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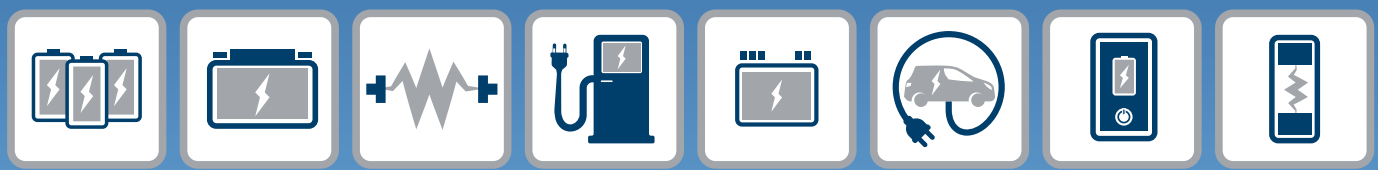

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For Electronic Test & Measurement

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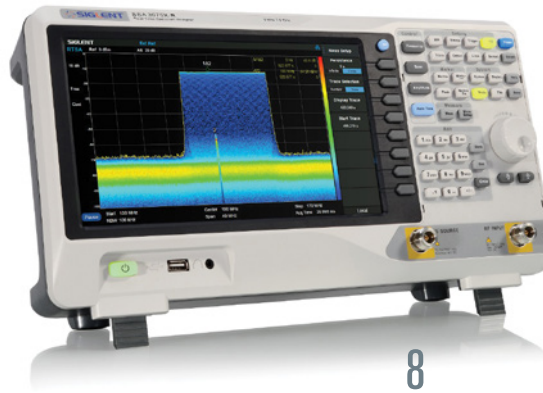

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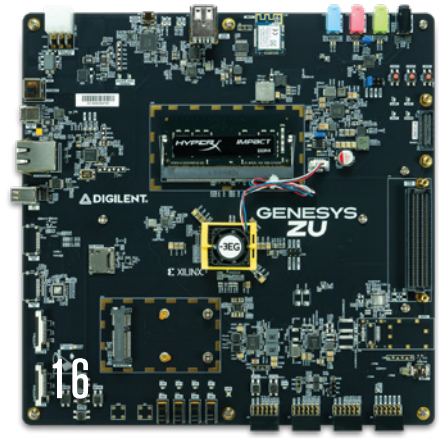

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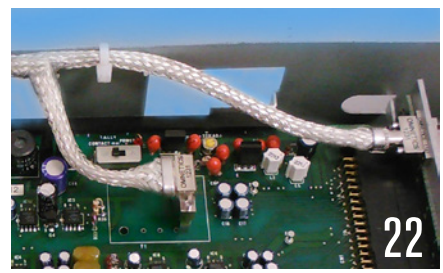

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EDITOR'S NOTE

EVALUATION IS ENGINEERING

This column is part of an informal series of thought pieces expressing our expanded editorial philosophy, and the direction we are taking *Evaluation Engineering*. The new world of the fourth industrial revolution is a direct result of advances in precision in both core technologies and their implementation, and the evaluation technologies that enabled those advances.

It's been an interesting couple of decades in the electronics industry. Ever since the commercialization of electronic technology in the middle of the 20th century, the pace and scope of development has been unprecedented in human history. This near-exponential rate of development is creating a disruptive state of evolution at every level and facet of society.

It took a couple of centuries from humankind to migrate from open-flame weapons to breech-loading cartridge-based rifles, and even societies that prided themselves upon their advancement only discovered hygiene in modern history. In contrast, we've gone from a three-legged transistor in a ceramic package to advanced 3D system-on-chip (SoC) solutions in a matter of decades.

Precision measurement is at the heart of all advancement. Antoine LeCoultre created the Millionometre, the first instrument capable of measuring the micron, to refine the manufacture of watch parts in 1844. The very art of precision timekeeping led industrial and technical development, and today time is not only a critical component of every intelligent system, but is also an example of the commoditization of advanced technology. The world is awash in precision timekeeping, literally free to anyone who can capture the signal.

There is no precision without feedback, and most of evaluation engineering was a specialized space, dominated by specialists using single-purpose devices addressing a specific facet of the application addressed. Just as timekeeping was once a full-time job for the person responsible for the village clock, for example, performing advanced system test was once the realm of resource-rich laboratories.

Today, everyone is an evaluation engineer. Every electronic product and device designed today is developed in an environment of constant test, measurement, evaluation, and specification. The devil is truly in the details, and it is critical that the lines on your ruler are clean, precise, and very close together. For example, the difference in a power system being 96% efficient vs. 98% efficient can be measured in dollars and cents, in lost revenue due to poor battery life or other manifestation of poor power management.

This means getting your hands on the best and most versatile tools available, and using them at every stage of product design. Implementing advanced system topologies, high levels of sensor integration and fusion, heterogeneous computing, and other next-generation functionalities is impossible without the latest in testing technologies and methodologies. Encouraging discovery through interesting articles and webinars, providing news on the latest tools and techniques, and presenting you with the information you need to choose which is best for you, are among some of our others.

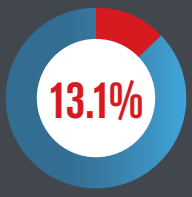
The capability and availability of advanced test and evaluation systems is impacting every level of society. Bridges and roads now have the ability to monitor themselves, for example, alerting civil engineers to pending damage and maintenance functions. Even old-timey electromechanical applications are being rejuvenated by the sensing and monitoring capabilities provided by Industry 4.0-level solutions. This and other evolutionary aspects of evaluation engineering will be among the things in our expanded coverage of the test & measurement space. EE

Alix Paultre,
Editor

BY THE NUMBERS

$2.35 BILLION

North American semiconductor equipment bills for May 2020

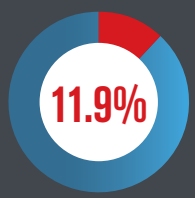


Increase over May 2019

Source: SEMI

1.2 BILLION

Smartphone units expected to ship in 2020 amid pandemic

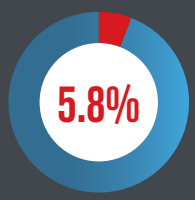


Expected year-over-year decline in smartphone market in 2020

Source: IDC

$35.0 BILLION

Global semiconductor sales in May 2020



Increase in semiconductor sales over May 2019

Source: SIA

Doers vs. Talkers

For more than 50 years, AR has delivered amplifiers with cutting-edge performance. Today, AR offers broadband amplifiers that generate in excess of 50,000 watts to serve all manner of military RF testing. Our Class A designs offer superior reliability, signal reproduction, and VSWR tolerance to handle the most demanding requirements. Furthermore, AR's experienced Engineering team can design chambers and test systems to provide a holistic solution. At AR, innovative solutions just keep coming.

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TE Connectivity surpasses global face shield donation goal

TE Connectivity has produced more than 120,000 face shields to donate to medical workers around the world working the frontlines in the battle against COVID-19. From Fremont, California, to Dinkelsbuhl, Germany, more than 360 TE employees at 12 sites logged in a combined 1,500 volunteer hours to manufacture, assemble and distribute the face shields, important personal protective equipment that has been difficult for many medical facilities to acquire during the pandemic. TE's initial goal was 100,000, but the volunteers kept working to fulfill continued requests from the medical community. Leveraging open source designs, TE engineering and technology teams selected and modified a shield design by verifying the design with medical professionals to ensure that it was effective and comfortable.

World Nagoyo show is on for September

The government and local governments of Japan lifted the state of emergency on May 26 in all area of Japan, and trade shows will be officially permitted again from August onwards. As a result, the Manufacturing World Nagoya show will be held as scheduled from September 9–11 at Aichi Sky Expo Nagoya. The exhibition will be held while following the guidelines for Covid-19 control measures of the government, municipalities and the exhibition industry to ensure the safety of the exhibitors and visitors at the exhibition.

INDUSTRY REPORT

inakiantonana/iStock/Getty Images

Analog Devices to Buy Maxim Integrated

Analog Devices said on July 13 that it has agreed to buy rival Maxim Integrated for more than $20 billion in stock to expand its scale and broaden its product portfolio in the market for analog semiconductors.

The all-stock deal would value the combined company at more than $68 billion, creating an analog semiconductor giant that will better compete with market leader Texas Instruments.

Under the terms of the agreement, Maxim shareholders would receive 0.63 of Analog Devices stock for each share they own. Once the deal closes, shareholders in Analog Devices would own about 69% of the combined company, with Maxim stockholders holding the other 31%.

Analog Devices said the deal would combine Maxim's strength in automotive and data center segments with its footprint in the industrial and communications markets. Once the transaction closes, the combined company will sell more than 50,000 products, giving it the ability to offer more complete solutions. The new company will serve over 125,000 customers and be better positioned to capture a larger share of a $60 billion market.

Analog Devices could acauire thousands of Maxim's hardware engineers in the deal. Between them, the companies employed more than 10,000 engineers and invested $1.5 billion in research and development in 2019. Competition for analog engineering talent has been escalating in recent years, the company said. Once the deal closes, Analog Devices believes that it will be in a better position to lure the industry's top analog engineers.

Sensirion Selects Production Site

Sensirion is expanding its production capabilities by establishing a production site in Debrecen, Hungary. The site is being built and financed by a local "build to suit" partner. Sensirion has signed a long-term lease agreement. The company termed the facility as an expansion which means that no existing jobs in Switzerland are affected. The site in Debrecen was selected after a comprehensive evaluation of potential locations throughout Central and Eastern Europe.

Keysight acquires Eggplant

Keysight Technologies and Eggplant, a digital automation intelligence specialist, announced that Keysight has completed the acquisition of Eggplant from The Carlyle Group. Eggplant is a software test automation platform provider that uses artificial intelligence (AI) and analytics to automate test creation and test execution. Eggplant's Digital Automation Intelligence platform can test any technology on any device, operating system or browser at any layer, from the user interface (UI) to application programming interfaces (APIs) to the

KEYSIGHT TECHNOLOGIES

database. By using artificial intelligence and analytics to automate testing, Eggplant enables improved software application development velocity and enhanced quality. The acquisition enables bi-directional leverage of measurement technologies between both companies, resulting in increased solution

differentiation in the expanded offering. The transaction is valued at $330 million.

Globalfoundries Plans to Build Out Its Most Advanced Chip Plant

Globalfoundries, a contract chip manufacturer, is trying to tap the US government's ambitions to disentangle the semiconductor supply chain from Asia and keep its technology lead over China and other countries. The firm said it agreed to purchase a large parcel of land adjacent to its most advanced US fab, as it looks to stay ahead of customer demand.

The Santa Clara, California-based company said it hammered out a contract giving it the right to purchase the property sometime in the future. Globalfoundries, the largest contract chip maker in the US, said the portion of land could be used to build out its most advanced US plant located in upstate New York. The production plant, Fab 8, is where it fills orders for chips based its highest-end 12-nanometer and 14-nanometer nodes for others.

The company said it has invested more than $13 billion in the foundry to date. It has also invested $2 billion for upgrading its other US fabs, including the former IBM plants it runs.

Globalfoundries, which makes chips for hundreds of customers from Advanced Micro Devices and Broadcom to Skyworks and Qualcomm, said how it proceeds with the property will depend on demand from its customers, including defense and aerospace contractors in the US.

Samsung: Initial 6G Networks in 2028

A white paper released by Samsung says that initial 6G networks could be deployed in 2030. The paper, "The Next Hyper-Connected Experience for All," outlines various scenarios of what the technology might look like, including technical and societal megatrends, services, requirements, candidate technologies, and an expected timeline for standardization. Samsung's R&D hub, Samsung Research, launched its Advanced Communications Research Center with the goal of accelerating 6G research. "While 5G commercialization is still in its initial stage, it's never too early to start preparing for 6G because it typically takes around 10 years from the start of research to commercialization of a new generation of communications technology," said Sunghyun Choi, head of the Advanced Communications Research Center.

Synaptics to Buy Broadcom's Remaining Wireless IoT Business for $250M

Broadcom is selling the remnants of its wireless Internet of Things business to Synaptics. Synaptics said it has agreed to pay $250 million to buy out Broadcom's WiFi, Bluetooth, GPS and other IoT-focused wireless assets, in its latest bid to beat out competitors to control the electronics crammed inside the next generation of smart consumer devices in the home.

Under the terms of the deal, Synaptics said it would pay for the rights to Broadcom's WiFi, Bluetooth and GPS products aimed at consumer Internet of Things devices, ranging from thermostats that programs itself based on how users change the temperature to smart speakers that can understand simple, verbal commands from users. The deal also gives it rights to new generations of wireless IoT chips currently in development at Broadcom.

Broadcom is a supplier of WiFi and Bluetooth chips for use in smartphones ranging from Apple's iPhone to Samsung's Galaxy devices, and it is holding onto that business unit. Around 60 employees from Broadcom's engineering division are also part of the deal, which is expected to close by the first quarter of 2021.

The assets Synaptics is buying include IoT-focused IP for WiFi 4, WiFi 5 and WiFi 6 as well as Bluetooth 5.1, Bluetooth 5.2, BLE and GPS L5 and GNSS. Once the all-cash deal closes, the new business will add around $65 million to Synaptics' annual sales. The agreement has been approved by the company's board of directors.

Standex Acquires Renco Electronics

Standex International announced that it has acquired privately-held, Florida-based Renco Electronics for approximately $28 million in cash with an additional three-year earnout payment based upon achieving certain financial targets. The transaction is being financed from Standex's existing cash balance. The Company expects the acquisition to be accretive to its earnings in its first year of ownership as well as additive to consolidated free cash flow.

"We are very pleased to have acquired Renco Electronics, a great strategic fit, deepening our significant engineering and technical expertise in end markets supported by strong engineer-to-engineer relationships. In addition, Renco's end markets and customer base in areas such as consumer and industrial are highly complementary to our existing business with the potential to further expand key account relationships and capitalize on cross selling opportunities between the two companies. Renco's design and manufacturing cycle is extremely efficient, reinforced by a strong global network of proprietary supplier relationships," commented President and Chief Executive Officer David Dunbar.

Renco Electronics designs and manufactures customized as well as standard magnetics components and products including transformers, inductors, chokes and coils for power and RF applications. The products are used in consumer, industrial, military, and aerospace end markets. Renco's trailing twelve-month revenues were approximately $28 million.

Power Electronics for Electric Vehicle Market Growing Stongly

According to a report by Report Ocean, the power electronics for electric vehicle market for 2018 was estimated at $2.5 billion, and is expected to increase to $30.01 billion by 2026. This strong growth is accompanied by a CAGR of 35.5% from 2019 to 2026. The inverters segment scored the largest revenue share for the market in 2018. The report predicts that the on-board charger market is likely to experience a higher growth rate for the forecast period, as a result of increased vehicle electrification. EE

SPECIAL REPORT

ANALYZERS SERVE MARKETS FROM WIRELESS IOT TO RADAR

By Rick Nelson, Contributing Technical Editor

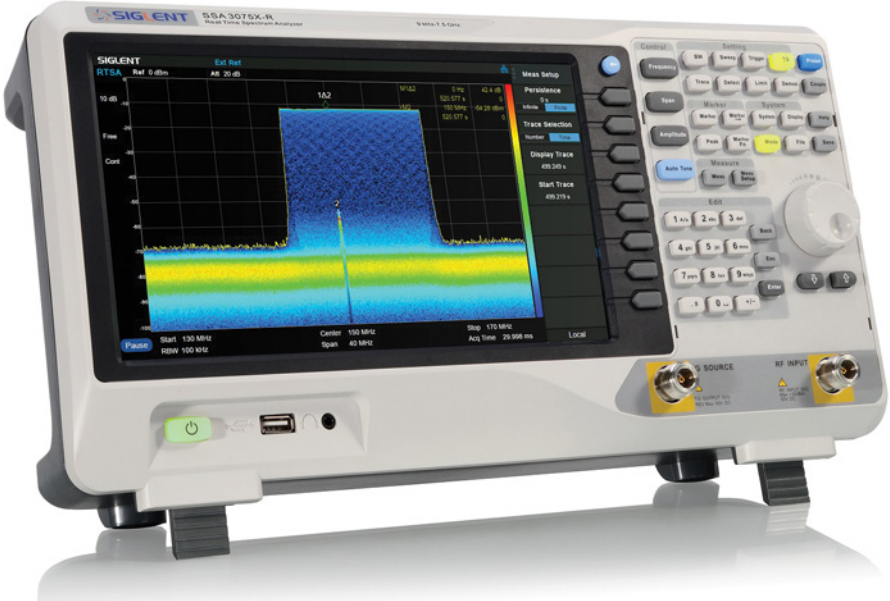
Signal and spectrum analyzers are key instruments for measuring the performance of products operating through the RF and millimeter-wave frequency ranges. They are available in a variety of form factors, including modular, USB, portable, and benchtop.

