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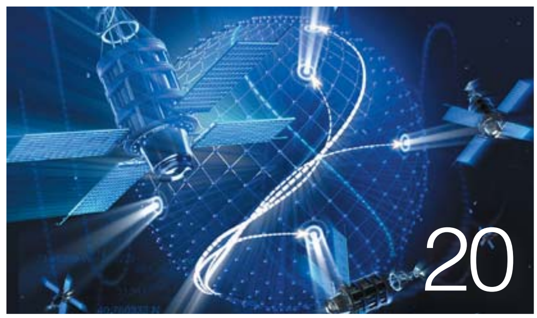

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Editorial

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U.S.-Made MMICs Not Immune to Illegal Export

One can't be too careful when it comes to safeguarding sensitive RF/microwave technology, especially when it involves potential military applications by adversaries.

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Our RF/microwaves industry is a critical technology sector in the overall fabric of daily life. It's also key to many commercial and military applications, and the latter especially behooves us to safeguard the "secret sauce" in defense-related recipes. So, a news item out of the U.S. Department of Justice caught my eye, especially as the story concerned illegal export of monolithic microwave integrated circuits (MMICs).

A 66-year-old Chinese-American man, Shih Yi-chi of Hollywood Hills, Calif., has now been convicted and sentenced to more than five years in prison and ordered to pay out over $660,000 in IRS restitution and fines in a scheme to illegally export MMICs with military applications to the People's Republic of China (PRC).

Shih, a former president of a Chinese semiconductor company and an adjunct engineering professor at UCLA, certainly knew what he was doing when he put up an associate to pose as a domestic customer of an unnamed U.S.-based MMIC manufacturer. Through that associate, Shih gained access to the company's web portal, defrauding it out of proprietary information, and concealed his true intent to pass the custom MMICs on to a PRC-owned entity called AVIC 607.

Shih's old Chinese company, Chengdu GaStone Technology Co. (CGTC), in 2014 was placed on the U.S. Commerce Dept.'s Entity List for its involvement in "illicit procurement of commodities and items for unauthorized military end use" in China. That company was then building a MMIC fab in Chengdu. There was no way Shih could use that operation as a cover, of course, so he used a Hollywood Hills-based company he controlled, Pullman Lane Productions, LLC, to funnel financing from yet another Chinese company that was placed on the Commerce Dept.'s Entity List the same day as CGTC.

Shih was convicted of conspiracy to violate the International Emergency Economic Powers Act and the Export Administration Regulations. There were also numerous counts of mail and wire fraud and false statements to both the FBI and IRS, among other charges. His associate, convicted of smuggling, received 18 months of probation plus a $5,000 fine.

The custom MMICs Shih tried to move to China had both commercial and military applications. The latter include missiles, missile guidance systems, fighter jets, electronic warfare and EW countermeasures, and radar. Given the current tension over trade with China, not to mention the country's potential as a military adversary, it would be a disaster if sensitive technology got into its hands. Even more reason, then, to maintain vigilance when it comes to RF/microwave-related matters. mw

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P1T-DC40G-65-T-292FF-1NS


P2T-100M56G-100-T


P3T-500M40G-60-T-55-292FF


P4T-100M53G-100-T-RD


P5T-500M40G-60-T-55-292FF-5G40G

PMI Model No.	Frequency Range (GHz)	Insertion Loss (dB Typ)	Isolation (dB Typ)	Switching Speed (Typ)	Power Supply	Configuration Size (Inches) Connectors
P1T-DC40G-65-T-292FF-1NS https://www.pmi-rf.com/product-details/p1t-dc40g-65-t-292ff-1ns	DC - 40	5.5	65	5 ns	+15 V @ 15 mA -15 V @ 40 mA	SPST, Absorptive 1.2” x 1.3” x 0.5” 2.92mm (F)
P2T-100M56G-100-T https://www.pmi-rf.com/product-details/p2t-100m56g-100-t	0.1 - 56	5	100	50 ns	+5 V @ 100 mA -5 V @ 100 mA	SP2T, Absorptive 1.0” x 0.75” x 0.4” 2.4mm (F)
P3T-500M40G-60-T-55-292FF https://www.pmi-rf.com/product-details/p3t-500m40g-60-t-55-292ff	0.5 - 40	6	60	50 ns	+5 V @ 35 mA -5 V @ 15 mA	SP3T, Absorptive 1.0” x 1.0” x 0.5” 2.92mm (F)
P4T-100M53G-100-T-RD https://www.pmi-rf.com/product-details/p4t-100m53g-100-t-rd	0.1 - 53	6	100	50 ns	+5 V @ 200 mA -5 V @ 200 mA	SP4T, Absorptive 1.25” x 1.25” x 0.4” 2.4mm (F)
P5T-500M40G-60-T-55-292FF-5G40G https://www.pmi-rf.com/product-details/p5t-500m40g-60-t-55-292ff-5g40g	0.5 - 40	8	60	40 ns	+5 V @ 55 mA -5 V @ 45 mA	SP5T, Absorptive 1.25” x 1.25” x 0.4” 2.92mm (F)
P6T-2G18G-60-T-512-SFF-LV https://www.pmi-rf.com/product-details/p6t-2g18g-60-t-512-sff-lv	2 - 18	4	60	50 ns	+5 V @ 121 mA -12 V @ 33 mA	SP6T, Absorptive 1.5” x 2.0” x 0.4” SMA (F)
P7T-0R8G18G-60-T-SFF-SMC https://www.pmi-rf.com/product-details/p7t-0r8g18g-60-t-sff-smc	0.8 - 18	4.3	60	75 ns	+5 V @ 300 mA -5 V @ 100 mA	SP7T, Absorptive 1.5” x 1.5” x 0.7” SMA (F)
P8T-100M54G-90-T-RD https://www.pmi-rf.com/product-details/p8t-100m54g-90-t-rd	0.1 - 54	9	90	50 ns	+5 V @ 400 mA -5 V @ 300 mA	SP8T, Absorptive 1.6” x 1.68” x 0.4” 2.92mm (F)
P9T-500M40G-60-R-55-292FF-OPT1222 https://www.pmi-rf.com/product-details/p9t-500m40g-60-r-55-292ff-opt1222	0.5 - 40	6.5	60	100 ns	+5 V @ 450 mA -5 V @ 75 mA	SP9T, Reflective 4.5” x 1.5” x 0.4” 2.92mm (F)
P12T-0R5G18G-60-T-SFF https://www.pmi-rf.com/product-details/p12t-0r5g18g-60-t-sff	0.5 - 18	5	60	100 ns	+5 V @ 300 mA -5 V @ 100 mA	SP12T, Absorptive 6.0” x 2.0” x 0.4” SMA (F)
P16T-100M52G-100-T-DEC https://www.pmi-rf.com/product-details/p16t-100m52g-100-t-dec	0.1 - 52	18	100	100 ns	+5 V @ 1100 mA -12 V @ 720 mA	SP16T, Absorptive 8.0” x 3.0” x 0.77” 2.4mm (F)
P20T-7G18G-80-T-515-SFF-SP https://www.pmi-rf.com/product-details/p20t-7g18g-80-t-515-sff-sp	7 - 18	7.5	65	250 ns	+5 V @ 500 mA -15 V @ 200 mA	SP20T, Absorptive 4.0” x 4.0” x 0.63” SMA (F)
P32T-0R5G18G-60-T-SFF https://www.pmi-rf.com/product-details/p32t-0r5g18g-60-t-sff	0.5 - 18	9.5	60	100 ns	+5 V @ 1450 mA -5 V @ 200 mA	SP32T, Absorptive 8.0” x 3.5” x 1.0” SMA (F)


P6T-2G18G-60-T-512-SFF-LV


P7T-0R8G18G-60-T-SFF-SMC


P8T-100M54G-90-T-RD


P9T-500M40G-60-R-55-292FF-OPT1222


P12T-0R5G18G-60-T-SFF


P16T-100M52G-100-T-DEC


P20T-7G18G-80-T-515-SFF-SP

P32T-0R5G18G-60-T-SFF

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NI Joins 6G Initiatives

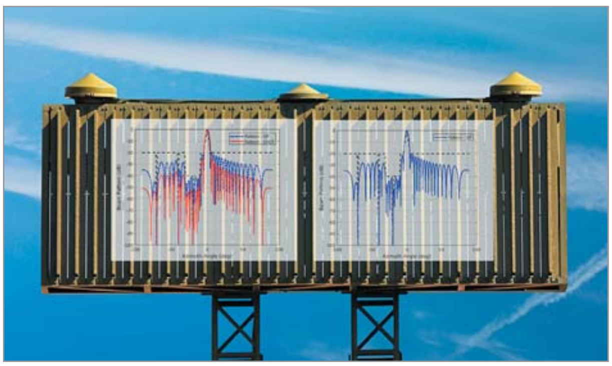
David Hall, NI's director of semiconductor marketing, discusses NI's targeted business cases for 6G development in the context of the company's memberships in the Next G Alliance and NYU Wireless's Industry Affiliates program.

https://www.mwrf.com/technologies/systems/video/21171074/ni-joins-6g-initiatives

Why We Need to Talk IoT Security Right Now

Microwaves & RF speaks with Ian Drew, Chairman at Foundries.io, on the importance of IoT security and what it means for the future of the connected world.

