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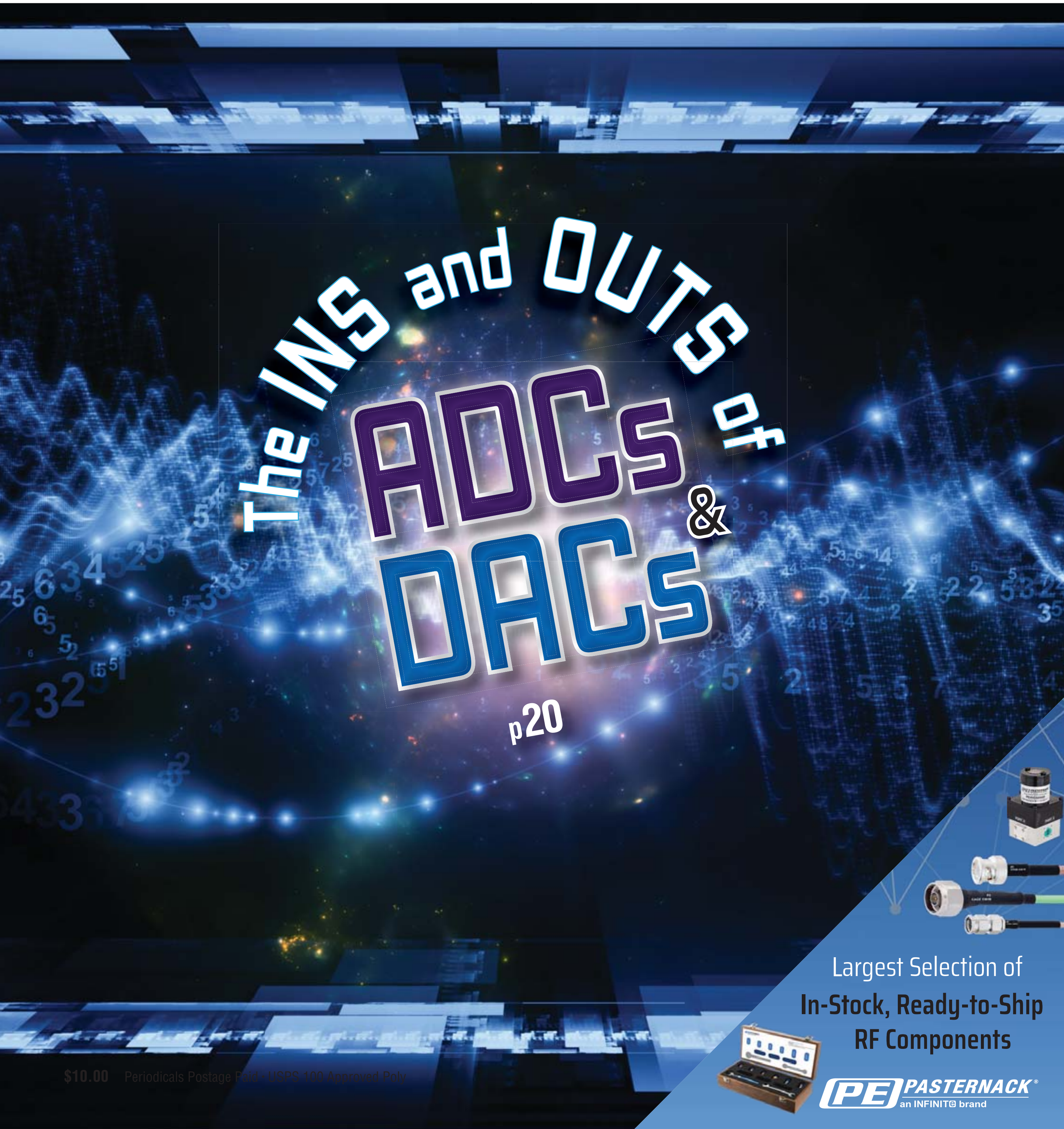

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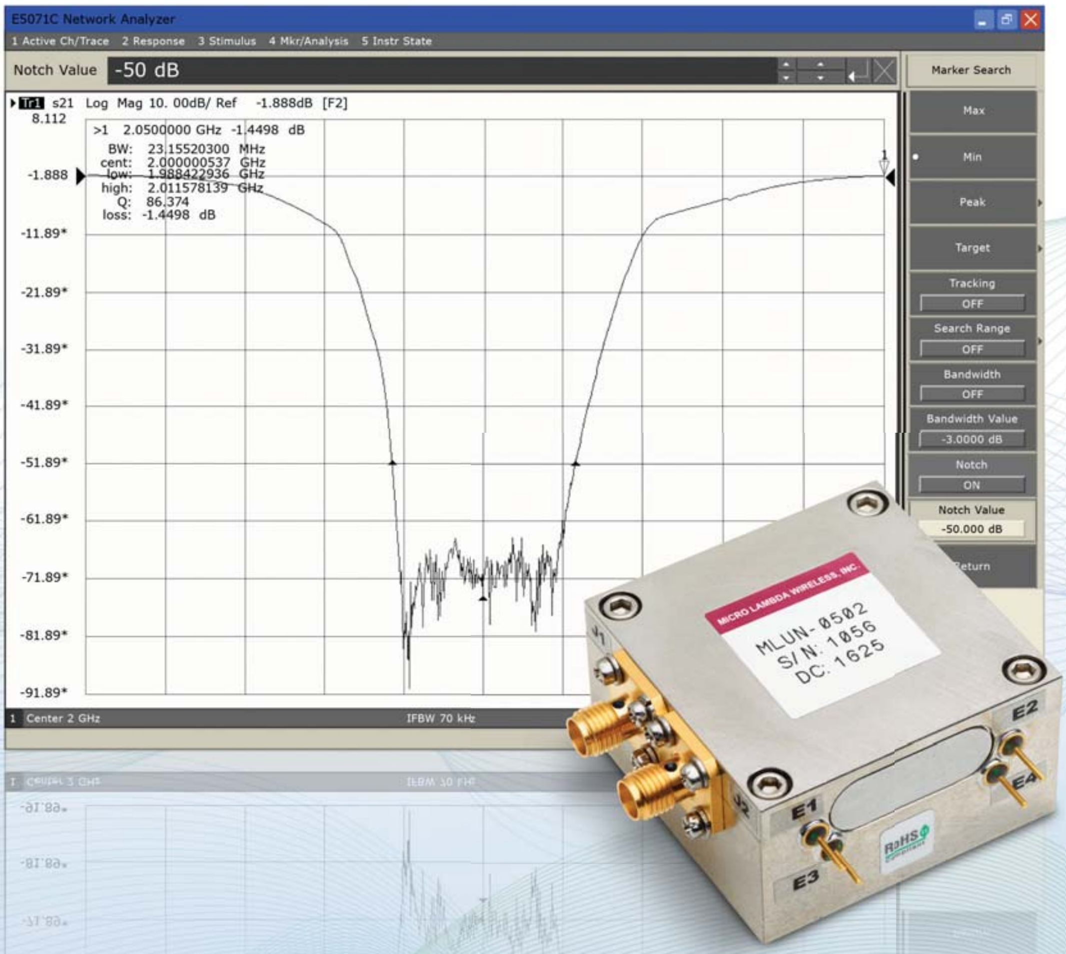

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June 2021 VOLUME 60, ISSUE 5

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Editorial

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Connecting Minds. Exchanging Ideas.

IMS 2021 Brims with Technical Fare

This month, IMS returns as a live event, in addition to a having virtual version. Though the format changes up from IMS shows from the past, prepare for the same massive amount of technical programs and product announcements it has on tap.

Every business and industry under the sun has its conferences and exhibitions. My older brother, now retired, owned and operated a carpet and upholstery cleaning business for decades, and every couple of years he'd take a day or two off and hit the industry's convention. He'd come back having learned a ton about things like stain-removal technology and how to properly apply fabric protectants like Scotchgard. It was mundane, sure, but it was good, practical information that made him better at his work.

When RF and microwave engineers think "conference and exhibition," the first—and maybe only—one that comes to mind is the International Microwave Symposium (IMS). IMS is happening this month, with a live event taking place in Atlanta (June 7-10) and a virtual version (June 20-25). Last year, of course, was unlike any other in recent memory, and the live event obviously didn't happen, with only a virtual IMS occurring in September. The organizers went with the split approach for this year, because some exhibitors and attendees remain understandably wary of the risks of travel and large public gatherings.

Just like at a carpet cleaners' convention, you can learn an awful lot at IMS. If you don't, it won't be because the opportunity isn't there. Both the live and virtual events have tremendous technical programs this year. In Atlanta, the program kicks off with traditional plenary keynotes by the chief technology officers of Honeywell and Texas Instruments. There's also a pair of invited lectures, one on software-defined radio and the other covering the unfolding commercialization of terahertz technology, once solidly the domain of researchers and scientists. That's changing quickly.

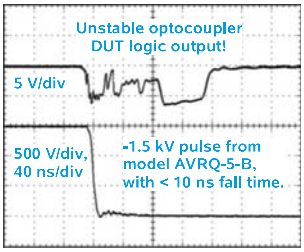
Connecting for a smarter, safer world
Atlanta 2021

The slate of technical sessions offered at both the live and virtual events is exciting. IMS has mobile apps for both IOS and Android—by now, you can likely download the technical content of sessions in which you registered. Sessions cover everything from front-end circuit building blocks to new array-based wireless systems to physical-layer security, the latter being of great concern these days.

Both portions of IMS also will feature what's being called Microwave Application Seminars, or MicroApps. These 15-minute sponsored presentations take place right on the exhibition floor in a theatre setup. Whereas the traditional technical sessions lean toward the theoretical and academic side, MicroApps promise to be very practical in nature. You can hear about all kinds of test-and-measurement topics, design techniques, and production-related information. It's the sort of thing you can just wander over to when you have a few minutes, and who knows, you might pick up something that's immediately useful or sparks an idea. Hey, it's got to be better than hearing about stain removers, right? mw

Transient Immunity Testers

The Avtech AVRQ series of high-voltage, high-speed pulsers is ideal for testing the common-mode transient immunity (CMTI) of next-gen optocouplers, isolated gate drivers, and other semiconductors. GPIB, RS-232, Ethernet ports are standard.



