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JUNE/JULY 2022

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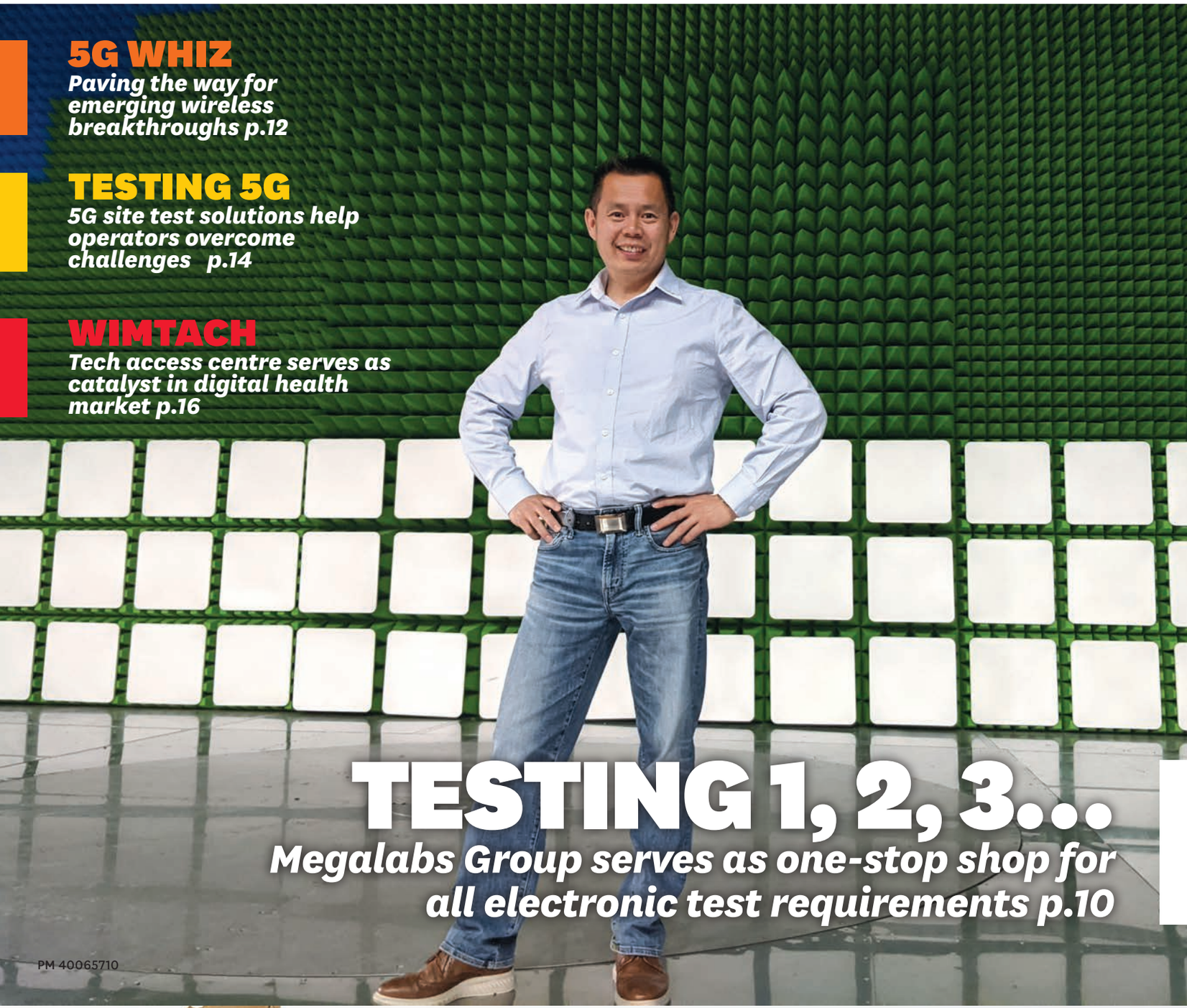

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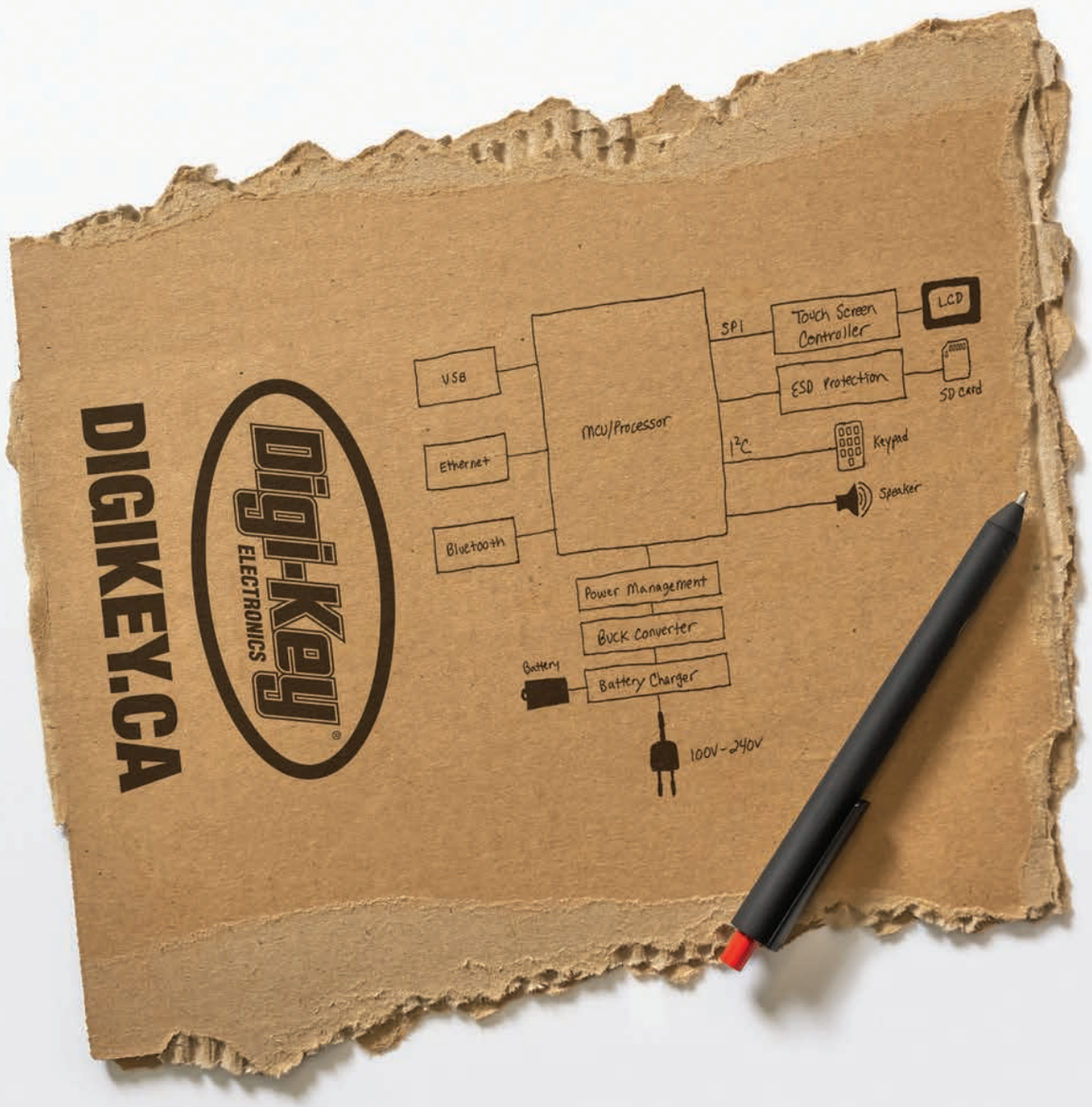

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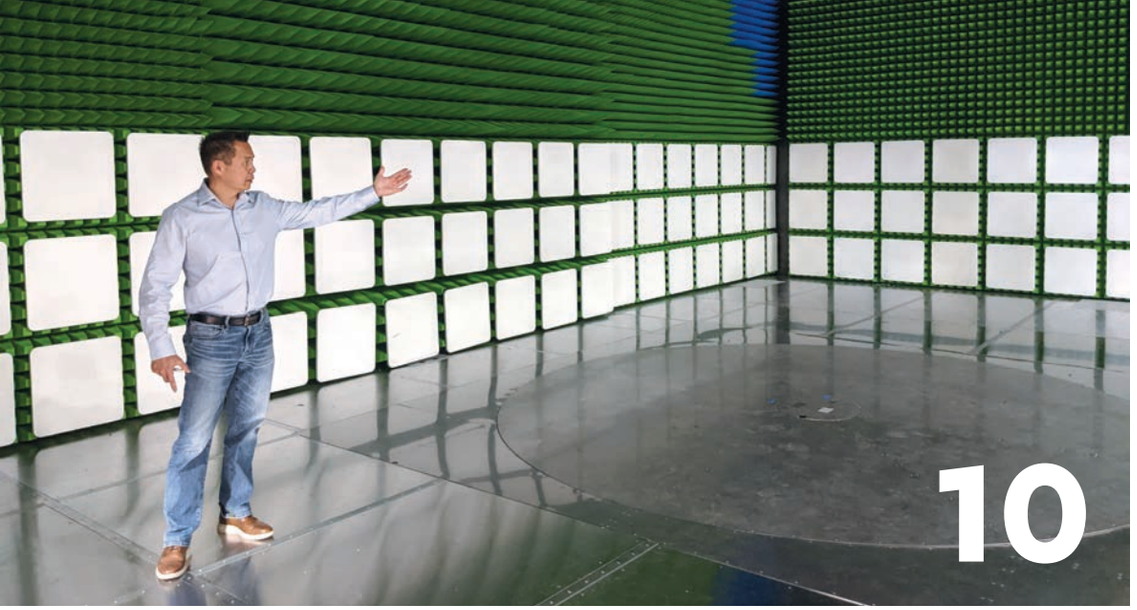