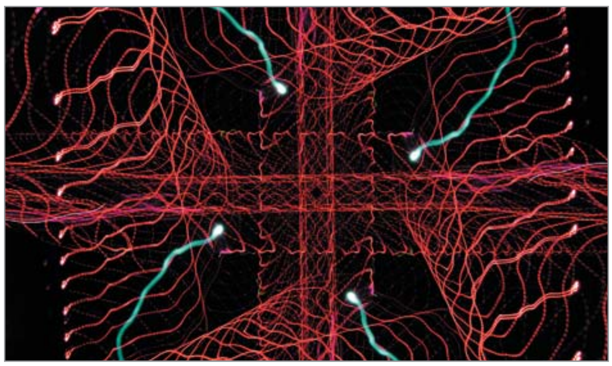
https://www.mwrf.com/technologies/systems/article/21170416/microwaves-rf-why-we-need-to-talk-iot-security-right-now



Optimization Techniques for Phased-Array Synthesis

This edition of "Algorithms to Antennas" discusses optimization solvers, which can be used to achieve a desired pattern in radar and wireless system applications that use phased-array front ends.

https://www.mwrf.com/technologies/systems/article/21170239/mathworks-algorithms-to-antennas-optimization-techniques-for-phasedarray-synthesis



Back to Basics: Impedance Matching (Part 1)

The term "impedance matching" is rather straightforward. It's simply defined as the process of making one impedance look like another. Frequently, it becomes necessary to match a load impedance to the source or internal impedance of a driving source.

https://www.mwrf.com/technologies/systems/article/21167982/electronic-design-back-to-basics-impedance-matching-part-1

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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

SPACE-READY SDR MODULE Carries Open Reconfigurable FPGA

In a credit-card-sized module, CesiumAstro's SDR-1001 delivers four Tx and four Rx channels of SDR for LEO satellites and airborne missions.

CesiumAstro

In its SDR-1001, a flight-ready, credit-card-sized modular software-defined radio (SDR) module, CesiumAstro delivers four transmit and four receive channels tunable from 300 MHz to 6 GHz for commercial, government, and defense applications. The module, which is tested to NASA GEVS standards, ships with a default BPSK/QPSK modem and optional FPGA Developer Toolkit, enabling custom waveform development.

Meant for low-Earth-orbit satellites (LEOS) and airborne missions, the SDR-1001, which weighs just 100 grams, offers custom waveform support with 70% of its FPGA resources available for custom designs. It integrates a flexible RF front-end with high-performance FPGA to support a 5-to-7-year mission duration. Mil-Spec connectors provide access to RF signals and enable both SpaceWire and Ethernet connectivity. Integrated redundancy and failover logic provide resiliency from radiation events with onboard telemetry delivering system health and power management information.

The pre-loaded reference modem functionality provides a carrier-sense multiple-access (CSMA)-based, multi-point mesh networking capability out of the box. When two SDRs establish a connection, data packets from Ethernet, SpaceWire, or serial ports are routed across the link. The company is also developing turnkey waveform support for DVB-S2, DVB-S2X, and CCSDS with Tx data rates up to 500 Mb/s.

An available FPGA development kit allows communications engineers to build and deploy custom waveforms on the SDR-1001's open and reconfigurable FPGA. The underlying board-support package (BSP) firmware provides a simplified API for controlling the RF front end and data management while enabling full access to baseband IQ data for custom waveform and modem development. Support and training are provided with the FPGA development kit to accelerate user success.

The SDR-1001 is offered as a standalone module, but also forms the backbone of other Cesium products, including fully integrated L-band, S-band, X-band, Ku-band, and Ka-band connectivity and phased-array solutions. Producing low-SWaP, plug-and-play hardware with high-volume manufacturing techniques, Cesium can support volume orders for LEO space and airborne applications. mw

Mercury Systems

SOLID-STATE MEMORY Tolerates Space Radiation

SATELLITES ARE BECOMING increasingly important components in a global electronic network for communications and navigation, even though the components within satellites are subject to high radiation levels that can limit reliability and operating lifetimes. Fortunately, electronic devices such as the model RH3480 solid-state data recorder (SSDR) from Mercury Systems are being designed with radiation in mind, with the capabilities to withstand radiation levels found in space applications and on board low-Earth-orbit satellites (LEOS).

Based on single-level-cell (SLC) NAND flash memory, the RH3480 SSDR provides reliable 480 GB of storage in a compact 3U VPX-compatible form factor *(see figure)*. Designed and built according to reduced size, weight, and power (SWaP) demands, it features highly dense data storage but weighs only 750 g in keeping with satellite communications (satcom) and navigation requirements. In addition to high radiation tolerance, the SSDR employs advanced error-correction-code (ECC) algorithms to maintain data integrity under the harsh operating conditions of space. It functions in linear and host-addressable operating modes. The dual-port design can write data at rates to 18.4 GB/s and read data at rates to 16.0 GB/s. ■

Per Vices Corporation

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FOR MISSION CRITICAL APPLICATIONS

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The Best Valued SDR in its Class

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- 1300MHz of bandwidth in one platform
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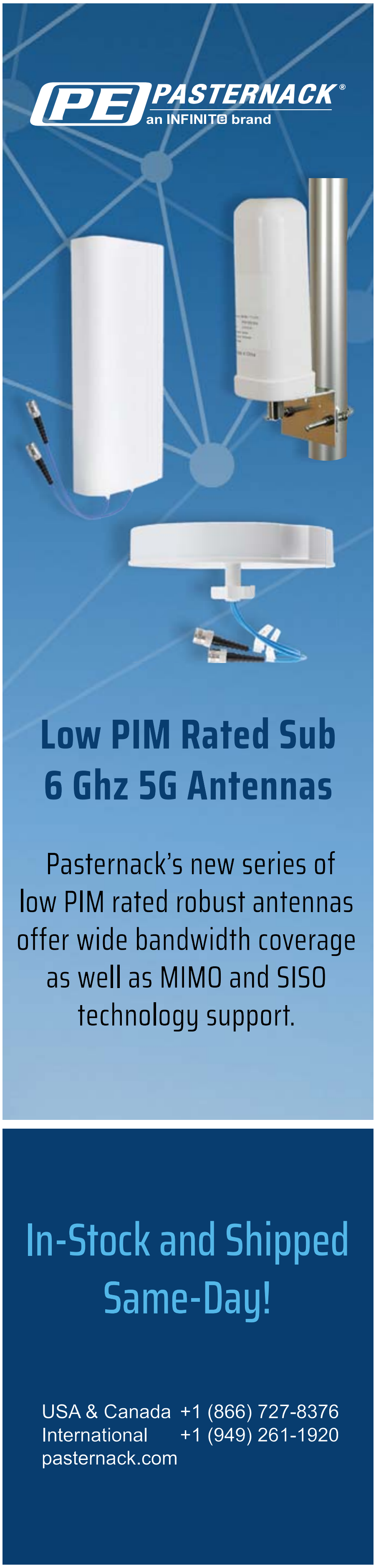
- 1U Form Factor

CYAN

The Best SDR Available

- DC to 18GHz
- Up to 16GHz of bandwidth in one platform
- Up to 16 independent radio chains
- 3U Form Factor



GALLIUM NITRIDE + MCM = More 5G Efficiency

NXP

BY ADDING GALLIUM-NITRIDE (GaN) technology to its multichip-module (MCM) platform, NXP has hit a significant milestone for 5G energy efficiency. Building on the company's investment in its highly advanced GaN fab in Arizona, NXP is the first to announce RF solutions for 5G massive MIMO that combine the high efficiency of GaN with the compactness of multichip modules.

Reducing energy consumption is a major goal for telecom infrastructure, where every point of efficiency counts. The use of GaN in multichip modules increases lineup efficiency to 52% at 2.6 GHz—8% higher than the company's previous module generation. NXP has further improved performance with a proprietary combination of LDMOS and GaN in a single device, exploiting GaN's inherent wideband performance to achieve 400 MHz of instantaneous bandwidth. As a result, it's now possible to design wideband radios with a single power amplifier.

This energy efficiency and wideband performance are now available in the small footprint of NXP's 5G multichip modules. The new portfolio will enable RF developers to reduce the size and weight of radio units, helping mobile network operators lower the cost of deploying 5G on cellular towers and rooftops. In a single package, the modules integrate a multi-stage transmit chain, 50-Ω in/out matching networks, and a Doherty splitter/combiner. NXP is also adding bias control using its latest SiGe technology. This new step in integration removes the need for a separate analog control IC and provides tighter monitoring and optimization of power-amplifier performance.

"NXP has developed a unique technology toolbox dedicated to 5G infrastructure that includes proprietary LDMOS, GaN, and SiGe, as well as advanced packaging and RF design IP," said Paul Hart, executive vice president and general manager of the Radio Power Business Line at NXP. "This enables us to leverage the benefits of each element and combine them in the most optimal way for each use case."

Like the previous module generation, the new devices are pin-to-pin compatible. RF engineers can rapidly scale a single power-amplifier design across multiple frequency bands and power levels, reducing design cycle time and accelerating the rollout of 5G around the globe

NXP's new 5G multichip modules will sample in Q3, with production starting later this year.

