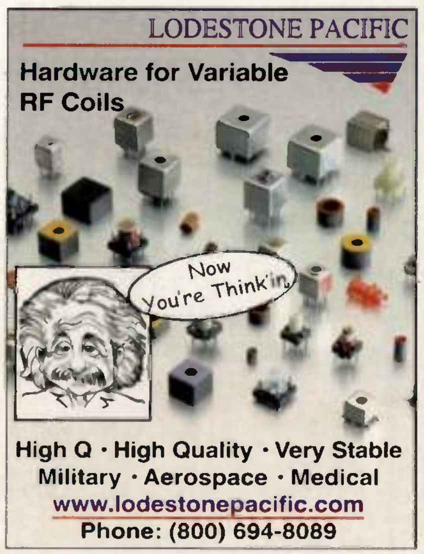
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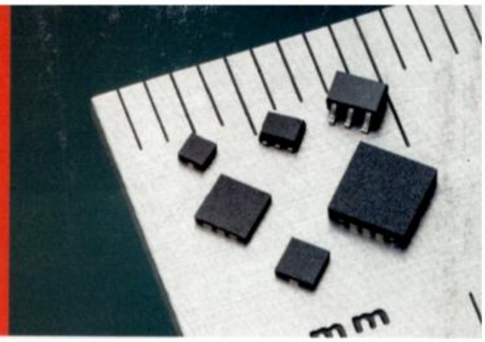

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