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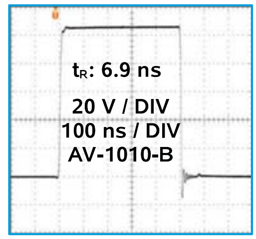

AV-1015-B:	±50V, 10 MHz, 20 ns - 10 ms, 10 ns rise
AV-1010-B:	±100V, 1 MHz, 20 ns - 10 ms, 10 ns rise
AV-1011B1-B:	±100V, 100 kHz, 100 ns - 1 ms, 2 ns rise
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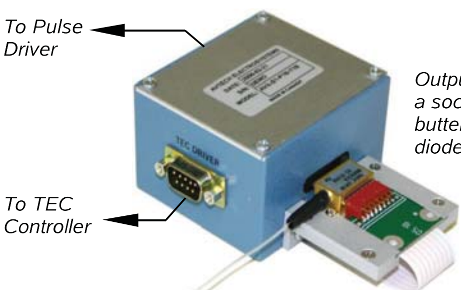
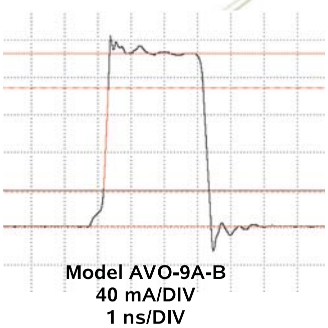
Nanosecond Laser Diode Drivers With Butterfly Diode Sockets



Output module with a socket-mounted butterfly-packaged diode installed.



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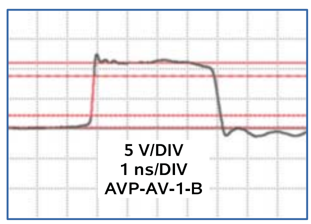

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20 V	120 ps	1 MHz	AVP-AV-HV2-B
20 V	200 ps	10 MHz	AVMR-2D-B
40 V	150 ps	1 MHz	AVP-AV-HV3-B
50 V	500 ps	1 MHz	AVR-E5-B
100 V	500 ps	100 kHz	AVR-E3-B
100 V	300 ps	20 kHz	AVI-V-HV2A-B
200 V	1 ns	50 kHz	AVIR-1-B
200 V	2 ns	20 kHz	AVIR-4D-B
400 V	2.5 ns	2 kHz	AVL-5-B-TR

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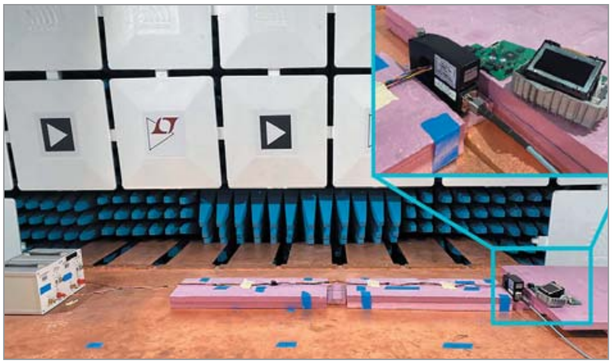


Mitigation Strategies for Tricky FM Band Conducted EMI

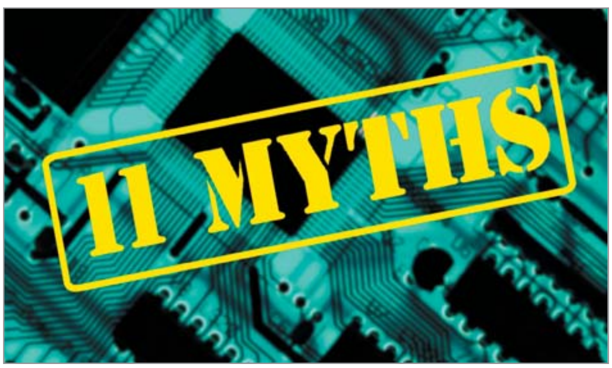
Simple techniques that can help lower this type of EMI range from using a common-mode choke or inductor orientation to reducing switch frequency or shrinking the switch-node area.

https://www.mwrf.com/technologies/systems/article/21162165/analog-devices-mitigation-strategies-for-tricky-fm-band-conducted-emi

Wireless Time-Sensitive Networks: When Every Microsecond Counts

This article evaluates the various technology options for the roll-out of wireless TSNs and elaborates on the importance of an accurate time synchronization.

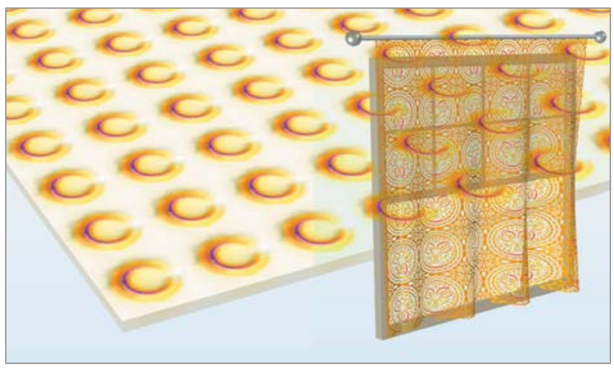
https://www.mwrf.com/technologies/systems/article/21164984/wireless-timesensitive-networks-when-every-microsecond-counts



11 Myths About the PCB Industry

Today's high-data-rate, high-frequency designs create new challenges for printed-circuit-board design.

https://www.mwrf.com/technologies/systems/article/21165267/avishtech-11-myths-about-the-pcb-industry



Pulling Back the Curtain on Frequency-Selective-Surface Fabrics

As more wireless devices populate densely populated areas, unwanted EMI becomes an increasingly persistent problem. One way to diminish or eliminate EMI altogether is via frequency-selective surfaces.

https://www.mwrf.com/technologies/software/article/21159252/comsol-pulling-back-the-curtain-on-frequencyselectivesurface-fabrics

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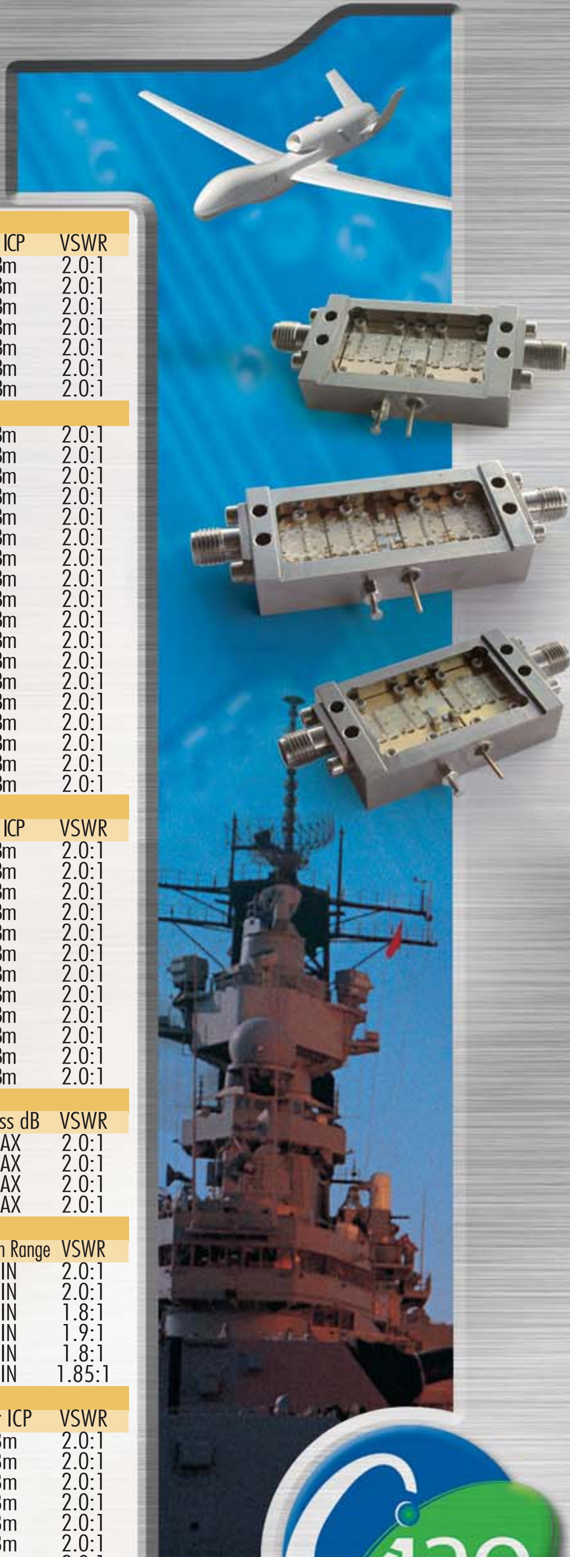

OCTAVE BAND LOW NOISE AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2110	0.5-1.0	28	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA12-2110	1.0-2.0	30	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA24-2111	2.0-4.0	29	1.1 MAX, 0.95 TYP	+10 MIN	+20 dBm	2.0:1
CA48-2111	4.0-8.0	29	1.3 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA812-3111	8.0-12.0	27	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA1218-4111	12.0-18.0	25	1.9 MAX, 1.7 TYP	+10 MIN	+20 dBm	2.0:1
CA1826-2110	18.0-26.5	32	3.0 MAX, 2.5 TYP	+10 MIN	+20 dBm	2.0:1

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2111	0.4 - 0.5	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA01-2113	0.8 - 1.0	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3117	1.2 - 1.6	25	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3111	2.2 - 2.4	30	0.6 MAX, 0.45 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3116	2.7 - 2.9	29	0.7 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA34-2110	3.7 - 4.2	28	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA56-3110	5.4 - 5.9	40	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA78-4110	7.25 - 7.75	32	1.2 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA910-3110	9.0 - 10.6	25	1.4 MAX, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA1315-3110	13.75 - 15.4	25	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3114	1.35 - 1.85	30	4.0 MAX, 3.0 TYP	+33 MIN	+41 dBm	2.0:1
CA34-6116	3.1 - 3.5	40	4.5 MAX, 3.5 TYP	+35 MIN	+43 dBm	2.0:1
CA56-5114	5.9 - 6.4	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6115	8.0 - 12.0	30	4.5 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6116	8.0 - 12.0	30	5.0 MAX, 4.0 TYP	+33 MIN	+41 dBm	2.0:1
CA1213-7110	12.2 - 13.25	28	6.0 MAX, 5.5 TYP	+33 MIN	+42 dBm	2.0:1
CA1415-7110	14.0 - 15.0	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA1722-4110	17.0 - 22.0	25	3.5 MAX, 2.8 TYP	+21 MIN	+31 dBm	2.0:1

