Understanding Low Loss Coaxial Cables and Their Applications

Delivering the World's First Digital Radar on Chip (RoC)

Product Highlights

RIP: Industry Pioneer Chuck Swift

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Including These Connector Series

<table>
<thead>
<tr>
<th>Connector Series</th>
<th>Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.85mm DC-65 GHz</td>
<td>2.92mm DC-40 GHz</td>
</tr>
<tr>
<td>2.4mm DC-50 GHz</td>
<td>3.5mm DC-34 GHz</td>
</tr>
<tr>
<td>7mm DC-18 GHz</td>
<td>SSMA DC-40 GHz</td>
</tr>
</tbody>
</table>

ISO 9001:2008

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sgmcmicrowave.com

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LadyBug Technologies’ 20 GHz thermally stable LB680A USB pulse profiling power sensor is in stock for immediate shipment. The sensor is available with various connector options allowing it to be placed directly on the DUT to achieve the best match and accuracy. It will perform CDF, CCDF & PDF functions as well as displaying the power profile of the pulsed signal. ATE users will appreciate the statistical peak and pulse measurements that can be made with the power meter software.

LadyBug power sensors provide high accuracy NIST traceable RF Power measurements from -40dBm to +20dBm. A virtual power meter application is included with each unit. LadyBug’s patented No-Zero No-Cal technology eliminates the need for user zeroing, but does not compromise accuracy, even for very low level measurements. In addition to pulse measurements, the sensor can deliver over 2,000 average power measurements per second with no buffer latency.

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LMR-PVC
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LMR-LLPL
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TFlex 405
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22: Feature Article

Understanding Low Loss Coaxial Cables and Their Applications

By Dan Birch

Coaxial assemblies form the wired backbone necessary to accomplish wireless systems. They are therefore utilized in a broad range of environments and circumstances. The military-style RG coaxial cables have been the go-to standard when first understanding what cables to leverage in a particular installation. However, there are times where these cables will not suffice and a low loss alternative is necessary. This article attempts to cover the general construction of a low loss cable as compared to standard RG assemblies and some application-specific considerations for these coax.

30: Feature Article

Delivering the World’s First Digital Radar on Chip (RoC)

By HFE Staff

Uhnder has developed the world’s first automotive digital radar on chip (RoC). The company has been working to transform the automotive industry by delivering a new generation of radar chips capable of achieving unprecedented levels of performance in the new mmWave automotive radar band of 76 GHz to 81 GHz.

16: Featured Products

Featuring SignalCore, Passive Plus, Response Microwave, OML, Ducommun, Ancortek, Fairview Microwave, and more.

6: Editorial

Tom Perkins reflects on the fact that aperture tuning is not a new concept.

12: RIP Chuck Swift

HFE pays tribute to industry pioneer Chuck Swift.
Our Re-Flex™ Cables Really Have the Competition Bent Out of Shape...

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Impedance: 50 Ω  
Time delay: 1.4 ns/ft  
Cut off frequency: 62 GHz for RF 085  
34 GHz for RF 141  

<table>
<thead>
<tr>
<th>Frequency (GHz)</th>
<th>RF .085</th>
<th>RF .141</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
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<td>660</td>
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<td>100</td>
<td>80</td>
</tr>
<tr>
<td>32</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

RF leakage: Equivalent to semi-rigid cable  
Temp range: -55°C to 165°C  
Bend radius: 1/16 inch for RF 085  
1/8 inch for RF 141

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Aperture Tuning: Not a New Concept

Tom Perkins
Sr. Technical Editor

Over the years many methods have been developed to make antennas operate with reasonable efficiency over multiple bands. At lower frequencies tuned L-C circuits can act as “traps” that appear as antenna end-points at some frequencies, while passing energy on to additional conductor lengths at longer wavelengths. Other schemes use antenna tuners at the transmitter source.

Multi-band operation can take advantage of harmonic relationships such as operating at fundamental resonance and working reasonably well when stimulated at its third harmonic. An amateur radio example is using a 40-meter (7-MHz) dipole on the 15-meter (21-MHz) band, or a 2-meter (144-MHz) antenna on the 70-centimeter (432-MHz) band. Telescoping antennas have been around for years. With the aid of markers, they can be adjusted for various resonant lengths on a handheld transceiver. Also, in ham radio, albeit HF antennas, Yagi antennas and even some verticals incorporate motorized telescoping elements that can be physically adjusted on the fly to change the resonant frequency. Two manufacturers are SteppIR and Ultra Beam. The latter firm refers to their technology as “Dynamic Antenna Systems.”

Many sophisticated schemes have been developed in the military arena to allow limited aperture real estate, such as the leading edge of an aircraft, to be optimized for multiple functionality to support RF technology such as radar, communications, surveillance, mapping, tracking, electronic warfare, and more. These can be reconfigurable programmed electronic windows, dielectrically loaded monopoles, movable ground planes, and use of diverse feed points, to name a few. Log periodic antennas can fulfill some requirements.

Smartphones Require Many Antennas

One of the growing challenges with smartphones, and to a lesser extent tablets and laptops, is the increasing range of microwave frequencies required to achieve 5G performance. More antennas are required involving techniques such as carrier aggregation (CA) and multiple-input and multiple-output (MIMO). As we enter the 3rd decade of the 21st century, smartphones are changing in design with more curved-edge screens or even folding displays, resulting in less frame periphery for antennas. At the same time the antenna count is increasing typically by 60% to as many as 10. The challenge is less available space for more antennas.

As in most over-the-air systems, antennas are a key element for successful operation. Shrinking antenna size only reduces efficiency which lowers data rates, shortens battery cycles, pushes data rates in the wrong
direction, and affects BER and connectivity. 5G generally requires support for four independent downlink channels requiring four antennas just for this functionality. Additionally, there is Wi-Fi, GPS and Bluetooth connectivity required. Although there are many clever antenna designs, the added and smaller antennas are more likely to be affected by external factors such as hands-on the phone. If antennas remain the same in size, efficiency can be traded for bandwidth, but as antennas are reduced in size, they must be tunable.

Aperture Tuning

Total Radiated Power (TRP) and Total Isotropic Sensitivity (TIS) can be improved by at least 3 dB. With Aperture Tuning a solid-state PIN diode or transistor switch is connected between the antenna element and ground. This is used to adjust the resonant frequency of the antenna to match the operating frequency of the phone at any instant. A time-proven technique, using an inductor or capacitor between the switch and antenna can provide additional tuning range. Of course, more complex switched circuitry can further increase antenna tuning diversity. Applying these techniques and leveraging multiple resonances mentioned earlier can produce an aperture with considerable agility to accommodate and indeed help define 5G.