Trends

"The increasing research and development in IoT and smart sensor technologies has driven the need for test equipment that provides solid performance and ease-ofuse without the high costs associated with traditional RF test equipment," said Jason Chonko, applications marketing manager at SIGLENT Technologies North America. "Engineers are looking for the best performance without paying a premium."

Chonko has also seen interest in flexible instrumentation that can provide traditional spectrum analysis, data demodulation, and device characterization in one box. He said, "The convenience of having an instrument capable of adequately performing a variety of measurements really increases the usefulness of a tool—and if it is portable, even better!"

Marty Leeke, market development manager, software and modular solutions division (retired), and Giovanni D'Amore, product marketing operating manager, high-frequency measurement products, both at Keysight Technologies, said, "The RF/microwave test field is witnessing a profound change related to the diffusion of technologies using RF signals to communicate, transfer, and exchange information. It's even estimated that by 2023, over 70% of the global population will have mobile connectivity.[1] To accommodate these users, mmWave frequency bands provide a large amount of contiguous spectrum for high data-rate applications."



▲ SIGLENT SSA3075X-R Series real-time spectrum analyzer.

Leeke and D'Amore continued, "Aside from the growing communications industry, signal and spectrum analyzers play a pivotal role in radar and defense development. Aerospace and defense market advancements pave the way for more industries. Monitoring the spectrum will become even more important in the next few years when thousands of new low-earth-orbit (LEO) satellites are expected to launch."

Darren Tipton, director of product management, signal and spectrum analysis at Rohde & Schwarz, talked about the increased need for higher frequencies and more bandwidth. "The ever-increasing consumer demand for faster and more convenient data usage drives technologies such as 5G and new wideband digital payloads in the satellite industry. Test methodology in these areas are much more focused on modulated testing compared to CW- or VNA-based approaches from just a few years ago."

Matt Maxwell, product manager for Rohde & Schwarz, divides benchtop instruments into two major classes: midrange and high-performance. "Mid-range spectrum analyzers are leapfrogging the performance from previous generations," he said. "What was once high-end is now considered midrange, and high performance is already pushing the leading edge with respect to RF performance. Now we also see high performance adding ultra-wide bandwidth up to 8.3 GHz internally to handle the latest radar, satellite, and next-gen 5G work, in addition to 6G."

Maureen Lipps, product manager, Test & Tools, Newark, said, "As the current spectrum is getting more crowded, these increases in data usage are driving the market towards spectrum and signal

analyzers capable of utilizing higher frequency spectrums (micro and mmWave), which offer greater bandwidth for transmitting large amounts of data."

Jose Rodriguez, technical marketing manager at Tektronix, noted that in April the FCC voted to unlock spectrum in the 6-GHz band for Wi-Fi 6E using the latest 802.11ax protocol.[2] The move positions Wi-Fi 6E to compete with 5G NR in indoor applications that demand low latency, with detailed cost-benefit analysis required to choose the optimum technology for a given application, said Rodrigues, citing research from Counterpoint.[3]

Whichever technology wins out for a specific application, said Rodriguez, "a next-generation device—whether it's 5G NR, Wi-Fi 6, or any other modern wireless protocol—requires extensive simulation, design, troubleshooting, planning, spectrum-coverage testing, and monitoring over various power scenarios to ensure new chipsets conform to power standards and avoid interference."

Anritsu also sees a trend toward 5G. "Engineers designing and manufacturing UE utilizing emerging technologies, such as those used in 5G and IoT, need test solutions to verify that products are in compliance with the latest industry standards, but also have a flexible, cost-efficient pathway to measure UE based on future requirements," said a company spokesperson. "Test solutions that have modular platforms to support a variety of applications and have software options for modulation analysis of communications technologies can satisfy this need."

▼ Per Vices Cyan software-defined-radio platform.

According to Brandon Malatest, COO, Per Vices Corp., "Signal and spectrum analyzers are becoming increasingly powerful and flexible through the further adoption and integration of software-defined-radio technology. This trend has led to the need for high-performance SDR platforms with high sampling bandwidths, converter resolution, extended tuning range, and a greater number of channels."

Malatest continued, "This trend has been further augmented by the use of open-source tools that work out of the box with these high-performance SDRs. These tools, such as GNURadio, offer a wide community of users and resources to help implement the features demanded by signal and spectrum analyzers while harnessing the power of SDRs."

Steve Sandler, managing director at Picotest, a maker of probes and accessories for spectrum measurements, identified a need for more real-time performance and wider bandwidth. "Oscilloscopes are also incorporating more sophisticated spectrum-analysis features, such as Spectrum View from Tektronix," he said. "These tools provide separate hardware paths for the time domain and frequency domain so that the resolution bandwidth is independent of the time base," and they also support time-correlated spectrum measurements.

When asked about challenges customers are facing, Sandler said, "Getting a sense of EMI early in the design is a big one." He added that components such as LNAs, PLLs, and clocks are sensitive to noise, "…and spectrum is the best way to look at it." Picotest serves applications including low-noise-circuit troubleshooting and optimization as well as jitter assessment, he added.

Challenges

Chonko at SIGLENT addressed increasing complexity in design and troubleshooting tasks and tighter budgetary constraints. "They are looking for tools that provide the widest range of uses without compromising measurement integrity at the lowest costs."

Leeke and D'Amore at Keysight, pointed out, "With more users joining the network every day, and each one wanting faster speeds, higher throughput, and utmost reliability, providers must be able to simulate and monitor these challenging environments to provide the quality needed. As 5G and mmWave markets progress, governing bodies such as 3GPP introduce new standards to meet. Manufacturers must ensure their devices meet expectations of both governing organizations and the everyday consumer, making testing pivotal."

Leeke and D'Amore continued, "In the defense market, spectrum monitoring allows users to ensure high-capacity links remain secure, keep an eye on radar sensors, and utilize mmWave frequencies for EW sensing, active denial systems, and many more. It has become more important for tests to be repeatable and reliable."

Cory Allen, marketing director at Signal Hound, cited controlling costs as a key challenge. "Our customers are often dealing with deployments in quantity. The proliferation of wireless technology in society is driving demand for RF testing capabilities at every level—from product development to infrastructure maintenance and configuration," he said. "Larger organizations often require an allocation of devices across a distributed team—a team that typically doesn't have the ability to physically share analyzers between personnel. Modern lower-cost test equipment provides the critical RF data-analysis functionalities, while maintaining organizational budgets."

Lipps also cited cost, saying customers are interested in affordable, portable, rugged handheld analyzers that can be used in the field, particularly to track down interference. "Customers also face problems with interference between the devices that generate RF signals. Given the challenge of characterizing the behavior of RF devices, it is necessary to understand how frequency, amplitude, and modulation parameters behave over short and long intervals of time; therefore, it is crucial for engineers and scientists to be able to reliably detect and characterize RF signals that change over time."

According to Malatest at Per Vices, "Our customers, like many of those in this market, face challenges associated with performance with specific emphasis on operating frequency, bandwidth, and channel count. Many applications that make use of signal and spectrum analyzers have advanced with respect to their needs and require operation above 6 GHz with 400+

MHz of bandwidth and many independent radio chains (6+)."

"This year, the clear ramp up to mmWave 5G has been a big challenge for many customers," said Tipton at Rohde & Schwarz. "Converting from conducted testing to OTA testing brings new challenges. Many customers have needed to learn that testing at 3 GHz does not work in the same way as at 28, 39, or 44 GHz. Here, Rohde & Schwarz has acted as a consultant to our customers due to our long experience in testing at such high frequencies."

According to Maxwell at Rohde & Schwarz, test time represents a key challenge. "As 5G begins to mature, exhaustive testing is underway to verify that these designs work in every condition in order to meet customers' diverse needs," he said. Fast testing is essential to managing capital equipment budgets, in addition to fully characterizing and validating 5G designs and hitting the early market windows.

"We see performance of radar systems advancing in automotive for self-driving vehicles," he said. "It's important to equip vehicles that can resolve smaller objects from larger objects for better safety, and this is achieved by using wider bandwidths."

MathWorks addresses signal analysis from a software perspective, as described by Eric Wetjen, product manager, test and measurement products, and Houman Zarrinkoub, product manager, wireless and communications products. Zarrinkoub said, "In the 5G era, new millimeter-wave frequency bands are being introduced. Distortions and impediments to wireless communication must be analyzed and verified for these frequencies, and new devices must be built and tested at these frequencies."

Wetjen explained that configuring test equipment and SDRs to validate 5G and other communications signals over the air (OTA) can take too much time and is cumbersome to set up.

"Continuous evolution of communication standards like 5G and Wi-Fi are aiming to address the insatiable need for speed and throughput in wireless networks," added Zarrinkoub. "To satisfy these needs, new innovative algorithms such as massive MIMO and beamforming are introduced. This, in turn, adds significant complexity to the design of wireless systems."

Products

SIGLENT's Chonko pointed out, "We have expanded our standard spectrum-analyzer platform to 7.5 GHz with the new SSA3075X Plus, added two new real-time spectrum analyzers in the SSA3075X-R Series, and also added a 7.5-GHz spectrum and vector network analyzer model, the SVA1075X. All of our analyzers have swept superheterodyne analysis and optional firmware upgrades to provide automatic measurement and signal demodulation," he said. "The Plus, X-R, and SVA models have distance-to-fault, vector-signal-analysis, and other toolkits to help with more specialized measurements. With each product in these categories, engineers are getting serious measurement performance on a flexible platform that won't break the bank."

Recent products from Keysight include the N9021B MXA signal analyzer, which ranges from 10 Hz to 50 GHz and provides the widest analysis bandwidth in its class, allowing for analysis of next-generation wireless signals, according to Leeke and D'Amore. "With RTSA options, the MXA sees through the complexity of challenging signals, including debugging transmitter designs for elusive transients."

They continued, "Using PathWave X-Series Measurement Applications and PathWave Vector Signal Analysis (VSA), different application bundles allow you to tailor your measurement solution to your specific industry application. This includes advanced demodulation of the latest standards and formats. The low phase noise and high bandwidth allow for the accurate analysis of complex signals, including 5G NR measurements with EVM as low as 1%."

Keysight also just released the MXR oscilloscope, which Leeke and D'Amore explained combines the analysis power of both time and frequency domains in one instrument. "With up to eight channels, the MXR provides faster test speeds than ever before, from 500 MHz to 6 GHz," they said. "By supporting over 20 protocols from triggering, complete decoding, and compliance tests, the MXR helps to view fast-switching signals and ensure your device meets compliance standards. With preconfigured tests and high waveform memory, tests can be run over and over to ensure consistent results. The ASIC analog performance allows this instrument to operate in frequency domain, being able to display the spectrum characteristic of the signal. The eight phase-coherent channels can be used simultaneously, and 310-MHz RTSA is available to analyze the most challenging signal configuration."

▲ Keysight N9021B MXA signal analyzer.
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Tipton at Rohde & Schwarz said that the company continues to address high-frequency, high-bandwidth requirements. "We released options for our R&S FSW signal and spectrum analyzer to address bandwidths of 4, 6, and 8.3 GHz," he said. "This is already starting to pave the way for 6G research." He also sees impacts on the satellite industry where transponder frequencies are moving to the Q/V bands, with bandwidths approaching 4 GHz, and expected to increase over time.

According to Maxwell, Rohde & Schwarz in April introduced the R&S FSV3000 and R&S FSVA3000 midrange signal and spectrum analyzers, covering 44 GHz with up to 400 MHz of bandwidth. "The R&SF SV3000 is designed to help users set up complex measurements in the simplest and fastest way possible, while the R&S FSVA3000 enables users to perform highly demanding measurement applications such as linearizing power amplifiers and characterizing frequency-agile signals." He described them as cloud-ready with fast signal processing and a 10GbE connection.

Maxwell also said that the R&S Spectrum Rider FPH handheld spectrum analyzer offers customers a versatile, user-friendly instrument with a rugged design. "In addition to featuring a state-of-the-art color, touchscreen and on-screen keyboard

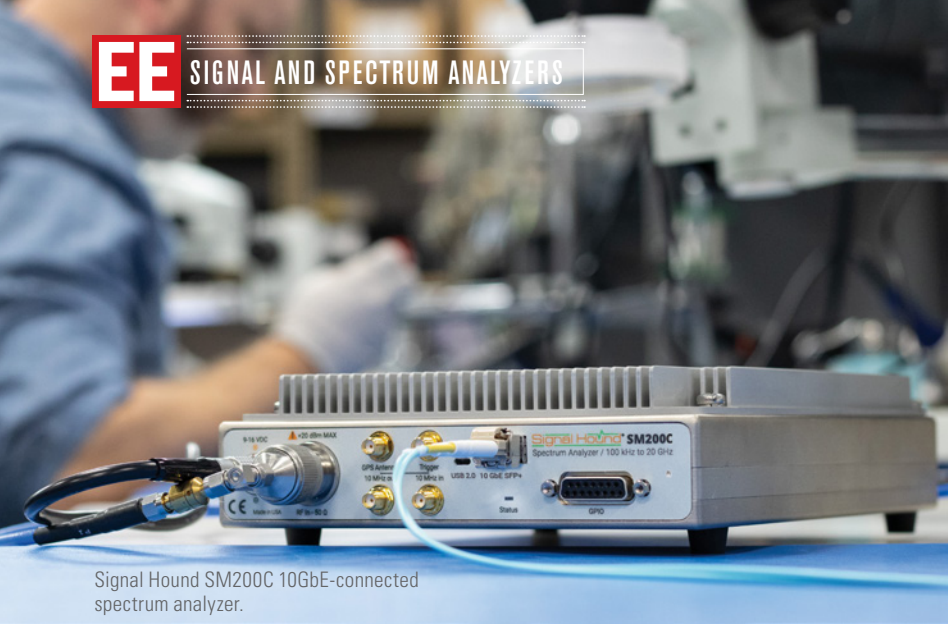
to provide ease of use for engineers, the instrument includes a backlit keypad to support analyzer use in the dark, and a bright nonreflecting display for readability in sunlight," he said. "Each basic model includes a unique frequency extension concept via keycode, and the analyzer supports a wide frequency range up to 31 GHz. Plus, weighing less than six pounds and offering a battery lasting six hours or more, the instrument is designed to suit both field and lab applications in indoor and outdoor environments."

In addition, Maxwell said, the R&S FPC1500 spectrum analyzer, with a frequency range of 5 kHz to 1 GHz, which can also be upgraded to 2 GHz or 3 GHz, continues to be one of Rohde & Schwarz's most popular instruments. "As the only entry-level spectrum analyzer on the market with the value and capabilities of a three-in-one instrument—a spectrum analyzer, vector network analyzer, and a signal generator—the R&S FPC1500 is designed to the same quality standards as high-end instruments."