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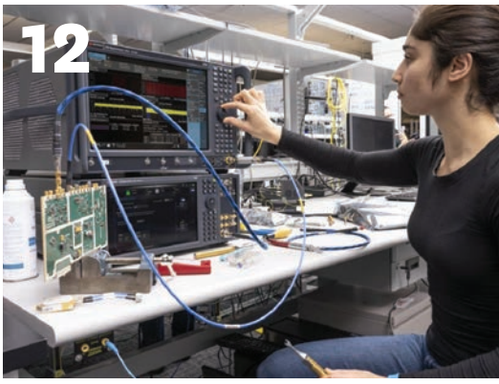

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Cover photo: Megalabs Group
Photos (this page, from top): Megalabs Group; Blackline Safety; Keysight Technologies; iFixit

Wearable tech in health care: A cure-all?

The rapid, breakneck speed that technology is hurtling toward humanity at this time in history is unprecedented. Tech development is progressing at a speed that is increasing almost by the day.

The enormous amount of data now available about the human body is enabling the advancement of personalised medicine tailored to the specific needs of the individual patient. In fact, it's now easier and faster for patients to procure medical services outside of the traditional four walls of the medical establishment, enhancing convenience and accessibility for all.

Thus, the market for consumer medical wearables is one of the fastest-growing design sectors in tech today, driven by a range of contributing factors — including consumer responses to COVID, the roll-out of 5G connectivity and improvements in the range and efficacy of devices.

Tech part of daily life

There's been substantial growth in the consumer medical devices market in recent years according to some Canadian-specific survey data about wearable technology provided by Cisco AppDynamics, a full-stack application performance management (APM) and IT operations analytics (ITOA) company based in San Francisco.

An estimated 320-million consumer medical wearables will ship globally in 2022 - ranging from heart rate monitors that can be used to detect heart disease and long COVID, to bracelets which aid ovulation prediction and conception.

Now, consumers are incorporating this technology in their daily lives to improve their overall health and wellbeing.

In a study of more than 12,000 consumers globally, including Canada, Cisco AppDynamics uncovered how quickly consumers are adopting this technology, the level of trust they have when allowing third parties to handle their data, and their expectations for incredible digital experiences when using these services.

The results show a booming industry, with consumers keen to realize a range of health and wellbeing benefits. But, at the same time their expectations for flawless digital experiences are higher than ever. One bad digital experience could be the make-or-break moment in a technology failing to reach its full potential.

Key Canadian takeaways from the report include:

- 82% of Canadians think wearable technology has the potential to transform both their personal health and public health as a whole
- 61% of Canadians say they intend to use more of these types of wearable technologies or applications in the next 12 months
- 33% of Canadians say they currently use at least one wearable health tech device
- 73% of Canadians say a bad digital experience may stop them using a specific wearable device or application and 51% say it may put them off trying other health or wellbeing wearables or applications

The biggest components of a bad digital experience for Canadians are:

- Data privacy / data security leak (61%)
- Application or device crashing (58%)
- Slow run time / unresponsive (57%)
- 86% of Canadians say reliable, real-time access to health data and accuracy of this data is critical to a good user experience

Of course, the medical wearables market is about more than the devices. Most devices are primarily data collection vehicles that feed vital statistics to a website or application.

There are over 350,000 digital health applications currently available to consumers, with 47% focused on managing specific health conditions. This number is expected to increase even further during 2022.

Some perspective

The good news is that medical institutions can now draw on these resources to relieve some of the burden from overworked, stressed-out physicians, nurses and staff – and many of them come in the form of technological advancements that may transform how we offer care in the years to come.

Experts say careful application of advanced tech could usher in a golden age of healthcare

New technologies could enable medicine to progress in leaps and bounds, but only with the right regulatory and ethical frameworks. The over-arching goal should be to create a crisis-resistant and 'future-proof' regulatory system for healthcare. **EP&T**

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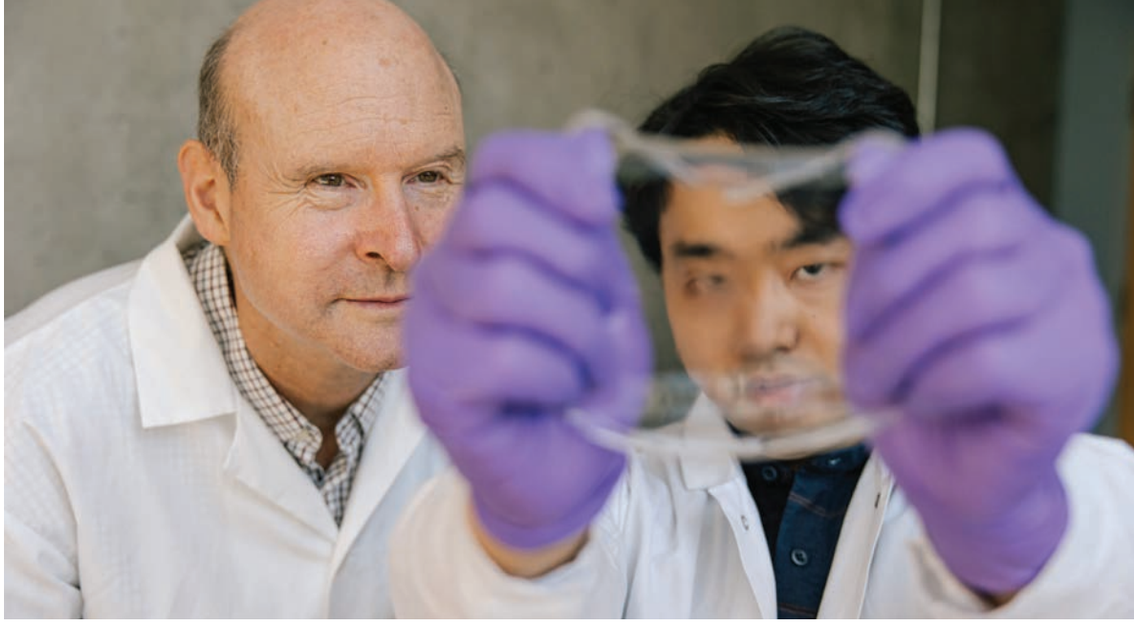

Dr. John Madden and Yuta Dobashi study a hydrogel sensor. Photo: Kai Jacobson/UBC Applied Science.

FLEXIBLE ELECTRONICS

YNVISIBLE EXPANDS LICENSE DEAL WITH RISE

Ynvisible Interactive Inc. a Vancouver-based printed e-paper display company, has expanded its license from the Research Institutes of Sweden (RISE), a leading research institute in the field of printed electronics. The amended license agreement includes exclusive worldwide rights to key patent families around printed electrochromic devices and displays.

With more than two decades of pioneering research in printed electrochromic technologies, RISE holds strong patents and know-how in printed display technologies. The combined capabilities and assets in printed electronics manufacturing will enable both groups to expand their potential for display products in their target markets, according to Ramin Heydarpour, Ynvisible's CEO.

A sample electrochromic flexible display component developed by Vancouver-based Ynvisible.

UBC ENGINEERS BUILD FLEXIBLE HYDROGELS

In the quest to build smart skin that mimics the sensing capabilities of natural skin, research engineers at the University of British Columbia have developed ionic skins that have shown significant advantages. Made of flexible, biocompatible hydrogels that use ions to carry an electrical charge, the devices have the softness of natural skin in contrast to smart skins made of plastics and metals. This offers a more natural feel to the prosthetic arm or robot hand they are mounted on, and makes them comfortable to wear.

The hydrogels can generate voltages when touched, but scientists did not clearly understand how — until the team of UBC researchers devised a unique experiment.

The researchers say this new knowledge confirms that hydrogels work in a similar way to how humans detect pressure, which is also through moving ions in response to pressure, inspiring potential new applications for ionic skins. The obvious design is creating sensors that interact directly with cells and the nervous system.

CPES2022 EVENT CREATES COMMUNITY, NETWORK

Returning to a live, in-person format after a two year hiatus due to the Covid-19 pandemic, the intelliFLEX Innovation Alliance recently hosted its CPES2022 conference at the Rose Theatre in Brampton, ON. The Canadian Printed and flexible Electronics Symposium focused on sustainability the most relevant, state-of-the-art technical topics, and global networking.

"intelliFLEX continues to build and broaden our ecosystem and CPES2022 clearly met a need for our community" says Dr. Michelle Chrétien, intelliFLEX president and CEO and associate vice-president, research at Conestoga College. "It is refreshing to experience the excitement of people enjoying the symposium and be surrounded by the resulting energy."

The annual intelliFLEX awards were delivered to these winners:

Research Innovation Award - FPInnovations won for its work with cellulose nanocrystals (CNCs), renewable nanomaterials obtained by strong acid hydrolysis of biomass.