Aperture tuning switches exhibit “on” resistance and “off” capacitance. These parameters can impact antenna efficiency and need to be held to a minimum. Where one antenna is used in two bands simultaneously, generally known as carrier aggregation (CA), the placement of aperture tuning switches requires careful simulation and design so that what affects, as an example, peak voltage at one frequency might be in a null at a second frequency. Thus, exclu-
Meetings and Events

WAMICON 2019
April 8 - 9, 2019
Cocoa Beach, FL
http://www.wamicon.org/

ICMIM
April 15 – 16, 2019
Detroit, MI
https://www.icmim-ieee.org/index.html

IWS
May 19 – 22, 2019
Guangzhou, China

IMS 2019
June 3 - 7, 2019
Boston
https://ims-ieee.org/

IEEE Wireless Power Transfer Conference
June 18 - 21, 2019
London
https://www.mtt.org/conference-calendar

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LabVIEW Core 2
Online
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Object-Oriented Design and Programming in LabVIEW Online
http://sine.ni.com/tacs/app/fp/p/ap/ov/pg/1/
Free, online LabVIEW training for students and teachers.
http://sine.ni.com/nievents/app/results/p/country/us/type/webcasts/

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https://wie.ieee.org/leadership-summits2019/

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“Look to the leader in YIG-Technology”
Wi-Fi Still Dominates but G.hn and MoCA Trying to Carve Out a Place in the Home Network

As the device count per household grows and use of multimedia and smart home applications increases, so does the demand for reliable high-capacity home networks. While Wi-Fi dominates the home network market, demand for wired home networking devices supporting high throughput is on the rise. ABI Research expects that Multimedia over Coax Alliance (MoCA) 2.5 or G.hn specification network node shipments will reach 8 million units in 2019.

“Wi-Fi networks are highly penetrated in today’s broadband homes due to the convenience of wireless connectivity. Newer Wi-Fi standards and devices such as Wi-Fi mesh systems do improve the coverage and throughput of home networks, however, wired connectivity can improve the stability and throughput, especially while using bandwidth-intensive applications,” noted Khin Sandi Lynn, an industry analyst at ABI Research. G.hn standard can support home networking data rates up to 2 Gbps over coaxial, power lines, optical fiber or telephone wiring while the MoCA 2.5 standard can support up to 2.5 Gbps speed over coaxial cables.

There is growing interest from service providers in both technologies to deploy as an efficient backbone for residential Wi-Fi networks. Taiwanese service provider, Chunghwa Telecom recently announced the launch Gh.n adapters to its FTTH subscribers. Operators including China Telecom, China Unicom, and UK Liberty Global have also joined HomeGrid Forum in support of G.hn technology.

MoCA home networking adoption is mainly concentrated in North America, however, the Multimedia over Coax Alliance continues to eye growth in Europe and the Asia Pacific, particularly since 2017 with the introduction of MoCA Access 2.5 which added broadband access specifications based on MoCA 2.5. Companies including InCoax from Sweden, Teamly Digital from France, and ZTE have announced MoCa Access 2.5 solutions.

Wi-Fi is certainly the preferred home network connectivity, however, there is significant market potential for wired networking devices supporting high capacity or to complement Wi-Fi installations. The increasing use of live video streaming, gaming, and VR applications is likely to boost demand for 100% reliable coverage of home networks. Service providers can take advantage of advanced home networking devices and integrate with Wi-Fi offerings to optimize customer experience. ABI Research forecasts that advanced home networking node shipments will reach 39 million units in 2023.

5G: The De Facto Connectivity Choice for Outdoor Robots of the Future

Low latency and cloud intelligence are the two main features of 5G that will significantly change the deployment of mission critical and business critical robots, particularly those deployed outdoors. According to ABI Research, the commercialization of a 5G network is expected to usher in the significant growth of commercial robotics. Shipments of 5G robots are expected to reach 570,000 by 2027, largely deployed in mission critical and business critical settings. Outdoor applications that will be enabled by 5G connectivity include public safety and first responders, critical asset inspection, last mile delivery and transportation, precision agriculture, field extraction, and haulage.

Traditionally, high-speed broadband connectivity is only available to robotics systems in indoor environments via Wi-Fi and broadband fiber. Therefore, existing outdoor commercial and industrial robots are often fully autonomous devices with onboard intelligence. With 5G, robots’ capabilities will be upgraded.

“Existing onboard capabilities, such as object and people detection, path planning, and optimization can be shifted to the cloud to benefit from a larger set of data lake,” said Lian Jye Su, Principal Analyst at ABI Research. “At the same time, robotics systems will have access to capabilities that could not be previously hosted on existing systems. At present, remote control appears to be the focus, with Toyota's T-HR3 and Naver’s AMBITEX, but the real game-changers will be conversational Artificial Intelligence (AI) and swarm intelligence. 5G's low latency will enable robotics vendors to augment the onboard intelligence or even move parts of it to the cloud to introduce new capabilities to existing robotics hardware. Enterprise users will be able to connect their fleet of outdoor robots to the cloud and enjoy the performance, scalability, and flexibility of the cloud-based intelligence.”

In order to enable 5G capabilities, robotics vendors must work closely with connectivity and chipset vendors in their design and prototyping phase to maximize the benefits of ubiquitous connectivity. Qualcomm has recently launched the Robotics RB3 Platform, powered by its Snapdragon 845 SoC with future 5G upgradability and Inseego has partnered with CloudMinds to provide 5G connectivity to the XR-1 Cloud Robot.

—ABI Research
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Find out why our customers are so bullish on our wirewound ceramic chip inductors. Order your free samples today at www.coilcraft.com.
RIP: Industry Pioneer Chuck Swift

Longtime, beloved C. W. Swift & Associates founder and industry pioneer Chuck Swift passed away at 92 last month after a brief illness. In 1958 Mr. Swift founded the industry’s original stocking microwave distributor, and the business endures to this day.

Mr. Swift was widely known throughout the RF and microwave industry for both his business acumen and his love of jokes, pranks, and good humor of all types. He was fond of passing out colorful trinkets, bags of pistachio nuts, and all manner of feel-good items on sales calls, at trade shows, and during other industry events. Chuck knew everyone, and in turn everyone knew Chuck, and the tales recounting his adventures and practical jokes are legion.