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA0102-3111	0.1-2.0	28	1.6 Max, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA0106-3111	0.1-6.0	28	1.9 Max, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-3110	0.1-8.0	26	2.2 Max, 1.8 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-4112	0.1-8.0	32	3.0 MAX, 1.8 TYP	+22 MIN	+32 dBm	2.0:1
CA02-3112	0.5-2.0	36	4.5 MAX, 2.5 TYP	+30 MIN	+40 dBm	2.0:1
CA26-3110	2.0-6.0	26	2.0 MAX, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA26-4114	2.0-6.0	22	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA618-4112	6.0-18.0	25	5.0 MAX, 3.5 TYP	+23 MIN	+33 dBm	2.0:1
CA618-6114	6.0-18.0	35	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA218-4116	2.0-18.0	30	3.5 MAX, 2.8 TYP	+10 MIN	+20 dBm	2.0:1
CA218-4110	2.0-18.0	30	5.0 MAX, 3.5 TYP	+20 MIN	+30 dBm	2.0:1
CA218-4112	2.0-18.0	29	5.0 MAX, 3.5 TYP	+24 MIN	+34 dBm	2.0:1

LIMITING AMPLIFIERS

Model No.	Freq (GHz)	Input Dynamic Range	Output Power Range Psat	Power Flatness dB	VSWR
CLA24-4001	2.0 - 4.0	-28 to +10 dBm	+7 to +11 dBm	+/- 1.5 MAX	2.0:1
CLA26-8001	2.0 - 6.0	-50 to +20 dBm	+14 to +18 dBm	+/- 1.5 MAX	2.0:1
CLA712-5001	7.0 - 12.4	-21 to +10 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1
CLA618-1201	6.0 - 18.0	-50 to +20 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	Gain Attenuation Range	VSWR
CA001-2511A	0.025-0.150	21	5.0 MAX, 3.5 TYP	+12 MIN	30 dB MIN	2.0:1
CA05-3110A	0.5-5.5	23	2.5 MAX, 1.5 TYP	+18 MIN	20 dB MIN	2.0:1
CA56-3110A	5.85-6.425	28	2.5 MAX, 1.5 TYP	+16 MIN	22 dB MIN	1.8:1
CA612-4110A	6.0-12.0	24	2.5 MAX, 1.5 TYP	+12 MIN	15 dB MIN	1.9:1
CA1315-4110A	13.75-15.4	25	2.2 MAX, 1.6 TYP	+16 MIN	20 dB MIN	1.8:1
CA1518-4110A	15.0-18.0	30	3.0 MAX, 2.0 TYP	+18 MIN	20 dB MIN	1.85:1

LOW FREQUENCY AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure dB	Power-out @ P1-dB	3rd Order ICP	VSWR
CA001-2110	0.01-0.10	18	4.0 MAX, 2.2 TYP	+10 MIN	+20 dBm	2.0:1
CA001-2211	0.04-0.15	24	3.5 MAX, 2.2 TYP	+13 MIN	+23 dBm	2.0:1
CA001-2215	0.04-0.15	23	4.0 MAX, 2.2 TYP	+23 MIN	+33 dBm	2.0:1
CA001-3113	0.01-1.0	28	4.0 MAX, 2.8 TYP	+17 MIN	+27 dBm	2.0:1
CA002-3114	0.01-2.0	27	4.0 MAX, 2.8 TYP	+20 MIN	+30 dBm	2.0:1
CA003-3116	0.01-3.0	18	4.0 MAX, 2.8 TYP	+25 MIN	+35 dBm	2.0:1
CA004-3112	0.01-4.0	32	4.0 MAX, 2.8 TYP	+15 MIN	+25 dBm	2.0:1

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News

QUALCOMM DIGS DEEPER
into 5G Phones With Radio-Frequency ICs

The world's largest smartphone vendor is wrestling to win more market share in radio-frequency chips from rivals Broadcom, Qorvo, and Skyworks. These chips are invaluable to getting the best possible performance out of the latest 5G phones.

Qualcomm has become one of the global leaders in 5G on the back of baseband modems that dial into the next-generation networks. But the mobile chip giant is also making a bigger play in radio-frequency (RF) chips that surround the cellular modem, RF transceivers, and antennas and carry out tasks such as amplifying and filtering radio signals, suctioning up more of the bill of materials (BOM) in 5G phones.

The San Diego, Calif.-based company said its radio-frequency front-end (RFFE) business soared to more than $900 million in its second quarter, up 39% year over year, buoyed by stronger demand for 5G phones. Qualcomm has landed supply agreements for RF components and modules with Samsung and Google as well as Oppo, Vivo, and Xiaomi, which are taking advantage of China's ambitious 5G rollout.

"We're winning not only at the system level; we're winning at the component level," said Cristiano Amon, Qualcomm's president and incoming CEO, on its quarterly conference call with analysts last month. He said Qualcomm is not only landing sockets for its millimeter-wave components in 5G parts of phones, but it is also winning orders for chips that support 4G and sub-6 5G, where it faces more competition.

"The fact we're winning designs across the board, it's a testimony that our strategy is working," he said.

The company's ambitions are raising the stakes in the more than $20 billion radio-frequency IC market, which is on pace to reach $25.8 billion by 2025, according to market researcher Yole Développement. The smartphone chip giant is trying to close the gap in market share with Broadcom, Murata, Qorvo, Skyworks, and other industry leaders that dominated different parts of the RFFE in 4G LTE phones.

Apple, Google, Samsung, and other players in the smartphone arena are paying hefty premiums for RF chips, which are critical to getting the best possible performance out of new 5G phones. Qualcomm has been expanding its footprint in the market in recent years with new power amplifiers, switches, RF filters, antenna tuners, LNAs, and other chips often packaged in diversity and power-amplifier modules (PAMs). These chips are playing more of a central role as the guts of 5G phones become far more complicated.

Qualcomm said that there are more than 10,000 combinations of frequency bands used in 5G globally, up from 1,000 currently used by 4G networks, which is increasing the cost and complexity of the RFFE. These bands include millimeter waves, which are very fast but can only travel limited distances and are vulnerable to being blocked by walls or other obstructions, including a person's hand holding the phone.

Qualcomm has rolled out 5G modems that also support the sub-6 bands widely used by 5G networks in China and other regions, relaying signals over longer distances than the millimeter waves favored by U.S. telecom giants. Both types of 5G technology place different demands on the RFFE in the phone, forcing electronics manufacturers to cram more RF chips in their devices to accommodate all of these variations.

"As 5G millimeter-wave technology expands into other geographies, we expect significant expansion of our RF opportunity due to increased silicon content and value," said Amon.

Qualcomm is trying to persuade phone makers to buy its radio-frequency chips—pre-integrated with its 5G modems, RF transceivers, and millimeter-wave antennas—instead of buying them all from separate vendors and assembling them part by part. Qualcomm was one of the major standard-bearers behind 5G, giving it an early lead in incorporating the standard with support for all global 5G bands—including millimeter waves where other firms struggled with early in the 5G era—in its modem chips and RF ICs.

Skyworks CEO Liam Griffin has previously said that the BOM cost of the RF components in the average smartphone would rise by roughly 40% from around $18 in current 4G phones to $25 in 5G models.

Qualcomm said these types of pre-integrated solutions bring boosts in power efficiency to the signal chain and reduce the real estate of the RF subsystem in 5G handsets. Qualcomm dominated the first generation of 5G phones from LG Electronics, Samsung Electronics, Xiaomi, and other vendors, which leaned on its suite of RF components to reduce development costs and ease the burden of integration.

"5G presents a level of complexity that our advanced RF front-end solutions and comprehensive portfolio can uniquely resolve," Christian Block, SVP and GM of the RFFE business at Qualcomm, said in February. Last month, executives said that more or less every 5G phone based on its 5G modems—totaling more than 200 design wins—also leverage its 5G RFFE solutions for both sub-6 bands and millimeter waves.

But it is facing questions about its ability to fill out its market share as Broadcome, Qorvo, Skyworks, and other rivals roll out RF components and modules supporting both millimeter waves and other 5G bands.

Last year, Broadcom landed major, multi-year supply deals with Apple, its largest smartphone customer. Broadcom said that it agreed to supply a wide range of wireless components, including ICs used in the RFFE, for Apple products. Broadcom, which was working to sell its RF chip business before it reached the deal with Apple, said the three-and-a-half-year agreements will deliver around $15 billion by 2024.

While Broadcom sells power amplifiers, switches, and other RFFE chips, the crown jewel of its product family is the FBAR filters. FBARs are widely used in 4G and 5G smartphones and base stations to filter out stray signals from radio transmissions. Broadcom CEO Hock Tan said the Apple deals give it more "clarity" around its long-term roadmap in 5G phones and positions it to continue to invest in the sector.

Skyworks is also expanding its production of RF filters that are specifically designed for the wide range of frequency bands used by 5G technology and integrating them in RF modules that it is selling to Apple, Samsung, and other smartphone giants. The company said it has focused on the development of BAW filters based on its proprietary IP that can better handle the high bandwidths and power levels for 5G.

"We know how hard it is to deliver a 5G socket with all the bells and whistles that can handle spectrum across the board, the complexity of roaming, the size constraints, and current consumption. It is really hard. So we've spent a long time creating a solution that makes it very easy for our customers to go to market," Griffin said about Skyworks' Sky5 RF modules on a conference call with analysts last month.

Qorvo has started supplying its RF Fusion family of integrated modules to all of the largest 5G smartphone manufacturers. The modules encompass the major 4G and 5G frequency bands and integrate its power amplifiers, filters, switches, LNAs, and RF shielding to handle transmit and receive coverage at the same time. The modules also feature different configurations for different regions, including the U.S. and China.