Most Innovative New Product/ Commercialization – PulseForge won with its next-generation thermal processing, enabling applications such as soldering SAC305 onto lightweight PET.

Women in FHE STEM – Dr. Chantal Paquet, National Research Council of Canada, a talented polymeric materials chemist whose impactful scientific contributions generate commercially relevant materials and processes.

Photo credit: Stephen Law, EP&T

Stan Farnsworth, chief marketing officer PulseForge Inc. (left) receives his award from Howard Campbell, chair of the intelliFLEX board.

ARTIFICIAL INTELLIGENCE

STATS CANADA, MILA PARTNER ON ETHICAL AI

Statistics Canada has established a partnership with Mila, a Montreal-based academic research centre in deep learning (DL). By joining Mila's diversified community, StatsCan will be able to access a broader artificial intelligence (AI) ecosystem and partnership toolbox, effectively accelerating Statistics Canada's ethical AI and ML research.

"Data science is a team sport and this partnership allows us to collectively grow our respective teams' knowledge in these crucial research areas," said chief statistician of Canada Anil Arora. Mila, a non-profit organization, is internationally recognized for its significant contributions in the areas of language modelling, machine translation, object recognition and generative models.

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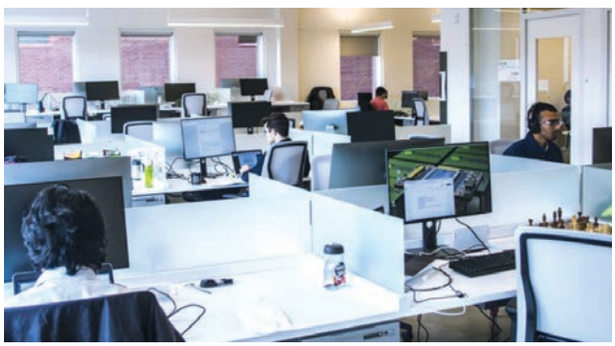

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Round-the-clock safety for industry operators

Blackline Safety's breakthrough technologies enable sustained security

BY SOHAIL KAMAL, WEST COAST CORRESPONDENT

More than ever, job sites require staff to do more with less, to respond faster and perform better. In response to this, and the demand for one-stop solutions that keep workers safe, Blackline Safety Corp., headquartered in Calgary, has announced a major expansion of its round-the-clock safety monitoring service.

The expansion includes growing the Blackline Safety Operations Centre (SOC), the only in-house safety monitoring service operated by a connected safety vendor, that operates at every hour, through every holiday.

With already more than 600 employees in six offices around the globe, Blackline is betting that the more connected the world becomes, the more we will see a need for improved monitoring solutions.

West Tech Report recently had the opportunity to speak with Sean Stinson, chief revenue officer at Blackline, about industries' quest for worker safety programs - what makes Blackline unique - and about an experience where they made a white-knuckle decision to stay ahead of the competition.

Blackline Safety's G7 EXO safety gas detection device is cloud-connected and automatically records and streams every bump test, calibration, exposure & more.

Cloud-based safety

Blackline works to keep staff safe using cloud-based safety sensors, levering internet of things (IOT) technologies, to connect workers to monitoring systems. But, it was a need for better gas detection that was the impetus for starting Blackline.

"We were looking to secure additional funding and partners when the company attracted the attention of Cody Slater, former CEO of BW Technologies, a Calgary-based world leader in portable gas detection," says Stinson. "Cody became an investor and then took on the role of chairman & CEO - recognizing an opportunity to marry Blackline's lone worker monitoring technology with his gas detection expertise to create a powerful safety solution."

This union works. Blackline's connected safety products are now deployed in over 60 countries protecting more than 100,000 workers. The primary pain point they solved is by offering real-time visibility to workers on location and their ongoing safety status so that should an incident or emergency occur, immediate information is at their fingertips to make an informed response.

"Our cloud-enabled safety devices and customized analytics reports help managers who want to eliminate and mitigate safety risk, proactively manage and improve compliance, and reassurance that should there be an incident, the fastest response time with vital information is available 24/7," explains Stinson.

Leveraging IoT

And, it helps that they are based in resource rich Alberta. Tapping into the talent and technological innovation in Calgary, the company has evolved.

"[We serve] the world's leading oil and gas companies to supporting global heavyweights in a wide range of industries, including household names like FedEx, Coca-Cola, BAE Systems (British Aerospace), Tyson and Heineken," Stinson enthused. "We are active across many customer segments from consumer goods to transportation to utilities."

Blackline stands out by leveraging the Internet of Things (IoT) and cloud-connectivity to link workers to live monitoring.

"The result is better worker protection combined with the generation of data-driven insights that help companies prevent incidents… and boost efficiency," Stinson adds.

But they have had their challenges along the way. Often, workers need explosive gas sensors on their bodies, but almost every sensor on the market has major drawbacks.

"The most common solution, called a Pellister, draws a quarter of a watt, which means it needs to be tied to a large battery. So, when we first launched the G7 we decided we couldn't support a Pellister because it would have made the unit too heavy to comfortably wear all day," explains Stinson.

In short, Blackline was not going to have a great product if it couldn't solve this problem.

"We scoured the market until we had found a solution, but the solution wasn't commercialized. This white-knuckle decision was made to place a million-dollar order for these sensors, before we completed our rigorous internal testing."

As things turned out, Blackline had a strong enough team to carry the project over the finish line.

"It was the type of decision that wakes you up at two in the morning," says Stinson, adding, they need to stay two steps ahead - as other companies improve their capabilities. "It's also essential to tap into industry trends, which in our case is the digital transformation of the workplace. Leveraging IoT, our technology can support that transformation," Stinson concludes. **EP&T**

The result is better worker protection combined with the generation of data-driven insights that help companies prevent incidents… and boost efficiency

To learn more, go to www.blacklinesafety.com.

***Sohail Kamal** is EP&T's West Coast correspondent.*
sohail@nextgear.ca

Photo: VanHack

Navigating the muddy waters of ESG requirement

BY RASHIDA SALAHUDDIN, PRESIDENT & CEO, THE CORPORATE CITIZENSHIP PROJECT

The need for more corporate responsibility has evolved for today's corporations and the next generation of business leaders in the form of environmental, social and governance (ESG). Investors, activists, and regulators are now requiring proactive, community-structured commitment and accountability that is designed to step above shareholder returns.

Photo: © Murrstock / Adobe Stock

Today's global capital markets aren't interested in more marketing from companies in every industry. Instead, they are demanding sustainability and eco-friendly business practices as well as a reasonable return. Global technology companies and their executives are now hearing this call, and the industry is being more proactive in this movement.

Why are ESG standards needed?

Although ESG metrics are still trying to find their proper place in today's standardized financial reporting, that hasn't stopped technology companies and other industry institutions from making promises and illustrating the proactive nature of their ESG standards.

What's needed at this critical step is the ability for companies across all industries to truly quantify their company's present position relative to investor objectives of integration, values, and impact in the areas of governance over environmental and social contexts. American stakeholders and shareholders aren't interested in window dressing and empty promises only for the benefit of a feel-good investor report. They want to know that companies are holding themselves accountable to the promises and commitments they're making in these key areas.

Proxy advisors making unfair pressures

Many technology companies, specifically, have felt their fair share of pressure into adopting more ESG-forward practices. Whether through a reduction of plastic carrier bag usage or gender pay gap reporting, shareholders have certainly brought pressure on a large number of technology companies over their supply chain strategies, environmental and sustainability impacts, and certainly gender-diverse practices. This focus has led to a significant overhaul of many business processes alongside the appointment of a new addition to the C-Suite – the Chief Sustainability Officer (CSO). Other companies inside and out of technology continuously look at leaders in this movement and have started to replicate their operational changes.

However, making promises about ESG commitments and holding true to them are apparently two different stories for some. Many companies are being pushed into making ESG improvements and commitments, especially through institutional investors and oversight organizations such as Institutional Shareholder Services (ISS).

This has led some to wonder if these proxy advisors have become too focused on ESG issues, have conflicted, and have broadly too much power over the operation of America's largest technology companies.

ISS hypocrisy over ESG requirements

As an example, ISS talks a big game on the issue of Diversity and Inclusion. ISS demanded publicly traded companies disclose the ethnicity of each and every member of their board of directors. More recently, ISS has been accused of refusing to recommend voting for board slates that they allege do not contain enough 'diverse' representation.

However, it appears that ISS lacks representation from even a single person of color. Moreover, it does not appear that ISS's two corporate owners---Genstar Capital and Deutsche Boerse---have even a single person of color on their executive teams. This is troubling given the fact that they have claimed Diversity, Equity, and Inclusion is a priority and have asked publicly traded companies and technology companies to make commitments towards those ends. Standards are not only needed, they must be adhered to at all levels.

Tech firms have a chance to serve as models

Despite the hypocrisy demonstrated by organizations such as ISS, technology companies have the opportunity to truly bring about change – not just in their marketing but in the way they go about doing business. In fact, as business models have had to adapt to this new landscape and changed customer behaviors, there has been evidence of the incorporation of ESG elements across the technology industry.

These moves recognize it is not solely about making money and preserving the bottom line, but that technology companies have been working toward having a positive societal impact.

There is no doubt that these newly implemented strategies have the potential to drive increased valuations, which pushes up the appetite of investors, but that they also attract more qualified people into technology companies who are extremely committed to the corporate cause.