Born in Iowa in 1927, Mr. Swift arrived in Los Angeles in 1939. He attended UCLA after returning from serving in the U.S. Army in Japan at the end of WWII. He worked at Hughes Aircraft before teaming with wife Dolly to found C. W. Swift & Associates in 1958.

Chuck and Dolly had three children: sons Steve and Andy, who took over and today run the business their parents founded; and daughter Amy, who lives in Canada. They are also survived by several grandchildren and great-grandchildren.

A celebration of Chuck’s life will be held in June. Chuck frequently remarked that he was forever grateful to have been a part of the microwave industry.

—Tim Burkhard

Progress on Lifelong Learning Machines Shows Potential for Bio-Inspired Algorithms

Today’s machine learning systems are restricted by their inability to continuously learn or adapt as they encounter new situations; their programs are fixed after training, leaving them unable to react to new, unforeseen circumstances once they are fielded. Adding new information to cover programming deficits overwrites the existing training set. With current technology, this requires taking the system offline and retraining it on a dataset that incorporates the new information. It is a long and arduous process that DARPA’s Lifelong Learning Machines (L2M) program is working to overcome.

“The L2M program’s prime objective is to develop systems that can learn continuously during execution and become increasingly expert while performing tasks, are subject to safety limits, and capable of applying previous skills and knowledge to new situations, without forgetting previous learning,” said Dr. Hava Siegelmann, program manager in DARPA’s Information Innovation Office (I2O). “Though complex, it is an area where we are making significant progress.”

First announced in 2017, L2M is over a year into research and development of next generation AI systems and their components, as well as learning mechanisms in biological organisms capable of translation into computational processes. L2M supports a large base of 30 performer groups via grants.
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In the News

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Today, L2M researcher Francisco J. Valero-Cuevas, professor of biomedical engineering and biokinesiology at USC Viterbi School of Engineering, along with USC Viterbi School of Engineering doctoral students Ali Marjaniejad, Dario Urbina-Melendez and Brian Cohn published results regarding exploration into bio-inspired AI algorithms. In an article outlined in the March cover of Nature Machine Intelligence, Valero-Cuevas’ team details their successful creation of an AI-controlled robotic limb driven by animal-like tendons capable of teaching itself a walking task, even automatically recovering from a disruption to its balance.

Behind the USC researchers’ robotic limb is a bio-inspired algorithm that can learn a walking task on its own after only five minutes of “unstructured play” – or conducting random movements that enable the robot to learn its own structure as well as its surrounding environment. The robot’s ability to learn-by-doing is a significant advancement towards lifelong learning in machines. The current machine learning approaches rely on pre-programming a system for all potential scenarios, which is complex, labor intensive, and inefficient. What the USC researchers have accomplished shows that it is possible for AI systems to learn from relevant experience, finding and adapting solutions to challenges overtime.

Siegelmann noted, “We’re at a major moment of transition in the field of AI. Current fixed methods underlying today’s smart systems will quickly give way to systems capable of learning in the field. The missing ingredients to safer, more flexible, and more useful AI are the abilities to both learn while in operation and to apply learning to new circumstances for which the system was not previously trained. These abilities are necessary, for instance, for complex systems like self-driving cars to become truly functional. Incorporating L2M technologies will allow them to become increasingly expert as they drive in different conditions and will make them safer than human-driven cars. Professor Valero-Curevas and his team have successfully taken us closer to that goal; that’s what the L2M project is about.”

—DARPA

Designing Chips for Real Time Machine Learning

“A critical challenge in computing is the creation of processors that can proactively interpret and learn from data in real-time, apply previous knowledge to solve unfamiliar problems, and operate with the energy efficiency of the human brain,” said Andreas Olofsson, a program manager in DARPA’s Microsystems Technology Office (MTO). “Competing challenges of low-SWaP, low-latency, and adaptability require the development of novel algorithms and circuits specifically for real-time machine learning. What’s needed is the rapid development of energy efficient hardware and ML architectures that can learn from a continuous stream of new data in real time.”

DARPA’s Real Time Machine Learning (RTML) program seeks to reduce the design costs associated with developing ASICs tailored for emerging ML applications by developing a means of automatically generating novel chip designs based on ML frameworks.

—DARPA
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- Insertion Loss: < 1 dB  
- Termination: Tin Plated over Nickel Barrier (RoHS) Compliant

**Passive Plus**  
passiveplus.com

**Waveguide to Coax Adaptor**

The new model RMAD.BS. W137Nf operates over the 5.85-8.2GHz band with typical electrical performance of 0.25dB max insertion loss, and 1.10:1 max VSWR. Power handling is 50W CW. The unit is operational over the -10° to +85° C range and mechanical package is 2.7 x 1.75 x 0.94inches with precision SS/P type N female connector and WR137 flange. Alternate bands and connectors are available on request.

**Response Microwave**  
responsemicrowave.com

**Economical 5G Sub-harmonic Pumped Mixer Module**

OML has developed an economical sub-harmonic pumped mixer down-converter module for the 5G market. M28H2ADC operates from 24 to 40 GHz with an IF bandwidth >5 GHz. Its compact size is well suited for both field and lab uses. The M28H2ADC can be connected directly to portable handheld instruments such as Keysight FieldFox and Anritsu Spectrum Master or it can be configured to use with bench-top instruments. It is powered via USB port.

**OML**  
omlinc.com

**Two-Channel Transmitter**

Ancortek launched a new advanced software-defined two-channel transmitter and four-channel receiver radar kit SDR-KIT 2400T2R4 (see Figure 1) to support digital phased-array beamforming and MIMO capabilities. The new SDR-KIT 2400T2R4 is designed for applications in direction of arrival (DOA) measurement, radar interferometry, digital beamforming, and MIMO radar. It is especially suitable for monitoring human activities, occupancy sensing, gesture sensing, and 3-D imaging among other uses.

**Ancortek**  
ancortek.com

**Relay Switches**

Fairview’s new line of electromechanical relay switches consists of 44 different +12V and +28V designs offered in SPDT, SP3T, SP4T and SP6T configurations that support either latching, failsafe or normally open actuators with usable features such as indicators, terminations or TTL logic. They operate in frequency ranges from DC to 26.5 GHz and fea-
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ture a D-SUB multi-pin connector interface for secure and reliable DC voltage and command control functions. These switches are designed to be compact and rugged, supporting N-type or SMA connectors. Typical performance includes 90 dB isolation levels and 0.15 dB insertion loss. Power handling capability is rated up to 600 watts. They are highly reliable with an operational temperature of -20°C to +70°C and a rating of up to 5M lifecycles when used in a make before break (cold switching) condition. All models in this line are RoHS and REACH compliant and guaranteed to meet MIL-STD-202 test conditions for vibration and shock.