"As 4G became more complex over the past couple of years, the move towards integration began to take off. And then when 5G emerged, there really was no looking back for our customers that are bringing out new high-performance handsets," said Steve Creviston, president of Qorvo's mobile products, earlier this year. Qorvo is winning sockets in the "main path" of 5G phones in all three major types of bands, he said.

But as its first-mover advantage continues to fade and its competitors lure in smartphone makers with new RF offerings, Qualcomm is also under pressure to stand out at the component and module levels.

In February, the company rolled out a new integrated 4G and 5G power-amplifier module, the QPM6679, which can supply the power required by the higher


5G
PE21014
0316
010716
PE85N1005
PE15A5061

frequency bands used in 5G. These power amplifiers translate data into radio signals that are beamed out to cellular base stations. It also upgraded its latest dual-band diversity receive module, the QDM5579, to further amplify radio signals while limiting noise.

The power amplifier can be paired with its QET7100 wide-band envelope tracker to prolong the battery life of the latest phones for 5G. With 100 MHz of bandwidth, the chip supports up to 30% more power efficiency and higher transmit power in a smaller die area than the average power-tracking technology from rivals. It also supports all global 5G bands in the sub-6 range and 4G bands, the company added.

The improved power efficiency comes from its ability to follow the output of multiple 4G and 5G power amplifiers. Wide-band envelope tracking is considered critical for managing the power to 5G radios.

Last year, the mobile chip giant introduced its UltraSAW filter technology, its new category of RF filters featuring improved insertion loss to isolate signals from any interfering radio transmissions. The chips, which entered mass production at the end of last year, are designed to compete against other RF filters, including BAW filters from Qorvo and Skyworks and FBARs from Broadcom, in the sub-6 bands.

The company also introduced its proprietary antenna-tuning technology that uses AI to identify where hands are gripping a smartphone and then fine-tune the antennas in real-time to improve performance for 5G. Qualcomm said the AI antenna tuning technology could boost performance by up to 3 dB in the transmit chain and 4 dB in the receive chain, resulting in faster upload speeds and improved coverage.

Qualcomm has closed the gap with Broadcom, Qorvo, and Skyworks in the RFFE market. But as the cost and complexity of the RFFE continue to grow, the bar to beat out the competition is higher than ever. mw

TE Connectivity

PACKAGING AIDS INTEGRATION of Electric Ground Vehicles

ELECTRONICS PACKAGING IS becoming more essential for ground vehicles as they rely more on electric power, whether for commercial or military applications. To help with the packaging and integration of sensors and other electronic subsystems into military ground vehicles, TE Connectivity developed its Mini Modular Rack Principle (MiniMRP) solution to enable efficient use of available space in manned and unmanned ground vehicles.

The packaging solution builds upon lessons learned during the development of compact, lightweight electronics packaging solutions for avionics systems and is a viable electronics packaging approach for next-generation manned and unmanned avionics systems.

The MiniMRP solution reduces packaging volume with a modular, distributed architecture with high-speed copper or fiber-optic communications backplane. Designed to the ARINC 836A standard, MiniMRP components *(see figure)* achieve faster data rates with smaller size and weight than current system packaging solutions based on the ARINC 600 packaging standard.

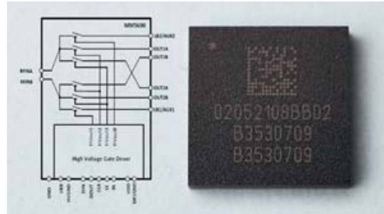
The new approach provides easily reconfigurable packaging solutions with minimal risk to interconnections during re-installation and effective thermal dissipation for high-power applications. A wide range of packaging and interconnect options are available in both copper and fiber-optic versions for many different power and data-rate requirements.

> "What truly sets TE's MiniMRP apart in its design within defense applications is that it is both rackable and configurable."

Martin Cullen, senior business development manager for TE's Aerospace, Defense, and Marine division, says, "We've built to EN4165 standards with four and five bay connectivity and are excited that TE's MiniMRP packaging will offer system architects increased flexibility to design optimized electrical subsystems for platform and end-user optimization."

Cullen adds, "What truly sets TE's MiniMRP apart in its design within defense applications is that it is both rackable and configurable." The electronics packaging approach supports many different system architectures by means of flexible nodal locations, which also enables electronic layouts that can be designed for ease of maintenance. ■

DPDT DIFFERENTIAL SWITCH Hammers Out 40-Gb/s Rate



Menlo Micro

WITH THE LAUNCH of its MM5600 DPDT differential switch, Menlo Micro claims the industry's highest performance and data rates for high-speed differential switching applications. Based on the company's Ideal Switch technology, the MM5600 offers high-speed operation from dc to 20 GHz or 40 Gb/s, significantly outperforming conventional electromechanical (EM) relays and solid-state switches. The MM5600 switch's flexible configuration also enables internal differential crossover capabilities, greatly simplifying board routing.

The MM5600 provides a high-performance differential switching device for high-speed digital applications based on the latest PCI Express standard, PCIe Gen 5, which doubles interconnect speeds over the PCIe 4.0 specification (32 GT/s vs. 16 GT/s). Faster PCIe speeds are essential for next-generation artificial intelligence (AI), machine learning (ML), 5G infrastructure, data center, and cloud-based applications, as well as automated-test-equipment (ATE) device interface boards and high-speed computer peripheral interfaces. The MM5600 switch can also be configured for single-ended operation for RF and microwave applications.

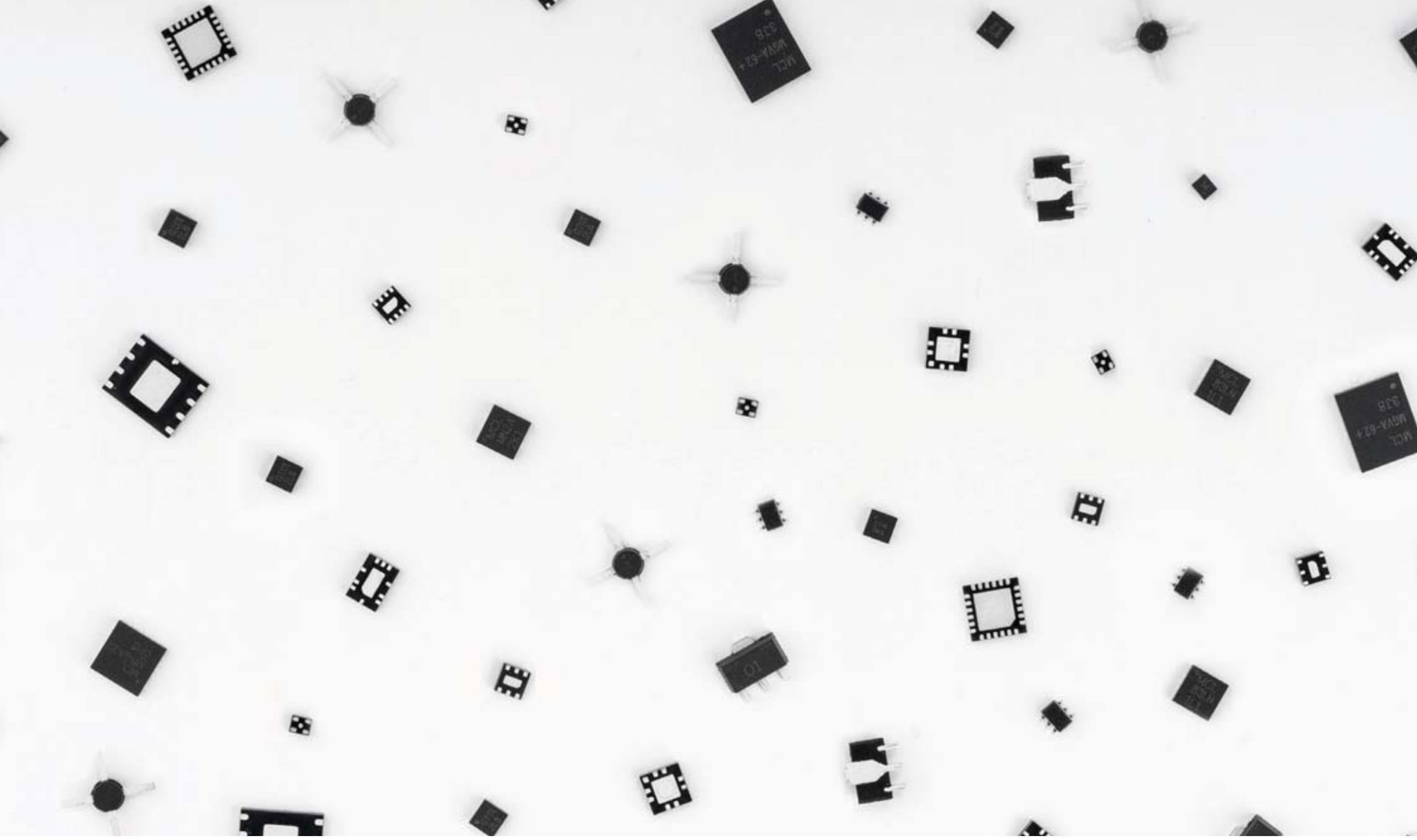
Among the highlights of the MM5600 is its ultra-fast switching, with <10-µs operation time and <2-µs release time, said to be 1000X faster than EM relays, enabling reduced test time and cost-to-test. Additionally, the switch is rated for more than 3 billion switching cycles, which also is a 1000X improvement over the lifetime of EM relays.

The MM5600's small-footprint/low-profile 64-mm^2 design in an 8- x 8- x 1.6-mm QFN package provides a 90% size reduction compared to EM relays. The device also operates at less than 0.08 mW, a 99% reduction in power consumption compared to EM relays.

An integrated driver offers two modes of operation and can be controlled through a serial or parallel interface to drive the switch's high-voltage gate lines. Full electrostatic-discharge (ESD) protection is included on all I/O ports.