Anritsu recently introduced 5G New Radio (5G NR) FDD measurement and waveform generation software for its MS269xA signal analyzers. "The new software packages expand the capability of the instruments by providing 5G NR FDD measurement support and signal output for more efficient verification of 5G chipsets, mobile devices, and base-station elements," the spokesperson said. "The Measurement Software NR FDD sub-6-GHz Downlink/Uplink supports easy, fast, and stable analysis of key parameters, such as power, frequency error, and EVM, of sub-6-GHz 5G FDD downlink and uplink signals. The 5G NR FDD sub-6-GHz IQproducer software generates sub-6-GHz 5G FDD downlink and uplink signals for evaluating 5G system transmitter and receiver characteristics."

▲ Rohde & Schwarz R&S FSVA3000 midrange signal and spectrum analyzer.

"Signal Hound's SM200C is a 10GbE-connected spectrum analyzer that provides 160 MHz of continuously streaming I/Q over the 10GbE connection," according to Allen. "No longer requiring the USB connection for data transfer means that the analyzer can be placed at a great distance from the PC—perfect for remote analysis applications," he said. "This is a helpful addition to the field of remote-monitoring-focused analyzers already on the market, offering a powerful lower-cost option to



Signal Hound SM200C 10GbE-connected spectrum analyzer.

organizations needing increased device rollout without increasing spend." In addition to remote monitoring, he said, the Signal Hound instruments can be used in ATE environments, in SIGINT as a receiver for third-party applications, and in general-purpose spectrum-analysis applications.

To meet the challenges of testing next-generation 5G, Wi-Fi 6E, and other devices, Tektronix offers the 6 Series MSO oscilloscope, which covers the spectrum up to 8 GHz with 2 GHz of instantaneous bandwidth, according to Rodriguez. "Our unique architecture IP introduces a DDC (digital down converter) that separates the signal path, enabling Spectrum View software to analyze the frequency domain independently from the time domain. Correlation between time and frequency domains is as simple as a finger pinch on its 15.6-inch touchscreen."

Rodriguez said. "The 4-channel MSO6 with its Spectrum View feature enables multichannel spectrum analysis as well as basic multichannel vector signal analysis—both amplitude and phase—and IQ capture of signals, which is essential for both 5G and Wi-Fi 6 testing due to the demand for multiantenna transceiver designs, which use technologies like MIMO and beamforming to improve SNR."

In March 2020, Tektronix introduced the RSA7100B spectrum analyzer with up to 800 MHz of real-time bandwidth. "The instrument doubles as an I/Q data recorder by providing options of up to 2.5 hours of record time at full acquisition bandwidth," he said, adding that it features a 232-ns 100% probability of intercept (100% POI).

Rodriguez said Tektronix in December 2019 (with an update in March 2020) introduced an API for 64-bit Linux to support the RSA306B, RSA500, and RSA600 Series spectrum analyzers. "This API enables users to build custom signal-analysis and spectrum-monitoring applications on Linux Ubuntu, CentOS, and Debian systems," he explained. "The new Linux API is identical to Tektronix's API for Windows, but due to its flexibility, security, and reliability over a traditional Windows environment, we've seen a significant preference for Linux in recent years in military and government environments."

Malatest said Per Vices offers the Cyan platform, which can support solutions ranging from 500 MHz of bandwidth (up to 1 GHz) per radio chain, operation to 18 GHz, and up to 16 radio chains. "This high-performance platform also offers on board FPGA resources for additional customer-specific DSP and 4x40-Gb/s throughput for streaming data to a host system," he added.

B&K Precision offers its 2680 Series spectrum analyzers, which include frequency ranges from 9 kHz to 2.1 GHz or 3.2 GHz. "Each model includes advanced measurements such as channel power, adjacent channel power, occupied bandwidth, total power, third-order-intercept, along with a 2D and 3D spectrum monitor," said Jamie Pederson, product marketing manager.

Pederson elaborated on the compact instruments, suitable for both lab and field use. "The 1-Hz minimum RBW and advanced measurements work well in many applications ranging from R&D, production test, field test, and EMI precompliance," he said. "To complement these features, we offer a reflection measurement option and reflection bridge which enable VSWR, reflection coefficient, and return-loss measurements for tuning and determining the efficiency of antennas, filters, or RF transmission modules. We also offer an EMI option and near-field probe kit that enable the instrument's EMI measurement function, which includes predefined bandwidth set points of 200 Hz, 9 kHz, and 120 kHz; a -6-dB EMI filter; and the quasi-peak detector as specified by CISPR 16-1."

Lipps at Newark cited several products, including the R&S Spectrum Rider FPH handheld spectrum analyzer, which she described as "suitable for both field and lab applications indoors and outdoors. "Its backlit keypad makes the analyzer usable in dark environments while the bright, nonreflecting display makes it readable in sunshine," she said. "This spectrum analyzer's lightweight, small form-factor and ruggedness make it easy to carry. Due to its fanless design, the analyzer not only operates noise-free, but is also clean and reliable, since no dust or water can enter through the vent guard."

Lipps also cited the Triplett WiFi HOUND handheld RF spectrum analyzer

▲ Tektronix RSA306B spectrum analyzer.

(for 2.4-GHz and 5-GHz networks), which offers analysis and reporting functionality for IT and A/V technicians, system integrators, and troubleshooting consultants in indoor and outdoor environments. "It also addresses one of the customer concerns highlighted already—affordability—coming in at under $700 at Newark."

Saelig is another distributor offering signal-analysis products, including the aforementioned SIGLENT SSA3075X-R and SSA3075X Plus, according to CEO Alan Lowne. The company also offers the Aaronia AARTOS drone/UAV detection system and handheld Bug Finder monitoring device, the Microrad NHT 3DL electromagnetic field safety analyzer, the ThinkRF R5x50 real-time 8/18/27-GHz spectrum analyzers, and spectrum analyzers from AIM-TTi and Triarchy. Saelig also offers Pico Technology's line of PicoScopes, which, Lowne said, include FFT capabilities that let them serve spectrum-analysis applications, albeit at lower sensitivity than is available with dedicated spectrum analyzers.

Wetjen and Zarrinkoub said MathWorks has introduced products and features that support wireless-signal design, analysis, and validation. To address the challenges of conformance testing at millimeter-wave frequencies, the company has introduced software-based scopes such as a spectrum analyzer into several of its add-on products like DSP System Toolbox and RF Blockset, said Zarrinkoub, adding, "The Spectrum Analyzer lets designers view the detailed spectrum of a simulated signal and perform specific measurements associated with the development of individual system components."

"Since these spectrum analyzers are software-based, we don't need to wait for RF circuitry necessary to transmit and receive millimeter-waves to be ready before we can test them. Using software models of radio-frequency frontends, power amplifiers, and digital pre-distortion (DPD) units we can perform simulated measurements including channel power, occupied bandwidth, frequency offset, harmonic distortion, and SNR to name a few. The scopes also enable the design of custom measurement tools that can be used on live or prerecorded signals."

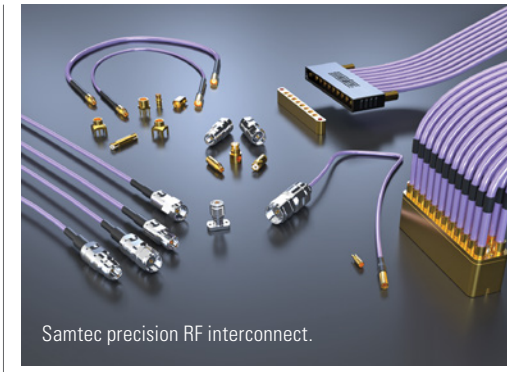
"At some point in the design cycle, engineers move from simulation to validation of a signal that is transmitted over a cable or OTA," said Wetjen. "To address the challenge of improving the time to setup and configure OTA validation tests, we have added a number of hardware support features that can be used to quickly bring data into the MATLAB environment from SDRs or benchtop signal analyzers from vendors."

Wetjen continued, "To help engineers prototyping with SDRs, we have introduced hardware support packages that can be used to enable radio-in-the-loop testing and prototyping from MATLAB and Simulink. Specifically, we've added support for popular platforms like the USRP E310 from National Instruments and the Xilinx Zynq-based software defined radios. With these support packages, engineers can quickly connect to the SDR platform and send and receive IQ signals which can be further analyzed in MATLAB."

Zarrinkoub explained that the continuous evolution of communication standards has prompted MathWorks to provide standards-compliant waveforms for use with MATLAB. "For each of these wireless standards, we enable engineers to design, simulate, and test communication systems including the ability to perform channel modeling, channel coding, and receiver operations. Engineers working in this wireless space need the tools they rely on to stay current so that they can generate and decode these signals."

He continued, "MathWorks toolboxes like 5G Toolbox and WLAN Toolbox are keeping up with the latest wireless standards such as 5G Release 15, WLAN 802.11ax, and Bluetooth Low energy. These up-to-date software solutions, combined with flexible RF front ends on T&M gear or software-defined radios provide a powerful combination that helps engineers test and verify their work on the latest versions of these standards before there is widespread support for those standards in the marketplace. In addition, communication engineers can modify the standards-compliant signals provided in our add-on products to explore potential variants of the standard."

Samtec addresses signal analysis with its precision RF interconnect portfolio,



Samtec precision RF interconnect.

according to Matt Burns, technical marketing manager. "With performance to 110 GHz and a combination of PCB connectors, RF cable connectors, RF cables, and RF cable assemblies, Samtec offers the ideal solution for precision RF interconnect on signal and spectrum analyzers," he said.

Burns cited a proliferation of RF protocols using high carrier frequencies—40 GHz, 50 GHz, 65 GHz, and beyond. "New signal and spectrum analyzers need to push their performance to keep up," he said. "They also need components—such as precision RF interconnect—that support those needs as well. Burns added, "As carrier frequencies get higher, RF interconnec typically gets smaller. Signal and spectrum analyzer designers are always looking for the optimal interconnect solution for their application."

Applications

According to Chonko at SIGLENT, "Our products are used in antenna design/characterization and installation, wireless data monitoring, satellite up/downlinks, wireless microphone/soundstage production testing, RF site surveys, transmitter troubleshooting and verification, and a host of broadcast testing applications."

Leeke and D'Amore at Keysight said signal and spectrum analyzers find use in areas like 5G and wireless development, defense development, and automotive technology. "In wireless, the analyzers ensure reliable data transfer, such as short-range, high-data-rate networks like IoT," they said. "Ultrawideband analyzers ensure a view of the entire signal, ideal for EVM measurements and satellite tests. This brings us to defense development, where deeper views of elusive and wideband signals make all the difference."

Gap-free analysis, they said, allows recording and simulation of real-world environments while keeping a close eye on fast hopping and transients in radar, electronic-warfare (EW), and other signals.

"Automotive radar technology has now entered the mmWave band," Leeke and D'Amore continued. "Many predict this application area to grow to include hundreds of millions of connected cars in the next few years, including around 14 million self-driving cars by 2025. This means there can be no sacrifices in quality when validating designs of collision threat detection, autonomous driving, connectivity, and eco-friendly efficiency."

Wetjen and Zarrinkoub said MathWorks' products are used for waveform analysis, algorithm design, and system development across a diverse mix of application domains and signal types. "Notable examples include wireless communications, radar and sonar, audio, and noise and vibration," they said. "In the wireless area, our products are used to design and test wireless signals for low-power IoT applications, delay-sensitive vehicle-to-vehicle communication, and high-throughput cellular base-station applications."

Maxwell at Rohde & Schwarz said, "Our signal and spectrum analyzers are used in a wide range of applications, including EMC precompliance and troubleshooting and field testing of wireless signals, as well as 5G and Wi-Fi physical layer testing, electronic warfare, radar, and satellite."

Tipton added that Rohde & Schwarz is moving into 6G pre-research while also addressing any communication technology using high-frequency, wideband signals. "We are also heavily focused on component characterization for amplifiers or frequency-converting devices, with modulated signals. We are making large strides with the measurement science for understanding all contributions to modulation quality, and we are making use of network-analysis techniques to compensate and de-embed the effects of the measurement instruments. This is important, for example, in the satellite industry where wideband signals need to be applied to transceivers with flat frequency response."

▲ Anritsu MS2690A signal analyzer.

According to the Anritsu spokesperson, the MS269xA has the performance, such as a level accuracy of ±0.5 dB across a 6-GHz span, necessary for R&D. "It also has a wideband FFT signal analyzer for analysis bandwidth of 31.25 MHz with options for 62.5 MHz/125 MHz to support high-speed continuous measurements on the manufacturing floor," the spokesperson said. "The MS269xA Series can conduct physical-layer tests on 5G chipsets, mobile devices, and base-station elements in accordance with all 3GPP technologies, including 5G NR (sub-6-GHz). The analyzers can also be configured to perform WLAN testing, including IEEE802.11a/11b/11g/11j/11n/11p and 11ac, on chipsets and devices."

According to Rodriguez at Tektronix, the RSA7100B is suited for applications involving wideband radar, electronic warfare and mission-critical communications systems, aerospace electromagnetic environmental effects (E3) testing, military range testing, and other RF recording operations. "The Tektronix RSA7100B addresses all the requirements of good data collection: recording the highest quality data to disk, completely understanding the situational environment, and providing real-time feedback—simultaneously," he said. "With a frequency range of 26.5 GHz and a maximum receiver bandwidth of 800 MHz, this instrument can capture key radar, countermeasure, and telemetry signals and store at least 2.75 hours of spectrum data at full rate on its own solid-state RAID storage system."

Rodriguez added, "The new Linux API on the RSA300, RSA500 and RSA600 Series (USB RTSAs) will serve to support applications such as electronic-warfare spectrum monitoring, deep-data signal analysis, RF sensor SIGINT, high-mix/low-volume manufacturing programmatic control and test, and custom SATCOM transmitter range testing. These instruments are used to monitor RF signals over a large field of operation. In the military, such as on a ship or on an airfield, the ability to network multiple RTSAs can be a significant benefit."

Varying form factors

Signal and spectrum analyzers come in a variety of form factors. "Modern analyzers have similar functionality and performance in most cases, regardless of form factor," said Chonko at SIGLENT, adding that benchtop models typically have the best price/performance ratio because they eliminate the cost of specialized parts required for battery operation. "Some benchtop equipment is also fairly portable and can be used in the field in some cases," he said, "but benchtop equipment can also be a little too large to haul around in a work truck." In contrast, he said, "Handheld designs are very portable and easy-to-use in the field, but they come at a price premium for parts and design expertise required to engineer battery-powered devices."

Chonko continued, "USB and PXI modules are ideal for production test where space for instrumentation is at a premium, but a computer is required for operation and there is no easy way to simply 'see' what is going on without working through a computer interface."

Leeke and D'Amore at Keysight also weighed in on instrument form factors. "One size doesn't fit all—not every lab needs the same form factor instrument," they said. (Leeke is the author of Keysight's One Size Does NOT Fit All—Choosing the Right Instrument Form Factor.) "PXI modules are the fastest-growing segment of test and measurement equipment. These modular instruments allow for a small footprint by including multiple instruments in a compact space, high throughput with direct backplane speed, and a highly flexible configuration, by allowing custom solutions. This solution especially

applies to multichannel measurements, especially since these instruments are scalable, allowing for maximum number of ports."

They added that usually, a soft front panel facilitates the viewing of measurements on an external display. "For example, the M9290A CXA-m PXIe signal analyzer enables full performance of a 26.5-GHz signal analyzer in a compact format," they said. "The form factor enables the combination of functionalities and creates new instrument categories."

They also cited the Keysight M9410A/M9411A PXIe vector transceiver (VXT), which integrates a 6-GHz vector signal generator (VSG) and a vector signal analyzer (VSA) in a 2- or 3-slot PXIe module with up to 1.2 GHz bandwidth. "It enables the user to access industry-leading RF performance in a compact modular design, for improved efficiency and scalability in design verification and manufacturing test," they said. "By incorporating high-performance mmWave heads, the frequency range can be extended up to 40 GHz to cover 5G applications."

They described benchtop instruments as the classic solution, providing an all-in-one, self-contained instrument. "Keysight benchtop signal analyzers reside in many labs due to specifications like performance, speed-of-test, and accuracy," they said. "Due to a multitouch, large front panel, measurements and viewing results are easy and intuitive."