NXP's new 5G multichip modules will sample in Q3, with production starting later this year. The devices will be supported by NXP's new RapidRF series of RF front-end board designs that helps accelerate the design of 5G systems. ■


5G
PASTERNACK

SOSA-ALIGNED DEV PLATFORM Speeds System Integration

IF YOU'RE DEVELOPING and integrating systems that mesh with the Sensor Open Systems Architecture (SOSA) technical standard, you might be interested in Pentek's model 8256 development platform. The platform, which is aligned to the SOSA standard, is a 3U VPX platform with Intelligent Platform Management Interface (IPMI) and connectivity for RF and optical interfaces. The Model 8256 is built for application development with Pentek's Quartz RFSoC data-acquisition and processing boards. Pentek's SOSA-aligned products facilitate interoperability, reuse, and rapid technology insertion, all consistent with the SOSA Consortium's approach and vision.

Several Pentek partners and key contributors to the emerging SOSA Technical Standard are involved in the development of this platform. Pentek teamed with Elma Electronic for backplane and system management components, Interface Concept for backplane switch modules, Concurrent Technologies for single-board computer modules, and Crossfield Technology for IPMI and chassis management support; all specifically designed to be in alignment with the SOSA Technical Standard.

Pentek

The Open Group SOSA Consortium created a common framework, the emerging SOSA Technical Standard, for sensor systems based on key interfaces and open standards established by industry-government consensus. The forthcoming SOSA Technical Standard implements numerous VITA standards that are reflected in the Pentek Model 8256 configuration. The Model 8256 takes advantage of several advanced features including cooling, platform system management and RF/optical interface options.

For one, the Model 8256's built-in forced-air cooling is designed to support conduction-cooled boards in a standard 19-in. rackmount profile chassis. This provides the convenience of development on conduction-cooled boards in a desktop or laboratory environment. The development chassis uses the VITA 46.11- and HOST-aligned Chassis Management Module (CMM). This CMM is software-upgradeable to the forthcoming SOSA v1.0 standards. SOSA-aligned systems will feature, and the CMM will enable, meaningful integration between the functional elements (SOSA Modules) and the System Manager, the CMM, and every plug-in card (PIC).

Model 8256 is designed for convenient access to RF and optical interfaces. Each RF payload slot can be optioned with 20 coaxial breakout connectors located on the back panel of the chassis, providing direct connections to the VITA 67.3C backplane connector. In addition, each RF payload slot can be optioned with two rear-panel MPO adapters to provide access to the VITA 67.3C dual optical interfaces.

The Model 8256 is immediately available. Several options for Quartz RFSoC data-acquisition and processing boards, RF, and optical interconnections are possible. Pentek integration assistance is available to select and configure modules that are most appropriate for prototyping specific applications. ■

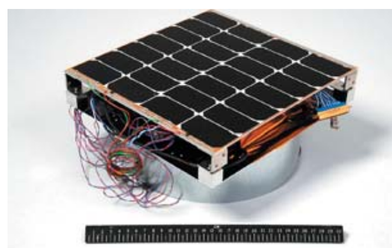
PRAM PASSES First Year in Space

HUMANITY'S DEMAND FOR sources of energy is growing, even if those sources are from outer space. As the U.S. Naval Research Laboratory (NRL) has demonstrated for over a year with its Photovoltaic Radio-Frequency Antenna Module (PRAM) experiment, solar energy captured in space may serve as a practical source for terrestrial applications on Earth. The PRAM energy-capturing device *(see figure)* was launched aboard the U.S. Air Force X-37B Orbital Test Vehicle last May 17, 2020.

The PRAM experiment is evaluating components for what may be a power-satellite network to capture energy from space and transmit it anywhere on Earth. The PRAM team has been receiving data from the module on a regular basis, to better understand the mechanical and electrical performance requirements over time that will be needed for the long-term success of a power satellite network. "It's been exhilarating getting to this point," said Paul Jaffe, Ph.D., PRAM principal investigator. "While we would have liked the moment to arrive sooner, it's great to feel that we're making forward progress."

Jaffe offered, "Seeing some of the effects of key differences between testing in space and on the ground has definitely been eye-opening. PRAM is successfully laying the foundation for the next iteration of experiments and demonstrations for space solar."

Chris DePuma, PRAM program manager, explained, "The analysis to this point has shown that it has performed as well in orbit and even in some cases exceeded our pre-launch laboratory testing," DePuma noted satisfaction from the first data pack-


Naval Research Laboratory

age received from the X-37B Orbital Test Vehicle: "It confirmed all our hard work had paid off and PRAM was working in orbit, and delivering valuable data to advance space solar and power beaming research."

Electromagnetic (EM) energy beams are used to transfer power from the PRAM unit to terrestrial receivers. If these experiments are successful, they will offer a means of collecting significant amounts of solar energy with a constellation of satellites and transferring the energy across free space via EM technology. ■

43.5-GHz SPECTRUM ANALYZER Takes on mmWave Tasks

WITH ITS NEW SM435B RF spectrum analyzer and monitoring receiver, Signal Hound has taken the leap into millimeter-wave spectrum analysis. The instrument touches a broad swath of mmWave applications from 5G to military, aerospace, and many others.

The SM435B tunes from 100 kHz to 43.5 GHz, boasts 160 MHz of instantaneous bandwidth (IBW), a high dynamic range of 110 dB, and a sustained sweep speed of 1 THz/s. It also brings to the table a built-in sub-octave preselector from 100 kHz to 43.5 GHz, and ultra-low phase noise—introducing no more than 0.1% error to EVM measurements. This low level of phase noise rivals the most expensive spectrum analyzers on the market, the company claims. Its system noise figure ranges between 12 and 15 dB and between 700 MHz and 15.2 GHz.

The minimalist design of the SM435B brings only the essentials and comes in a small form factor that fits seamlessly into a test-bed or production-line scenario. The streamlined and portable design makes it suitable for the bench, the lab, or wherever your work takes you. The unit measures 10.45 x 7.2 x 2.15 in. (265 x 183 x 55 mm) and weighs 9.51 lbs. (with passive cooling, ac desktop adapter, and power cord). As with its other products, Signal Hound includes a fully-documented API, supporting features such as spectrum sweeping, setting record-on-event triggers, real-time analysis, and 40 MHz of calibrated I/Q streaming data.

Digital signal distribution from the SM435B for high-speed RF signal analysis is possible via an on-board Intel 10AX027 FPGA and an external personal computer with an Intel Core i7 processor (available USB 3.0 port and fourth-generation processor required). This flexibility gives users the option to scale to any current or future configuration. The unit includes built-in GPS for automatic time and geolocation stamping of the received signals. This analyzer comes paired with Signal Hound's Spike spectrum-analysis software; featuring real-time analysis, WLAN modulation, digital demodulation, and interference-hunting measurements, among others.

The SM435B is available for pre-order now, with a U.S. retail price of $22,000. It can be purchased direct from Signal Hound or from one of its worldwide distributors. A company-issued PO is required for pre-order. Ship date is mid-October 2021. ■

Signal Hound

1 MHZ TO 50 GHZ

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Simulate Real-World Mesh Communication in Your Lab

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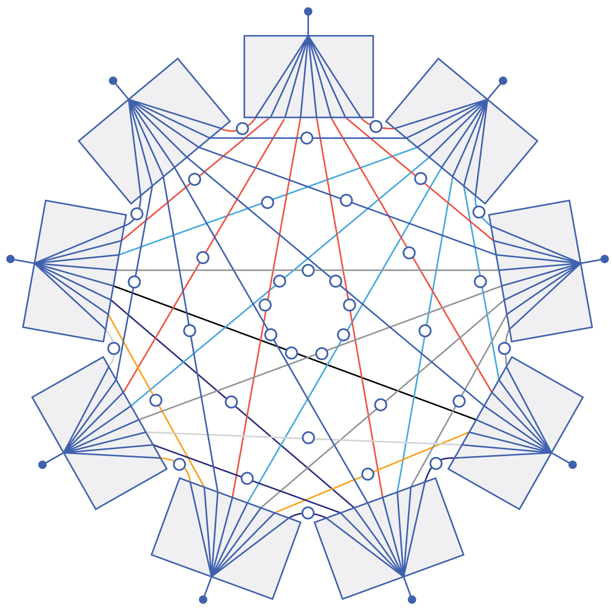
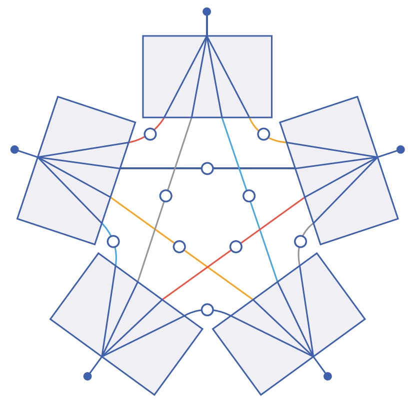
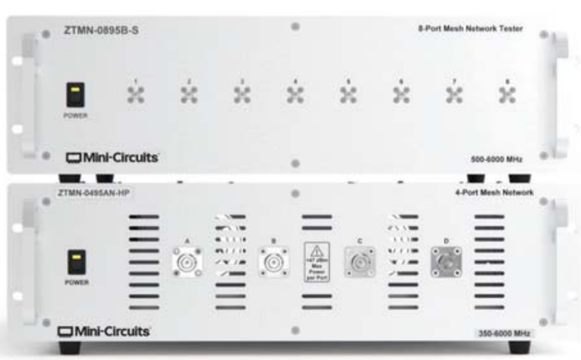
 



Ideal for testing receiver sensitivity, changes in range between devices, effects of interference on performance and more!