Finally, the MM5600 achieves an IP3 linearity of more than +90 dBm with a power-handling capability of +33 dBm, enabling large reductions in distortion and delivering up to a 10,000X improvement over existing EM relays and solid-state switches. IP3 is the figure of merit in determining how much distortion a switch will introduce into a system, impacting the quality of transmitted or received signals.

Samples of the MM5600 DPDT differential switch are currently available. ■



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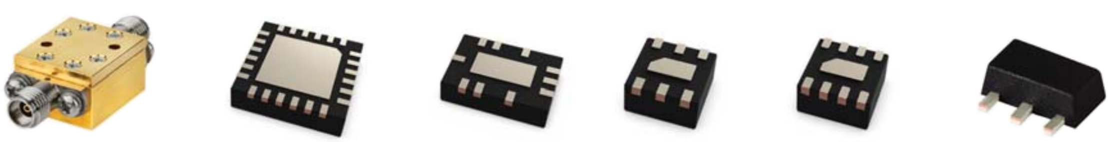

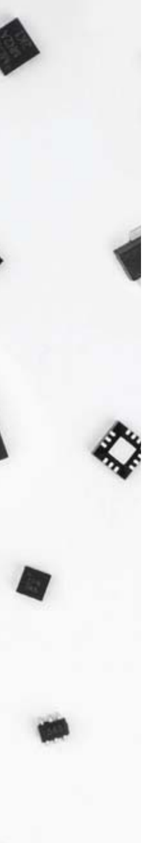

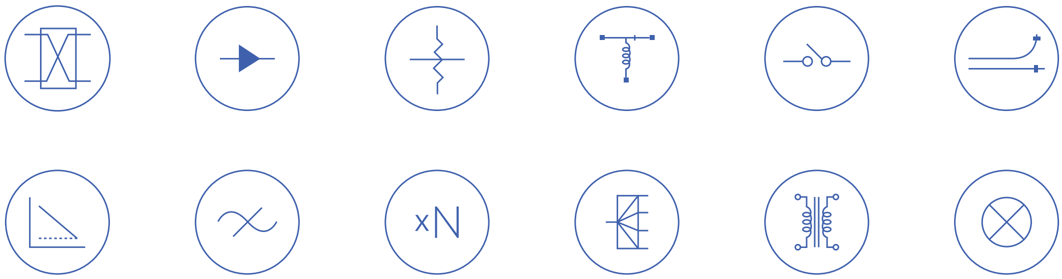

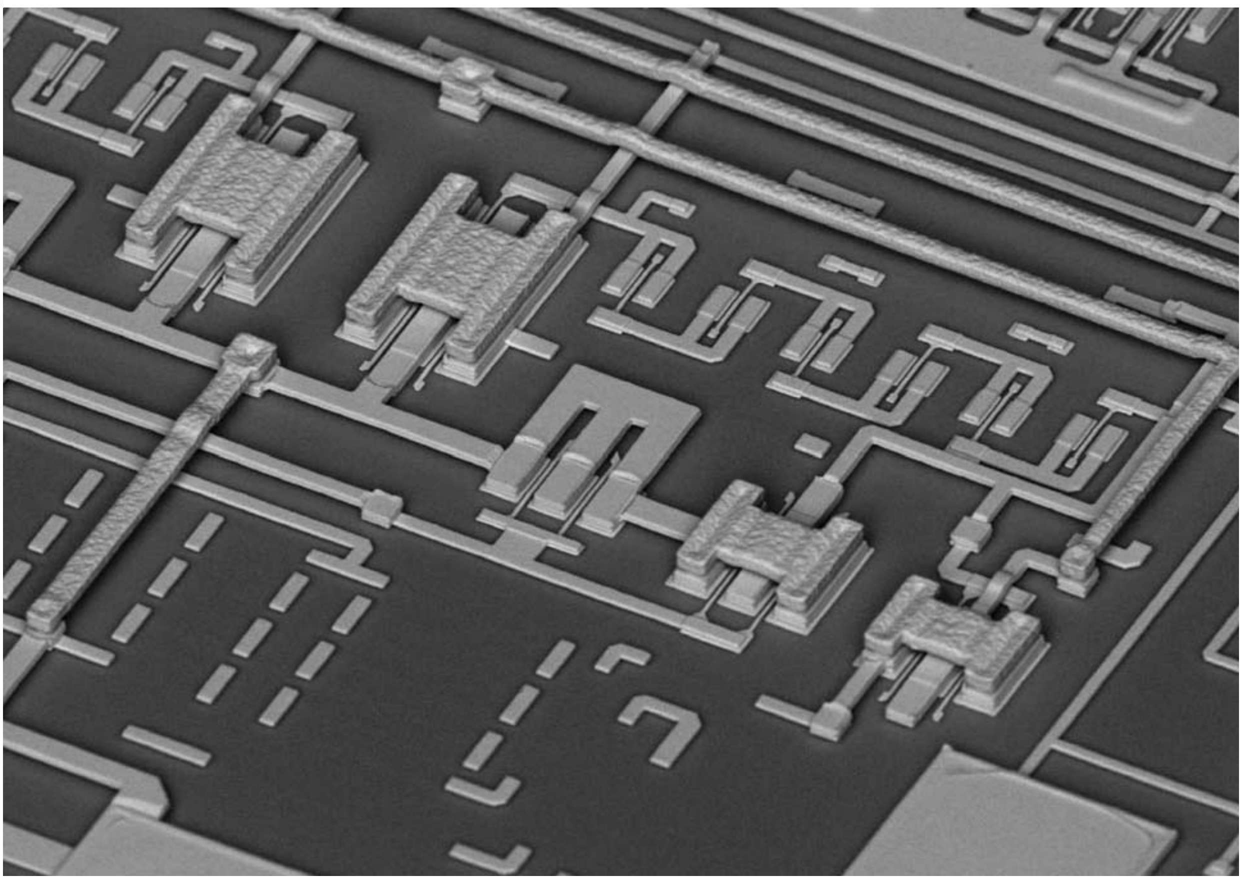

ALIX PAULTRE | Contributing Editor

Small-Cell Development is Key to a Successful 5G Infrastructure

Rex Chen

Small cells are crucial for mobile operator 5G network deployments, enabling increased coverage, high data rates, and low latencies. We talk with Rex Chen of LitePoint about some of the things the company is doing in that space.

The most important aspect of our modern cloud-based IoT-oriented society is the infrastructure required to sustain it. For all the wireless wonders that abound today, they rely on a lot of wiring behind the wainscoting. Establishing, managing, and maintaining the wireless infrastructure is vital to the continued functioning of the Internet of Things as we know and expect it to be.

Development and deployment of that infrastructure is multi-tiered and -faceted. The modern RF airways are superhighways in the sky, relying on proper lane and traffic management to prevent complete chaos. Within the 5G infrastructure, small cells are crucial, providing increased coverage and uniform 5G user experiences, as well as maintaining high data rates and low latencies.

Addressing the emerging 5G small-cell market and accelerating 5G deployments in outdoor metropolitan and indoor enterprise locations, LitePoint, a provider of 5G test solutions, announced it has signed an agreement with Qualcomm Technologies to support LitePoint's development of 5G test solutions for the Qualcomm 5G RAN Platform for Small Cells (FSM 100xx).

A Comprehensive Solution

LitePoint's IQgig-5G is a fully integrated, versatile, multiband, millimeter-wave (mmWave), and non-signaling test solution and the first of its kind to support all 5G FR2 frequencies within the 23- to 45-GHz frequency range. All signal generation, analysis, processing, and RF front-end switching are self-contained inside a single chassis. The one-box design makes it simple to set up, use, and maintain to achieve reliable measurements.

Enabling small-cell waveform generation and analysis for 5G radio technologies, it provides an intuitive graphical user interface (GUI) and allows for real-time RF parametric analysis for small cell products. The Qualcomm 5G RAN Platform for Small Cells (FSM 100xx) is the industry's first 5G NR solution for small cells. The 10-nm solution supports both sub-6-GHz and mmWave spectrum bands.

This platform is designed to support original equipment manufacturers (OEMs) to reuse both software and hardware designs across sub-6-GHz and mmWave products. To take a deeper look at this development and the role of small cells in 5G development, we spoke with Rex Chen, Director of Strategic Business Development at LitePoint.

Radio has been a fundamental part of society since Tesla developed the core technologies and Galvani implemented them. But for a long time, radio was considered more of a public good and a niche asset. Now applications for wireless have become mainstream, and we are adding new applications every day. Where would you say, Rex, the tipping point came, where wireless became a critical infrastructure commodity?

I think the tipping point where it became a commodity was when we transitioned from analog to digital. In particular, I would say it really got started around the 3G era, when you had clear voice communications and an actual device to carry with you to make a call anywhere, any time. I think that started

The emergence of O-RAN, also known as open radio access network, is another good example of how a closed-loop system is now opening up and allowing white-box vendors to participate in different layers of the network stack and lower the cost for operators to deploy new wireless infrastructure in the market.

the momentum of wireless and seeing how powerful it is and has become prevalent. It's become a part of society, and part of our everyday usage.

There are businesses that are developed on top of wireless systems that would not otherwise survive today without it. A good example would be something like Uber, right? It's an app, sits on your mobile device, and it entirely relies on the wireless communication to identify where a person is located at any point in time. Being able to communicate and request a service that they need and to get a ride to go somewhere. I think even though it's a crowded space, we're still in the early innings of how this can really transform industries with 5G.

Now there's a challenge to ensure that we can provide these services. Because it places demands on the equipment, the precision. Right? It's like having a soda fountain, each of the flavors better be in their own pipe.

It's certainly crowded. I think the idea of where the wireless system used to be, I think you mentioned earlier, kind of a very tight-knit or closed-loop asset, is now kind of moving from that kind of central base concept into the edge or open-loop concept.

Excellent point. What are your observations on that? Now that it is becoming decentralized and digitized and almost like a part of the web?

I think a variety of things can happen. Look at how the media is transforming itself today. You have YouTube influencers, you have documentaries or films that are not from the core mainstream. I think what you'll see in these wireless networks is also kind of the similar path. Where you still have your core network infrastructure, but as it kind of moves and decentralizes, you'll have these smaller, mini base stations, what we call small cells, that are going to be prevalent in places that are high density, metropolitan areas.