They also commented on portable instruments. "Instruments like the FieldFox and HSA handheld spectrum analyzers allow the user to carry microwave measurements wherever they go," they said. "These instruments are rugged and weather-resistant, making them ideal for field measurements. With a long operating life of four hours and a field-replaceable battery, handheld instruments provide an option that the user can take with them. Latest enhancements such as 100-MHz analysis bandwidth and RTSA make this solution the ideal companion for advanced wireless field test such as 5G and satellite communication."

"Expectedly, traditional benchtop analyzers with their larger size allow for more: more ports and connectivity, built-in displays, physical buttons, and powerful processors," said Allen at Signal Hound. "Industry familiarity with the benchtop formfactor is also an advantage. The larger footprint of these devices can be a disadvantage, though, in some work environments."

Allen continued, "Handhelds deliver power in a convenient purpose-built formfactor/UI and portability. USB-connected devices also deliver portability—albeit to a lesser extent due to display/PC connection requirements—but the flexibility afforded by USB devices in terms of cross-PC portability, device sharing between employees, and lower-cost-of-entry makes for a perfect solution across a variety of applications. And with powerful processors getting both smaller and less expensive, the use of USB-powered test equipment in critical situations is becoming more commonplace.

Finally, Allen said, "The PXI analyzers fill the void between power and configurability—allowing for custom, application-specific design and powerful processing capabilities in a headless form-factor—but this high performance and flexibility can come at a higher monetary cost."

According to Malatest at Per Vices, "Handheld and small form-factor instruments always offer the convenience of portability, smaller footprint, and lower power requirements; however, these also come with a limitation in performance. These solutions may be ideal for enthusiasts and for applications that do not require the higher performance offered by other configurations. Other form factors, including benchtop instruments and rackmount instruments, offer significantly greater performance and are ideal for an audience that requires the high performance that typically comes from these instruments."

When asked about the choice of benchtop, portable, USB, PXI, and other form factors, Tipton at Rohde & Schwarz responded, "Wow, that is a big question. We clearly see the advantages of each, related to the task that is needed. There is also a clear distinction in the price and performance class of each instrument."

Tipton added, "PXI modules are sometimes considered as a lower cost, compact form factor. But often the cost of chassis and more importantly the costs of the required software integration and future engineering support are neglected in the decision-making process, resulting in budget overruns for an organization in the course of a project. There are also questions around metrology and traceability of measurement results relating to instrument specifications, which are not always clear to the customer and which take significant time and effort for the user to understand."

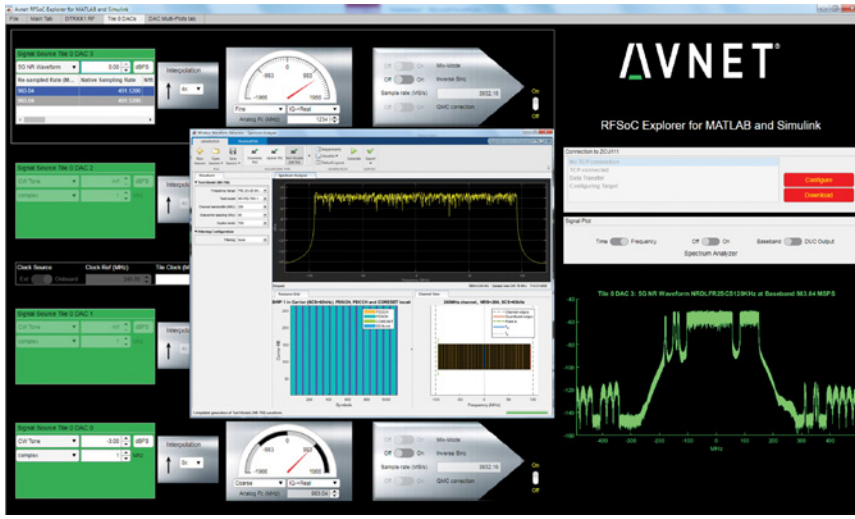
Tipton said Rohde & Schwarz's approach is to integrate the company's hardware and software tightly, to produce an optimal price/performance ratio for customers. "It saves them both time due to rapid integration and deployment as well as money and long-term operational support costs for their platforms," he said.

Maxwell at Rohde & Schwarz commented that many users favor having a contained instrument that does not require a separate PC, is easy to carry, and has a long battery life. "For benchtop instruments, having a complete instrument with fully tested and supported application software is an advantage for many users," he added. "Some of the alternative form-factor instruments require ongoing maintenance of FPGA code and verification that any kind of analysis software works correctly. These are some of the hidden costs associated with modular instruments. Fully integrated and tested benchtop instruments work right out of the box and can help users quickly get up and running with testing."

Sandler at Picotest attributed form-factor selection to personal preference. "Traveling is obviously much easier with a portable handheld instrument," he said. "USB requires a computer, and while many do have computers in their lab, installing software can require an act of Congress." Consequently, engineers often ask for an all-in-one instrument, he noted. EE

REFERENCES

1. Cisco Annual Internet Report (2018–2023) White Paper, Cisco, March 9, 2020 (updated).
2. FCC Adopts New Rules For The 6 GHz Band, Unleashing 1,200 Megahertz Of Spectrum For Unlicensed Use, Federal Communications Commission, April 23, 2020.
3. Owen, Gareth, Wi-Fi 6/6E—A Viable Alternative to 5G NR for Low Latency Applications? Counterpoint, April 2020.



Avnet RFSoC Explorer application for MATLAB and Simulink.

SPECIAL REPORT

VENDORS ADDRESS 5G, WI-FI, V2X TEST NEEDS

By Rick Nelson, Contributing Technical Editor

Test-equipment vendors are keeping pace with rapidly evolving technologies, including 5G, Wi-Fi 6, and vehicle-to-everything (V2X). Measurement chores extend from testing small devices to massive MIMO antenna arrays. Products available include dedicated communications-test platforms as well as general-purpose instruments that can be adapted for specific communications technologies. Software also has a role to play in bringing together effective communications test solutions.

Challenges

According to Craig Hendricks, market development manager at Anritsu, "Our customers are designing products utilizing new technologies with evolving standards, so they need test solutions that can verify performance efficiently." He added that Anritsu is involved in the standard organizations to stay current with the necessary tests. "We use that knowledge to develop test modules and software that address emerging technologies such as 5G NR and Wi-Fi 6 for our flexible product platforms to provide customers with the necessary support," he said, explaining that Anritsu solutions can conduct RF, functional, and protocol tests.

Adam Smith, LitePoint's director of product marketing, commented on the proliferation over the last few years of new global spectrum availability. "Of particular note are the licensed 5G FR2 mmWave bands (today at 24 to 40 GHz, and continuing to expand) and the '6 GHz' unlicensed band (5.925 to 7.125 GHz). These frequencies are outside of the under-6 GHz 'comfort zone' of the majority of consumer wireless technologies, and require the makers of products using these bands to tool with new equipment."

Smith continued, "This is particularly true in the manufacturing space, as the installed base of test and measurement equipment does not support these higher frequency bands. Product companies are finding themselves in need of bringing leading-edge technology to market, while also needing to keep the production economics in line with established price points for consumer products. Additionally, companies need to quickly adopt these technologies and be able to produce devices with high quality and high production yield."

Luc Langlois, director, products and emerging technologies/DSP at Avnet, cited two challenges facing customers—the first being system modeling for wireless communication. "Modern wireless communication systems are designed by multidisciplinary engineering teams working collaboratively," he said. "In the initial concept phase, the system architect will work at a high level of abstraction to create mathematical models of the system in a simulation environment such as MATLAB and Simulink. Typically, the goal of this phase is to demonstrate proof-of-concept in a reasonable amount of time using existing off-the-shelf hardware. One of the main challenges at this point is to exercise the model with realistic test vectors that represent actual operating conditions once the system is ultimately deployed."

The second challenge, Langlois said, relates to characterizing RF hardware for 5G applications. "Concurrent to system modeling, the RF engineer must characterize the RF performance of candidate hardware platforms for a given application, he said. "For new and evolving standards like 5G, this characterization task is made more complicated as system requirements will likely evolve along with the standard. This places additional burdens on the characterization process, as it needs to be flexible enough to deal with shifting requirements."

Complicating the characterization task even further, he said, is the advent of silicon devices with high levels of system integration, such as the Xilinx Zynq UltraScale+ RFSoC with integrated multi-gigasample-per-second RF data converters. "For these complex devices, access to the data converters can only be achieved through the processing subsystem, which may put an RF engineer used to working with discrete converters on a workbench into unfamiliar territory, as accessing the

RF components will now involve some level of FPGA and embedded processor software design," he said.

Langlois said that meeting these challenges requires a development environment that provides flexible signal generation and analysis for 5G standard-compliant waveforms, as well as for new waveforms as the standards evolve. "The generation and analysis capability must also be able to communicate with the hardware in a way that allows RF engineers to concentrate on the RF performance of the hardware, and not worry about programming embedded devices," he said. "To ensure a seamless workflow between system-level exploration and RF characterization, the development system should include a proven pre-engineered RF front end allowing capture of real-time signals over-the-air which can serve as stimuli to drive the system model."

Jeffrey Phillips, head of automotive marketing at NI, commented on the challenges of testing V2X devices. He first cited constant changes in underlying technology and new standards, which create changes in test needs. "Speed is creating a challenge in test," he said. "Customers can't buy systems fast enough, so we help them 'buy' an integrated test system that they can still edit/upgrade over time."

Phillips next commented on system integration. "Connectivity is a critical component of autonomous vehicles," he said. "Validating the entire system means bringing together hardware, software, and communication from multiple vehicle domains."

He also addressed a software-connected approach. "Systems are built to the customer's need, but done so on top of open, reconfigurable software running on modular, flexible, COTS-based hardware," Phillips said. "They can evolve the tester as the test requirements evolve, meaning smaller upgrades to systems. We've seen this approach reduce the time to build a tester by 50%, 70%, 80%."

When asked what challenges customers are facing, Reiner Stuhlfauth, wireless technology manager at Rohde & Schwarz in Munich, responded, "Let me reply to this question with two major aspects: the past and the future. We enable technologies, thus we have to deliver test solutions covering the forefront of technology evolutions. In close contact with our customers, we try to anticipate testing needs. This is the look into the future."

Stuhlfauth continued, "The introduction of new technologies does not stop the evolution of existing technologies. This is the look into the past, as we fully need to support legacy technologies." He added that the company's solutions need to cover a wide range in terms of both technology and application. "To give an example in terms of technology: mobile radio technology today ranges from 2G to 5G and includes non-cellular technologies like Wi-Fi 6, UWB or Bluetooth," he said, adding that with respect to the application, those RAT technologies are subject to R&D test, conformance test, and production test, "… so our solutions need to cover a wide application range as well."

Legacy testing entails various user and programming interfaces depending on the application, according to Stuhlfauth. "While early R&D testing requires the programming of user-specific scenarios with detailed access to all layers within the protocol stack, users in the field of conformance testing require an easy parameterization and a reporting concept when running RF or protocol test cases," he said. "With the combination of R&S CMsquares and R&S Contest, we provide an expert solution for each application. The new CMsquares offers one single user interface for protocol development, RF parametric test, and application testing. And the existing R&S Contest brings the long experience from type approval testing into the area of protocol testing in the lab."

Stuhlfauth said that with the introduction of 5G NR, the test-and-measurement world sees a paradigm change. "The connection between DUT and system simulator becomes over the air," he said. "Even if OTA testing is not new, it has become more important as it's a pivotal element of an everyday test setup. With a wide range of OTA antenna testing and chamber portfolio, Rohde & Schwarz supports an easy upgrade of conducted to OTA, and integration of shielding chambers into the measurement setup for all possible devices, ranging from a single component via complete device up to a full vehicle."

According to Amr Haj-Omar, market segment leader for wireless communications at Tektronix, circuit density on RF chips is exploding because of integrated antennas on a single chip and MIMO requirements. "Bandwidths on these devices are also going up," he said. "The unique challenge of multiple channels at a wide bandwidth is something that has been difficult not only for chip designers, but also for test instrument vendors. Tektronix is uniquely positioned in this area, because of in-house ASICs that address both multiple channels and wide bandwidths."

Products

Hendricks at Anritsu commented on several products and enhancements that address next-generation communications technologies including Wi-Fi 6, 5G, and V2X. "The Wireless Connectivity Test Set MT8862A WLAN tester has been enhanced to support RF TRx characteristics of IEEE802.11ax Wi-Fi 6 devices," he said. "By using the MT8862A Network Mode, RF TRx characteristics, such as Tx power and modulation accuracy (EVM), can be measured with the Wi-Fi 6 devices in realistic operating conditions," he said. "The MT8862A can simulate access points (AP) and stations (STA) to establish the DUT network connection using IEEE802.11a/b/g/n/ac/ax WLAN protocol messaging, allowing it to measure devices utilizing any Wi-Fi generation."

Hendricks also said Anritsu's recently-released LTE-V2X Tx Measurement MX887068A software for its Universal Wireless Test Set MT8870A enables it to measure Tx power, frequency deviation, occupied frequency bandwidth, and adjacent channel leakage power, as well as conduct spectrum emission mask test and modulation analysis as specified by 3GPP. "The bundled LTE-V2X Waveforms MV887068A package includes general RF test-signal waveform files required for non-signaling Rx testing for easy output of RF test signals, simply by selecting the waveform file," he said. "The MT8870A, specifically designed for high-volume manufacturing environments, can also be used in R&D. It supports 5G NR sub-6-GHz, LTE, NB-IoT, Cat-M, WLAN up to 11ax Wi-Fi 6, and Bluetooth up to v 5.0."

In addition, Anritsu recently introduced its SmartStudio NR (SSNR) environment for interactive GUI-based functional 5G device testing. "With a built-in, state-machine-based GUI, SmartStudio NR emulates the network conditions and communication between a 5G/LTE network and mobile terminal to implement efficient functional, application, and software regression tests," said Hendricks. "Among the tests supported by SmartStudio NR are network connectivity and carrier aggregation; power consumption and temperature; IP throughput; messaging/IMS; and applications using an Internet-connected test server and real application server."

Hendricks said Anritsu offers modular, flexible solutions that address current needs while providing a cost-efficient path to the future. "A perfect example is the MT8000A, a one-box solution that can conduct tests for 5G non-standalone (NSA) and standalone (SA) technologies, based on designated modules and software to support future 3GPP 5G releases."

▶ Anritsu MT8000A radio communication test station.

Rohde & Schwarz has introduced several solutions covering all areas of testing 5G, Wi-Fi 6, and automotive V2X technologies, according to Stuhlfauth, adding that the new solutions represent a steady evolution. "One example to point out is the introduction of a revolutionary operating concept for mobile radio testers, R&S CMsquares. It offers not only a web-based operation of the 5G radio tester R&S CMX500, but allows the configuration of 5G tests ranging from an interactive mode up to a sequencer and Python scripting mode for advanced testing." The solution covers both the FR1 and FR2 5G frequency ranges, he added.

Rohde & Schwarz R&S CMX500 5G radio tester.

"Another example is the antenna test solution R&S PWC200," Stuhlfauth said. "It is rooted in the longstanding idea of using a massive MIMO antenna array, not for the purpose of beamforming, but as a method to generate a plane-wave zone in a short distance. Moreover, this OTA testing method reduces FAC (full anechoic chamber) size significantly and has recently been approved by the standardization body 3GPP as a plane wave synthesizer concept for base-station conformance testing."

Stuhlfauth also mentioned the R&S CMW platform, which he described as the first wireless communication tester supporting Wi-Fi 6 in full signaling mode. "Now it also supports the 6-GHz frequency range," he said. "And for automotive V2X applications, we have extended RF and signaling testing with higher-layer application testing for LTE based C-V2X. We are able to offer this solution based on the R&S CMW thanks to our partner Vector, who contributed their CANoe .Car2x solution."