Fairview Microwave
fairviewmicrowave.com

Tech Hub
Richardson RFPD announced the launch of the GaN & SiC for Power Electronics Tech Hub, a microsite featuring the latest news on gallium nitride (GaN) and silicon carbide (SiC) innovations, news and product releases. The new GaN & SiC for Power Electronics Tech Hub offers a robust library of GaN and SiC new product features and technical resources, including white papers and videos, as well as links to online purchasing and the option to sign-up for product updates via email.

Richardson RFPD
richardsonrfpd.com

LNAs
Pasternack’s new line of input-protected low-noise amplifiers consists of 12 different models that cover a broad range of frequency bands from 10 MHz to 3.5 GHz. These designs exhibit typical performance that includes low noise figure levels from 0.8 to 1.6 dB, high-small signal gain ranging from 25 to 40 dB, and low VSWR levels from 1.3:1 to 1.5:1. This performance is achieved.
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PMI offers a variety of High Power RF / Microwave Limiters with power handling up to 100 W CW & 1 kW Peak for military and industrial applications. PMI’s limiters offer low loss, fast recovery along with low RF leakage levels and broadband coverage to 18 GHz. More available at: https://www.pmi-rf.com/categories/limiters

**PMI Model No.**

<table>
<thead>
<tr>
<th>FREQ Range (GHz)</th>
<th>Insertion Loss (dB)</th>
<th>VSWR</th>
<th>Maximum Input Power</th>
<th>Leakage Power (dBm)</th>
<th>Recovery Time</th>
<th>Size (Inches) / Connectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM-30M2G-5CW-1KWP-SFF</td>
<td>0.03 - 2</td>
<td>1</td>
<td>2.0:1</td>
<td>5 W CW Min, 1 kW Peak (0.1% Duty Cycle, 1 µs Max Pulse Width)</td>
<td>17</td>
<td>22 ns</td>
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<td>0.7</td>
<td>2.0:1</td>
<td>4 W CW Max, 1 kW Peak (1% Duty Cycle, 1 µs Max Pulse Width)</td>
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<td>1.6</td>
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<td>17</td>
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<td>LM-1G18G-16-4W-SMF</td>
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<td>2.3</td>
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<td>4 W CW</td>
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<td>24 ns</td>
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<td>LM-1G18G-15-3W-500WP-SFF</td>
<td>1 - 18</td>
<td>2.5</td>
<td>2.0:1</td>
<td>3 W CW 500 W Peak</td>
<td>17</td>
<td>33 ns</td>
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Understanding Low Loss Coaxial Cables and Their Applications

By Dan Birch

Abstract
Coaxial assemblies form the wired backbone necessary to accomplish wireless systems. They are therefore utilized in a broad range of environments and circumstances. The military-style RG coaxial cables have been the go-to standard when first understanding what cables to leverage in a particular installation. However, there are times where these cables will not suffice and a low loss alternative is necessary. This article attempts to cover the general construction of a low loss cable as compared to standard RG assemblies and some application-specific considerations for these coax.

RG and Low Loss Coaxial Cables
The RG coaxial cable has been around for decades and was originally coined by the military as “Radio Guide” or “RF Government”. Similar to the MIL-STD-348 for connectors interfaces, the military had pre-specified dimensions for different coaxial transmission lines to generate a predictable system of interconnects to utilize in various military applications. As time passed, commercial variants of these military-born cables were introduced with similar construction and performance. Figure 1 shows some RG cables dimensions and their respective attenuations.

The range of impedances for RG cables can vary between 50 ohms, 75 ohms, and even 92 ohms. More often than not, the 50 ohm impedance coax are utilized for data applications (e.g.: WLAN, GPS, cellular, etc.) while the 75 ohm cables can be used for audio/video applications (e.g.: security system, CATV). Traditional RG cables, are quite lossy and this is especially...
apparent at long distances for wireless applications. For this reason, datasheets for cables used in wireless applications do not specify average insertion loss, or attenuation, in its decibel (dB) value, but attenuation over a specified distance such as: dB/100ft, dB/100m. Furthermore, the nominal attenuation value is listed at a number of frequency points within the cable’s operational bandwidth.

There is a significant need for various wireless applications (e.g.: WLAN, SCADA, PCS, ISM, etc.) to have an alternative to typical RG cable constructions—particularly for medium to long distance runs. Low loss cables offer an alternative to this type of cabling while vaguely holding up to the dimensions of the RG cables.

What is a “Low Loss” Coaxial Cable?

As the name implies, Low loss coax will deliver a lower attenuation when applied as a replacement for similar diameter RG cables used in very same wireless applications. They offer a lower overall attenuation due to several key factors:

- Solid inner conductor
- Superior dielectric material
- Superior shielding and more shielding
- Application-specific jacketing materials

Inner Conductor

There are several factors that make a solid inner conductor less lossy than the stranded conductors that are often used in RG cables. The main contributor is the losses due to the proximity effect—the tendency for EM energy in a con-
Cables

Figure 3 • The proximity effect plays an important role in the degradation of signal performance at high frequencies. [1]

ductor to gather farthest away from nearby conductors carrying current in the same direction (Figure 3). This multi-conductor version of the skin effect, or the tendency for current to concentrate at the periphery of a conductor at high frequencies. And, while carefully stranded cables have been shown to reduce the losses due to skin effect [2], it does not offset the effects of proximity. This lack of uniform current distribution causes the AC resistance of a conductor to increase rapidly thereby increasing transmission loss with frequency.

Another factor to consider is the conformity in the cross-sectional area of the coax. The characteristic impedance of a coaxial cable is directly correlated to the uniformity of its inner dimensions. Stranded center conductors are inherently less uniform than a solid inner conductor and can therefore cause more reflections and ultimately loss of signal. Stranded cables, however, are known to be much more flexible than solid inner conductors. Depending upon the application, this may or may not be pertinent as there are many variations of coax with solid inner conductors that offer higher flexibility. Furthermore, the center conductor is not the only variable that limit the flexibility of a coax; the dielectric and shielding are also considerations for high flex cabling.