Common applications:

- R&D testing of wireless “smart” devices
- Bluetooth, Zigbee, Z-Wave, Wi-Fi, IoT
- Qualification / acceptance testing of military radios
- UHF / VHF band man-pack / vehicular systems
- PMR / TETRA

Mini-Circuits

MARC PEGULU | Vice President, IoT Strategy and Products, Semtech

RETURN to the OFFICE SAFELY with IoT TECH

As employees return to the office, businesses must provide a safe work environment. Here are four ways IoT technology can help ensure safety in office and work settings.

The COVID-19 pandemic presented the world with striking challenges. As restrictions continue to lift, businesses are responding by leveraging Internet of Things (IoT) technologies to balance health and safety concerns while employees return to office work settings. This is critical since many employees are hesitant about the "return to normal."

Early on in the pandemic, a study from Just Capital found that 90% of Americans wanted companies to prioritize health and safety in the wake of COVID-19. More recent research suggests there's still a lot of fear from employees when it comes to returning to the office. Despite being vaccinated, many employees still seek additional measures taken by their employers when it comes to comfort level and assurance of health and safety.

As more companies welcome employees back to in-person settings, the pressure on these businesses is mounting to provide a safe work environment. Luckily, there are four key ways that connected technology can be used to ensure safety in office work settings:

Proximity Sensing & Contact Tracing

Whether restrictions are fully lifted or just relaxed, many businesses can continue enforcing safe social-distancing practices and contact tracing in the office so that their employees feel more confident about working in a co-located physical workplace. The ability to automate monitoring of new safety policies, while empowering

employees as part of the new normal in business operations, is critical for any organization.

Over the past year, there have been significant developments around contact tracing. This technology went from a slightly unknown commodity to an imperative necessity, but issues remain. In several countries, manufacturers are developing and testing contact-tracing apps for smartphones, but these apps are collecting and storing data about an individual's whereabouts 24 hours a day. While contact tracing is important, it should not compromise the privacy of individuals when they are outside the office. Companies can choose a less intrusive method, and are able to do so with IoT technology.

The ideal solution would leverage wearables over a smartphone with support for robust long-range wireless communications to alert when employees may have been exposed to a co-worker or visitor who tests positive. At the same time, these wearables also can be used for proximity sensing, alerting employees when they are closer than the allotted distance. Employees can confidently bring their wearable device to work knowing that their privacy is protected because the only environment in which they are traceable is within company premises.

People-Counting Solutions

As capacity limits increase across the board, it is critical for employers to monitor their office spaces to ensure appropriate public health guidelines are being followed. However, office monitoring is an incredibly difficult task.

With common spaces, conference rooms, desk areas, and other spaces, there are a lot of different elements to look after. All must be accounted for, requiring attention to detail and efficiency from employers throughout this process. Occupancy monitoring technology provides real-time insights on population activity, measuring the effectiveness of social distancing and other public health guidelines based on local compliance with these regulations.

Employers can use a number of different IoT-based solutions, including density control sensors to provide anonymous, real-time people counting in different spaces set for pre-defined capacity levels. Employers also may enable solutions that involve green-red "traffic light" alerts to regulate access to buildings. The key is that all of these solutions can be used to inform practical adjustments to operating procedures and flow throughout an office space.

Air-Quality Monitoring

Scientific research has indicated that quality airflow is a key to increasing protection and slowing the spread of COVID-19. The Centers for Disease Control and Prevention (CDC) recommends multiple mitigation strategies to combating COVID-19, including significant improvements to building ventilation to reduce the spread of disease and lower the risk of exposure. In doing so, looking to carbon dioxide (CO_2) in combination with humidity and temperature will be a reliable indicator for indoor air quality, which can now be measured in real time thanks to IoT-based solutions.

IoT-based building and indoor environment monitoring solutions are extremely innovative and comprehensive tools in minimizing the spread of COVID-19 in support of safe building and workspace reoccupancy. Indoor air-quality sensors for CO_2, humidity, and temperature can reduce COVID-19 aerosols. Long-range and low-power technology is particularly critical here as building layouts can be diverse and sensors can be hidden in or around walls and the ceiling.

Maintaining humidity levels between 40% and 60% is proven to reduce the transmission of viruses. The utilization of these continuous environmental monitoring solutions, including the measurement of humidity and CO_2 levels and optimizing ventilation, is crucial in helping businesses reoccupy in a post-COVID world.

Hygiene-Monitoring Solutions

The COVID-19 pandemic had a major impact on all of us, especially our behavior and mindset when it comes to hygiene. Businesses should focus on enhanced cleaning and disinfecting practices to address the health and safety of workers, tenants, customers, and others who pass through their facilities.

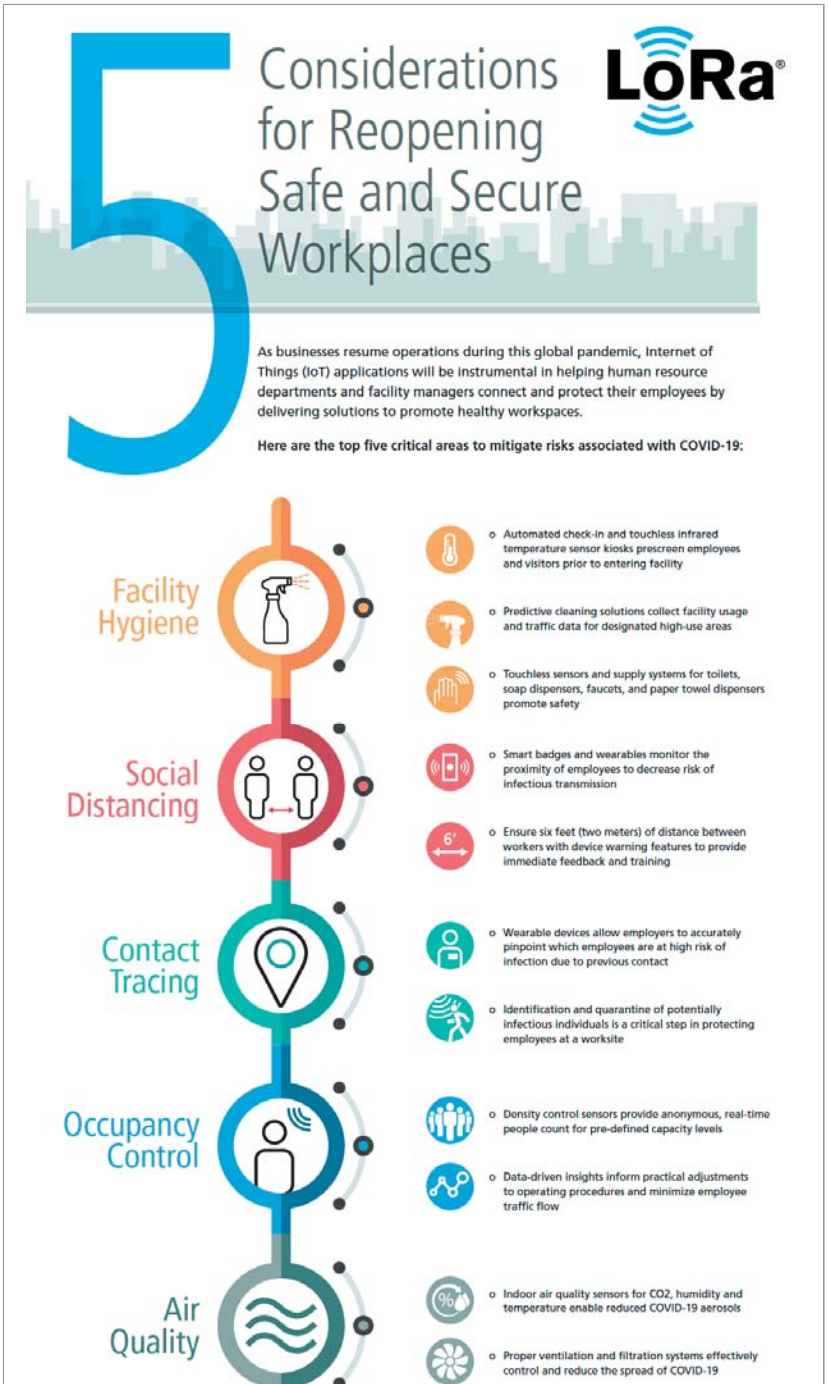
IoT-based hygiene-monitoring solutions can enable contactless check-in and predictive cleaning. For example, automated check-in and touchless infrared temperature sensor kiosks can be used to pre-screen employees and visitors entering a facility.

Additionally, predictive cleaning solutions can monitor and record traffic and usage data in designated high-use areas. Having insight into heavily trafficked areas means refills of soaps or disinfectant can be more easily predicted. Touchless sensors and supply systems for toilets, soap dispensers, faucets, and paper towels also help lessen the transfer of germs, promoting safety in shared spaces.