He elaborated on the R&S CMW test platform, saying that it together with the R&S CMX extension covers not only the mobile radio technologies from 2G to 5G, but also noncellular technologies. "It's the first tester supporting Wi-Fi 6 signaling, the first tester supporting location-based services on 5G, and the first tester supporting LTE C-V2X signaling and application testing," he said. "It's the mobile radio tester with the highest number of 2G to 5G test cases, including LTE-M and NB-IoT. The operating concept with R&S CMsquares using a single user-interface for wide-based application range mobile-radio testing, and the R&S Contest for protocol and RF conformance testing, sets the optimized GUI for each purpose. The internal fading solution for signal generators and mobile radio testers reduces hardware size and cost."

Finally, Stuhlfauth commented on the trend toward software as a service and cloud integration, explaining that Rohde & Schwarz has introduced server- and cloud-based testing as two solutions bringing the virtual world into the test and measurement space. "Server-based testing offers dedicated application-specific functionality in a customer environment, allowing the configuration of repetitive and automated procedures, while improving speed and integration complexity," he said. "Cloud-based testing offers R&S test software as a cloud-based service, making access possible anytime and anywhere. Users benefit from a lower total cost of ownership."

According to Jon Semancik, director of marketing at Marvin Test Solutions, "The requirement to cost-effectively test

mmWave devices is a major challenge for suppliers of device and SoC components.

"MTS recently introduced a mmWave/5G production test system capable of supporting the testing of 50-GHz devices," Semancik said. "The system integrates laboratory-grade RF instrumentation with a high performance DUT-instrument interface to support the testing of mmWave devices for multisite production test or device characterization. The system also includes digital and parametric test capabilities as well as SPI/I2C interface support to functionally control and monitor the device under test. For production test applications requiring integration with an automated handler, the TS-960e-5G is available with an inTEST manipulator which provides precise positioning of the test head, and the flexibility to interface to automated probers and device handlers. The TS-960e-5G's device interface board (DIB)/receiver interface is designed to be compatible with virtually any device handler."

▶ Marvin Test Solutions TS-960e-5G mmWave production test system.

Smith at LitePoint said the company's products typically serve the product development (R&D), design characterization (DVT), and high-volume manufacturing phases of a wireless product's life cycle. He cited as an example the IQgig-5G Model B. "In 2019, we saw the introduction of early 5G products in the market," he said. "In 2020, we are on the cusp of the high-volume ramp for 5G end-products. The IQgig-5G is currently helping device makers scale their mmWave 5G products to volume manufacturing."

He also commented on the IQxel-MW 7G. "The IQxel-MW 7G is in heavy use in R&D and product characterization (DVT) teams, helping to bring new Wi-Fi 6E products to market later this year that take advantage of the new 6 GHz unlicensed band."

NI helps customers meet the challenges of cellular V2X test with its recent introduction of a solution for characterizing C-V2X chip performance in the lab. "The C-V2X Open Loop Test System helps our customers validate the functionality of their V2X applications, whether based on EU, US, or Chinese regional standards," said Phillips. "With a flexible, software-connected architecture, this solution reduces the risk in adapting to continually-evolving technologies."

Phillips said NI helps its customers protect their investment in test solutions by being open. "We're built on COTS processors and software capabilities."

For communications applications, Avnet offers products such as their XRF16 RFSoC system-on-module, released in May 2020. Langlois described the XRF16 as a production-ready 16x16 direct-RF sampling module with 5 GHz analog bandwidth featuring the Xilinx Zynq UltraScale+ RFSoC Gen 2, with 16 RF-ADC and 16 RF-DAC channels. "The SOM is designed for integration into deployed RF systems demanding small footprint, low power, and real-time processing," he said. "An XRF carrier card and comprehensive software suite are available for rapid prototyping, enabling you to develop application code for the XRF16 SOM that is ready for deployment when your custom carrier arrives."

The company also offers the Avnet Zynq UltraScale+ RFSoC Development Kit, which Langlois said enables system architects to explore the entire signal chain from the antenna to the digital circuitry using tools from MathWorks and RF components from Qorvo. He described Avnet's RFSoC Explorer as "…a graphical interface that allows system designers and RF engineers to generate signals to the RFSoC hardware, and acquire signals from the hardware within the MATLAB environment."

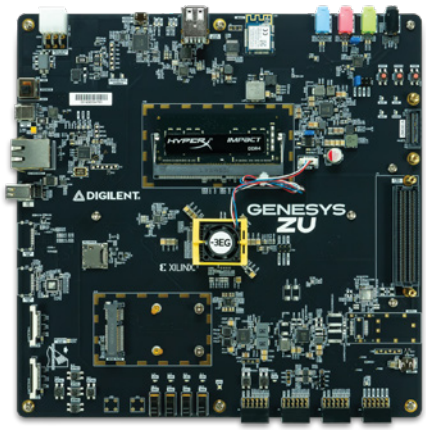
Digilent also addresses Xilinx Zynq technology and recently released the Genesys ZU-3EG prototyping and development board—an advanced computing platform with multiple network connectivity interfaces," a spokesperson said, adding that 5G and Wi-Fi 6 will bring scalability, predictable latency, and power efficiency to networks expected to accommodate an increasing number of connected devices. "Reprogrammable devices like the Xilinx Zynq UltraScale+ allow systems to adapt to requirements like low latency, low power consumption, or wide area coverage, opening the door to differentiated service offerings."

He continued, "As a heterogeneous computing platform, it offers a single-chip radio solution that can also implement a radio protocol stack, network functions and multimedia capabilities close to where they are needed. The Genesys ZU is a well-rounded prototyping platform for Xilinx Zynq UltraScale+ MPSoC. Radio front-ends and ADC/DACs can be easily interfaced through the FMC and Zmod connectors, while different modulation schemes and MIMO beamforming are implemented in the programmable logic. The integrated 2.4-GHz Wi-Fi and the Mini PCIe expansion option provide a good wireless connectivity base to compare custom implementations against."

In addition, he said, "The versatility of the Genesys ZU-3EG makes it a flexible solution that can adapt as communications standards continue to evolve."

When asked about specific products, Haj-Omar at Tektronix cited the 6 Series mixed-signal oscilloscope and the release of a 2-GHz span for SpectrumView software; the latter allows customers to use the MSO6 as an analyzer for 5G and Wi-Fi 6 signals. "With the latest releases around Wi-Fi 6, customers need to be able to operate at up to 7.125-GHz center frequency, and the upper range of the MSO6 is 8 GHz," making the instrument suitable for time-domain and RF measurements on 5G and Wi-Fi 6 devices.

"For V2X communications, Tektronix has introduced new capabilities in our



▲ Digilent Genesys ZU development platform.

low-cost USB RF portfolio," Haj-Omar said. "Instruments such as the RSA306B, RSA500, and RSA600 provide ultraportable instrumentation for RF measurements. These instruments can be powered by USB, battery, or AC. The C-V2X has a bandwidth of 20 MHz today, with a possibility of 40 MHz in the future. All USB RF instruments provided by Tektronix have a bandwidth of 40 MHz, making them ideal for C-V2X measurements."

The distributor Saelig offers several products suitable for testing 5G, Wi-Fi 6, and other advanced communications technologies. CEO Alan Lowne reported that ThinkRF real-time spectrum analyzers are geared for 5G, and Saelig offers one 8-GHz model for less than $4,000. "Our SIGLENT and Rigol spectrum analyzers…go to 7.5 GHz, so would be useful for Wi-Fi 6 work." He added that Saelig offers Triarchy USB modules which generate or analyze signals up to 8 GHz, and Windfreak modules that can generate signals up to 24 GHz.

A variety of special-purpose test sets, general-purpose instruments, and even thermal test platforms are now available, such as TotalTemp's Model SD288 for fast, efficient testing of large or multiple RF modules, according to John Booher, chief technology officer. "We have new sizes of thermal platforms that by using the capability of conduction and liquid nitrogen (or advanced refrigeration systems) can quickly test emerging hardware to quickly automate and validate new hardware," he said.

EE-Evaluation Engineering's August special report on signal and spectrum analyzers and our July special report on RF/microwave test provide additional information on products and techniques that can be applied to 5G, Wi-Fi 6, V2X, and other next-generation communications standards.

Indeed, several contributors to our RF/microwave test special report have elaborated on their solutions for advanced communications technologies.

For example, Rick Gentile, product manager, RF and signal processing systems, MathWorks, said the company launched its 5G Toolbox not long after the 5G NR standard was approved. "This was possible by working closely with companies directly tied to the standards process," he said. "We have multiple standards-based products for wireless beyond 5G, including LTE, WLAN, and Bluetooth. These products are focused on standards compliance and interoperability."

Gentile continued, "Our toolboxes for wireless applications are all written in MATLAB. Anyone that has the toolboxes also has the code for all of the algorithms and building blocks.

Gentile said the company's R2020a release, which became available in March, includes highlights such as Interactive Apps that help with common tasks, including the Wireless Waveform Generator App to connect 5G waveforms with commercially-available test equipment; support for 5G NR standards for modeling and simulation; RF propagation analysis and visualization in dense urban scenarios; modeling for large installation platforms and radar cross section analysis; multifunction RF modeling through tracking and resource scheduling; and automotive radar design for high-bandwidth systems.

According to Manohar Raju, senior product specialist at Ansys, the company's tools serve in various verticals, including but not limited to 5G, Wi-Fi 6, automotive radar, and IoT. "Engineers use Ansys HFSS to model diversity and MIMO antennas appropriate for spatial beamforming in 5G and Wi-Fi 6 applications," he said. "5G networks utilizing mmWaves rely on the performance of the user equipment (UE) and microcell (or base station) antennas and propagation channel. Ansys HFSS is used to virtually prototype and simulate human device interaction with UEs. Ansys Icepak is combined with HFSS to predict the thermal performance of the UEs. Our tools reduce the cost of regulatory and compliance testing."

Raju further said that 5G can extend the scope of IoT to enable smart cities. "With virtual-city models in HFSS, engineers can simulate large dynamic wireless scenes. The solutions give insights into a network's physical channel performance and base station siting before field deployment—thus reducing the cost and time of producing physical prototypes and OTAs. These solutions (with CSI extraction techniques) exploit the potential of multiuser massive MIMO beamforming and adaptive beamforming approaches to design effective end-to-end 5G wireless networks and antenna systems. Ansys tools simulate RFICs and the standalone and installed performance of radar, and engineers can virtually recreate dynamic ADAS scenarios involving V2V and V2X communications in Ansys HFSS SBR+.

Keysight Technologies spokespersons said Keysight's 5G design and test solutions address the complete 5G mobile ecosystem. "Our solutions are used across the workflow for each component—R&D, design validation, manufacturing, deployment, and monitoring, from the physical layer to the application layer," they said. Keysight's chipset and device solutions cover the following applications: waveform R&D, protocol R&D, RF automation, functional and performance testing, protocol conformance testing, RF/RRM conformance testing, carrier acceptance testing, and manufacturing test.

They also discussed automotive applications. "Keysight is deeply involved in test and development solutions supporting vehicle-to-everything (V2X) technologies that enable direct, real-time, and safe communication between vehicles, road users, and roadside infrastructure," they said. "These technologies pave the way for the development of autonomous driving by enabling advanced driver assistance systems (ADAS) to work with V2X systems, eventually enabling self-driving cars." EE

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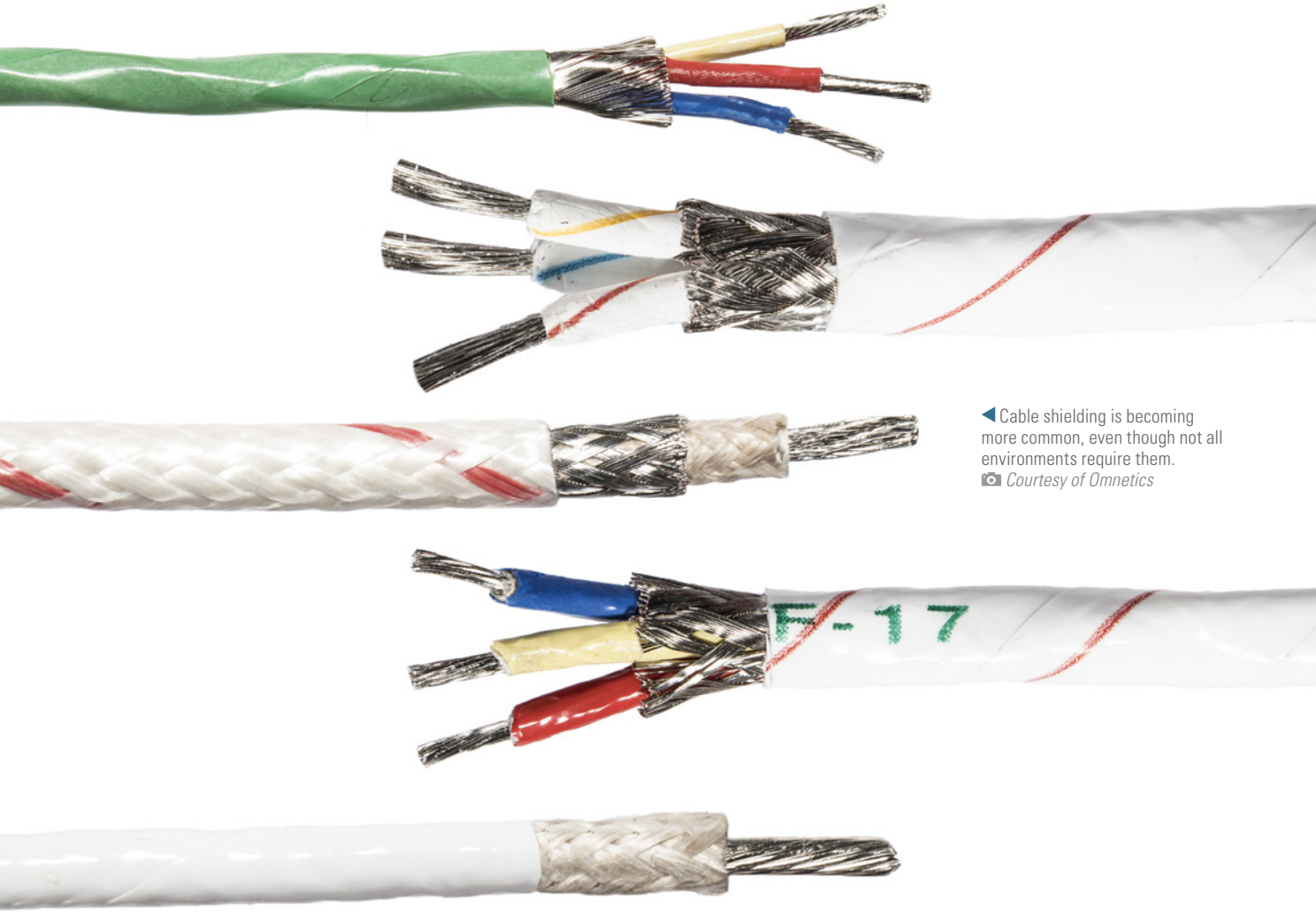


Cable shielding is becoming more common, even though not all environments require them. *Courtesy of Omnetics*

EMI AND SIGNAL NOISE MANAGEMENT IN MINIATURE CONNECTOR AND CABLE SYSTEMS

By Bob Stanton, Director of Technology, Omnetics (www.omnetics.com)

Electronic interconnection designs for defense electronics, highly mobile robots, surgical monitoring devices and other embedded systems are rapidly changing. Signal speeds are increasing, and are often crammed into smaller and tighter spaces, and potential signal interference as well as crosstalk can become a technical issue. Instrument-level connections must contribute to ensuring electromagnetic compatibility (EMC), is achieved.

EMC standards specify four levels. Level 1 includes discrete components, Level 2 is focused on circuit boards, OEM electronic products are addressed at Level 3, which includes electronic circuitry, power sources, motherboards, and interconnect systems. Cables extending beyond the enclosure should comply to Level 4, depending on the application.