Dielectric

The main purpose of the dielectric material in a coaxial cable is to separate the inner conductor from the outer conductor while holding uniform cross-sectional dimensions across the transmission medium. One major consideration is the fact that a signal traveling in a dielectric is significantly slower than one traveling in free-space. This is the reason why a lower dielectric constant is preferred to minimize the delay in the line. Introducing air into the dielectric lowers the dielectric constant and can be done a number of ways including helically wrapping dielectric around the inner conductor, using dielectric spacers, or by foaming the dielectric material. The foaming is accomplished during the extrusion process by introducing bubbles to the perfluoropolymers such as Polyethylene (PE), Fluorinated ethylene propylene (FEP), and PTFE. For instance, the dielectric constant of solid Polytetrafluoroethylene (PTFE) is 2, while the dielectric constant of foamed PTFE is 1.6 (free-space is 1). The foaming minimizes attenuation in the coaxial assembly for two main reasons:

- Small loss tangent
- Larger center conductor

The introduction of air reduces the loss tangent, or the dielectrics inherent dissipation of electromagnetic energy. The lower dielectric constant allows for the dimensions of the foaming material to be smaller, this in turn, allows for a larger center conductor for a given diameter cable. Much
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of the resistive loss in a coax is due to the surface area of the inner conductor which is much smaller than that of the outer conductor. The larger surface area mitigates the losses due to the skin-effect and therefore minimizes resistive losses. As an additional note, foamed dielectrics also exhibit higher temperature stability, where less changes in electrical length occur due to temperature variations. This allows for a higher phase stability which is relevant for phase stable applications such as vertical risers in building installations flame resistance dielectric materials are very important to minimize the spread of flames. In these cases the foamed FEP (FFEP) material allows for optimized electrical and environmental performance while maintaining cost-effectiveness due to the manufacturability of FFEP dielectric with the extrusion process.

**Shielding**

The shielding also plays a role in the attenuation, especially for high frequency signals if there is a lack of coverage, signal degradation will occur. The outer conductor acts as the return path for the inner conductor.
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and carries current in the opposite direction. This, in turn, functions as a shield because it carries equal and opposite signals to those in the center conductor. The skin effect plays an important role in the shielding as well where the braided shields perform well at low frequencies (hundreds of kHz) but as the frequency increases and the signal is pushed towards the surface of the shielding, fields can emerge through the holes in coverage that can cause EMI. Much of this is mitigated through the addition of a bonded or non-bonded aluminum foil shielding preventing losses in the transmission line. The tradeoff for the addition of aluminum foil is less flexibility, this is mitigated through bonding the aluminum foil to the dielectric. Shorter connections make require a higher flexibility or tighter bend radius while long cable runs would likely require far less attenuation without the need for flexibility.

**Jacketing**

Jacketing materials can make or break a coaxial cable based upon its environmental conditions. Outdoor applications will require resistance to moisture from rain and humidity, resistance to vibrational strain from wind, resistance to UV and, in some cases, resistance to chemicals/oils. Typical PE or PVC cable jackets may not be able to hold up these conditions causing the jacketing crack, swell, melt or otherwise degrade. Plasticizers can be inserted into the jacketing material that generate UV resistant properties. For underground burial applications, a flooded cable, or a cable covered in a water resistant gel, may be necessary to prevent moisture ingress through minor flaws in the cable jacket. Plenum applications can use FEP, FR-PVC, or kynar to meet the UL-1581 standard that includes tests for flammability and suitability for plenum applications. Aside from the use of typical thermoplastics such as PE, PTFE, PVC, and FEP, Thermoplastic Elastomers (TPE) can be used. These materials benefit from both the manufacturability and flexibility of a thermoplastic and the inherent mechanical strength (e.g.: elongation, tensile strength, resistance to abrasions, etc.) of thermosets such as neoprene, epoxy resin, and polyurethane.

**Practical Considerations in Wireless Network Installation**

Indoor and outdoor wireless installations will invariably...
require coaxial cables of varying dimensions and operational frequencies to route to amplifiers, antenna feeds, or access points. Generally speaking, the thinner cables are highly flexible and can therefore be used for short pigtail connections to access points, surge protectors, and amplifiers. The thicker cables can be used for medium/long antenna runs such as base station tower installations that can be over 100 feet off the ground. Thicker cables will have a larger inner conductor surface area and therefore less overall resistive losses and lower attenuation. This is necessary for long cable runs where attenuations can become unmanageable beyond 100 feet. Smaller cables are not subject to this and can therefore afford smaller dimensions with a higher level of flexibility.

Application-Specific Considerations
Direct burial cables are relevant in a number of applications including WLL, GPS, WLAN, WISP, WiMax, and SCADA. These are often governed by long cable runs that must be moisture resistant. As stated earlier, thicker cables that with flooded cable jackets offer the benefits of a reduced attenuation as well as resistance to moisture infiltration. Indoor building installations must meet National Electrical Code (NEC) and have cables tested against standards such as UL-1581 to be viable. As shown in Figure 4, Cables routed in risers and plenum spaces such as in HVAC vents are necessary flame resistant as these cables can rapidly spread flames. This is especially true for ventilation systems that push air through an entire building. For this reason CMP-rated or plenum-rated cabling go through more stringent testing than CMR, or riser-rated cabling. The jacketing material in these cables must be flame resistance and also mitigate flame propagation. Dielectric materials such as FEP can be used as well to minimize flammability.

Base stations can have long feeder cables that extend beyond 150 feet. These coaxes will be exposed to UV, vibrations, moisture in the atmosphere, and in some cases, Passive Intermodulation Distortion (PIM). Both connector heads and cable are serious considerations in these environments so that vibrational strain does not cause the connectors to cause temporary lapses in signal transmission. Moreover, low PIM connector heads can be employed as they are specifically built to eliminate common sources of PIM such as contact between dissimilar metals and ferromagnetic materials. Industrial Supervisory control and data acquisition (SCADA) applications can be exposed to a fairly broad range of environmental stressors depending upon the industrial application. If the cable jacketing material may be exposed to chemicals such as oil, it is important that it does not degrade.

Conclusion
Wireless applications cover a very large swath of applications across many industry verticals from commercial to industrial. These cable installations can be small jumper cables for routing to radio equipment to very long runs in base stations and vertical risers in tall buildings. Each of these applications come with material, construction, and installation considerations that ensure signal integrity through its operational lifetime. While there are RG variations of cable that are considered sufficient for all of these applications, employing low loss cable assemblies can allow for much more design flexibility and improved overall system performance.