Semtech

Looking Forward

With millions of Americans receiving COVID-19 vaccinations, we continue to move closer to a return to normal everyday activities. This means that places such as restaurants, stores, and most notably, offices, will begin fully reopening. We must continue to emphasize the importance of safety in work settings with the use of IoT-enabled solutions for contact tracing, people counting, and air and hygiene monitoring. mw



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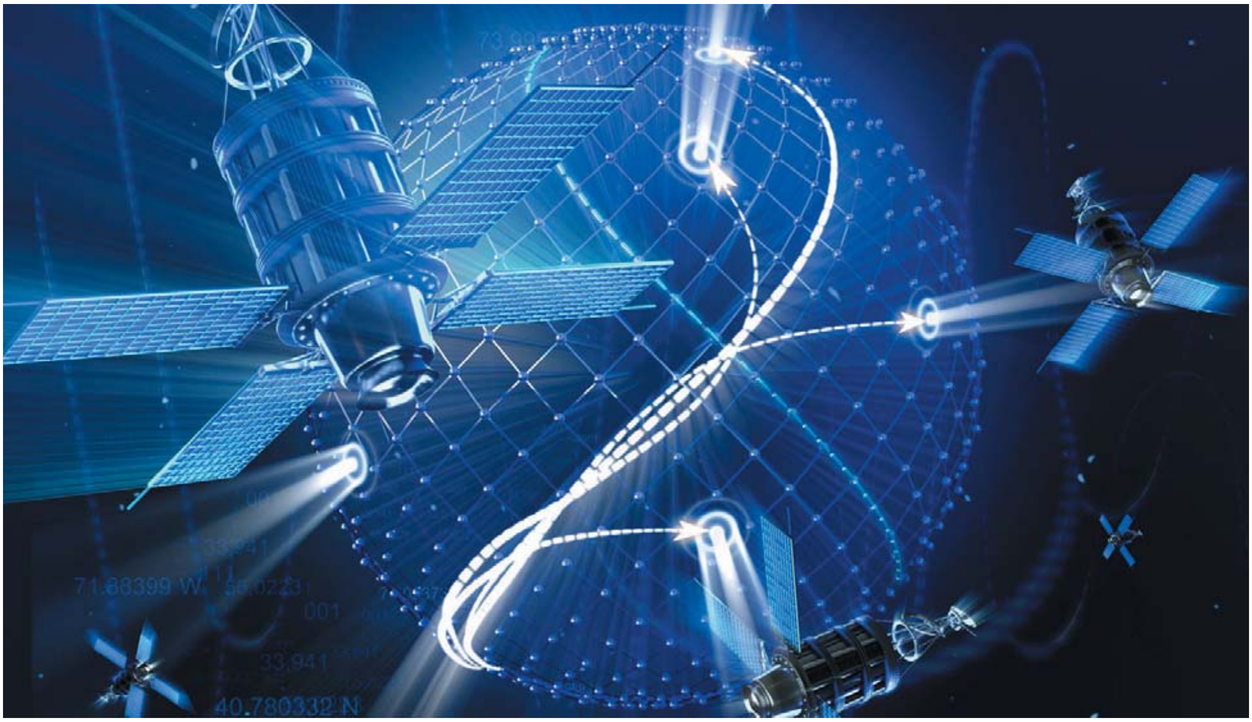
SIMON NDITIRU | Electrical Engineer, Per Vices



SDRs as a Reference and Common Clock Source for GNSS Timing Apps

Software-defined radios can monitor the integrity of satellites and ground stations and ensure the functionality of GPS tracking, autonomous driving, automation, and financial markets.

A software-defined radio (SDR) is a versatile radio communication system that employs reconfigurable software-based components for processing digitized signals. The SDR paradigm offers high flexibility, facilitating upgrades or updates to radio communication systems at a low cost due to functionality and components implemented as a software embedded system. Some of these components include filters, amplifiers, decoders, and mixers. In addition, SDRs offer superior performance, suiting them for a broad array of industrial applications.

An SDR generally consists of two parts: a radio front end and a digital back end. In a typical SDR receiver, the radio front end is an RF tuner that converts the incoming radio-frequency (RF) signal into an intermediate-frequency (IF) signal. Subsequently, the IF signal is then fed into an analog-to-digital converter (ADC) that converts it into a digital signal. The digitized signal is then channeled into a digital back end for processing

In the case of a typical SDR transmitter, the front end consists of an RF converter and a power amplifier. The RF converter receives an analog IF signal from a digital-to-analog converter (DAC) and converts it into an RF signal that's amplified by a power amplifier before being fed into an antenna for transmission. Unlike conventional radio communication systems, an SDR is capable of handling signals over a wide bandwidth. The highest-bandwidth SDRs can manage signals over a bandwidth of up to 18 GHz.

The digital back end of an SDR system features a field-programmable gate array (FPGA) with onboard digital-signal-processing (DSP) capabilities. This board handles digitized signals and consists of various reconfigurable components, including mixers, filters, modulators, and demodulators. It also provides the means to implement various application-specific functionality ranging from triggering and queuing waveforms for radar or MRI, to implementing any wireless communication standard/protocol into the chip itself. DSP operations also occur as a block in the FPGA, incorporating computational tasks like upconverting, downconverting, modulation, demodulation, and error control.

The versatility, reconfigurability, interoperability, and superior performance of SDRs makes them a suitable choice for use in a broad array of industrial applications. This includes mission-critical applications such as radar, test-and-measurement systems, spectrum monitoring and recording, MRI/NMR systems, network security systems, and GNSS systems. An example of a high-performance SDR platform, suitable for a variety of mission-critical applications, is one developed by Per Vices *(Fig. 1)*.

Global Navigation Satellite System

The Global Navigation Satellite System (GNSS), which has worldwide coverage, serves timing and/or geospatial positioning applications. Some of today's fully operational GNSSs include the Global Positioning System (GPS), BeiDou Navigation Satellite System (BDS), Global Navigation Satellite System (GLONASS), and Galileo. GNSSs leverage precise clocks to deliver the time and position accuracy required by today's applications.

1. Shown is an example of a high-performance SDR platform, suitable for various mission-critical applications.

GNSS satellites use onboard atomic clocks, while ground stations employ crystal oscillators in SDRs or external reference clocks to ensure highly accurate timing and positioning. The superior performance of SDR clock systems makes them a popular choice for GNSS timing applications.

Most of today's financial institutions, radar stations, and data networks consist of many nodes that form a distributed network. Such distributed systems require precise timing to ensure that all transactions are accurate and synchronized. The tight timing accuracy of GNSS makes it a good choice for synchronizing nodes in distributed systems.

Some applications such as precision farming, autonomous driving, port automation, commercial aircraft tracking, and Google Maps require precise position data. Moreover, GNSS provides accurate location data and is used in a broad array of industries, including agriculture, defense, mining, and construction.

Using SDR Clock Systems in GNSS Timing Apps

An SDR time board provides the clock distribution for all receiver and transmitter ADCs/DACs and the FPGA to work synchronously. This internal time board consists of an oven-controlled crystal oscillator (OCXO) that delivers a very stable (5 parts/billion) and accurate 10-MHz signal. Such oscillators also offer high frequency stability, a low noise floor, and the low phase noise required for accurate timing and synchronization of functions. The unmatched frequency stability of this oscillator makes the SDR clock ideal for applications with strict timing requirements, such as GNSS systems.

The SDR clock distribution ensures that various functions of a GNSS system are properly synchronized. Apart from sampling-related functions, this clock-distribution system also can synchronize other processing operations like upconverting and downconverting functions.

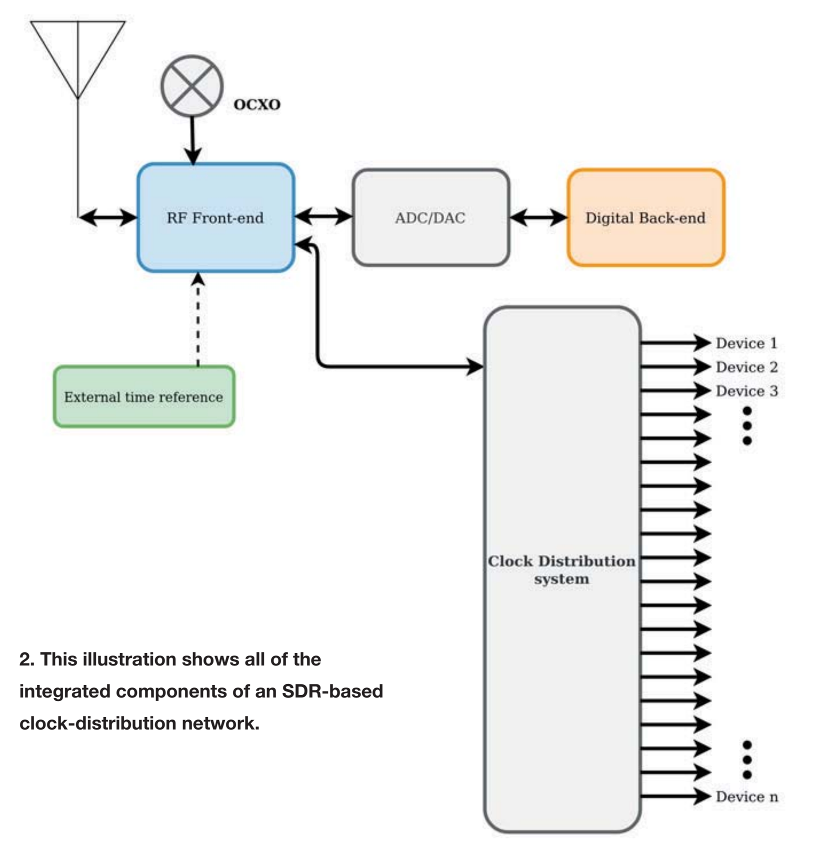
One may use an SDR clock in either master or slave mode. In master mode, the internal clock is used within the SDR platform. Using the SDR clock in slave mode requires an external reference clock. This gives engineers the flexibility to utilize a clock system that best matches the timing requirements of a given application. Applying an SDR as a master clock for your GNSS system enhances the flexibility of your systems and saves you time and resources.