The emergence of O-RAN, also known as open radio access network, is another good example of how a closed-loop system is now opening up and allowing white-box vendors to participate in different layers of the network stack and lower the cost for operators to deploy new wireless infrastructure in the market.

I think these new technologies moving from the core to the edge and becoming more transparent are just some display of where we are going in the future.

Because this announcement with Qualcomm directly impacts development of small cells, why don't you put it into context of what you just explained?

Considering the importance of small cells within the context of the cloud, and the importance of precision performance to make sure that you stay "within your lanes." So how does this announcement with Qualcomm impact the development of small cells?

This announcement with Qualcomm directly impacts the OEMs building these small cells, helping accelerate products getting out in the market faster. The reason it's able to do that is because a lot of the test metrics and methodologies are highly dependent on the chipset inside the product. So this license agreement between LitePoint and Qualcomm inherently speeds up OEMs that use Qualcomm small cells (FSM 100xx) to get the end device tested in production faster and it really helps the entire ecosystem moving forward.

Let's talk about the designers involved in the deployment. How much handholding are you willing to offer? What kind of engineering support can you provide people who want to maximize and optimize this?

I think there are a couple of angles to look at. For some OEMs, they want to be able to have the ability to manage production, not just the actual device, but all the software and tools involved. For others, they are looking for already-existing optimized software solutions that are vetted by industry standards. What we do besides working with the chipmakers here is also offer not just the test instrument hardware, but all the software involved and the ability to turn on certain knobs and optimize those test methodologies.

How do you actually optimize, for example, your test time? That requires understanding what is underneath the hood in the system software and what tradeoffs or compromises can be made between quality versus time. That tradeoff has a direct impact on the bottom line of how much it costs to get a product out in the market. The collaboration with Qualcomm has been going on for many years in our cellular technologies and connectivity product, but this is kind of the next step forward.

The area where small cell plays, it's going to have a more and more important role in the future for these mobile operators to deliver higher data rates, lower latencies, and better performance. We are at the center stage of that enablement, in particular areas where there's high density, metropolitan cities, or enterprise environments, indoor corporate spaces, campuses, and facilities. The ability to get these small-cell base stations in a faster time with better cost structure is really enabling the industry and ecosystem at large for the 5G evolution. mw

FOR MORE information on LitePoint's 5G testing solutions, visit https://www.litepoint.com/products/iqgig-5g/.

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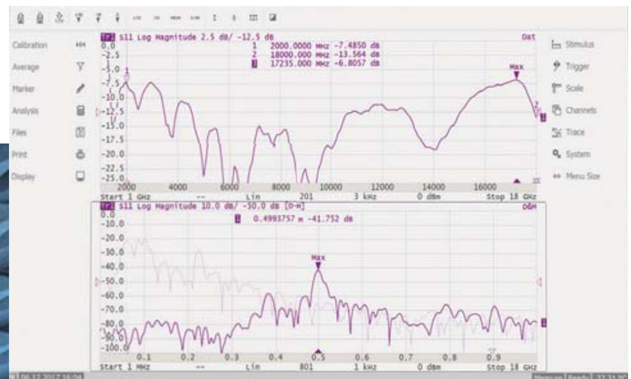

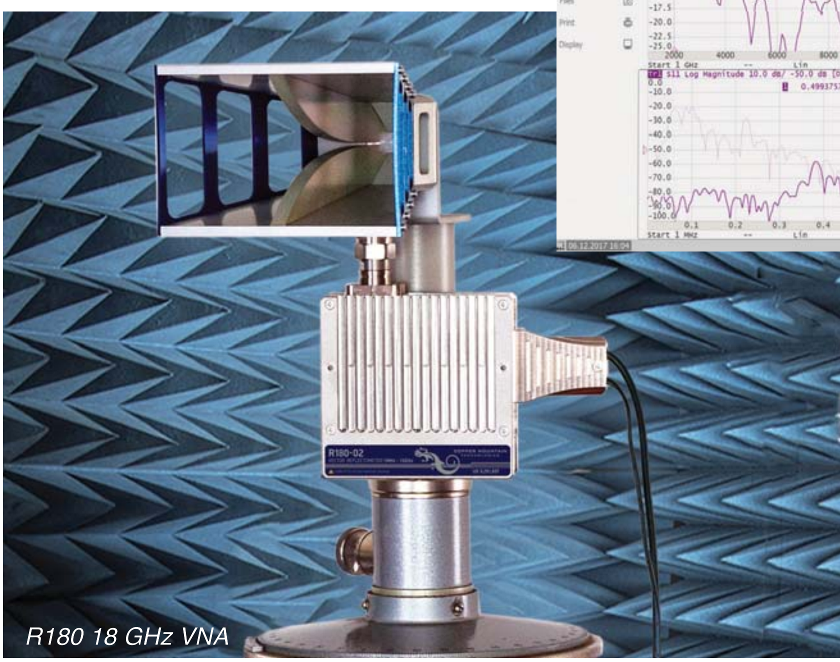

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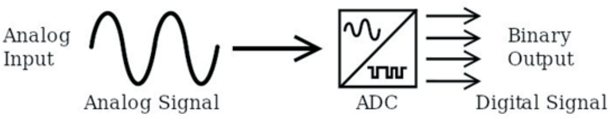
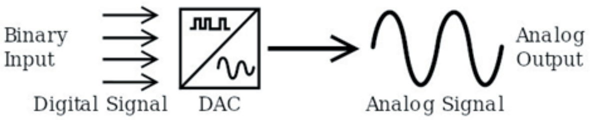
Evaluating ADC and DAC Performance Characteristics

At the boundary of the digital and analog domains is the ADC and DAC, both of which have numerous architectures. The article discusses the types of performance characteristics associated with these architectures and their application within SDRs.

As its name implies, an analog-to-digital converter (ADC) takes an analog wave as an input and converts this wave to a digitally represented output form *(Fig. 1)*. A digital-to-analog converter (DAC) essentially does the reverse, converting a digital representation into an analog form *(Fig. 2)*. How this happens largely depends on the type of ADC or DAC architecture in play.



1. This schematic illustrates basic ADC functionality.



2. Here's a schematic showing basic DAC functionality.

In the case of ADCs, various architectures are available. A few architectures of interest have the following circuits and basic operating principles:

- *Flash (direct conversion):* Flash ADCs require the use of cascading high-speed comparators, where an N-bit converter circuit uses $2^N - 1$ comparators, essentially comparing an input voltage to a reference voltage (ladder "rungs") and encoding this value in binary via Unary or thermometer code.
- *Pipeline:* These ADCs comprise several successive stages, including a sample-and-hold (S/H) circuit, low-resolution ADC/DAC, and digital error correction, before outputting the encoded signal via digital correction logic.
- *Delta-sigma:* Such devices basically consist of an oversampling modulator that feeds a very-high-rate signal into a digital/decimation filter, which produces a high-resolution and slower digitally encoded wave.
- *Successive approximation register (SAR):* The basic SAR architecture is to take an input voltage signal, sample and queue it with an S/H circuit, and then apply a comparator to

determine if the input-voltage sample is less than or equal to a reference voltage using a binary search algorithm and a register of reference voltages.

DACs, which generally accept a digital signal (serial data link) or parallel interface (such as LVDS), are designed with various architectures to convert the data, including the following popular examples:

- *Binary-weighted DACs:* These devices convert a binary number into an analog output signal proportional to the digital number, including these two types:
  1. *String resistor*: For simplicity, we can think of this type as having a string of 2^N matched resistors and switches, where N is the number of bits of the DAC. When an N-bit digital input enters the device, it's decoded and a switch is closed associated with the particular digital code, generating an output voltage signal.
  2. *R-2R binary ladder*: This type uses a binary input (b0, b1...) and two precise resistors, R and 2R, to convert data to an analog signal proportional to the value of the digital number.
- *Interleaving and pipelined*: These modern DAC architectures use multiple DAC cores in parallel via S/H circuits and can be interleaved in the frequency or time domains.

ADCs and DACs are ubiquitous in today's world, finding uses in everything from consumer electronics like cellphones, cameras, and soundcards; to electronics enthusiasts tinkering with Raspberry Pi devices; to their incorporation into high-performance software-defined radio (SDR) transceivers. The requirements of the application dictate the type of ADC and DAC needed to ensure the optimal performance and functionality of an electronic system.

Some Performance Characteristics of ADCs

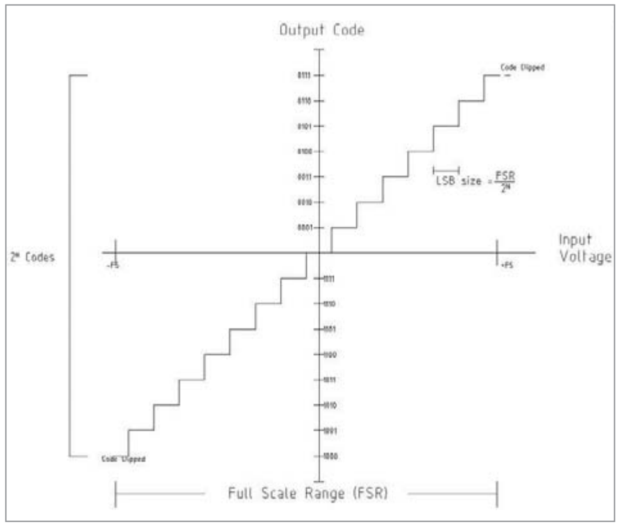
Many characteristics of ADCs must be assessed and evaluated before being designed into a system. The most basic of these characteristics are speed, resolution, dynamic range, and accuracy. ADC conversion speed refers to samples-per-second, and measures how quickly the device can accurately convert an analog signal/voltage. Many applications require these conversions to happen as quickly as possible, which is evident from the incorporation of high-speed ADCs in the highest-bandwidth SDR platforms.

Theoretically, the conversion speed is constrained by the Nyquist-Shannon theorem. In other words, the ADC sampling frequency must be at least twice the analog signal frequency. The resolution of these samples stem from the basic principle by which all ADCs convert signals—using incremental voltage steps, expressed by the number of bits (*N)* of the ADC and referred to as the least-significant bit (LSB). A step function is employed in the quantization of the analog signal into a digital representation. 1 LSB is defined as follows:

$$1\ LSB = (V_{REF} - V_{GROUND})/2^N = FSR/2^N \quad (1)$$

where V_{REF} is the reference voltage and V_{GROUND} is the analog ground voltage.