As more technology companies focus on staying committed to their ESG promises, everyone will win in the end, including customers, stakeholders, investors, the environment, and certainly employees.

These companies will truly serve as models of operation in the future. But, we must move beyond just promises and commitments, a new set of ESG standards must be developed to level the playing field of reporting. **EP&T**

For more information on The Corporate Citizenship Project, visit https://corporatecitizenshipproject.com/

Testing 1,2,3... at MegaLabs

Toronto-area one-stop shop serves multiple electronic test requirements

BY STEPHEN LAW, EDITOR, EP&T

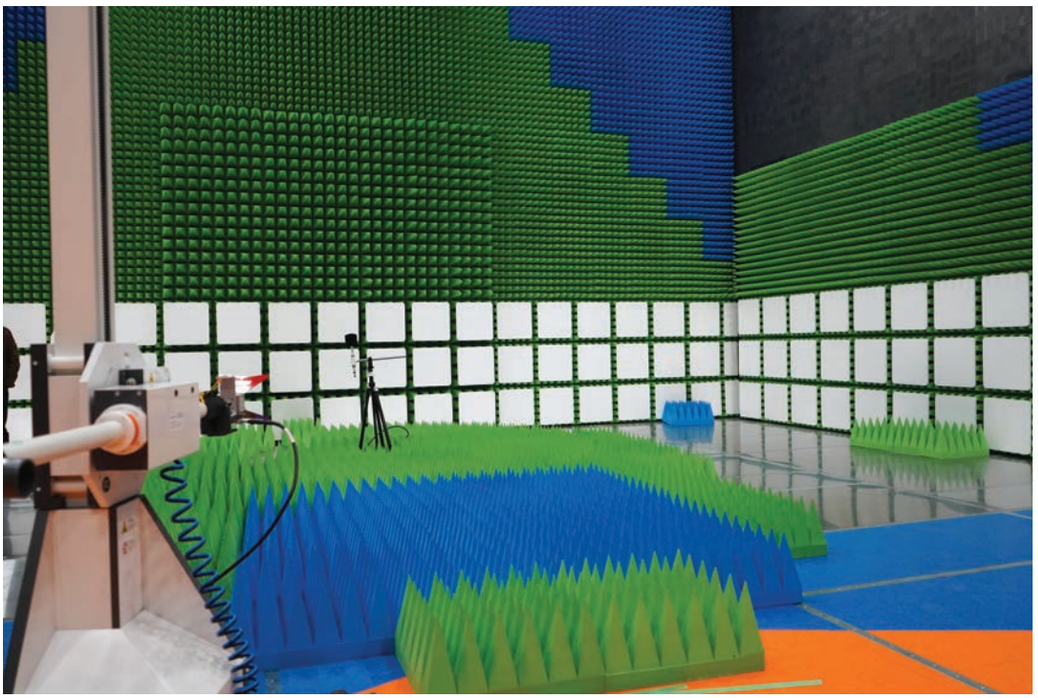
Just as Walmart or Costco serves its customers with every consumable need, Garry Lee has constructed a new facility outside of Toronto that can deliver any test requirement imaginable for an electronic design. Founder and partner of Megalabs Group Inc., Lee recently opened his doors to a 45,000-square-foot building in Aurora, ON, specializing in independent laboratory testing services – including all-inclusive ISO 17025 A2LA accredited, EMC, product safety, mechanical & laboratory testing services.

"We provide testing and validation assistance services to help design teams assess their product's performance – especially when that product needs to withstand rigorous environmental conditions," says Lee, a 27-year veteran in electronic test services in Canada, who previously operated the firm as EMTS Labs Inc. in Stouffville ON.

"The biggest difference we have here is the inclusion of more services. We've brought together the right people and the right equipment, and the right technology to provide that maximum client benefit," says Sreyas Dasika, business manager at Megalab, which employs 13 people, nine of which are test engineering experts.

"In our previous location, we were having growing pains with respect to the space (at EMTS). Now we have unshackled that, and with our expanded footprint and services we can make the test experience much more enjoyable for the client," Dasika notes.

"The name of our company (Megalabs) speaks to our aspirations as to what we're trying to do here. This building represents an all-inclusive test facility – we want to push our excellence and lessons that we've learned in test over several decades to all of our customers," he adds.



Megalabs' facility can manage multiple key test requirements. Above, this measurement setup is for >1GHz with a dual ridge guide horn antenna.

Garry Lee, founder and partner of Megalabs Group stands inside a test chamber at his 45,000-sq-ft facility in Aurora.

Design sectors served

Between the varied and unique industries it serves, the tests vary a lot, says Dasika. Each industry and even each component type has its own regulatory sub-standards that dictate how performance has to go for it.

"So, the implication for that is – in order for us to service each industry, we have to have the expertise and background to know the standards," Dasika adds. "We are incredibly blessed, as we have years and years of experience working with everyone from automotive, military, medical, industrial, and consumer electronics manufacturers. Right across the board - these customers all have a commonality – and they need a fact validated."

EMC/EMI testing

Dasika points out that essentially every circuit is susceptible to both magnetic waves on the outside, as well as being an emitter of these waves on the inside.

As a result, every device needs to be assessed to make sure it cannot be interfered with and it does not interfere with other devices externally.

"The equipment used to test this means that all the signals must be measured in isolation. So, the reason why our test apparatus is so big and heavy is because it must literally block off the outside world," he says.

Among the testing services Megalabs provides in this category includes: wireless, EMC pre-scan, EMI site survey, shielding efficacy, conducted

Photo: Megalabs Group

emission, radiated emission, ESD and flicker & harmonic testing - to name most.

Product safety testing

These tests explore a variety of factors, such as detecting if a product gets too hot, will it shock the end-user, is the voltage correct on it. Megalabs tests for some of the most very basic things that consumers take for granted in their devices.

"We are really trying to make sure that the regulatory hurdles that those products need to clear, can be assessed cleanly, impartially and that product users are safe," says Dasika.

Among the safety testing services managed include: Construction review, CE mark, NRTL/C approvals, UKCA approvals, consumer & industrial safety, and medical design testing.

Environmental testing

When it comes to testing for environmental conditions, simulation scenarios are used to assess performance. As a sample example - if a product needs to operate in a hot environment for a long time and to continue operating.

"The entire nature of this type of testing directly relates to your product's efficiency with waterproofness, corrosion, temperature resistance, ability to withstand shock and vibration resistance," says Dasika.

"These are all of the things that exist in nature and can beat your product down. These factors will destroy products that are not designed or tested to withstand them."

Global market access

Every country has its own regulatory framework – thus, its own way to assess safety, according to Dasika. And, each country has similar, but divergent viewpoints.

What this means is that each country has its own scheme and way it is to be done in order to make the product available in their particular market.

"We have experts on staff that are ex-engineers from some of the largest consulting organizations in the world – CSA, DEKRA, International Certification Agencies. They are able to assess the customer's product – take their reports and tell you what the gap is to getting the product into any of these countries. The best part is, we have all of these services under the same roof," Dasika says.

Turnkey test experience

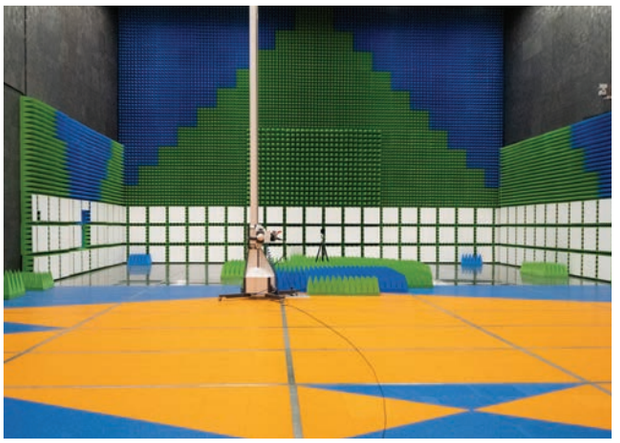
Time to market is essential in any design process, as every OEM operates with two factors – time and money. Design engineers are all trying to make the time factor as short as possible and the cost factor as low as possible. If they cannot do those things, their businesses will fail – it's as simple as that, Dasika notes.

"By recognizing these hurdles and challenges, our organization is structured to be that partner, who is going to push their goal as quickly as possible," he adds.

Dasika underscores the importance of OEMs realizing the implications of freight, and its imposing associated costs. Shipping a prototype design from the OEM's lab to a multitude of different labs for testing only extends the build process - thus lengthening the intended 'time to market', Dasika warns.

Testing accreditations

Certified to the nth degree, Megalab's engineering services are ISO/IEC 17025:2017 accredited, while also certified by ISTA as a transit packaging laboratory in the areas of processes and procedures, along with equipment qualification. The firm is also certified in the Controlled Goods Program to examine, possess or transfer controlled goods.



3M EMC radiated emisssions test setup - Floor visible which serves a chamber ground plane, mounted on a 4mm remote control anetenna mast.

> ***"By recognizing these hurdles and challenges, our organization is structured to be that partner, who is going to push their goal as quickly as possible,"***

"We often find OEMs hitting design roadblocks when it comes to discerning regulatory or certification process hurdles. We want to be the OEMs all-inclusive answer to solving their problems on the engineering side," he says.