Most of today's financial institutions, radar stations, and data networks consist of many nodes that form a distributed network. Such distributed systems require precise timing to ensure that all transactions are accurate and synchronized.

An SDR-based clock-distribution system offers high flexibility and enables engineers to implement new functions and protocols without the need to change or modify the available hardware. In addition, because software-based components are reusable, the technology reduces the time and resources required for prototyping and testing sophisticated clock-distribution systems.

The SDR's clock system is suitable for a broad array of applications that require accurate timing. With an SDR platform, it's not necessary to build a separate clock-distribution network for your application. *Figure 2* illustrates all of the integrated components.

The availability of a built-in clock system enables engineers to save time and



2. This illustration shows all of the integrated components of an SDR-based clock-distribution network.

5G RF Components & Cable Assemblies

Whether you're building the future of enhanced mobile broadband or designing applications for IoT and mission-critical communications, Fairview Microwave offers the most extensive portfolio of in-stock and ready-to-ship 5G RF components and cable assemblies. Fairview Microwave is ready to support 5G innovation, testing, and deployments, through an expansive product offering, product support, and a commitment to same-day shipping.

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resources, thereby cutting the overall cost of implementing, testing, and deploying complex systems. In addition, the SDR's clock system offers impressive timing accuracy, and its performance is comparable or even superior to fully external clock systems.

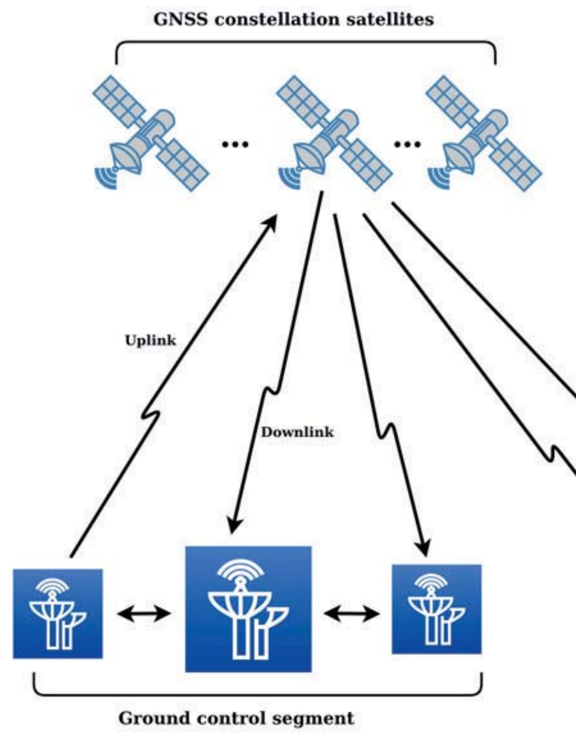
SDR-Based GNSS Ground Station

A ground-control station is a critical segment of any GNSS system requiring extremely accurate clocks *(Fig. 3)*. Some of the key functions of this station include tracking satellites, computing precise locations of satellites, monitoring drift in satellites, and adjusting their direction to ensure that they remain in the right orbital plane while also monitoring the satellite integrity and resolving satellite anomalies.

At the heart of any GPS/GNSS ground station is a reference clock that makes sure the entire system is accurately synchronized. Due to the superior performance of an SDR's clock, it's well-suited for use as the reference clock of a GNSS ground station. For such applications, the SDR's clock is employed in master mode.

The accuracy of the timing signals provided by GNSS heavily depends on signal transmission and reception. GNSS uses the L1 and L2 bands for signal communications between the ground stations and the satellites. Ground segments use atomic clocks to generate system time while receivers use clock oscillators to maintain their time. Although these two time scales feature high accuracy, their time measurements have a small deviation. As such, it's necessary the time signal from the satellite that's received by a user be traceable to a reference time scale.

The system time scales used by GNSSs are based on Coordinated Universal Time (UTC). This post-processed time scale is generated and disseminated by the International Bureau of Weights and Measures (BIPM). The UTC time scale provides a reference for time measurements to a wide range of timing systems, including those for GNSSs.



3. A ground-control station is a critical segment of any GNSS system requiring extremely accurate clocks.

Institutes and research centers that maintain realizations of UTC, known as UTC(k) time scales, utilize high-quality clocks and time transmission equipment. Precise timing systems such as GNSS timing systems must ensure that their time measurements are reliable and traceable to regional or international standards.

The performance of an SDR's clock system also makes it ideal for various DSP operations, including decoding, encoding, modulation, and demodulation. In addition, the reconfigurability of SDR platforms allows engineers to prototype and test new functions and protocols without modifying the existing hardware. This greatly reduces the overall cost of maintaining the radio communication system of a GNSS system.

Conclusion

Conventional radio communication systems are implemented using dedicated hardware-only components. This implementation approach consumes high amounts of resources and yields systems that are rigid and highly susceptible to obsolescence. Such hardwired systems are difficult to upgrade because the process involves modifying or replacing existing hardware.

The configurable architecture of SDRs enables engineers to implement new functions and protocols without modifying the available hardware, suiting them for timing applications in GNSS systems. The flexibility of these platforms allows engineers to implement versatile systems that are interoperable with various GNSS constellations. The SDR paradigm also makes it possible to implement scalable systems capable of accommodating current and future GNSS constellations.

Thanks to the tight timing capabilities of SDR clocks, these platforms can meet the strict timing demands of today's GNSS timing applications. Furthermore, reusability of an SDR's reconfigurable modules saves time, money, and resources required for developing and testing new GNSS ground-control stations. As such, SDR platforms are generally recognized as the most suitable radios for GPS/GNSS test and simulation.

DR. NIKHIL ADNANI | Chief Technology Officer & VP Sales, thinkRF

Wi-Fi 6E is Reshaping RF Security Requirements

Even as it promises a less-congested Wi-Fi spectrum, the advent of Wi-Fi 6E poses new challenges to RF security professionals. Here's a look at how an SDR-based approach to spectrum analysis can help get the job done.

Fixed and mobile internet usage is growing rapidly as our world depends more on the wireless spectrum, thanks in large part to the great migration to working from home. A May 2020 report found that overall internet traffic grew by more than 40% between February and April, with video streaming accounting for 58% of all traffic.[1] Much of this traffic is being driven away from mobile back to fixed Wi-Fi access points.

The arrival of Wi-Fi 6E will help to alleviate the congestion on existing Wi-Fi networks. In response to the need for greater reliability, access, and performance, the Federal Communications Commission (FCC) voted in April 2020 to open up the 6-GHz band (5.925 to 7.125 GHz) for unlicensed use.[2] Adding more than 1.2 GHz of high-frequency spectrum, the announcement represents the largest addition to Wi-Fi since the original 802.11b standard of the late 1990s and paves the way for the Internet of Things (IoT), virtual and augmented reality (VR/AR), and other high-bandwidth, low-latency applications.

However, the move to the 6- to 7-GHz band and beyond presents a new challenge to RF security and technical surveillance countermeasures (TSCM) professionals. With most previous devices using signals in the 2.4- or 5-GHz bands, spectrum-analysis equipment also was designed to cover up to a maximum of 6 GHz. As a result, many users will need to increase the frequency range of their RF measurement equipment to get a complete view of the spectrum environment in their facility.

This article will introduce the Wi-Fi 6E standard and provide an overview of the new specifications, improvements over previous standards, and potential applications and uses. It will then explore how these new signals will impact RF security professionals before showing how a software-defined approach to spectrum analysis allows for greater performance at a lower cost than traditional hardware.

RF security will always play an important role in corporate offices, government facilities, sensitive compartmented information facilities (SCIFs), and other environments where sensitive information must be protected. By understanding the new standard, security professionals can ensure they have the equipment and

performance needed to maintain control of the wireless spectrum.

Understanding Wi-Fi 6E

A recent Cisco report estimates that 5.6 billion people will use the internet by 2023. The number of connected devices is expected to grow from 18.4 billion in 2018 to more than 29 billion by 2023.[3] In addition to this rapid rise in the number of connected devices, high-definition video streams and other high-bandwidth applications have dramatically increased the amount of data flowing at a given time.

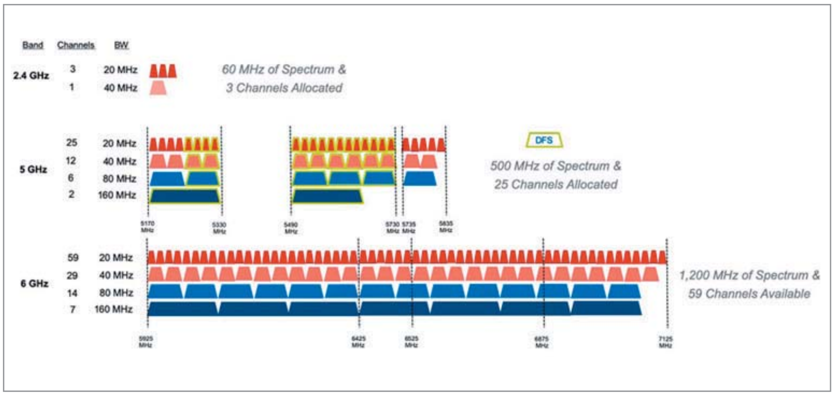
Low-latency applications such as gaming, VR/AR, and autonomous vehicles also require high levels of performance and reliability, whereas IoT applications often have wide networks of low-powered sensors all sharing data in real-time.