Figure 3 provides an example of a 4-bit ADC's quantization levels. While this is illustrative of the ADC encoding process and available resolution, it's clear that 2^4 allows for only 16 possible quantization levels (0 to 15), resulting in a rather low resolution. For this reason, modern ADCs are 16-bit devices (2^{16} = 65,536 = 0 to 65,536 levels) and they're incorporated into mission-critical applications such as high-performance SDRs.



3. In this plot, we see the step function (transfer function) of an ideal 4-bit ADC.

The dynamic range refers to the ratio between the largest and smallest values an ADC can accurately measure. In other words, it's the ratio between the strongest undistorted signal to the minimally detectable signal. For an ideal N-bit ADC, the minimum detected value is 1 LSB, and the maximum $2^N - 1$.

In terms of decibels, we have:

$$Dynamic\ range_{dB} = SNR_{dB} = 20log_{10}\big(((2^N - 1) * LSB)/LSB\big) \simeq 6.02 \times N \quad (2)$$

Hence, for a 16-bit ADC, the expected value is 96.32 dB of dynamic range. However, ADC dynamic range can only be truly understood by accounting for quantifiable performance measures such as signal-to-noise-and-distortion ratio (SINAD), effective number of bits (ENOB), signal-to-noise ratio (SNR), total harmonic distortion (THD), and spurious-free dynamic range (SFDR).

Perhaps the most infamous of these is the theoretical SNR, which uses the oft-quoted formula SNR = 6.02N + 1.76 dB. While we know that the first term in the equation comes from the dynamic range of the ADC itself, the second term derives from quantization noise. The quantization noise can be approximated as a sawtooth waveform having a peak-to-peak amplitude of 1 LSB, and the probability of an error occurring is ±0.5 1 LSB (i.e., one quantization level) over a uniform distribution.

Still, the theoretical dynamic range/SNR is never truly accurate due to several other factors noted above. Notably, ENOB is significant in establishing the real-world dynamic range of an ADC and is caused by noise within the signal and circuity of a converter, effectively reducing the ADC's true resolution, SNR, and dynamic range.

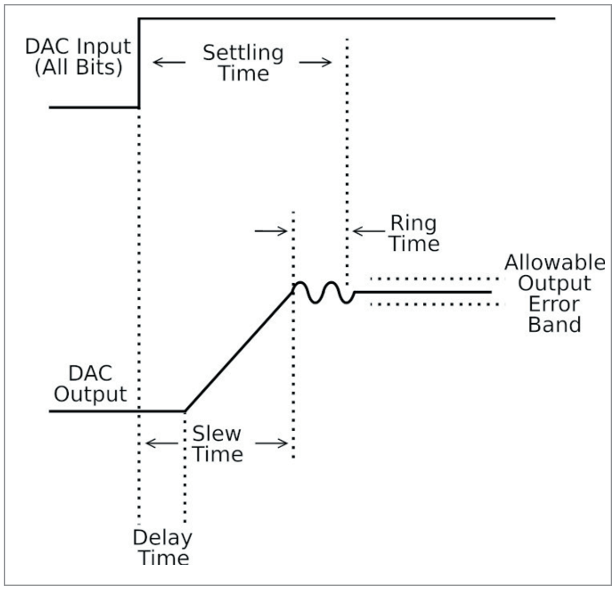
But it's not just quantization and ENOB errors that limit the accuracy of an ADC. Other factors that can cause a real device to deviate from the transfer function of an ideal ADC include offset errors and gain errors (due to temperature fluctuations), differential linearity error, and total unadjusted error (TUE), among others. Other components can also introduce errors, such as clock jitter and thermal noise, triggering further errors deviating from ideal ADC performance. Finally, there's ADC aliasing. This occurs when an input-signal frequency exceeds the Nyquist-Shannon frequency, and the signal is "folded" or replicated at other positions in the spectrum on either side of the Nyquist frequency.

Some Performance Characteristics of DACs

Like ADCs, DACs must be evaluated based on numerous criteria. This includes resolution, speed, dynamic range, SFDR, ENOB, and SNR. A performance characteristic unique to DACs is the undesirable image signals appearing within each Nyquist zone of the output. Other important characteristics include settling time and glitch-impulse area. Settling time refers to the time it takes from the input code application until the output arrives at, and remains within, a specified error band around the final output voltage *(Fig. 4)*.

Glitch-impulse area is another important characteristic behavior of a DAC, which differs significantly for an R-2R and string-resistor DAC. The glitch impulse is defined as the voltage transient appearing at the DAC output during a "major-carry transition." What this means is that during a single code transition, a MSB is changing from low to high while LSBs are changing from high to low, or vice versa (i.e., code transition from 0111 to 1000).

The glitch impulse is measured in nV*s (energy) and is equivalent to the area under the curve on a voltage-time graph. This glitch impulse arises because real circuits don't move from one conversion value to the next monotonically, thus inducing glitch energy into the output and in turn deteriorating a DAC's SFDR.



4. This illustration of DAC settling time shows the difference in time it takes from input to output, until the output arrives and remains at a specified error band around the final output voltage.

Like ADCs, DACs must be evaluated based on numerous criteria. This includes resolution, speed, dynamic range, SFDR, ENOB, and SNR. A performance characteristic unique to DACs is the undesirable image signals appearing within each Nyquist zone of the output.

How Can Performance be Improved?

ADC dynamic range can be improved by reducing quantization error/noise using two techniques: Either by oversampling or by introducing dither (white noise) into the analog signal before conversion. ADC errors related to the external environment can be minimized by several design precautions. These include ensuring the voltage and power supply has load regulation and minimal temperature drift, eliminating analog input noise, and matching the dynamic range to the maximum signal amplitude encountered.

Further improvements can be made by minimizing I/O-pin crosstalk and reducing EMI noise with EMI shields, as well as by making appropriate PCB layout changes. Often, an anti-aliasing filter is placed before the ADC in the signal path to filter out frequencies outside its bandwidth.

DAC performance characteristic issues discussed above also can be addressed. For instance, settling times largely depend on the specific DAC chip. Therefore, if the system requires high conversion speeds, use a DAC with a short settling time.

There are two approaches to minimizing glitch energy—place either an RC filter or a S/H capacitor and amplifier after the DAC. The first approach increases settling time, though, whereas the second approach is expensive in both cost and PCB space. To get rid of images within Nyquist zones, an anti-imaging filter is generally placed after the DAC, especially in high-end SDRs with the ability to generate a large frequency band.

Tables 1 and 2 compare some basic performance characteristics of different ADC and DAC architectures.

TABLE 1: COMPARISON OF PERFORMANCE CHARACTERISTICS FOR DIFFERENT ADC ARCHITECTURES

Architecture	Advantages	Disadvantages	Applications
Flash	• Ultra-high-speed sample rates	• Sparkle codes • Metastability • Component matching limits resolution to 8 bits • High power consumption • Large size • Expensive	• Wireless communications • Optical communications
Pipeline	• High-speed sample rates • Good resolution • Increased throughput • Small form factor • High SFDR • Low THD • Fewer sparkle codes	• Parallelism causes greater power consumption and latency • Requires digital error correction	• High-speed cellular base stations • Telecommunications • Satellite base stations • Radar
Delta-sigma	• Low-to-medium sample rate • High resolution (up to 31 bits) • Low cost • Low power consumption	• Complexity of circuitry due to oversampling • Limited bandwidths • No need for anti-aliasing filters	• Digital audio applications • Process control • Temperature measurements
SAR	• Low power consumption • High resolution and accuracy	• Limited speed • May require anti-aliasing filter	• Data acquisition for medical imaging • Industrial process control • Optical communications

TABLE 2: COMPARISON OF PERFORMANCE CHARACTERISTICS FOR DIFFERENT DAC ARCHITECTURES

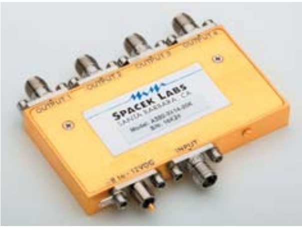
Architecture	Advantages	Disadvantages	Application
String resistor	• Fast sample input rate • Low power • Monotonicity • Low glitch energy	• High element count (2N resistors/bits for N bits) • High settling time • Gain/offset error • High noise	• Portable instrumentation • Process control • Data-acquisition systems
R-2R	• High voltage output • High resolution • High accuracy	• Binary-weighted resistors generally require expensive op amps • Switching delay • Gain/offset error • Low sampling rate	• Industrial applications
Interleaved and pipelined	• High bandwidth • High resolution • Extremely fast data input rate • Low power • Fast settling time	• High cost • Integral nonlinearity • Gain error at analog output	• Radar/jammers • Test and measurement • Satellite communications • Multiband base stations

Example Application: SDR Transceivers

As a case study, we'll discuss implementing an ADC and DAC into an SDR transceiver, an example being Per Vices' Cyan SDR transceiver *(Fig. 5 on page 28)*. An SDR transceiver includes a radio front end and digital back end, wherein ADCs and DACs take on transmit and receive functionality. SDR mission-critical applications include spectrum monitoring and recording, radar, satellite deployment/ground station tracking, and test and measurement.

To achieve the high data-rate conversion and sample rates required for these applications, SDR transceivers use a pipeline ADC and interleaved DAC. Both support JESD204B serial data communicating signals decomposed into in-phase and quadrature pair (I/Q pair) components.