When it comes to turnaround times on test needs, Megalabs aims to get the job done as quickly as possible, according to Dasika. Simple or standard test procedures can be turned around quickly, such as in three to five business days.

Some tests, however, can be limited by the fact that the test itself will take 35 days. As a result, Megalabs moves to initiate the process as quickly as possible and return the results as speedy as possible.

"Our real focus is speed and efficiency – because once we achieve those qualities - our customer becomes speedy and efficient. We pass that time saving directly along to them, because we don't want to bog them down with the process. EP&T

Pave the way for next wireless breakthroughs

BY ERIC HSU, PRODUCT MARKETING MANAGER – KEYSIGHT TECHNOLOGIES INC.

The pace of wireless innovation is accelerating to enable faster, more responsive and more reliable connections worldwide. The wireless communications industry is ready for significant technology changes across multiple systems. While cellular communication is transitioning from 4G to 5G to enable extreme data throughputs, satellite communications providers are building networks in space to provide high-speed communications from anywhere in the world. Wireless engineers look for breakthrough technologies to maximize system throughput, robust links, and data handling capabilities. The key technology components of the wireless system physical layer are wider bandwidths, higher-order modulation schemes, and multi-antenna techniques in wireless systems.

FIGURE 1: Accurately validate RF components with stimulus-response measurements.

Wider signal bandwidths

Standard development organizations are looking for wider bandwidths at higher frequency bands because of the limited spectrum allocation. For example, 5G New Radio (NR) Release 15 specifies frequency range 2 (FR2) from 24.25 GHz to 52.6 GHz and a maximum channel bandwidth of 400 MHz. Release 16 introduces to unlicensed frequency band in the 5 GHz and 6 GHz frequency ranges. By the middle of 2022, 3GPP Release 17 will extend the spectrum range up to 71 GHz for unlicensed bands.

Satellite communications provide connectivity for a variety of television, phone, broadband internet services, and military communications. Satellites operate in many frequency bands, from the L to the Ka band. The International Telecommunication Union (ITU) allocates the 71 to 76 GHz / 81 to 86 GHz segment of the W band to satellite services. These frequency segments are of increasing interest to commercial satellite operators for wider bandwidths. On June 30, 2021, a satellite with a W-band radio transmitter successfully launched; more commercial projects in the W band are in the not-so-distant future.

Millimeter-wave frequency bands provide more available bandwidths. Wide bandwidths enable high-throughput data and low latency, but wider bandwidths also introduce more noise that degrades system performance. Wireless engineers need to manage the noise problem for wideband communications. In addition to creating more system noise, wider bandwidths at higher frequency bands introduce other design and test challenges such as path loss, frequency responses, and phase noise.

Higher-order modulation schemes

Higher-order modulation schemes achieve faster data rates without increasing signal bandwidth and require closer symbols that are more sensitive to noise. Devices require better modulation quality as the modulation density increases. Table 1 shows the error vector magnitude (EVM) requirements for 5G NR base stations defined in 3GPP release 16 technical specification 38.141. Under consideration is the adoption of 1,024 QAM for 3GPP, which requires tighter design and test margins.

TABLE 1: Modulation quality requirements for 5G NR base station transmitter tests.

Modulation scheme	Required EVM (%)
QPSK	18.5%
16 QAM	13.5%
64 QAM	9.0%
256 QAM	4.5%

Both wider signal bandwidths and higher-order modulation schemes increase throughput. However, more bandwidth may not mean more system capacity. You must consider the signal-to-noise ratio (SNR) in the communication system. Proper SNR is critical to maintaining communication links. Wider bandwidths introduce more noise into the system, and higher-order modulation schemes are more susceptible to noise. You will need to transmit a high-power signal without distortion and reduce system noise to sustain the communication links. To test your designs, an accurate characterization of each component and subsystem is required, as shown in Figure 1.

Multi-antenna techniques

Most wireless systems, whether in commercial applications or aerospace and defense, use multiple antennas techniques at the receiver, transmitter, or both to improve overall system performance. These techniques include spatial diversity, spatial multiplexing, and beamforming. Engineers use multi-antenna techniques to achieve diversity, multiplexing, or antenna gains. Through these gains, wireless systems can increase a receiver's data throughput and SNR. For example, 5G NR uses eight spatial streams for FR1 to improve spectral efficiency without increasing signal bandwidth. As a result, 3GPP defines performance tests with multiple spatial streams for 5G NR base stations in Technical Specification (TS) 38.141-1. The tests require up to two transmitter antennas and eight receiver antennas, and each

Photo: Keysight Technologies

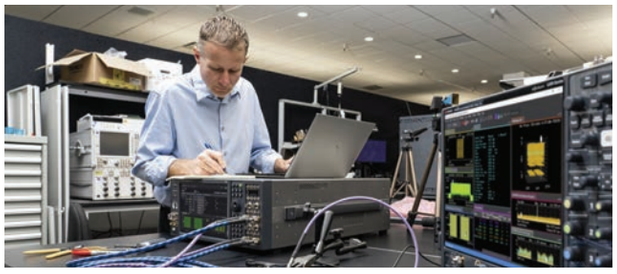


FIGURE 2: A multichannel test solution with a Keysight M9484C VXG four-channel vector signal generator and a four-port oscilloscope.

test case applies specific propagation conditions, correlation matrix, and SNR. For example, a 5G base station performance multiple-input multiple-output (MIMO) test configuration includes two transmitter antennas and four receiver antennas with hybrid automatic repeat request (HARQ) feedback.

Compared with IEEE 802.11ax, the next-generation Wi-Fi standard, IEEE 802.11be (Wi-Fi 7), provides twice the signal bandwidth, 16 spatial streams, and quadruples the density of a modulation scheme. These together provide data rates up to 40 Gbps. Table 2 illustrates the significant changes in the IEEE 802.11 physical layer.

Testing multi-antenna systems that use spatial diversity, spatial multiplexing, and multiple antenna arrays requires a test system capable of providing multichannel signals with stable phase relationships between them. However, a commercial signal generator has an independent synthesizer to upconvert an intermediate frequency (IF) signal to an RF signal. A test system must provide precise timing synchronization between channels to simulate the multichannel test signals. The phase between test signals must be coherent and controllable. Figure 2 shows a fully integrated, calibration, and synchronized signal generation and analysis solution that helps you minimize measurement uncertainty for multi-antenna tests.

TABLE 2: IEEE 802.11 standard.

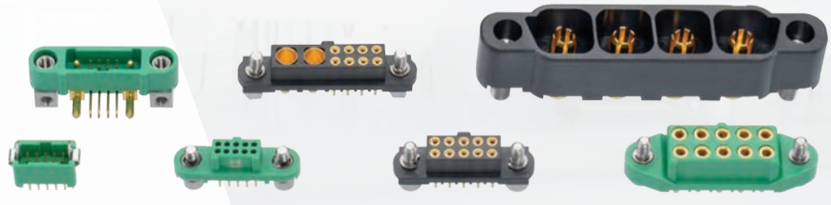
IEEE 802.11 standard	Maximum signal bandwidth	Modulation scheme	Number of spatial streams
802.11be (Wi-Fi 7)	320 MHz	OFDM, up to 4,096 QAM	Up to 16
802.11ax (Wi-Fi 6)	160 MHz	OFDM, up to 1,024 QAM	Up to 8

Summary

Next-generation wireless communication systems such as 5G, satellite, and Wi-Fi require higher frequencies, wider bandwidths, more complex modulation, and multi-antenna designs. This will enable you to face new design and test challenges, including increased test complexity, measurement uncertainty, excessive path loss, and noise, that impact device performance.

To overcome these challenges requires a scalable test solution that enables higher frequency coverage, wider bandwidths, and multichannel applications with ease and accuracy. A fully integrated, calibrated, and synchronized solution enables you to reduce test complexity and achieve faster, repeatable, and accurate results. **EP&T**

Eric Hsu is currently a product marketing manager at Keysight Technologies. He has over 18 years of experience in wireless applications with Keysight (formerly Agilent Technologies).



5G site testing, troubleshooting

BY PETER BUSH, MARKET DEVELOPMENT MANAGER, ROHDE & SCHWARZ

Commercial 5G rollouts are happening now and more and more 5G non-standalone (NSA) sites are being deployed. Existing LTE infrastructure is being converted into dynamic spectrum sharing (DSS) hybrid sites supporting 5G. An increasing number of private regional 5G networks in standalone (SA) mode are going into trial phase.

Each new installation must be commissioned and verified to ensure correct network performance and end-user quality of service (QoS) over the 5G network. 5G site testing requires specialist mobile network testing solutions that meet the testing demands of the new RAN architecture, including over-the-air (OTA) connectivity and new KPIs.

The link to the anchor site (usually low-frequency LTE) needs to be checked in parallel for NSA mode. New latency and reliability requirements are becoming reality in campus networks and need to be verified.

Over-the-air testing is moving into the front line of active antenna system (AAS) testing. The beams are produced directly in the antenna, by a varying number of antenna elements. This renders some traditional quality metrics, such as EVM (conducted measurements) unreliable indicators of proper working sites. Instead, beam-centric measurements (SINR/RSRP) measured over the air in front of the cell site are now vital. Deployment will be in the FR1 (sub6 GHz) band and in FR2 (microwave, usually 28GHz and higher). The LTE anchor cell uses the same antenna or even a different tower, making new test tools and procedures necessary.