About the Author
Dan Birch serves as a product manager at L-com.
Delivering the World’s First Digital Radar on Chip (RoC)

By HFE Staff

Uhnder, a stealth startup company based in Austin, Texas, has developed the world’s first automotive digital radar on chip (RoC). The company, co-founded by Manju Hegde and Curtis Davis in 2015, has been working furiously to transform the automotive industry by delivering a new generation of radar chips capable of achieving unprecedented levels of performance in the new mmWave automotive radar band of 76 GHz to 81 GHz. Sensors based on Uhnder’s digitally coded modulation (DCM) technology easily exceed current requirements for Advanced Driver Assistance Systems (ADAS) for the first three levels of autonomy, which are being planned for production automobiles today, and will scale to the much more stringent requirements as the industry transitions to full autonomy.

Traffic Safety

With traffic accidents causing 1.2 million deaths and 12 million serious injuries each year, not to mention the huge financial toll (car accidents cost the US $230 billion/year), industry and government have taken note and are mandating changes to improve safety. In February 2019, forty countries led by Japan and the European Union - but excluding the US and China - agreed to require new cars and light commercial vehicles to be equipped with Automatic Emergency Braking (AEB) systems starting as soon as 2020. The regulation will require all vehicles sold to come equipped with the technology by which sensors monitor how close a pedestrian or object might be. The system can trigger the brakes automatically if a collision is deemed imminent and if the driver doesn’t appear able to respond in time.

The US has been even more proactive about traffic safety. In 2016, 20 US automakers announced with the DoT that they’d voluntarily make AEB standard across their ranges by September 1, 2022. According to the Insurance Institute for Highway Safety (IIHS), those automakers’ cars represent 99 percent of the US market. And China is requiring commercial vehicles to have AEB beginning this year.

To address this mandate, the automotive industry is incorporating more technology into vehicles. The Society of Automotive Engineers (SAE) has outlined a progression of levels to facilitate the development of advanced driver assistance systems or ADAS to make vehicles safer.

- **L0** no autonomy
- **L1** driver assistance (foot off)
- **L2** partial automation (hand off)
- **L3** conditional automation (eyes off)
- **L4** high automation (mind off)
- **L5** full automation (no driver)

Levels 1 and 2 include Adaptive Cruise Control, Emergency Braking, and Collision Avoidance (not just collision warning). In order to achieve higher levels of autonomy, automobiles need more accurate and more precise sensors. Most vehicles today use cameras and radar. Cameras provide visual imagery of the surrounding environment but become less effective in bad weather and/or limited light conditions or when encountering distant objects. Radar is impervious to weather and light, but today’s state-of-the-art technology only provides coarse information in terms of an object’s distance and velocity and does not fulfill the promise of range. Moreover, today’s radars...
also have challenges with discerning objects close together because of the lack of precision.

Uhnder’s digitally coded modulation (DCM) technology is a leap above currently deployed technology and vastly improves corresponding safety features such as AEB and Collision Avoidance. Uhnder achieves this by implementing DCM on complementary metal–oxide–semiconductor (CMOS) technology, combined with advanced digital processing techniques borrowed from cellular communications. Sensors using DCM can effectively see and detect objects and potential threats sooner and with more precision – fundamental to improving vehicle safety, saving lives, and reducing costs by billions of dollars.

There are three main differences between the current automotive radars and Uhnder’s DCM solution. Conventional automotive radars use Frequency Modulated Continuous Wave (FMCW), a technique that modulates a sinusoid waveform in frequency to transmit and then capture the “echo” on the receive side. By measuring the frequency difference between the transmitted and the
received waveform, typical radar outputs such as range, velocity, and angle of arrival can be inferred.

DCM

Uhnder’s pioneering DCM technology, on the other hand, employs phase to modulate the transmit signal rather than frequency. It digitally codes the phase, essentially spreading the waveform in frequency to improve resolution. As a result, very precise direct measurements can be achieved with an order of magnitude better resolution on all critical parameters. Uhnder combines their DCM technology with advanced MIMO (Multiple-Input-Multiple-Output), a critical 5G communications technology, to enhance the field of view encompassing azimuth and elevation along with range and velocity to achieve a 4D visualization.

Secondly, Uhnder’s choice to use only CMOS, the underpinning technology of the world’s mass market devices, was deliberate and strategic. By using a natively digital architecture, Uhnder can continue to innovate as CMOS process nodes evolve along with Moore’s law, enabling denser, faster, smaller, and lower cost solutions as the transistor elements scale down. Uhnder’s solutions will benefit with each new process geometry introduced by the semiconductor industry, naturally becoming smaller and more powerful as the semiconductor industry evolves.

Finally, Uhnder integrates the entire radar on a single chip (hence RoC): all the RF, the analog front end, the baseband, the digital front end, the digital back end, and the post radar detections signal processing. This enables the best use of CMOS silicon area for performance per watt, allows for optimal division between analog and digital functions, and allows for high bandwidth interfaces between the various segments of the pipeline, whether it is the analog, the digital, or the programmable parts of the chip.

A prototype of Uhnder’s digital RoC is currently being evaluated by global automotive OEMs and the company expects the technology to be available later this year/early 2020.
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www.amcomusa.com

SDLVA

PMI model SDLVA-0120-70-100M2G-10DBM is a successive detection log video amplifier (SDLVA) that operates between the 0.1 to 2.0 GHz frequency range. It has a dynamic range of 70 dB minimum and a TSS of -65 dBm. This unit offers a maximum rise time of 25 ns and a fall time of 30 ns. This model provides a limited IF output of +10 dBm typically. Other specifications include VSWR 2.0:1 Max (1.8:1 Typ); Limited IF Output of +10 dBm - Measured 8.31 dBm Min. 11.84 dBm Max; Input Power +10 dBm and power requirements +7 to +18 V @ 300 mA - Measured 117 mA, -7 to -18 V @ 150 mA - Measured 138 mA. Unit size: 3.75 " x 1.50 " x 0.40".