In response to these changing requirements, the FCC has authorized a new band of spectrum for unlicensed use. This section will explore the differences and benefits of the new Wi-Fi 6E standard and the 6- to 7-GHz band.

How Wi-Fi 6E Differs from Previous Standards

Early Wi-Fi standards, such as 802.11b, were first deployed in the late 1990s. They operated in a tiny sliver of the unlicensed 2.4-GHz ISM band from 2.400 to 2.495 GHz. With a narrow range and overlapping channels, the ISM band eventually became too crowded to cope with the increasing density of devices and growing bandwidth requirements.[4]

Though the first 5-GHz standards go back to the same period, widespread use became more common with the introduction of 802.11n, known today as Wi-Fi 4.[5] Operating from 5.170 to 5.835 GHz, this higher-frequency standard reduced the strain on the overcrowded 2.4-GHz band and improved speed, reliability, capacity, and bandwidth. Further performance improvements were realized as technology advanced and new standards were launched, specifically 802.11ac (Wi-Fi 5) in 2013 and the more recent 802.11ax (Wi-Fi 6) in 2018.



1. Wi-Fi 6E supports 14 non-overlapping 80-MHz channels and seven non-overlapping 160-MHz channels, a significant improvement over previous 2.4- and 5-GHz standards.

With its approval from the FCC, Wi-Fi 6E represents one of the largest and most significant additions to Wi-Fi in its history. It has the potential to dramatically boost speed, bandwidth, capacity, and reliability while reducing congestion, latency, and power requirements. Put simply, it will increase the amount of spectrum available for routers and other devices by nearly a factor of five, resulting in more bandwidth and less interference.[6]

The biggest and more important change for RF security professionals is that Wi-Fi 6E will use the 6- to 7-GHz band ranging from 5.925 to 7.125 GHz. Previously used to support utilities, public safety, and wireless backhaul, unlicensed devices will now be allowed to share this spectrum through a regulatory framework that protects existing users while allowing for more efficient use of the wireless spectrum.

Wi-Fi 6E will support 14 additional non-overlapping 80-MHz channels and 7 non-overlapping 160-MHz channels, a dramatic improvement from the 20-MHz non-overlapping channels currently available in Wi-Fi 5 *(Fig. 1)*. Combined with advanced channel-allocation technology, this will greatly reduce congestion and interference for users in high-density environments such as office buildings, apartment complexes, or large public venues.

In addition, Wi-Fi 6E will dramatically improve speed and latency. One industry report suggested that the average fixed-broadband download speed would increase to 280 Mb/s by 2022, more than double the current U.S. average of 137 Mb/s.[7] Tests have demonstrated latency levels as low as 2 to 5 ms.[8]

Of course, the tradeoff when dealing with higher-frequency signals is a decrease in propagation and range. Compared to 2.4- and 5-GHz signals, 6-GHz signals will travel shorter distances and be more susceptible to physical barriers such as buildings, walls, trees, and other obstacles. In larger spaces, multiple access points will be required to ensure coverage and maintain reliability.

Finally, Wi-Fi 6E will only be accessible to new devices that support the standard and will have no backward compatibility. Early entrants should encounter a nearly clear playing field, away from the congestion and interference of the 2.4- and 5-GHz bands.

With so many advantages and the potential for substantial performance improvements, it's no surprise that Wi-Fi 6E devices are expected to become prevalent in 2021. One IDC research director estimates there will be more than 338 million devices entering the market by the end of the year, and nearly 20% of all Wi-Fi 6 device shipments will support the 6-GHz band by 2022.[9]

The resulting increase in broadband speeds, combined with the accelerated deployment of IoT and other advanced technologies, is expected to generate more than US$180 billion in revenue over the next five years.[10] So how does this affect RF security, and how will equipment requirements shift as new Wi-Fi 6E-enabled devices enter the market?

The Changing Nature of RF Security

RF security has evolved over the years as devices, hackers, and covert surveillance products became more sophisticated. For as long as there has been sensitive information, surveillance, and countersurveillance, operators have found new ways to evade and outsmart the other.

The widespread proliferation of low-cost, easy-to-use, and powerful wireless communications technology has made it relatively simple for governments, rival corporations, or even individuals to deploy surveillance devices, transmit sensitive information, and disrupt the wireless signal environment.

The following section shows how the new Wi-Fi 6E standard will change performance requirements for spectrum-analysis equipment used for TSCM and RF security applications.

What the New Standards Mean for Spectrum-Analysis Hardware

As mentioned earlier, the new standard operates in the range of 5.925 to 7.125 GHz, significantly higher than previous standards. Until now, most users were only concerned with signals below 6 GHz. Spectrum-analysis equipment, in turn, also was limited to these ranges. The result is that most existing TSCM and spectrum-analysis hardware deployed and used in the field today will be unable to detect and analyze these new 6- to 7-GHz signals.

This is an obvious issue for RF security professionals because they will basically be blind to these new devices, which presents a serious security vulnerability. It not only limits how users can detect and remove unauthorized devices, but it also prevents them from getting a complete view of the signal environment in their facility.

A second challenge is the width of the new band and channels. With 1.2 GHz of spectrum divided into 80/160-MHz channels, equipment with low instantaneous bandwidth (IBW) and sweep rates may miss out on sporadic and short-duration signals of interest.

Finally, as the requirements for TSCM and RF security rise in complexity and operators become more sophisticated, traditional sweeping techniques must be augmented with continuous, 24/7 coverage. Modern surveillance devices can store information and transmit it in short bursts outside of regular office hours to avoid detection by sweeps. Many also use frequency hopping or low-powered signals to further reduce the likelihood of detection.

Another consideration is that threats to RF security aren't necessarily malicious. For example, an employee may be unsatisfied with the connectivity in their office and decide to bring in a router from home to boost their connection. Similarly, an employee may forget to check their device before entering a SCIF or other restricted facility.

In such cases, the threat to RF security is the result of an honest mistake or accident rather than an intentional event. Continuous monitoring of the facility would allow security professionals to detect the transmitter and then take steps to remove or secure the device.

A Continuous, Software-Defined Approach to RF Security Applications

With much of the existing equipment currently deployed in the field unable to detect and analyze signals in the 6- to 7-GHz band, RF security and TSCM professionals will need to upgrade their capabilities. The question then becomes: What is needed to get the best coverage and ensure effective monitoring of the wireless spectrum?

Traditional, hardware-based spectrum-analysis equipment does provide the frequency range and bandwidth required for Wi-Fi 6E devices, but they are otherwise poorly suited for TSCM and security applications. Large, complex, and expensive, these solutions are designed for lab or manufacturing environments that require extremely high performance. On the other hand, existing handheld and low-cost analyzers do not generally cover the frequency ranges and bandwidths needed. Instead, users should consider the benefits of a software-defined approach to spectrum monitoring.

(Continued on page 32)

2. The Surveillance System developed by thinkRF includes real-time spectrum analyzers, a laptop, IP networks for multi-sensor deployments, Kestrel's TSCM Professional Software, omnidirectional antennas, and a carrying case for field deployments.

High-Gain Amplifier Covers 2 to 30 GHz

Mini-Circuits' model ZVA-02303HP+ is a wideband amplifier with 38-dB typical gain and ±1-dB gain flatness from 2 to 30 GHz. The RoHS-compliant amplifier operates on a single supply of +12 to +15 V dc and provides +28-dBm typical saturated output power. Typical noise figure across the full band is 3.8 dB. The rugged amplifier features built-in overvoltage and reverse-voltage protection and is ideal for use in 5G, electronic-warfare (EW), satellite-communications (satcom), and test-and-measurement applications. It measures 2.00 × 1.60 × 0.69 in. (50.80 × 40.64 × 17.60 mm) with 2.92-mm female connectors and is available with or without a heatsink. The 50-Ω amplifier handles ambient temperatures from -40 to +50°C.

MINI-CIRCUITS, http://www.minicircuits.com/WebStore/dashboard.html?model=ZVA-02303HP%2B

Wi-SUN Tech Gets Nod for Smart-City Deployments

Silicon Labs has announced certification of its Wi-SUN technology, paving the way for new IoT and smart-city applications. Silicon Labs' Wi-SUN solution combines an EFR32 hardware platform, a full IPv6 mesh stack, and advanced development tools to secure wireless connectivity for many applications, including metering infrastructure for street-lighting network asset management and smart-city sensors. The company's EFR32xG12 SoC is the first chip to support Wi-SUN (certified by the Wi-SUN Alliance), which packs an Arm Cortex-M4 processor with 1 MB of flash and 256 kB of RAM as well as an integrated +20-dBm PA for sub-GHz frequencies.

SILICON LABS, www.silabs.com/development-tools/wireless/efr32xg21-wireless-starter-kit

4-Output Power Supply Handles Benchtop Apps

Saelig's AIM-TTi MX100Q series of power supplies is outfitted with 4-output laboratory power sources that feature mixed-mode regulation to provide up to 210 W of power, which can be shared by up to four outputs. Each output on the PSU can provide 0 to 35 V at 0 to 3 A; it's able to combine outputs to extend output voltages up to 70 V and currents up to 6 A. The AIM-TTi MX100Q series offers precise output adjustment with resolutions of 1 mV and 0.1 mA. All information is displayed on a large backlit graphic LCD and controlled via soft keys, a numeric keypad, or a spin wheel. Additional features include the simultaneous display of meters and settings for all outputs, multiple ranges on each output for wider voltage/current choice, individual on/off control, sequenceable multi-on/off, and up to 250 memory settings for individual or multiple outputs.