5G site testing process

Site acceptance is by no means trivial. Well-defined test procedures and proper test tools create reliable results efficiently. What are the typical required RF tests? How do you group them into different deployment scenarios and itemize the necessary test equipment?

After a 5G site is installed, fundamental cell site performance must be secured, all parameters must be inside a specified range and additional 5G capacity needs to be advertised in the related LTE anchor cells.

Installation / acceptance tasks

- Check VSWR reflections via OSS counters.
- Ensure the PCI and beams are visible in the expected location (SS-RSRP, SS-SINR).
- Conduct power measurements on the allocated LTE anchor cell (RSRP, SINR).
- Make sure timing is correct (synchronization relative to UTC)
- Perform functional tests for proper integration of 5G cell into complete network.
- Measure the field strength radiated by the 5G station (EMF).

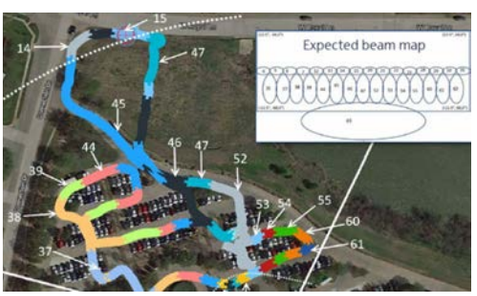
Troubleshooting steps

- If reflection counters indicate problems, measure reflection / DTF with a cable and antenna tester.
- If beams / PCI are not visible, check and correct the 5G site configuration file. Check cable and antenna.
- If the 5G cell is not used or throughput is too low, check on LTE-SIB 2 whether 5G cell is advertised.
- If SINR is not as expected, check for internal interference (side lobes) and external interference.
- When timing is not within limits, check distributed grandmaster clock timing. Make sure no other delays from broken parts are in the chain generating the RF-signal.

OSS can detect a reflection but does not know if it is originated in the RRH, jumper or antenna. Checking on site reflection / DTF only makes sense when the components are physically separated and the RF-connection between them can be detached.

Complex beam distribution

Beam distribution can be very complex in FR2. We have measured cells that distribute 64 beams and can change from one beam to another in just one step.



Beam distribution in a 5G FR2 site

Cable / antenna tests

Making sure antenna systems are working smoothly is ever more important in 5G. Since 5G deployment started in older LTE sites with dynamic spectrum sharing (DSS), distance-to-fault and reflection tests are crucial to 5G and LTE network performance.

Basic RF parameter OTA

A spectrum analyzer detects the initial indications of whether a 5G signal is present in the air. A directional antenna pointed to the sector antenna can be used to measure the occupied bandwidth with the maximum hold function. The SSB section is visible in the middle of the spectrum.

SSBs can be seen in the time domain by going into zero span and using the video trigger.

Demodulation and decoding

In 5G, it is important to add demodulation and decoding to spectrum measurements. Automated channel detection (ACD) displays all legacy and 5G signals. No channel, frequency or SSB position settings are needed. Further information about the signal content can be obtained by reading relevant broadcasting data (MIB and SIB). Even DSS sites (green rectangular) can be detected (band 1 LTE over 5G at same frequency, within a UMTS gap).

PCI and beam-centric measurements

The signal of interest can be selected and the availability of beams / PCIs, boundaries of beams/sectors and sidelobes can be checked by filtering via band, PCI, MNC/MCC or SSB.

Functional tests

Adding a smartphone to the 5G STS allows functional tests such as data uplink or downlink and throughput measurements. Layer 1 parameters and layer 3 signaling can be measured and recorded for further troubleshooting.

Conclusion

5G site test solutions help operators to overcome the challenges of verifying correct site installation and to troubleshoot sites of 5G networks. 5G site testing solutions should offer an efficient method to test layer 1 and layer 3 parameters, new performance KPIs, and the quality experienced (QoE) by end users. **EP&T**

Photo: Rohde & Schwarz

COMING IN AUGUST

Contract Electronics Manufacturing Guide

Playing an integral role in the eco system of the electronics industry in Canada, CEM's are one of the most important players in any design cycle. EP&T's August edition will feature a complete Source Guide for those looking to connect with a Contract Electronics Manufacturer (CEM) in Canada. This special section will list all the major CEMs in Canada, serving as a perfect guide to engineers seeking a design and manufacturing partner.

Contact Scott Atkinson • satkinson@ept.ca or Joanna Malivoire • jmalivoire@ept.ca for more information.

Hurry Deadline is July 8

WIMTACH: A digital health & wearable tech catalyst

Technology access centre situated at Centennial College in Toronto

BY STEPHEN LAW, EDITOR EP&T

In an effort to accelerate support to players in the rapidly evolving digital health technology market in Toronto, Canada and beyond – a number of key stakeholders from industry and funding partners formed WIMTACH. In long-form, Wearable, Interactive and Mobile Technology Access Centre in Health is an applied research centre at Centennial College Progress campus in Scarborough Ontario.

It uses a multidisciplinary approach to provide specialized knowledge, equipment and technology to companies and organizations involved with developing digital health tech.

As a technology access centre, WIMTACH serves as a catalyst for and contributor to the growing ecosystem by providing services to small to medium-sized (SMEs) businesses to carry out applied research projects. Through these projects, WIMTACH helps businesses activate their innovative ideas and transform them into commercialized successes.

WIMTACH began in April 2015 with a $1.75 million federal grant and is one of 30 Technology Access Centres funded by Natural Science and Engineering Research Council of Canada (NSERC). Since then, WIMTACH's record of success has continued to climb.

In this article, EP&T sets out to find out more about the centre and its services.

1 | *What type of tech development receives support?*

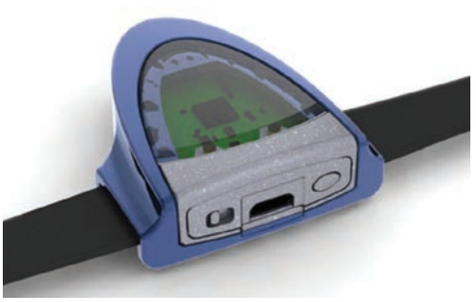
SMEs developing the following: Digital health; Mobile; Interactive; Wearable; Electronics and mechanical; Machine Learning, Deep Learning, Artificial Intelligence; Prototyping of hardware devices; Automation; Testing and validation of devices and applications; Virtual reality (VR) and interactive capabilities.

Some of the services provided include: Market intelligence; Opportunity assessment; Business planning; Strategic consulting; Market research.

2 | *How does a group or individual obtain assistance?*

They both may obtain assistance through completion of the Collaboration Request Form available on the WIMTACH website. Thereafter, an exploratory meeting will be arranged to meet with the technical team, who are invited to the meeting based on the information provided in the form. This will include discussions on project requirement, eligibility of company for funding, resources requirement, funding options, among others.

Toronto-based start-up exactMed Ltd. initiated a collaborative project with WIMTACH to develop a programmable pill dispenser device that can release a single pill at predetermined times according to the patient's prescription.



WIMTACH operates across research disciplines to bring cutting-edge expertise, resources and opportunities to companies – which may choose to develop prototypes such as this tech device for Smart Teacher.

3 | *What types of service does WIMTACH provide?*

A range of services are provided to industry clients with access to a variety of services, including research and development (R&D) services, networking opportunities, access to state-of-the-art facilities and students to participate in client projects using their technical expertise. Proposal writing and funding application assistance services for non-dilutive funding is also offered. Here are a few examples of services:

- **Prototyping**

The prototyping team is capable of designing and developing IoT, as well as medical devices and apparatus.

- **Mobile application development**

Expertise in developing mobile applications is offered with up-to-date technologies (e.g., Bluetooth, GPS tracking and push notifications to name a few). This includes a research technical lead, who brings experience in mobile and web app development.

- **AR & VR & interactive development capabilities**

Centennial College has highly-trained and industry experienced faculty members, who teach in programs such as graphical designing, game development, software engineering and mobile application development – and students with high-level skillsets to provide AR, VR and interactive development expertise.

- **Customized trainings**

Training and learning opportunities are offered to clients, which are designed to address specific challenges and provide expert advice in areas such as prototype development, concept design of mechanical engineering ideas, data analytics, cyber-security, gamification and interactive mobile app interface creation.

- **Data analytics & AI**

WIMTACH has collaborated with numerous industry partners and SMEs in developing state-of-art data analytics and AI-based software applications for various verticals in healthcare, wearable device development and biomedical data analytics.

- **Industry 4.0**

With experts in IoT, simulation, additive manufacturing and data analytics, WIMTACH initiated a new automation project with manufacturing company with a purpose of automating the production process/line of shea butter to scale up production from 100 units/hr. to 400 units/hr. and support the current growth and revenue generation of the company, as an example.

- **Hackathon**

WIMTACH has collaborated with

Photo: WIMTACH

different companies and hospitals for hackathons which were successfully converted into applied research projects.

• Grant proposal writing & fund acquisition service

A proposal writing service helps industry partners make the best financial investment for their company. An appropriate federal or provincial funding program is identified for the company and its team of writers, support companies in the proposal writing process.

4 | What are some wearable design examples

Some sample projects include:

• A wearable glove from BreqLabs Inc. with embedded sensors to enable individuals with motor disabilities or neurophysiological disorders to interact with a computer (or TV) using hand movements, or navigate and play in a 3D virtual environment.

• Development of an intelligent traction wearable device with a mobile application to collect data from sensor devices via Bluetooth for the improvement of human productivity and well being.