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End Launch PCB Connectors

Fairview’s new line of high-speed, end launch, PCB connectors consists of 16 models operating in a wide bandwidth that supports high data rates and VSWR as low as 1.10:1. They are offered with four end launch connector interface options: 1.0mm (110 GHz), 1.85mm (67 GHz), 2.92mm (40 GHz) and 2.4mm (50 GHz). These high-performance, end launch connectors are reusable and don’t require any soldering. Some of the models in this line feature reduced profiles with a 0.350-inch mounting width, allowing for more launches to fit into the same PCB area. These connectors are offered in male and female genders and are constructed with an outer conductor made of stainless steel and a gold-plated beryllium copper center contact.

Fairview Microwave
fairviewmicrowave.com

Sector Antennas

KP’s new small-angle ProLine series of sector antennas consists of three models that deliver interference mitigation with azimuth and elevation side-lobe suppression. These small-angle sectors offer ease and customization of installation with included brackets and hoisting hook. They are ideal for frequency-reuse and LTE deployments in the 2GHz band. These sector antennas feature extremely high front-to-back ratios and small side-lobes, helping to reduce noise in the link. This line is offered with 2 or 4 ports and a frequency range of 2300-2700 MHz or 4900-5900 MHz, depending on the model. They also boast 33° or 45° azimuth beamwidth and 19-20 dBi of gain.

KP Performance Antennas
kpperformance.com
RF Limiter

PMI Model No. LM-10M2D5G-100CW-1KWP-SFF is a RF limiter that operates in the 10 MHz to 2.5 GHz frequency range. This limiter can handle 100 W CW and 1 KW peak (1% duty cycle, 1 µs maximum pulse width) input power and provides a maximum leakage of +13 dBm CW input. This module has a low insertion loss of 0.5 dB and a recovery time of 2 µs typical.

Planar Monolithics Industries
pmi-rf.com

High-Speed End Launch Connectors

Pasternack launched a new extended series of mmWave, removable, edge launch, PCB connectors that are ideal for SERDES applications like high-speed networking, cloud servers and supercomputing. The new line comprises 16 models in four end launch connector interfaces: 1.0mm (110 GHz), 1.85mm (67 GHz), 2.92mm (40 GHz) and 2.4mm (50 GHz). They provide VSWR as low as 1.10:1 and a wide bandwidth that supports high data rates. These connectors don’t require soldering and are reusable. Some models offer reduced profiles with a 0.350-inch mounting width, this reduced mounting profile allows engineers and technicians to fit even more launches in the same PCB area.

Pasternack
pasternack.com

Product Highlights

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**Product Highlights**

**MM-Wave Amp**

The AMM-6702UC is a connectorized millimeter wave amplifier with an ultrawide 20 to 55 GHz bandwidth, over 25 dB gain, and up to +23 dBm saturated output power with only a 0dBm input. This GaAs MMIC amp features a power-efficient design, consuming a mere 570mW. High linearity broadband mmwave mixers such as our MM1-1850S require high power broadband LO driver amplifiers, but these amps were largely absent from the market at frequencies above 40 GHz - until now. The AMM-6702UC’s unmatched combination of bandwidth, power and efficiency make this an ideal LO driver amps for SATCOM, radar, 5G, and point-to-point applications.

Marki Microwave
markimicrowave.com

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**VNA: 100 kHz to 40 GHz**

The new R&S ZNBT40 from Rohde & Schwarz is the first vector network analyzer (VNA) with a broad frequency range from 100 kHz to 40 GHz and up to 24 integrated test ports. Developers can use it for applications such as measurements on 5G antenna arrays. The multiport architecture is not only advantageous for tests on multiport components, but also for simultaneous testing of multiple DUTs in production to boost throughput. Rohde & Schwarz ensures specified performance on up to 24 test ports with the R&S ZNBT40. Also new is the R&S ZNBT26 for measurements up to 26.5 GHz.

Rohde & Schwarz
rohde-schwarz.com

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Product Highlights

Front-End Solution

Skyworks introduced the SKY85716-11, a fully-integrated 5 GHz 802.11ac front-end solution that supports connectivity for nominal power applications including access points, routers and gateways. This high performance Wi-Fi product incorporates an SPDT transmit/receive switch, LNA with bypass and a power amplifier. It also includes an enable/disable function that allows for power savings during off mode. Because the SKY85716-11 occupies minimal board space, the solution is ideal for high-stream-count designs, compact devices an emerging wireless mesh networks when combined with modem reference designs.

Skyworks
skyworksinc.com

Vertical Launch Connector

Southwest Microwave, a global leader in the development of high-performance millimeter wave and radio frequency (RF) interconnect solutions, is pleased to release the industry’s first board (PCB) mounted 1.0 mm (W) Vertical Launch Connector.

For microstrip or grounded coplanar waveguide (GCPW) designs, Southwest Microwave vertical launch connectors provide optimal signal integrity, are reusable and can be installed without soldering. The new 1.0 mm Vertical Launch Connector delivers low insertion loss and a VSWR of 1.35:1 max across 70 to 105 GHz and a VSWR of 1.6:1 max across the complete 110 GHz bandwidth. Data represents two 1.0 mm connectors mounted on test-board.

Southwest Microwave
southwestmicrowave.com
White Paper: Load-Pull Primer for Optimizing PA Performance

This white paper presents application examples that showcase the load-pull analysis capabilities in NI AWR software for optimizing PA performance, including analysis of simple circuits, matching circuits, and circuit optimization, as well as simulation of wideband high-efficiency PAs, load-pull measurements for base-station PAs, and synchronized source/load-pull analysis.


National Instruments
awrcorp.com

QFN Socket

Ironwood Electronics introduced a QFN socket design using high performance elastomer capable of 75 GHz, very low inductance and wide temperature applications. The GT-QFN-3024 socket is designed for 10.5x5.5 mm package size and operates at bandwidths up to 75 GHz with less than 1dB of insertion loss. The contact resistance is typically 20 milliohms per pin. The socket is mounted on the target PCB with no soldering, and uses very small real estate allowing capacitors/resistors to be placed close by. This socket utilizes clamshell lid with integrated compression mechanism. The socket is constructed with cam actuated lever lid with central opening for direct thermal characterization of silicon.

Ironwood Electronics
ironwoodelectronics.com
Product Showcase

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Nanosecond Electronics Since 1975
Early last year, I was made aware of a report from the World Economic Forum (WEF) that highlighted the shift in skills sets employers have valued in the past versus those they will be looking for in next decade. The report emphasized that negotiation skills, emotional intelligence, and people management will be incredibly important skills over which new hires will need to have mastery in the upcoming decade. As I read through the report, a number of questions began to whirl within my head.