SAELIG, www.saelig.com/category/aim-tti-power-supplies.htm

AC-DC Power Supplies Target Cost-Conscious Applications

XP Power's VCE20 and VCE40 PCB-mount, single-output ac-dc power supplies offer a cost-effective solution for modern domestic, Internet of Things (IoT), and industrial tech applications. The power supplies provide 20 and 40 W of power, respectively, come in both encapsulated and lower-cost open-frame versions, and can be PCB mounted. The VCE20 and VCE40 feature an integrated EMC filter and hold-up capacitor and fuse, so no external components are required. They also offer an extended universal input range of 85 to 305 V ac, allowing them to be used in many applications, including those requiring higher-voltage operation. The single-output rail is available in seven voltages from 3.3 to 48.0 V dc.

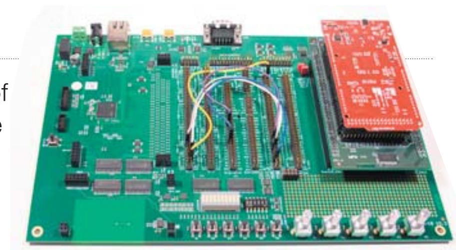
XP POWER, www.xppower.com

SiC Diodes Offer Improved Reliability and Ruggedness

SemiQ's 3rd-generation SiC diode family provides blocking voltages of 650, 1200, and 1700 V with a forward current up to 50 A per chip. The family features upgraded improvements over the previous generation, including increased reliability, ruggedness, surge current capability, and moisture resistance. Packages include TO-220-2L, TO-220-3L, TO-247-2L, TO-247-3L, SOT-227, and TO-263, as well as bare die, and all are 100% tested for unclamped inductive load. SemiQ also utilized a robust supply chain for high-volume packaging of the SiC diode family, including 3+ suppliers of SiC substrates, 4+ suppliers of SiC EPI, and a pair of qualified SiC wafer fabs.

SEMIQ, www.semiq.com

HIL Platform Tests Systems in a Virtual Environment



Hitex now offers extensive support for hardware-in-the-loop (HIL) testing of Infineon AURIX-based systems, allowing engineers to test embedded real-time control systems in a virtual environment. Hitex's miniHIL can emulate sensors and actuators to connect the test system to the environment and allow embedded systems to be secured at an early stage, significantly reducing time and cost during troubleshooting. The HIL platform also enables engineers to connect devices and supply various adapters and processors depending on the application. Proprietary hardware also can be utilized via customized adapters.

HITEX, www.hitex.com/tools-components/test-tools/minihil

SMARC Module Sets Sights on Low-Power Applications

Congatec's SMX8-Nano SMARC 2.0 COM (computer on module) is based on NXP's i.MX 8M Nano, which is outfitted with Arm's Cortex-A53 processor. The modules come in three variants, with a quad-, dual-, or single-core Arm Cortex-A53 with a secondary Cortex-M7, plus a GC7000UltraLite 3D GPU. The COMs come equipped with 2 GB of LPDDR4, Gigabit Ethernet, USB 2.0 (or USB OTG), SDIO 3.0, and Wi-Fi and BLE (optional). I2C, SPI, and three UART interfaces also can be found on the SMX8-Nano. Security options are extensive and include High Assurance Boot support, SRTC, SJTAG, TrustZone, AES-256, RSA-4096, SHA-256, 3DES, DES, ARC4, MD-5 Secure Real-Time Clock (RTC), eFuse Key Storage, true random number generator (RNG), and 32 kB of secure RAM.

CONGATEC, www.congatec.com/us/products/smarc/conga-smx8/

CAN Module Becomes Configurable with Analog I/Os

PEAK-System added another model to its PCAN-MicroMod-FD series of modules with the MicroMod FD Analog 1 plug-in board, which features spring terminals for connecting CAN, I/Os, power supplies, and more. The module is configured using the supplied Windows software, allowing I/O mapping to CAN IDs and function blocks for processing the data. Configuration can be done via PC, which is transferred via the CAN bus to the PCAN-MicroMod FD, then run as an independent CAN node. Multiple modules also may be configured independently on a CAN bus. Features include a pair of frequency outputs, 16 analog inputs (16-bit/12-bit), eight digital inputs, a 4-bit rotary encoding switch, a trio of status LEDs, and an aluminum casing.

PEAK-SYSTEM, www.peak-system.com/PCAN-MicroMod-FD-Analog.508.0.html

(Continued from page 29)

Real-Time Spectrum Analyzers and Surveillance Systems

In a software-defined spectrum analyzer, the software runs over a hardware layer. The hardware components tend to perform only the RF-to-digital conversion, allowing a standard PC or laptop to provide the necessary computing power.

An example of such an instrument is thinkRF's R5550-408 real-time spectrum analyzer, which provides a frequency range of 9 kHz to 8 GHz, 100 MHz of IBW, and a 28-GHz/s sweep rate. It enables users to monitor, detect, and analyze Wi-Fi 6E signals. It can be used either as an RF analyzer or as an RF downconverter for existing equipment.

This type of instrument can be integrated with specialized TSCM software such as Kestrel TSCM Professional Software from the Professional Development TSCM Group (PDTG). When combined with directional antennas and other equipment, users gain a complete surveillance system that allows them to conduct full-spectrum scans up to 8 GHz without additional upgrades *(Fig. 2)*. Users can distinguish between friendly and unauthorized signals, demodulate the signal if required, and locate the source for removal.

Networked for remote deployment, multiple units can be deployed throughout a facility for continuous, 24/7 coverage. Information from static and roaming units is able to be sent to a centralized location for analysis, while real-time alerts and triggers can be configured to notify security professionals of an unauthorized or unknown signal. Users also can create a signal library, record data for post analysis, and generate reports.

This approach offers numerous benefits when used in addition to regular sweeps by TSCM professionals. Not only does it provide greater coverage, but it also ensures that users maintain a full view of the spectrum environment and can identify unknown signals from new Wi-Fi 6E-enabled devices operating above 6 GHz. mw

REFERENCES

1. *https://www.sandvine.com/hubfs/Sandvine_Redesign_2019/Downloads/2020/Phenomena/COVID Internet Phenomena Report 20200507.pdf*

2. *https://www.fcc.gov/document/fcc-opens-6-ghz-band-wi-fi-and-other-unlicensed-uses*

3. *https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html*

4. *https://www.actiontec.com/wifihelp/evolution-wi-fi-standards-look-802-11abgnac/*

5. *https://www.cablefree.net/wireless-technology/history-of-wifi-technology/*

6. *https://www.fcc.gov/document/fcc-opens-6-ghz-band-wi-fi-and-other-unlicensed-uses*

7. *http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf*

8. *https://www.counterpointresearch.com/wi-fi-66e-a-viable-alternative-to-5g-nr-for-low-latency-applications/*

9. *https://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-delivers-wi-fi-6e-certification-program*

10. *http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf*

11. *https://www.everythingrf.com/community/what-frequency-band-does-wi-fi-6e-use*

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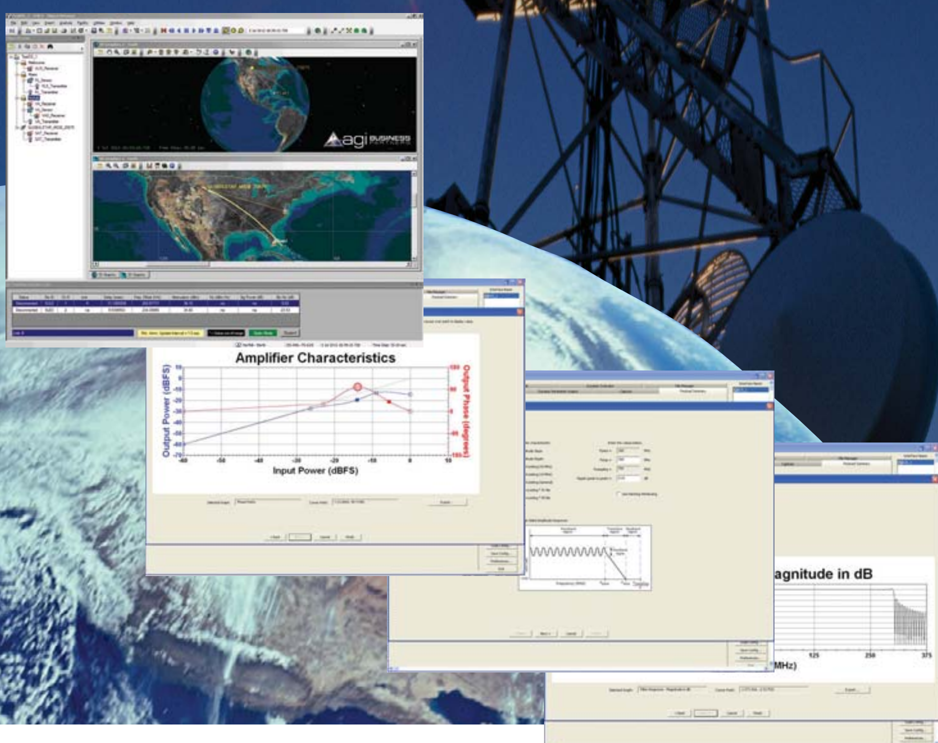

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