• Design and development of a needleless acupuncture device for AcuMade.

• Design and development of a flexible strain/pressure sensor for sleep monitoring applications for Noxware.

• Design, fabrication and testing of a smart sleeve for upper limb tele-rehabilitation using a novel strain sensor for Noxware.

5 | Describe the range of tech firms helped.

WIMTACH has supported a large number of SMEs, that have potential for commercializing the applied research results. A wide range of tech firms from start-up to large corporations, have also be assisted.

6 | Describe the level of client engagement.

All projects and engagements are collaborative in nature. Thus, WIMTACH works closely with clients to ensure the fulfillment of project commitments and high level of quality standard in delivering its services. This includes conducting weekly or bi-weekly meetings to ensure that the work plans are implemented accordingly as planned.

7 | Describe the varied skills that WIMTACH team members can deliver.

The core technical team is composed of R&D leads in software development, mechanical design and development, electronics design and development, artificial intelligence and data analytics. As part of the Centennial College system, WIMTACH also leverages the industry expertise of faculty members from various fields of expertise depending on the project requirement.

8 | What services are available through the Techology Access Centre?

Applied research project collaborations; Non-dilutive funding acquisition; Technology development; Customized training; Product commercialization; Networking; Hackathon.

9 | What kind of NSERC funding is offered?

NSERC Technology Access Center

NSERC Innovation Enhancement

NSERC Innovation Enhancement Extend

NSERC Applied Research and Technology Partnership

NSERC Applied Research and Development

10 | How do partners acquire funding.

To acquire funding, industry partners need to share the project requirements, while WIMTACH identifies the correct funding source for that project and then writes the proposal and initiates the funding applications.

WIMTACH has proven expertise in grant writing that ensures the high success rate of acquiring funding. There are few multi-year funding acquired by WMITACH such as NSERC TAC, NSERC IE and NSERC ARTP funding.

11 | How does WIMTACH's industry partner proposals writing services work?

The WIMTACH team works closely with clients to understand the project requirement, through series of meetings, and to develop the workplan and other related components of the funding application until its completion. This close collaboration between WIMTACH and client ensures the high integrity of the proposal and increases the chances of approval from funding agency.

12 | How does one get to work with WIMTACH on an applied research project?

It is imperative that a company is incorporated and registered in Canada in compliance with the mandate of the Centre to support Small and Medium-sized Enterprises (SMEs) to become the economic force of Canada. SMEs, which have at least two fulltime and with T4 employees and which have been incorporated for two years, are eligible industry partners for NSERC, OCI, and NRC-IRAP funding programs. Start-up companies can become an industry partner of WIMTACH and can initiate applied research projects supported by MITACS

13 | Who attends WIMTACH training?

WIMTACH trainings are provided for the benefit of industry partners and students, alike. WIMTACH, currently, has multiple customized trainings that are open to everyone, who are interested to learn about Mobile and web application development, Data Analytics using Python, Scrum framework, Mechanical designs and concepts, Cyber-security, Design 101, and Artificial intelligence, among others. **EP&T**

For more information on WIMTACH, visit: https://wimtach.centennialcollege.ca

VSG SERVES WIDEBAND MULTICHANNEL MMWAVE

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M9484C VXG four-channel vector signal generator provides frequency up to 54GHz and up to 5GHz of radio frequency (RF) bandwidth and low phase noise in a single instrument. Unit delivers real-time capabilities to support demanding wireless industry applications. Product expands the frequency range up to 110GHz to address the needs for the latest and evolving standards. Unit reduces test system setup complexity and achieve accurate and repeatable multi-channel measurements. Key benefits include: scalable architecture that enables the most demanding wideband and multichannel test signals with frequencies up to 110GHz. Generates test signals with a RF bandwidth up to 5GHz.

https://www.keysight.com/ca

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R&S LCX series LCR meter provides fast, accurate and versatile measurements and delivers an extended measuring frequency range up to 10MHz for ac components. Unit boosts precision impedance values with market-leading accuracy for engineers selecting suitable capacitors, inductances, resistors, and analogue filters to match a device application. Product can effectively take all industry standard impedance measurements as well as specialized measurements for selected component types. Units deliver high accuracy required in research and development and the high speed needed for production test and quality assurance.

https://www.rohde-schwarz.com

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6GHZ BAND TESTS LATEST WI-FI 6E DEVICES

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Anritsu Wireless Connectivity Test Set MT8862A has been integrated with the EMITE E600 Reverberation Chamber, allowing developers to test the OTA TRP/TIS performance of IEEE 802.11ax devices in a repeatable environment. Offering integrated communications protocols and optimized performance for testing, the joint solution provides reliable characterization of the latest Wi-Fi 6E devices on the market. System can measure the total radiated power (TRP) and total isotropic sensitivity (TIS) OTA performance indicators in IEEE 802.11ax devices.

https://www.anritsu.com/en-us/test-measurement/products/mt8862a

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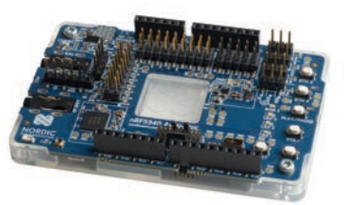
FLIR RS6780 long-range radiometric infrared camera system, designed for range tracking, target signature, outdoor testing, and science applications in all conditions. Featuring continuous zoom, camera includes an integrated motorized three-position filter wheel and optional factory calibrations to support thermography applications up to 3000°C. The optional 3x zoom a focal lens attachment provides engineers and scientists the flexibility to change the focal range from the standard 50mm–250mm to up to 150mm – 750mm.

https://www.flir.ca/



AUDIO DEV KIT ACCELERATES NEXT GEN WIRELESS DESIGN

NORDIC SEMICONDUCTOR

nRF5340 Audio Development Kit (DK) is a design platform for rapid development of Bluetooth LE Audio products. Audio DK contains everything needed to get started on LE Audio development projects. It is based on firm's nRF5340 System-on-Chip (SoC), a wireless SoC with two Arm Cortex-M33 processors. The SoC is suitable for LE Audio and other complex IoT applications. Highly configurable dev kit makes it easy to embark on LE Audio projects.

www.nordicsemi.com/nRF5340-Audio-DK

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https://www.masterbond.com/products/silicone-systems

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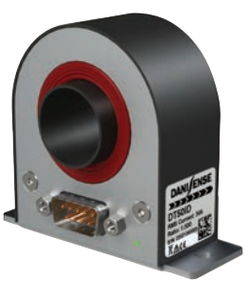

www.danisense.com

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PowerCu Soft Laser Ribbons (LRB) for Laser Bonding is an optimized copper ribbon that achieves improved efficiency and stability in power electronic systems. Product enables module operation temperatures higher than 250°C and allows the highest power density designs. Laser ribbon bonding is particularly suitable for joining bonding wire onto battery terminals and onto DCB substrates and copper terminals.

www.heraeus-electronics.com

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www.harwin.com

HOT AIR REWORK STATION ADJUSTS TEMPERATURE, VOLUME

NTE

ECG line of Soldering Tools now includes the J-HARW-1 Hot Air Rework station that features adjustable temperature and air volume controls. The bright easy to read display can be changed to display either Fahrenheit or Centigrade. Smart technology

places the unit in cool down mode when the heat gun is placed back in the holder. Product is ESD safe and provides rapid heat-up.

https://www.nteinc.com/ECGsolder_irons/pdf/J-HARW-1.pdf

SPLICING CONNECTOR PERMITS USE OF ADAPTERS

WAGO

221 Inline Splicing Connector comes equipped with WAGO's spring pressure, maintenance-free Cage Clamp connection technology and provides the option of using additional adapters where multiple poles are required. Product line allows universal conductor connection, a visibly secure conductor contact, and comes with intuitive orange levers for a tool-free wiring experience for solid, stranded, and fine-stranded conductors from 12-20 AWG.

https://www.wago.com

RF SIGNAL GENERATOR DELIVERS HIGH PURITY SIGNAL GENERATION

RIGOL TECHNOLOGIES

DSG3000B Series RF Signal Generator provides high purity signal generation and modulation. Unit is available in 6.5 and 13.6GHz models with optional built-in IQ baseband generator and OXO timebase with standard AM/FM/ØM analog modulation up to 3.6GHz, and I/Q modulation and I/Q baseband output up to 6.5GHz. Product delivers high signal purity with phase noise measuring ←116dBc/Hz@20kHz (typical) and a wide output amplitude range of -130dBm to +25dBm with an amplitude accuracy of <0.5dB (typical).

https://www.rigolna.com/products/rf-signal-generators/dsg3000b

PRODUCT SOURCE GUIDE

SUPPLY SIDE

LEADER TECH UPDATES WEBSITE

Leader Tech, manufacturer of EMI shielding products for circuit boards, electronic enclosures, interconnect cables and thermal solutions, unveiled its new 'state-of-the art' website.

Browsers will find an extensive video gallery full of product and technical videos that highlights product features and attributes. Customers are also able to request product samples with the site's KIT02 engineering ideas kit, which allows users to put their products to the test and develop a solution for their specific needs.

The site provides a news blog, along with a large tech document library.

ZESTRON appoints sales manager for Canada - John Neiderman.