For an SDR application, ADCs and DACs are selected based on number of channels, sampling rate, resolution, and SFDR to meet the high-performance demands of mission-critical applications. Furthermore, SDRs used in such applications require multiple-input, multiple-output (MIMO) architectures along with a dedicated ADC/DAC in each radio chain. Such high-performance SDRs feature an analog receive chain terminating at an anti-aliasing filter and ADC with a 3-Gsample/s rate, 16-bit



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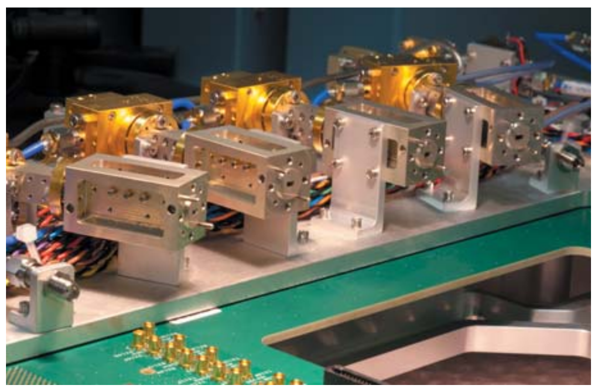
DELIVERING MILLIMETER-WAVE SOLUTIONS

Spacek Labs, Inc. is an ISO 9001:2015-certified, ITAR-registered, woman-owned, small business operating in Santa Barbara, Calif., for over 36 years. From engineering through manufacturing, we are involved in every aspect of building both active and passive millimeter-wave and microwave components and systems operating with RF frequencies from 10 to 110 GHz.

Come join our team! Spacek Labs is currently looking for an experienced RF engineer. Contact us at careers@spaceklabs.com.

Spacek Labs occupies two adjacent industrial buildings with 10,000 square feet. Our facilities include mm-wave design, development, and assembly laboratories, 30 separate assembly/test benches ranging from 10 kHz to 110 GHz with additional equipment and benches for project-specific work stations as required. Our on-site machine shop ensures consistent quality standards are met and prototype work is achieved with efficiency. Our testing facilities include vector network analyzers, spectrum analyzers, and a screen room (Faraday cage) for low-noise testing. We have the environmental equipment to temperature test our devices from −55°C to +165°C, as well as in-house cryogenic test facilities capable of temperatures as low as 15° Kelvin. Our digital design capabilities include 2D and 3D CAD and EM simulation.



PRODUCT FOCUS: MM-WAVE TRANSCEIVERS

SPACEK LABS' TRANSCEIVER designs are available in any frequency band between 10 to 110 GHz. Our engineers will design the exact solution for your transceiver requirement with single or multiple channels. Transmit channels offer a high 1-dB compression point output power. Receive channels have a low noise figure with 20-dB typical gain and 60-dB rejection of the unwanted sideband. Cross-channel isolation is greater than 60 dB.

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SPACEK LABS
MM-WAVE TECHNOLOGY

5. Per Vices' Cyan SDR transceiver uses ADCs/DACs to convert signals.

resolution, two input channels (for I and Q), 70.9-dB SNR, ENOB of 11.5, a 90-dB SFDR, and an operating temperature of −40 to 85°C.

On the transmit side, the DAC must be able to convert radar pulses; high-frequency modulated messages in the L, Ku, and Ka bands for satellite communications; and virtually any digital waveform to analog, before passing through an anti-imaging filter and the remaining transmit radio chain.

The DAC allows for a complex input data rate of 3 Gsamples/s per channel (I or Q data), 16-bit resolution, low SFDR and THD, low power consumption, high instantaneous bandwidth, short settling time, minimal glitch energy, and minimal temperature drift (10 ppm/°C). Because the ADC/DAC is central to the SDR's performance, and therefore to ensuring the success of mission-critical applications, careful attention must be paid to all performance characteristics. mw

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Low-Pass Filter Minimizes Loss from DC to 2.5 GHz

Mini-Circuits' model ZXLF-K252H+ coaxial reflectionless low-pass filter features a low-loss passband of dc to 2.5 GHz and a high-rejection stopband extending to 17.0 GHz. The 50-Ω filter is well-suited for aerospace, defense, GPS, 4G, and telecom applications. Typical insertion loss is 2.2 dB across the full dc to 2.5-GHz low-pass range, with typical VSWR of 1.30:1. And at 3.9 GHz, typical insertion loss is 3.5 dB. Typical stopband rejection is 36 dB from 7.0 to 14.5 GHz and 50 dB from 14.5 to 17.0 GHz. The typical VSWR is 1.50:1 from 7.0 to 14.5 GHz and 2.20:1 from 14.5 to 17.0 GHz. The compact filter measures 0.68 × 0.60 × 0.39 in. (17.1 × 15.2 × 10.0 mm) with 2.92-mm female input and output connectors. It is designed for operating temperatures from –55 to +105°C, 7.9-W maximum passband input power, and 1.58-W maximum stopband input power.

MINI-CIRCUITS, www.minicircuits.com

Tiny LoRaWAN Modem Slashes Current Consumption

Murata recently announced the expansion of its Type 1SJ family with a new LoRaWAN modem module. The modem module measures 10.0 × 8.0 × 1.6 mm, making it the smallest in the industry. The module operates from a single supply rail of up to 3.9 V dc. It incorporates several low-power modes that allow the real-time clock (RTC) to operate while drawing a typical current of only 1.3 µA. This allows the modem to run on a single battery for years before it needs recharging. Moreover, the modem module features a resin-mold package that allows it to operate in harsh environments at a temperature range of –40 to +85°C. The Type 1SJ comes preloaded with AT Command controlled modem firmware and a LoRaWAN stack with an AT Command middle layer, which allows for a faster time-to-market and eases design challenges.

MURATA, wireless.murata.com

Signal Analyzer Now Covers mmWave 5G Bands to 110 GHz

Thanks to the new V3050A signal analyzer frequency extender, Keysight Technologies' N9042B UXA X-Series signal analyzer enables users to test the performance of mmWave designs for 5G, aerospace/defense, and satellite communications. With the V3050A installed, the instrument delivers an unbanded, preselected sweep from 2 Hz to 110 GHz with up to 11 GHz of analysis bandwidth. It tests the true performance of a 5G NR transmitter with an advanced error-vector magnitude, and quickly finds out-of-band emissions or spurs in radar designs with superior swept displayed average noise level (DANL). The signal analyzer's performance is facilitated by Keysight's RCal receiver calibrator, which corrects signal-path losses and frequency response up to a 5-GHz IF bandwidth without the need for an external vector-network analyzer, cabling, and manual test-plane characterization.

KEYSIGHT TECHNOLOGIES, www.keysight.com

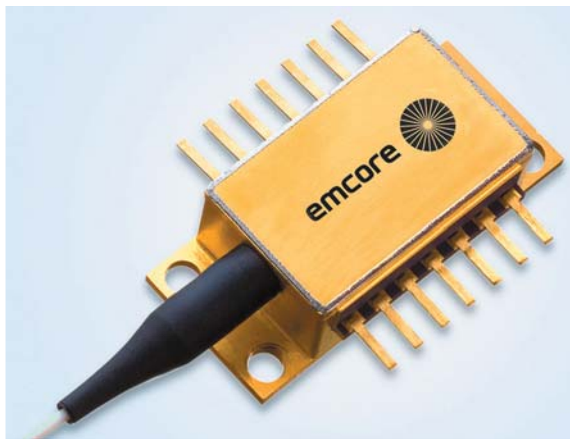
Rugged Embedded Computer Carries NVIDIA and AMD GPUs

OnLogic's Cincoze GM-1000 embedded computer brings ruggedness to challenging industrial environments in a configurable MXM form factor with GPUs from AMD and NVIDIA. The system is designed for graphics processing in applications such as machine vision, security, autonomous vehicles, medical imaging, and edge-AI applications. The GM-1000 comes equipped with an Intel 8th/9th-generation workstation-grade CPU (Celeron, Pentium, or Xeon), an MXM 3.1 Type A/B GPU module (AMD Radeon E9174/NVIDIA Quadro P2000), and up to 32 GB of DDR4 RAM. I/O and expansion include four USB 3.2 Gen 2 ports, a pair of GbE LAN connections, two 10GbE LANs, four GbE LANs, and PoE as optional add-ons.

ONLOGIC, www.onlogic.com/gm-1000/

High-Power Laser Module Drives Next-Gen LiDAR

EMCORE designed a new 1550-nm high-power laser module for LiDAR and optical sensing applications. The Model 1790 laser module is targeted for use as a CW (continuous wavelength) coherent optical source for next-generation frequency-modulation CW (FMCW) LiDAR systems in autonomous vehicles. Model 1790 provides extremely narrow linewidths combined with a high-efficiency coupling scheme to enable high optical output power of 18 dBm. The laser module is also dc-coupled with a built-in thermoelectric cooler (TEC), thermistor, and monitor photodiode, and comes packaged in a 14-pin, OC-48 pinout-compatible hermetic butterfly form factor with a double optical isolator mounted on the TEC. The 1790 features an operating temperature range from –10 to +65°C and is Telcordia Technologies GR-468 and RoHS-compliant.



EMCORE, www.emcore.com

OpenVPX Chassis Manager Gets Conduction Cooling

Pixus Technologies now offers a new conduction-cooled model for its 3U OpenVPX Chassis Manager with the Pixus SHM200. The latest chassis is VITA 46.11-compliant for system management and meets VITA 48.2 standards for mechanical design. The Tier 2 Pixus OpenVPX Chassis Manager features six temperature sensors and 10 fans with PWM/Tach control, along with 16 digital inputs and outputs. The standard model is outfitted with RS-232, RJ-45, and USB ports and includes a web interface to query the system and import images of their boards remotely. Monitoring each module's status is done by clicking on the image for each slot, making it easy to switch between them on-the-fly.

PIXUS TECHNOLOGIES, pixustechnologies.com

Spectrum Analyzer Provides Real-Time Analysis

Rigol Technologies expanded its RF test portfolio with the RSA3000E real-time spectrum analyzer. The RSA3000E, which combines the power of a high-performance swept-spectrum analyzer with a real-time analyzer's capability, is available in both 1.5- and 3-GHz models. It also comes standard with 10 MHz of real-time analysis bandwidth with seamless capture and a 9.3-µs 100% POI. What's more, the RSA3000E can function as a traditional swept-spectrum analyzer with a resolution bandwidth (RBW) of 1 Hz, a noise floor as low as –161 dBm, phase noise of –102 dBc/Hz, and a full-span sweep as fast as 1 ms. The analyzer has an integrated EMI pre-compliance option, allowing engineers to measure, compare, analyze, and report on EMI issues throughout the design process.

RIGOL TECHNOLOGIES, www.rigolna.com

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