The interconnect designer's goal is also to contain any potential electromagnetic interference (EMI) that would confuse the main signal system. Connector and cable shielding is used to attenuate the radiation signals from entering the interconnection, as it bleeds off any conducted noise running on the shielding. Selecting

good metal conductivity as well as insulation thickness is important for best cable shielding and back-shell technology.

Military-Specification connectors and cabled interconnections used in mission-critical and high-reliability modules for military avionics, autonomous vehicles, satellites, and soldier-worn systems are especially vulnerable to Cybersecurity issues. Surprisingly, internal-signal noise management is also a key element in controlling signal integrity within one's own system.

Standard noise and EMI control methods include isolation, grounding, filtering, balancing, shielding, signal separation, impedance control, cable design, and managing the signal/time domain. To help protect signal integrity, connector and cable harness designers are also adding back-shells and cable shields for EMI protection, as well as providing mechanical strain reliefs.

Many of the smallest cables require shielding inside and out to isolate mixed signals within the interconnection system. Do not overlook the need to directly connect cable shielding to metal shell connectors. It is important that there is a firm and direct connector ground on the board and/or the metal shell of the circuit package.

Connector sizes and metals

Micro- and nano-sized connectors are often used with metal shells connected to braided-cable shields. The metal frequently used is Aluminum 6061 with T6 treatment for the advantages of strength and lower weight, as well as the EMI sealing. Metal shells are usually treated with electroless nickel plated at .0005-inch thickness, and some novel designs use stainless steel for the metal housing, and occasionally see gold plating on shells used in environmentally-hazardous environments.

Connector shells can also use a separate metallic, back-shell covering that screws on, or is an integral portion of the connector shell. The back-shell is then attached to the outside shielded braid of the cable harness to finish the assembly. To ensure signal purity, miniature connectors often use beryllium-tempered spring-pin contacts, as small as 13 one-thousands of an inch in diameter, to provide constant connection through high vibration and physical shock.

▶ Circular connections provide rugged, high-reliability, watertight (IP67) links for continuous signal integrity in harsh environments
Courtesy of Omnetics

Preventing poor pin-to-socket connections during vibration is critical, as they can cause signal noise and be interruptive to very high-speed digital signal transmission. Shielding within both the connectors and cable is vital to prevent EMI problems. As designers focus on higher densities and increase the number of functions, the space available for internal wire-routing of signals is getting smaller and more critical. Custom designs are more frequently employed for cabling to specifically fit within each new instrument, to reduce overall size and weight.

Circular connectors

A Micro circular connector designed to work well for EMI reduction includes the triple-thread ratcheting metal mechanism made of lightweight aluminum and provides rugged, high-reliability, watertight (IP67) connections for continuous signal integrity in harsh-environment military, aerospace, security, and petroleum applications subject to high shock and vibration.

Such circular connectors are built with integrated back shells for EMI, and feature alignment keys and insulators that enable quick, secure couplings and over-molded strain reliefs on the back of each connector that conform to the cabling, improving the overall reliability. These connectors come in multiple pin counts, and are offered in various shell and plating materials to meet specific environmental challenges. They are rated for 3A per contact, 250VAC, and standard operating temperatures spanning -55°C to 125°C.

Rectangular connectors

Standard Micro and Nano-D connector models should be qualified to military QPL reliability and performance specifications, and connectors with 360 degrees of sealing assure high levels of RF and Conducted interference attenuation. For example, Omnetics offers metal-on-polymer EMI shielding gaskets for special designs. Such Micro-D or Nano-D backshells are designed to protect the back end of the connector shell and provide strain relief, preventing mechanical stress for the crimped contacts, for high-reliability applications.

Backshells provide additional EMI protection when they are used as a grounding point for the cable shield, a ground wire, or when braiding is added over the wires. Additionally, customized backshells are designed to specific shapes and functions to aid in meeting the key design requirements or challenges. Many design formats are available for Micro-D and Nano-D connectors, including two-piece solutions, straight, 45°, 90°, oval or round wire/cable exit, and with two distinct wire/cable exits.

Higher signal speeds and mixed-signal cable make for a noisy electrical environment, as the combination of electric and

magnetic fields are often hard to control. Unmatched impedance in an interconnect system can cause an EMI wave that couples from cable to cable to component to element, literally killing the performance of the electronics involved. Cable design and management systems have adopted a well-defined system of solving many of these problems using cable shielding.

Cable Shielding

There are many types of shielded cables, and each has their own advantages and properties. A cable with an overall foil shield and unshielded twisted pairs (UTP) is very similar to the common UTP cable, the difference being the addition of foil underneath the main cable jacket. Such cables are common in 10GBaseT applications. Other cables have an overall braid shield/screen with UTP. While occasionally referred to as a shielded twisted-pair (STP) cable, the two do not provide the same shielding. To identify between them, check for an overall barrier and/or individual pairs' shielding.

An SF/UTP cable shielding includes both an overall braid shield (S) and foil shield (F) with unshielded twisted pairs (UTP). This cable is also occasionally referred to as an STP cable. Cables with an overall braided screen are very effective at protecting EMI from entering or exiting the cable. In a cable with an overall braid shield (S) with foil-shield twisted pairs (FTP), the shield under the jacket is a braid, and each individual pair is wrapped with its own foil barrier. The purpose of the additional foil on individual pairs is to limit the amount of crosstalk between the pairs.

A cable with an overall foil shield (F) with FTP are commonly used in 10GBaseT applications, similarly to F/UTP cables. Cable shielding is becoming more common, even though not all environments require them. At first, shielded cables were used in spaces with high concentrations of electrical equipment and/or secure communications applications. Today shielded cables are commonly used in many spaces such as government, education, and healthcare buildings.

Cable shielding and wrapping

Wrapping conductor(s) inside the cable with EMI tape reduces the openings typically found in braided solutions. While its tradeoff is reduced flexibility, a greater level of attenuation can be obtained with the elimination of openings commonly found in braids. Typically used for high-speed applications, materials and wrap overlap are varied to change the level of shielding for the application, both internally and externally.

Generally used in high-speed applications where foil wraps or braids are not present, a conductive shrink-tube is a great option for shielding, helping control impedance in high-speed applications, or to bridge the gap between individual conductors as they exit the group braid and head to their individual locations within the connector. Values from 60 to 80db of attenuation can be obtained with a conductive shrink tube.

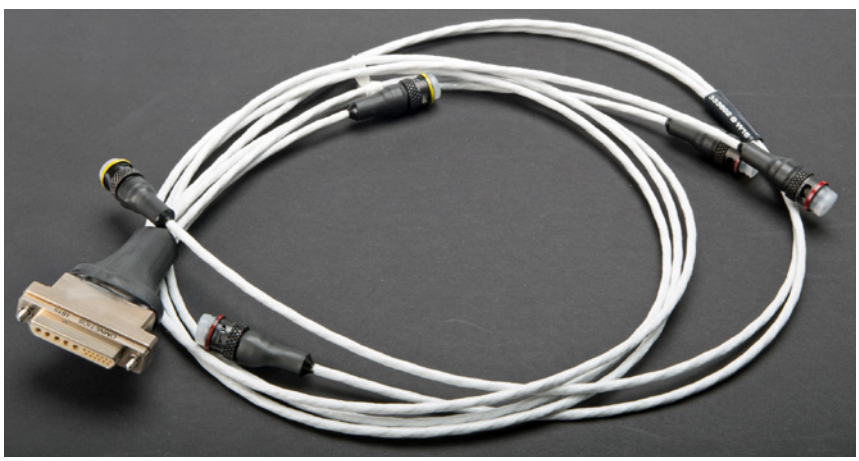
Signal type and cable function determines wire type, number of wires, wrapping, and insulation. Fire-wire, for example, uses a small wrapped pair of signal wires next to a single drain wire, to carry the differential signals and the ground reference. Placed over the 3-wire set is typically an aluminum shield-wrap around the bundle to isolate the signals from adjacent wiring within the cable. Adjacent wire pairs can be run within that cable to provide a power source for the instrument at the end.

If an RF set of cable is included, additional and separate wrapped aluminum shielding is needed to separate the coax from its neighbors inside the cable. Designers may consider conductive zipper or shrink sleeves, flat cable with EMI tape, and knitted-mesh shield wrapping to help with cable flex. Recently-introduced tubular metalized-fiber braid offers light weight, excellent flex, and isolation, but at higher prices with medium levels of isolation.

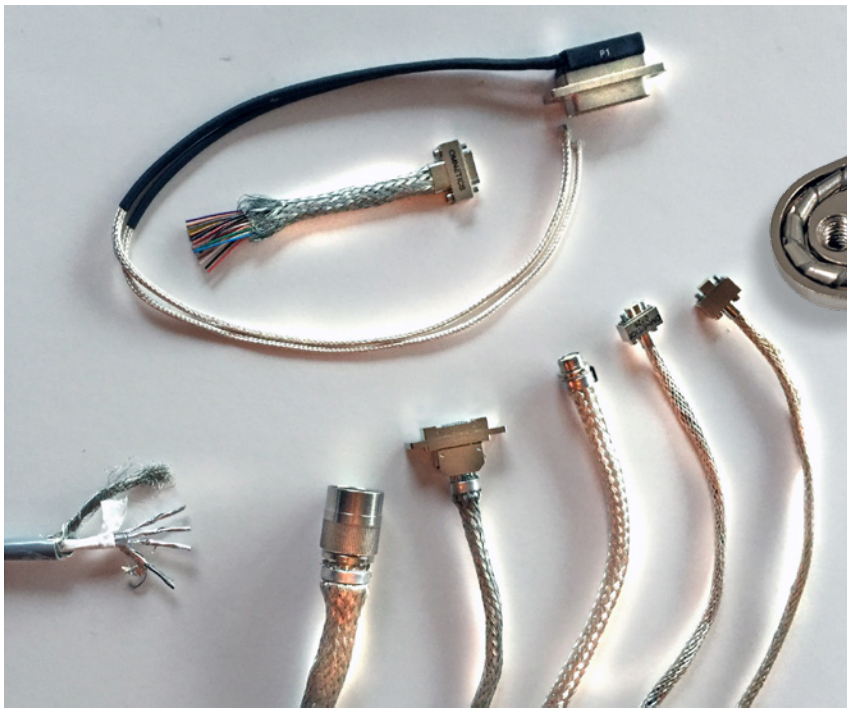
Shielding within both the connectors and the cable is critical to preventing EMI problems. The focus on higher density and increased functions within instruments, and the shrinking space available for the internal wire routing of signals from one section of the instrument to another, is getting more critical. Custom designs are more frequently employed for cabling to specifically fit within each instrument to reduce size and weight while increasing circuit speed, signal routing and impedance matching to other circuits in adjoining modules.

Braided shields can offer the highest isolation, but may need a number of options or trade-offs when they can be used. Exterior cable shielding is frequently employed to ensure that signals are not affected by exterior signal noise, and to contain the signals within the cable. The exterior shield is exceptionally helpful in protecting from cyber signal threats corrupting the purpose of the cable.

Exterior cable shielding materials can vary significantly in their ability to attenuate and isolate the signals from interference. Slip-on braid is rated for up to 65 db



▲ Application-specific wire-harnesses are also used in military sensor systems, processors for mine detection, portable camera and surveillance modules, and unmanned aerial vehicles.
Courtesy of Omnetics



Shielded application-specific wire-harnesses are used in systems where performance and electronic interference is a serious concern.
Courtesy of Omnetics

of isolation at 500mhz and solves most concerns. As frequencies increase, the ¼ wavelength of signals is shorter and can squeeze through gaps in slide-on braiding. Designers can consider a tighter weave braid and/or a combination of both foil wrapping and slide-on braid to retain signal integrity.

For example, when isolation and signal speed demands are very high, Omnetics adds machine-wrapped braiding with plated smaller diameter copper-braided wires, delivering up to 95% coverage without small windows for signal intrusion, while being able to handle higher temperatures and extreme environmental applications. Some exterior polymer braiding materials have evolved to assist in specific areas, which include solderable plated Kevlar braids that operate to 150˚C and pass NASA outgassing specifications. Plated LCP, (liquid crystal polymer), can also be used up to 150˚C, but is solder-resistant.

Serving demanding applications

Equipment benefiting from miniature shielded wiring harnesses begin with high-performance portable systems often used in military field operations, and other applications ranging from healthcare to robotics. In the medical industry, handheld surgery tools, dental camera modules, cosmetic lasers, and even spinal pain-management tools use uniquely-designed wiring to support both patient comfort and technical performance while reducing operating-room electronic noise.

Application-specific wire-harnesses are also used in military sensor systems, processors for mine detection, portable camera and surveillance modules, and unmanned aerial vehicles. Today's UAVs, faced with extreme conditions, are demanding minimum-weight miniature electronics to achieve increased payload and flight times with additional cameras, sensors, and broadcast equipment.

EMI shielding effectiveness testing is a detailed process that must meet the application needs of the cable harness. When possible, the test should list any known noise sources or frequencies the cable may be subjected to. It should also include the signal type and frequencies operating within the cable that may escape and cause trouble with adjacent electronics. Test methods often used include open field testing, which involves attempts to mimic the actual usage of the system and in what environments it will be used.

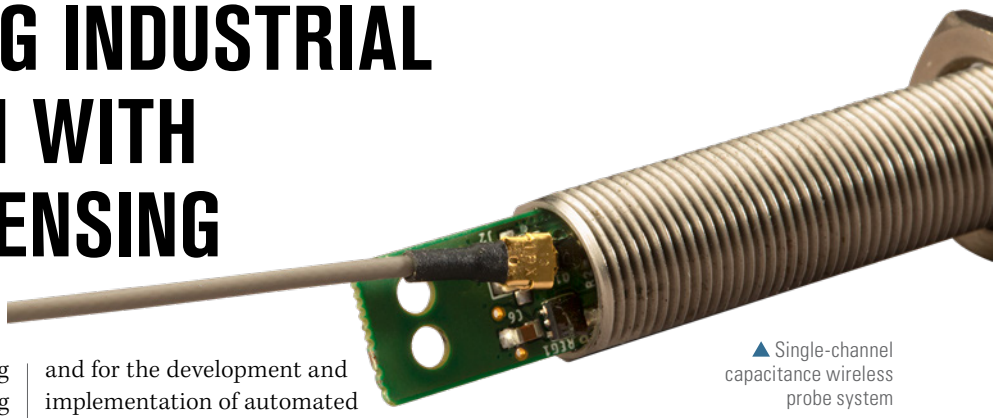
This is not done in a cage, but accomplished with a number of antennas situated about the system. When done in an open area, free-space measurements can be made of the strength and conduction of any emissions from the cable, and both noise level and EMI quantity can be detected and measured against the prime signal levels in the cable. Localized-area shield testing uses a containment box for higher-end frequencies above 500 megahertz ,to assist in measuring internal EMI from outside system EMI issues and to detect any of the higher-frequency harmonics from escaping beyond the test area.