ZESTRON ADDS TO SALES

Zestron Americas, provider of high precision cleaning products, services and training solutions, has appointed John Neiderman as sales manager for Canada and the USA. With more than 20-years of sales and technical experience in electronics manufacturing, Neiderman has served the electronics industry, focused on assisting companies with high reliability and mission-critical processes and applications.

BITTELE SUGGESTS AN ALTERNATIVE

Toronto-based pcb maker Bittele Electronics Inc. rolled out an online ordering system that is capable of suggesting alternate part numbers for out-of-stock components. This new capability assists clients in avoiding order completion delays due to the global component shortage.

Utilizing Octopart's new Nexar Legacy API, Bittele's online ordering system suggests alternate part numbers for out-of-stock components.

"This enables clients to quickly resolve stock issues that may otherwise delay orders," says CEO Ben Yang.

MIOVISION EXPANDS ITS HARDWARE PLATFORM

Miovision continues to expand its smart city infrastructure capabilities by launching a powerful new hardware platform to help cities and towns modernize traffic signals – Miovision Core. The recently announced product extension leverages flexibility by adding the firm's SmartView Approach to Miovision Core to provide state-of-the-art advance detection.

Advance detection allows traffic signals to anticipate vehicles approaching the intersection. This is particularly useful at higher speeds, where detecting traffic anywhere from 60-150 metres before the intersection offers meaningful advantages. For example, in light traffic, advance detection can allow traffic lights to provide oncoming drivers with a green signal as they reach the intersection, minimizing unnecessary stops where possible.

Miovision Core is a powerful new hardware platform that supports next gen software solutions.

AD INDEX

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Nothing ear wireless headphones

BY IFIXIT

Fig 1

Fig 2

Fig 3

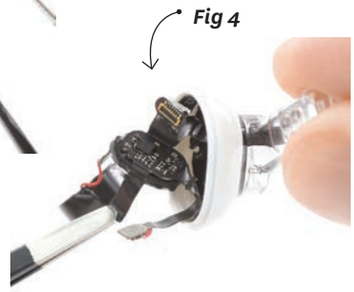


Fig 4

These findings are from iFixit, the open source repair guide. The popular online site teaches people how to fix just about any electronic device, and sells the parts and tools to make it possible. For this teardown, the engineers at iFixit tackle the Nothing ear wireless earbuds. The in-ear headphones use Clear Voice Technology and three high-definition mics to make sure you come through sounding like you. As you speak, advanced algorithms reference a million voice and sound combinations (even winds up to 40 km/h) to isolate and amplify your voice for remarkable accuracy.
Let's open it up and see what it looks and sounds like.

What it delivers

Active noise cancellation (ANC).
5 hours of listening time with the earbuds alone, and 34 total hours (ANC off) if recharged.
Three high-definition mics and Clear Voice Technology.
IPX4 splash and sweat resistance.
Customizable equalizers, gestures, and Find My Earbud function with the app.
Bluetooth 5.2.
A single earbud weighs 4.7g.

Fig 1

Peering through the partly see-through charging case, we see the buds lie flat in their charging case. Now we are wondering if the invisible adhesive in those see-through parts will become a nuisance in this teardown. Before finding a way inside these plugs, we remove the silicone eartips, which then provide a relatively large sound opening. The vise and heating procedure were a good choice to get inside the opaque head.

Fig 2

Inside, the first thing to catch our eye is adhesive – which never very pleasing. In order to continue, we need to disconnect the in-ear portion from the stem. And it looks like we're lucky with adhesive for once … A red glob glues a tiny press-fit connector to its socket and prevents it from accidentally disconnecting during a fall. With delicacy, and without any heating or tearing, we manage to maneuver our tweezers around the adhesive and disconnect the flex cable.

The in-ear portion of the ear houses the driver assembly, while the battery stays in the outer half of the head. Besides the driver, we find a microphone on this flex cable assembly. The driver used in the ear measures 11.6mm and the voice coil has a diameter of 5.7mm.

The last component of the in-ear portion is the tiny driver grille, quickly pushed aside with the help of a halberd spudger tool.

Now we're keen to finally check out the button cell - and we're stopped by two cables clenching the cell tight in their soldered embrace. A soldered battery makes a repair way more complex than we'd like. A battery replacement might be possible, but requires delicate soldering work.

Upon removal of the plastic brace, we find the main magnet embedded within.

With nothing left in the opaque white head portion, we lever open the stem rather quickly Now with some heat and prying, we are granted access to the remaining components.

Fig 3

Inside the stem we find a sandwich build consisting of the flex cable for gesture control, a protective cover for the board, and the board itself. Another glob of glue holds the press-fit connector for the battery cable assembly to the board.

Fig 4

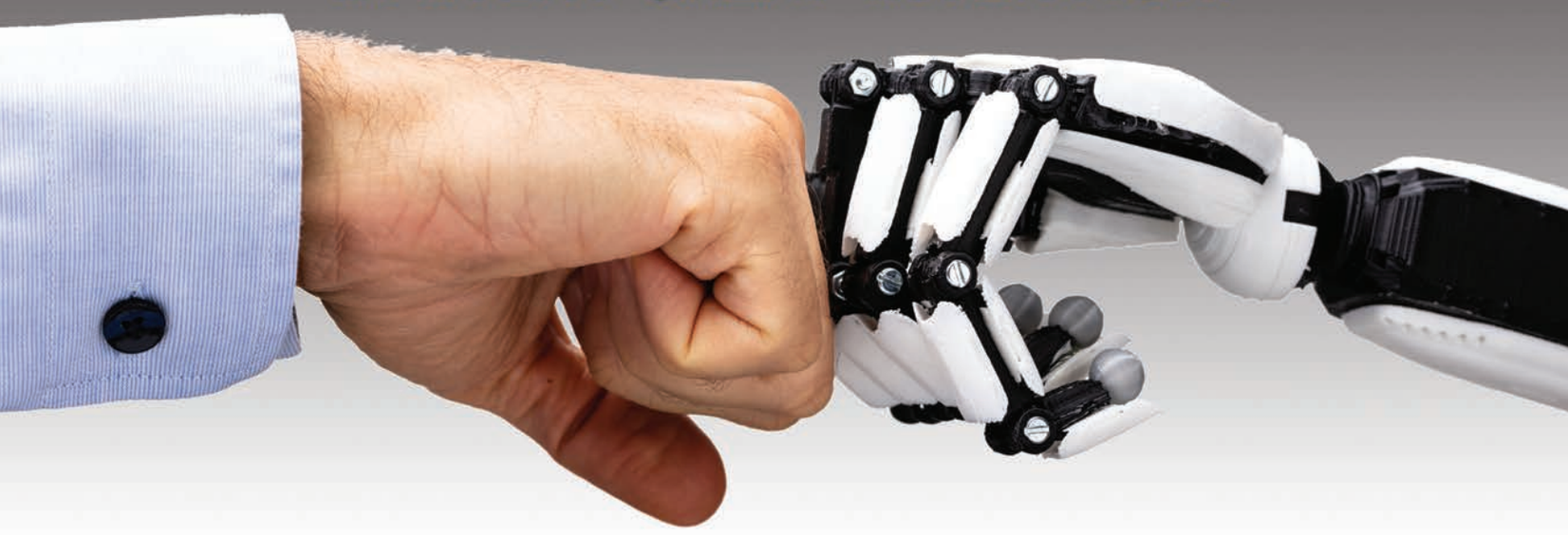
With the board removed, we're able to extract the full battery cable assembly—with plenty of odds and ends attached to it. This includes the gesture control cable; 2 connectors (one for the pcb and one for the driver assembly); An antenna cable; Goodix GH611 in-ear detection chip/touch controller; and the 10mm soldered battery, which runs at 3.7V with 31mAh.

Final analysis

Nothing broke during our disassembly of this unit, and no harsh methods were needed to reach any components. That said, this wasn't exactly a piece of cake compared with some other earbuds we've encountered.

These findings are from iFixit, the open source repair guide. The popular site teaches people how to fix just about any electronic device, and sells the parts and tools to make it possible. Anyone can create a repair manual for a device or edit the existing guides to improve them. iFixit empowers individuals to share their technical knowledge and teach the rest of the world how to fix their stuff. https://canada.ifixit.com

THERE'S A KEYSTONE IN EVERY GREAT INVENTION.



ROBOTS, AUTOMATION & THEIR ELECTRONICS

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Though robots and automation are in use today in a wide variety of industries, robotics is still considered a futuristic idea. Many may be surprised to learn that the first electronic robots were built in 1948. What's even more surprising is evidence of the first automaton taking us back 800 years and writings from Turkey indicating automatic devices used to entertain.

Entertainment was the main drive behind the development of automatons for many centuries. Eventually, the benefits of automating simple, repetitive functions reached the manufacturing sector and grew into the complex, computer-driven automation we know today.

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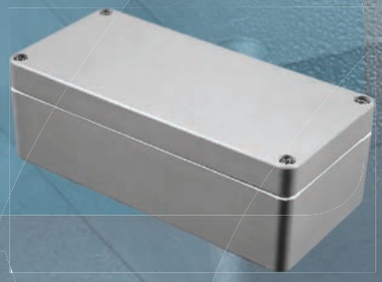

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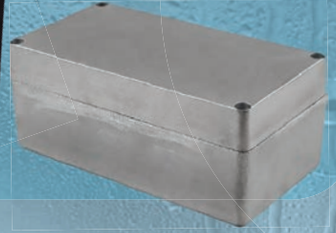

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