Coax line tests measure the field electromagnetic wave radiation for quantity and height of signal escape, and bending and moving the cable during testing is recommended to offer complete confidence in highly mobile systems. Coax signal and EMI testing should include both loaded and unloaded signal measurements to see the differences between the power source and the radiation under transmit and receive conditions. Shielded-room testing is often subcontracted to a specialty testing company with a metal-screened shield room where all random devices, EMI susceptibility, and emission issues can be evaluated. EE

For more information visit www.omnetics.com

EMPOWERING INDUSTRIAL AUTOMATION WITH ADVANCED SENSING

by Don Welch



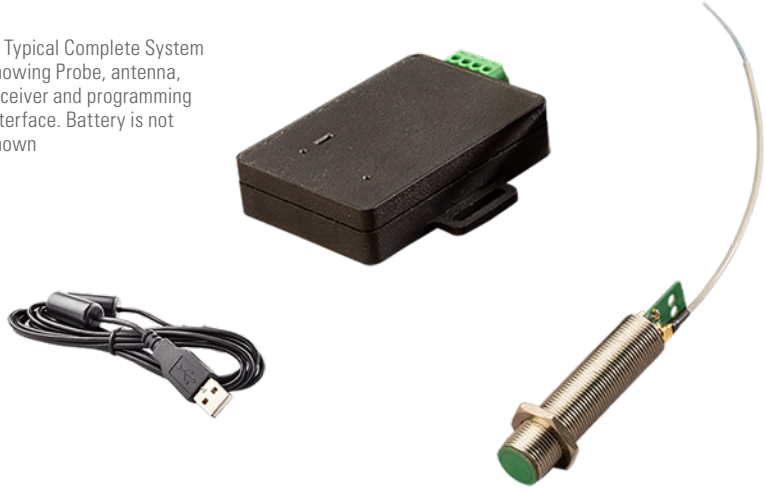
▲ Single-channel capacitance wireless probe system

Industry 4.0 is hot, and it's gaining traction daily because optimizing automated production systems doesn't just save energy, reduce downtime, and improve yields, it saves a lot of money for those very same reasons. A company with a facility operating at 90% efficiency will outperform a company whose production is only at 80% of its potential, all other things being roughly equal. Better systems save money, energy, and resources at every level, with cascading benefits.

These cascading benefits are like a good version of the horseshoe nail story. In the original story, the loss of a nail cost a kingdom. In the new Industry 4.0 paradigm, the horse is smart and self-monitoring, and provided the rider a predictive maintenance alert about the loose horseshoe. Smart tools empower intelligent processes and precision is the grail of any toolmaker. There is no precision without feedback, and accurate, efficient, and functional sensing is a critical enabler.

Systems for the precise measurement and control of products and processes, and for the development and implementation of automated manufacturing, assembly, and complex machinery operation, are the new solutions for Industry 4.0 applications. Recently, MTI Instruments created a Bluetooth 2.4GHz wireless capacitive-gap sensor, believed to be the first such device of its type. It's paired with a receiving device to accurately measure the distance to a grounded metal target, to address precision manufacturing processes. Bluetooth was chosen, as it has already been proven to work in noisy industrial environments and is immune to jamming by other wireless devices.

The transmitter can be permanently mounted on a fixture, or on a threaded probe holder using two jam nuts. The probe/transmitter unit has one connector for the antenna, and a second connector to attach the battery for portable operation The receiver communicates with up to 4 wireless displacement sensors to receive displacement readings, and interfaces as a RS-485 Modbus RTU device which is ideal for PLC interfacing.



▶ Typical Complete System showing Probe, antenna, receiver and programming interface. Battery is not shown

We should note here that what we refer to as a "receiver" and "transmitter" is a bit of an oversimplification. Both the "transmitter" sensor and "receiver" are both, in fact, transceivers that can transmit as well as receive. For example, one receiver can interrogate up to 4 separate "transmitter" sensors which allows the user to see rotor tilt, and rotor wear such as a bow in the shape of the rotor. The receiver can also transmit to a sensor and change its sample rate, filtering characteristic, or even check on the transmitter's remaining battery life.

A "start sample" command is sent to the selected sensor to begin receiving data at a selected rate. For single samples, a manual sample sequence command can be executed at any point. The sample sequence puts the sensor into a powered-on state for a single sample cycle. Upon completion of the cycle, the sensor transmits the data and goes back to a low-power state.

Both the transmitter "sensor" and receiver devices are "Bluetooth" radio frequency transceivers, capable of transmitting and receiving digital packet messages. Multiple sensor and receiver devices may be operated in a close environment as they will not interfere with each other. Users can program and calibrate the probe assemblies with MTI-provided software.

Improving manufacturing

In manufacturing processes, as in everything today, tolerances have tightened up. Even something as rudimentary as textile manufacturing, which has been going on for 50,000 years or more, the control of

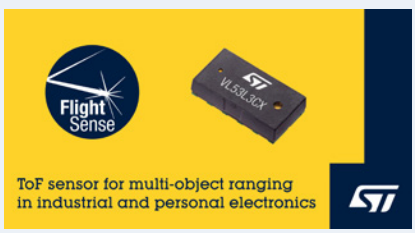
Advanced industrial distance measurement

By Alix Paultre

The precise measurement of clearances and operational distances is a critical factor in system efficiency, reliability, and safety. Tolerances are the measure of precision, and there is no accuracy without feedback of some kind.

TIME-OF-FLIGHT SENSOR

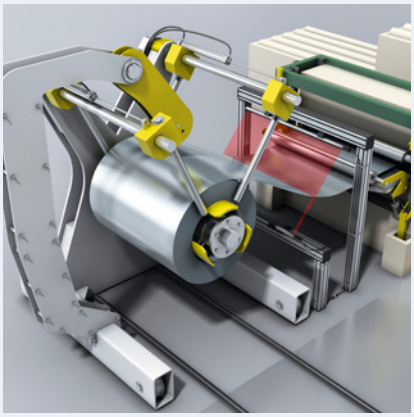
Enabling multi-object ranging, STMicroelectronics has extended the capabilities of its FlightSense Time-of-Flight (ToF) ranging sensors family by introducing the VL53L3CX, whose patented histogram algorithms allow measuring distances to multiple objects with increased accuracy. The sensor measures objects at distances from 2.5 centimeters to 3 meters, unaffected by the target color or reflectance.



The ST histogram algorithms increase cover-glass crosstalk immunity and allow real-time smudge compensation, preventing external contamination from adversely affecting the ranging accuracy. This is useful in applications where equipment may be used in a dusty industrial environment. Ranging under ambient lighting is also improved.

In addition, the VL53L3CX has superior linearity that increases short-distance measurement accuracy enhancing wall tracking, faster cliff detection, and obstacle avoidance in equipment such as service robots. Like all FlightSense sensors, the VL53L3CX has an all-in-one package design that eases integration, as well as low power consumption to extend battery runtime. The VL53L3CX is available now, priced from $1.70. Please contact ST for high-volume pricing options. **www.st.com**

MLG-2 WEBCHECKER LIGHT GRID INCREASES PACKAGING MATERIAL PROCESSING ACCURACY



SICK's MLG-2 WebChecker light grid performs high-performance running edge detection, as well as width and center measurement. Used for the processing of web-shaped packaging materials, it is able to detect web width changes or deviations in the web position and report to the follow-up control system of the packaging machine in the same work process with an accuracy of ± 0.3 mm and a resolution of 0.1 mm per web edge.

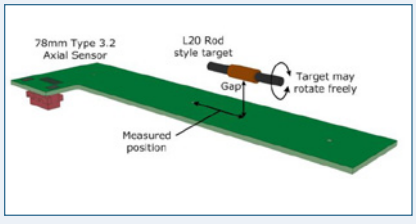
Available in detection zones between 150 and 3,150 millimeters, the device can also monitor smaller formats without having to readjust sensors or reparameterize the light grid. The user has the choice between different sensitivities for different measuring tasks and surfaces properties, and can even detect semi-transparent products.

Web running control systems are designed to guarantee stable web running through corrections in the machine with the aim of preventing creases in paper webs or ensuring perfectly adapted printing, punching and cutting processes, among other things. Edges are ideal reference variables in such overrun control systems because they can be detected with a high level of precision and reliability using suitable sensors. **www.sick.com**

NOVEL AXIAL LINEAR POSITION SENSOR FROM CAMBRIDGEIC CAN LOCATE FREE-ROTATING TARGETS

CambridgeIC's latest axial linear position sensor works with a rotating target and a big gap to the sensor. The Axial sensors can measure the precise continuous position of a freely-rotating wireless target, from the side and with a big gap, without interference from nearby magnets. Gaps of over 10mm are possible between sensor and target, meaning the sensor and the target can be housed in their own packages.

Addressing applications including valve control, hydraulic and pneumatic actuator position feedback, liquid level, and syringe-plunger position sensing, the sensor can tolerate substantial misalignment. In the float level-sensing application this means the float can move side to side with big clearances. In applications such as measuring the linear position of valves and pistons, there is no need to add a special linear bearing to constrain the motion of the target.



To calculate position, the sensor works with CambridgeIC's CAM312 central tracking unit. This chip measures and processes sensor signals and provides high quality position data to a host device over an SPI interface. CambridgeIC's resonant inductive position sensing technology is well proven across a wide range of high-volume applications worldwide. For test and evaluation an axial sensor development kit is available. **www.cambridgenetwork.co.uk**

TESTING FRONTIERS

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ENDEAVOR BUSINESS MEDIA

the machinery that makes this stuff has constantly gotten tighter and tighter and tighter. The tolerances have tightened up, so that you get more throughput out of the machinery. You get your money back faster, the ROI. The gap measurements that you're making in the cutting and sewing machinery are becoming tighter and tighter also. And these are tied directly to quality.

In this case, as an example, if we take a typical carding machine and want it to run in optimal performance, the tolerances, if they can be maintained, will produce the best throughput of the material from the machine, at the highest quality. in this particular case, considering the wireless functionality, sometimes you've got to make high tolerance gap measurements and you just can't get in there.

It used to present an impossible situation, where you can't make the measurement because it's dangerous to address the point of measurement. You can't get fingers in there. You can get a probe tip ripped off, or you can't get a tool in there because it would snag on a rotating surface and tear the tool out of your hand. There's a variety of measurements that are out there like this, where you want to make a high tolerance measurement and you just can't get ordinary tools in there.

Sometimes, the measurement needs to be in a hazardous environment such as exposed moving machinery or poor air-quality environments. It can be perhaps a type of environment that the traditional measurement tools are not suited for. The surface can be magnetized, or it can be an uneven surface. So, all those things may make the options of how else you would be able to measure it very limited. In the case of the carding machine, ripping wires in the machines,

In this application, the traditional way of measuring these things, other than shutting the machines down on regular intervals to take measurements, was with Eddy current probes. Well, because you have spaces between these ripping wires, the Eddy current will not flow into the surface and make a precise measurement. Whereas capacitance being electrodynamic in nature with an electric field—rather than a magnetic field—allows the wireless capacitive-gap sensor to make the measurement.

Predictive maintenance

Another example of an application where clearances are critical is in gas-turbine engines for power generation. In rotating turbine applications there is an output mechanism called a vane, and there's no easy way to make the measurement of the vane position. A wireless capacitive-gap sensor could measure that position.

Probe / Transmitter Specifications

Measurement Range	0.1-2mm
Resolution	0.014mm
Accuracy	0.043 mm
Linearity error	0.3% FSR
Max sample rate	4 SPS
Max latency	2 seconds
Power	3.4 - 4.5 VDC (1x 3.6V LTC battery) At 5 mA
Radio frequency	2.4Ghz
Maximum distance from receiver device	5 m , (Mounting dependent)
Maximum number of devices in close proximity	30 units
Radio Frequency Conformity	IEEE 802.15.1 (ISM standard)
Size	10 mm dia x 60 mm long
Weight	10,5 grams
Antenna connector required	Hirose U.FL-LP-040
Battery connector	SURS # SM05B-SURS-TF
Mounting thread	10 mm x .75
Battery life	Dependent on SPS and Sample Period

A key enabler here is predictive maintenance, where it may be very difficult to put a sensor into critical locations in a system, in this case—to determine a valve position. This applies to a multitude of applications, because once machinery has the ability to notice out of tolerance condition poor performance, it can trigger a preventive maintenance action.

Issues like bearing wear on rotating mechanisms, where you have a bearing and there are two surfaces on the bearing, you can't hook a wire to it because it's going to get wrapped around the axle. A wireless noncontact sensor is ideal for such situations.

The ability for a machine to look inside of itself while operating saves both money and effort. Knowing in real-time operational tolerances within a process allows for a feedback loop to adjust that tolerance on the fly. This improves performance, reduces wear, vibration, and thermal loads, while increasing system operational lifetime and reliability. A wireless capacitive-gap sensor gives engineers the ability to create such systems.

Scaling becomes possible

Micron-level measurement in difficult to access environments was just something commonly accepted that you just couldn't do. In many other industrial applications besides carding machines, where you need to deploy dozens—if not hundreds—of these sensors, not only was it cost-prohibitive, but you just couldn't reliably get the resolution you needed to make it even worthwhile. Self-contained wireless probes using a capacitance based noncontact method, makes real-time measurement taking feasible with miniature, self-contained capacitance probes to make micron level measurements.

Looking forward

Advanced remote wireless sensing is a force-enabler for next-generation automation functionality, as it enables the system to maintain operational tolerances more precisely and with no downtime. Increased precision in an electromechanical system delivers multiple advantages, each with their own cascade of peripheral benefits.

Smoother, faster, safer, and more reliable industrial systems run cooler, have less downtime, operate more efficiently, and are more reliable, as predictive maintenance significantly reduces the chances of catastrophic failure in any operational process. Wireless capacitive-gap sensor technology and its application can help create these advanced "self-aware" solutions. EE

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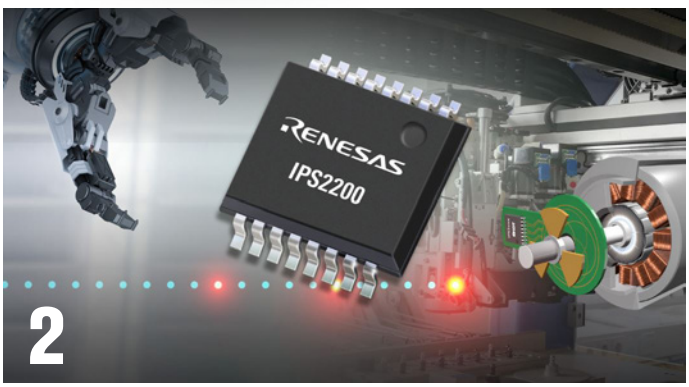

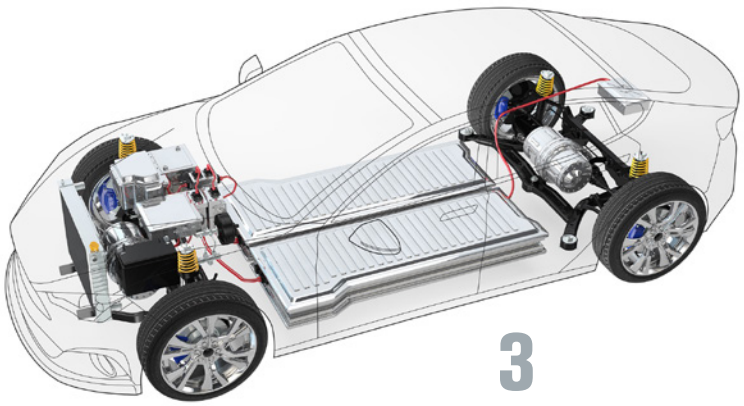

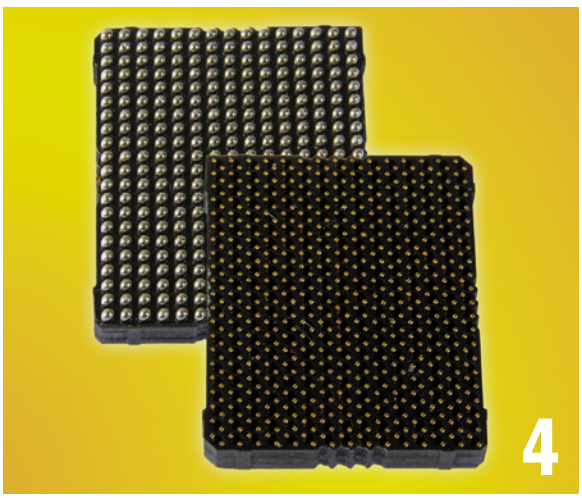

1. Thermal Power Sensors

Rohde & Schwarz added the R&S NRP90T and R&S NRP90TN models to its portfolio of thermal power sensors. Presented as the first test and measurement instruments in the market to support the novel, robust 1.35 mm precision coaxial connector, they cover frequencies up to 90 GHz. Emerging applications include automotive radar from 76 to 81 GHz, and the WiGig extension IEEE 802.11ay operating up to 71 GHz. These and others highlight the need for a novel, robust coaxial cable connector suitable for industrial applications at frequencies up to 90 GHz.

Rohde & Schwarz

2. Inductive Position Sensor

Renesas Electronics' magnet-free IPS2200 inductive position sensor features high accuracy and speed, total stray field immunity, and efficient motor integration, in a thin and lightweight form factor. Well-suited for use as an absolute position sensor in industrial, medical, and robot applications, among others, the sensor allows customers to cost-effectively tailor sensor design for their applications and maximize performance. The IPS2200 is designed around the motor, allowing customers to match the number of sectors to pole pairs of the motor to maximize accuracy, accommodating both off-axis (through shaft and side shaft) and on-axis positioning.

Renesas Electronics

3. Sensing and Balancing IC

Designed for batteries in hybrid and electric cars, the TLE9012AQU sensing and balancing IC is also suitable for other applications. It measures the voltage in up to 12 battery cells with an accuracy of ± 5.8 mV over the entire temperature and voltage range, as well as the operating life cycle. It also supports up to five external temperature sensors, provides an integrated cell balancing function, and uses an ISO-UART interface for communication. The TLE9012AQU provides the necessary measurement data, and ensures a balanced state of charge through cell balancing.

Infineon Technologies

4. LPDDR5 Grypper Sockets

Ironwood Electronics released new Grypper test sockets for the latest LPDDR5 memory. Ironwood's GR1032-0001 allows testing of the latest-generation LPDDR5 devices that have 315 Ball at 0.7 x 0.8mm pitch, at speeds up to 6400Mb/s. The LPDDR5 Grypper socket fits to the same location/PCB footprint as the device, allowing development and failure analysis. The socket has an electrical performance of -1dB insertion loss, up to 40.0 GHz. The force required to insert a device is 45 grams per contact, and the socket is sold in three configurations.

Ironwood Electronics

5

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5. SOLT Calibration Kits

Fairview Microwave unveiled a series of short-open-load-through (SOLT) calibration kits for use in lab, test and measurement, and RF and Microwave production test applications. Fairview's expansion of its VNA calibration kit line consists of 12 models including short circuit, open circuit, and load kits (SOL), as well as short circuit, open circuit, load, and thru kits (SOLT). Interface options include 2.4mm, 2.92mm, 3.5mm, 7/16 DIN, 7mm, N-Type and BNC. Every model of VNA calibration kits includes the required short circuit, open circuit, loads, and thru (model dependent) components required for VNA calibration.

Fairview Microwave

6. Featured Tech DVC 1000 Voltage Sensors

The DVC 1000 series of voltage sensors for insulated nominal voltage measurements in rail traction and industrial applications offers panel-mounted voltage measurement in a package measuring 29 x 51 x 89 mm (131.6 cm3). Designed to measure a nominal voltage of 1000 VRMS, the series uses an isolating amplifier, providing a safety insulation voltage of 4.2 kV. DVC 1000 voltage sensors are suitable for a broad range of small-to-medium voltage measurements in industrial markets such as DC power supply monitoring, EV chargers, and battery-storage applications.

LEM

7. GX3788 Multifunction Instrument

The GX3788 High-Performance FPGA Multi-Function Instrument combines A/D, D/A and digital I/O functionality. The GX3788 is a user-configurable 3U PXI hybrid-slot-compatible instrument, with digital and analog test capabilities. Suitable for challenging functional test applications, the instrument's A/D channels can be configured as 8 differential or 16 single-ended inputs, at sampling rates of up to 250 KS/s. Two-channel operation can support a sampling rate of 1 MS/s. The D/A channels support a simultaneous sampling rate of 1 MS/s, while the digital I/O channels are TTL-compatible and can be programmed as inputs or outputs.

Marvin Test Solutions

8. Positive Slope Equalizers

Pasternack's latest positive-slope equalizers compensate for gain variation in systems where excessive losses may occur at the low end of the frequency band. They are suitable for a variety of applications like aerospace and defense, MILCOM and SATCOM, test and measurement, and wireless infrastructure. The selection of positive-slope equalizers consists of 18 models operating over octave frequency bands from 500 MHz to 40 GHz. These 50-Ohm designs have fixed equalizing values from 2 to 8 dB, at the minimum frequency, and produce an attenuated response that increases linearly across the frequency band.

Pasternack

TECH FOCUS

HIGH-SPEED INTERCONNECTS

Interconnect: Testing in the Fast Lane

High-speed wired interconnect testing of interfaces like PCI Express and Ethernet is very challenging as speeds continue to rise. The need for reliable, high-throughput solutions has required the use of technologies like forward error correction (FEC) and 4-Level Pulse-Amplitude Modulation (PAM4).

Test equipment to handle these interconnects have to not only handle the high speeds, but also more demanding protocols. They are also the basis for more advanced systems such as NVMe, which runs on top of PCI Express. There is even an NVMe over Fabrics (NVMe-oF) that runs over interconnects like Ethernet.

Multi-Terabit Test Solution

Keysight's new UHD100T32 test system, co-developed with Barefoot Networks, is purpose-built to meet the requirements of the modern networking infrastructure ecosystem. In a 1U box, users get 3.2 Tbps of line-rate test traffic from 32 ports of 100GE, a requirement to validate the performance of ultra-high-density devices like those found in today's data centers and in manufacturing use-cases for full-box tests in production lines.

The 50/40/25/10GE enabled UHD100T32 can test all speeds in a data-center fabric, with Keysight's technology for Layer 2/3 traffic generation and analysis, as well as RFC 2544 tests for benchmarking throughput and latency of devices. Optional routing protocols for Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), and Intermediate System to Intermediate System (ISIS) are available to emulate from control plane to data plane for convergence testing. Clientless operation via web interface and a "Representational State Transfer" (REST) application programming interface (API) enable faster time-to-test and easy automation.

Keysight Technologies

In-Vehicle communications solution

Automotive Ethernet is a new solution for in-vehicle communications, offering date speeds up to 10Gbps. For data speeds up to 1Gbps (1000BASE-T1), the communication link can run on unshielded twisted pair (UTP) cabling. However, for speeds of 1 Gbps and higher, electromagnetic interference (EMI) becomes increasingly critical and can potentially threaten the integrity of other communications within the vehicle.

The OPEN Alliance TC9 group, which defines the requirements of cables and connectors for in-vehicle networks using automotive Ethernet, is now focusing on shielded cabling in order to minimize emissions, as the industry moves towards much faster speeds. Rohde & Schwarz assisted TE Connectivity in verifying the development and manufacturing of the cables and connector components used. The compliance tests were performed on STP cables with TE's MATEnet terminals and connectors using the R&S ZNB vector network analyzer together with the integrated in-situ de-embedding (ISD) function from AtaiTec.

Rohde & Schwarz

Protocol Exerciser/Analyzer for PCI Express 5.0

Teledyne LeCroy's Summit Z58 PCI Express (PCIe) protocol exerciser/analyzer for testing PCIe 5.0 designs and products provides 32 GT/s traffic generation on devices with link widths up to 8 lanes, with CATC Trace protocol analysis. The Summit Z58 can be used for traffic generation and device/host emulation, as well for development of standardized compliance test suites.

The Summit Z58 builds on the widely used Summit Z416 exerciser to insure interoperability of PCIe 5.0 products, and features a unified single application that incorporates traffic generation and protocol analysis.

Users will have access to analysis and reporting capabilities often used in the PCIe industry. When analyzers and exercisers are used together, developers can create powerful script level traffic and monitor the results of all tests. The Protocol Exerciser uses the new PXP-500A Test platform featuring both CEM and SFF-TA-1002 connectors, to allow wider support of different PCI Express add-in-cards.

Teledyne LeCroy

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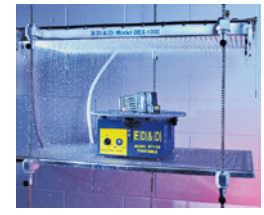

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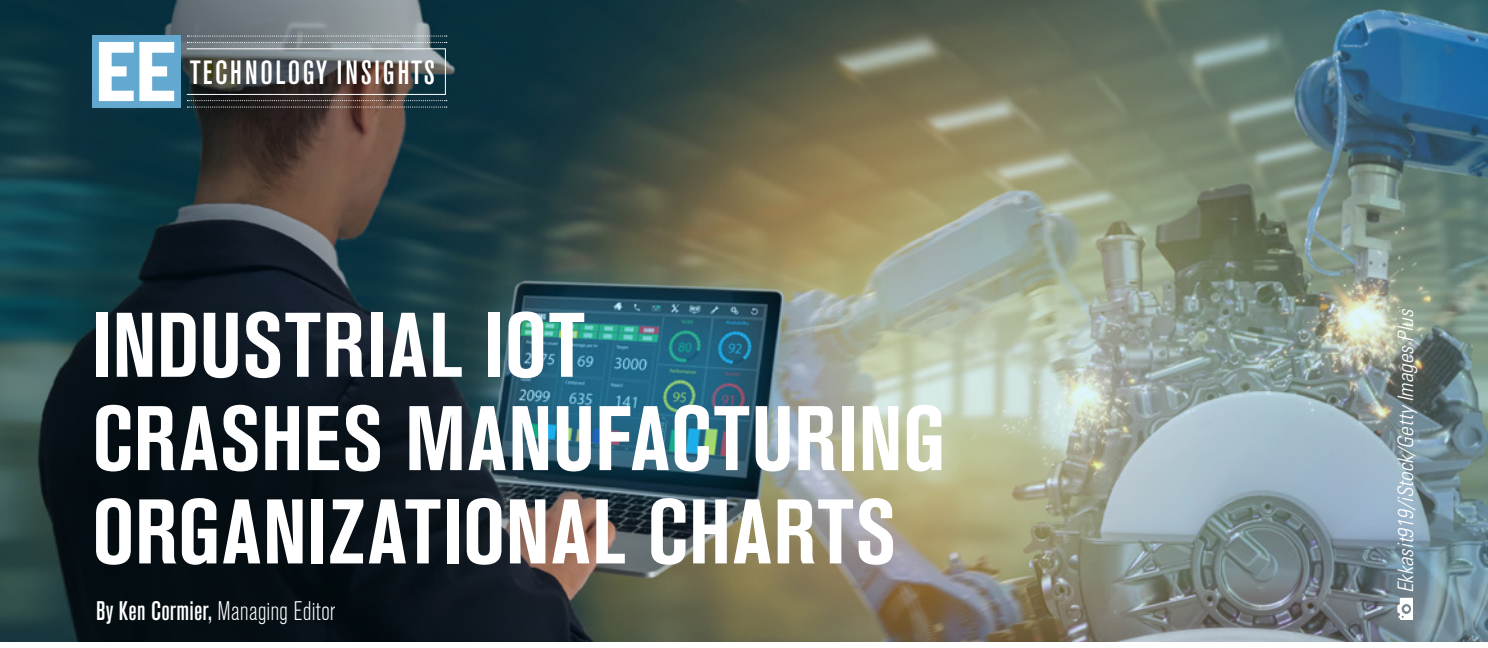

INDUSTRIAL IOT CRASHES MANUFACTURING ORGANIZATIONAL CHARTS

By Ken Cormier, Managing Editor

IIoT, the industrial sector of the IoT, integrates sensing and actuation systems in manufacturing, and allows for data collection, exchange and analysis, improved productivity, predictive maintenance, energy management, and cost reduction. This higher degree of automation is enabled using cloud and edge computing to optimize and refine process controls. With so many connected but fragmented hardware elements, security is a prime concern, often addressed with software or device-agnostic designs.

Here are some recent news items dealing related to the IIoT:

IoT in Manufacturing Market: $136.83B by 2026

According to a report, "Internet of Things (IoT) in Manufacturing Market," by Fortune Business Insights, IoT in manufacturing, which stood at $27.76 billion in 2018, is anticipated to balloon to $136.83 billion by 2026, a CAGR of 22.1% during the forecast period. The report attributes the IIoT's meteoric growth to its ability to "provide the organizations with comprehensive visions to examine complexities that often arise at the intermediate points of manufacturing processes," and enabling the ability for manufacturers to enact real-time adjustments.[1]

Will Smart Factories Revive U.S. Manufacturing?

A recent article in Forbes raises the question of whether the U.S. can win upmanship over China in manufacturing, post-coronavirus. It notes that some jobs have already returned to U.S. soil from China, as some pharmaceutical makers have moved their operations into the Carolinas. The article further states that China is currently ahead of the U.S. in the smart-factory arena, but in the midst of the COVID-19 pandemic, the U.S. is beginning to wake up to the risks of dependence on manufacturing in China. Noting that U.S. productivity is 8 times China's productivity, the added impetus of smart factories, just-in-time manufacturing, and a good supplier network, U.S. firms could be ready to break the grip that China has on the market. Alexander Stiehler, analyst for UBS said, "After Covid-19, we believe companies will start to localize some of their production." "Factories will need to be more digitized and automated to produce smaller quantities efficiently with localized manufacturing. The Industrial Internet of Things, 5G, and industrial software are all key enablers of the transformation to smart manufacturing."[2]

Power Source Maker Claims to Create Power from Air

According to a recent press release from SmartCone Technologies Inc. of Ottawa, Canada, the firm will partner with Conflow Power Canada Energy to bring a self-charging power source to market that they claim creates power from air. According to the press release, the patent-pending solution draws electrons from the air, and as they pass through a nanotech-based film, the electrons are charged. They then come in contact with a conductive surface which powers the device, and then are recycled back into the air." SmartCone will begin by integrating across the current suite products, further differentiating themselves from their competition. While it will benefit many solutions, the company plans to push its SIMS by SmartCone's wearable to the forefront, and will likely serve as the first product integrated with this novel power source.[3]

Russian Mine Using 5G with Autonomous Dump Trucks

The SUEK coal company open-pit mine in Khakassia, Russia, is testing the potential of 5G in a pilot project with 130-ton BELAZ-7513R autonomous mining dump trucks. The autonomous haulage system, based on robotics, IIoT, AI, and IoT, was developed by Zyfra, a Finnish-Russian industrial digitalization firm. A portion of the 5G network, with a route length of almost a mile, has been deployed on Huawei equipment with a view to performing the tests at the Chernogorsky open-pit mine. The cover is provided by two 5G-distributed two-section base transceiver stations (gNodeB), operating in non-standalone mode. The width of the operating channel is 100 MHz.[4] EE

REFERENCES

1. Fortune Business Insights, "Internet of Things (IOT) in Manufacturing Market to Reach USD 136.83 Billion by 2026; Ability to Develop Real-time Adjustments will Favor Growth," June 16, 2020
2. Forbes, "How To Bring Manufacturing Home To The U.S. From China," June 30, 2020
3. SmartCone Technologies Inc. "Press Release: Power From Air Will Revolutionize the Industrial Internet of Things (IoT) market," July 9, 2020
4. iVT, "Russia starts using 5G network on autonomous mining dump trucks," June 29, 2020

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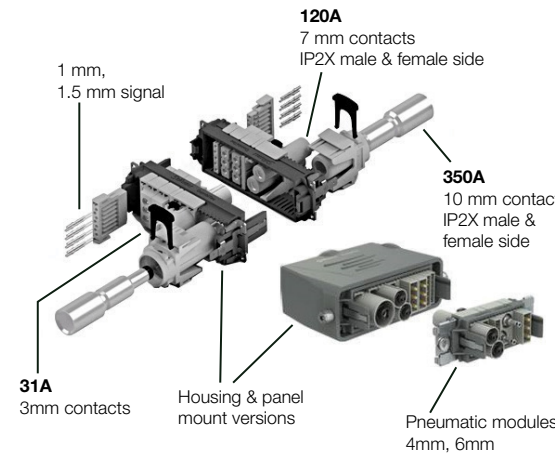

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