Q: How do we measure, evaluate, and perceive negotiation skills, emotional intelligence, people management, and problem solving?

Negotiation skills, emotional intelligence, people management, and problem solving, are hard to measure and I believe often harder to measure for men and women in STEM fields. By nature (or nurture?), engineers tend to be left brainers, so our thinking is linear and fact based, rather than emotionally based.

We have developed our careers to solve engineering and science problems, not people problems. So, now must we retrain ourselves to develop the people skills needed to value what others bring to the table? I believe if you want to go into management, you need to work at developing people skills and problem-solving abilities. Seek out mentoring by others whom you perceive as having these skills, or sign up for seminars on the topic.

Managers need to constantly remind themselves that people skills are as important as management skills, and that problem solving comes from looking at all sides of the issue, not just finding the quickest solution. Sharing an alternative viewpoint gets others to think, reflect, and take notice, and elevates the entire team’s decision making.

A room full of the same people will produce the same ideas, but a room full of diverse genders, ethnicities, and educations, will come up with a wealth of different ideas and viewpoints. This is the key to innovation and high productivity.

Q: Do these skills apply to our industry?

These skills absolutely apply to our industry and even more so today with the new economy. Ideas come and go so quickly -- if we can’t inspire others to follow, we lose opportunity. I think of Elon Musk and his many ideas that have spawned numerous companies, as well as Mark Zuckerberg of Facebook. Regardless of what you may think of these men or their firms, they were definitely the “engineering” type that imagined solutions to problems. “The ability to attract and motivate great people is critical to the success of a company, because a company is just a group of people that are assembled to create a product or service,” Musk remarked in a 2018 interview, noting that people sometimes forget this “elementary truth.”

Q: Can these skills attract more women into STEM professions?

Are the skills of emotional intelligence and people management inherently in the wheelhouse of females? And if so, will they play a positive role in attracting/growing the number of women in STEM careers?

These soft skills and/or people skills when equally encouraged across all employees, regardless of race or gender, are a good thing not only for employees, but for the company, as well. Certainly, a workplace atmosphere that values the contributions of women equally with those of men and encourages innovative thought and inclusiveness goes a long way towards inspiring women to enter and stay in STEM careers.

Yet I am not sure we are doing much in general, especially in this country, to move away from labeling women interested in STEM careers as nerdy or geeky. That perception needs to change as early as grade school to provide girls with positive role models and later on with mentoring that shows them women in STEM careers are highly esteemed and valued.

Q: As an employer/manager, how can we help employees develop these skills?

Being technical and highly competent, as well as able to articulate the big picture and interleave ideas and people in unique way is what the WEF report is really trying to say are “key attributes” to have for future jobs in 2020 and beyond. Competency happens and grows when employees are encouraged to believe in themselves and to feel confident in exploring options and putting their ideas out there. Having the courage to speak up is something we need to remember to do and value. If as managers we lead the way through good example, employees will follow.
Tiny MMIC Gain Slope Equalizers Flatten DC-20 GHz

Mini-Circuits’ EQY-5-24+ is an absorptive MMIC gain equalizer with a negative 5.1 dB slope versus frequency from DC to 20 GHz. Fixed slope MMIC equalizers are useful for flattening negative gain slope in wideband amplifiers, receivers and transmitters in applications from wireless communications to broadband/optical, satellite, defense and more. This model is capable of handling up to +34 dBm RF input power and provides 20 dB typical return loss across its full bandwidth. Fabricated using highly repetitive GaAs IPD technology, this equalizer provides outstanding repeatability of performance, making it suitable for volume production. It comes housed in a 2 x 2mm 8-lead QFN package, saving board space and minimizing the effect of parasitics. EQY-series MMIC gain slope equalizers are available with a wide range of slope values to meet your needs.

High Dynamic Range MMIC Amplifier with Shutdown Feature, 1 MHz to 1 GHz

Mini-Circuits’ TSS-13LN+ ultra-high dynamic range MMIC amplifier provides industry-leading noise figure and IP3 from 1 MHz to 1 GHz. An internal shutdown feature protects the amplifier in the presence of pulsed signals while keeping the power supply at constant voltage to minimize DC power consumption. This model provides 1.1 dB noise figure and +39.2 dBm IP3, making it ideal for maximizing sensitivity and dynamic range in high-performance receiver applications. It delivers 22.8 dB typical gain with ±3.0 dB flatness, and +19 dBm output power at 1 dB compression. The amplifier is fabricated using E-PHEMT technology with excellent repeatability. It operates on a single 8V supply, and comes housed in a tiny 12-pad 3x3mm QFN package.

Tiny High-Rejection LTCC Low Pass Filter, DC to 530 MHz

Mini-Circuits’ LFCG-530+ is an LTCC low-pass filter with a passband from DC to 530 MHz. This model provides 1.0 dB typical passband insertion loss and stopband rejection of 30 dB typ. The filter is capable of handling up to 4W RF input power and provides a wide operating temperature range from -40°C to 85°C. Housed in a tiny 0805 ceramic form factor with wraparound terminations, the LFCG-530+ is ideal for dense PCB layouts with minimal performance variation due to parasitics.

Tiny LTCC Dual/Differential Low Pass Filter, DC to 1600 MHz

Mini-Circuits’ DLFCV-1600+ is a dual low pass filter with a passband from DC to 1600 MHz designed into a single 1210 ceramic package. This design allows customers to use a single unit in systems where two filters of the same passband are required, saving board space. The dual filter can also be used as a differential filter in differential circuits where interference and noise must be minimized. This model provides 1.5 dB passband insertion loss, 50 dB stopband rejection, and RF input power handling up to 3W (each filter). It supports a wide range of applications and is ideal for minimizing interference at amplifier inputs and ADC outputs.

Ultra-Low Noise D-PHEMT Transistor, 10 to 4000 MHz

Mini-Circuits’ TAV1-331+ is a MMIC D-PHEMT transistor with an operating frequency range from 10 to 4000 MHz, supporting a wide range of wireless communications bands. This model provides a unique combination of low noise (0.6 dB) and high gain (24.1 dB), resulting in lower overall system noise. It also provides high IP3 performance of +31.8 dBm, making it ideal for sensitive receiver applications. Manufactured using highly repeatable D-PHEMT technology, the unit comes housed in a tiny 1.4 x 1.2mm MCLP package. This model requires external biasing and matching.

Coaxial Adapter Mates 1.85mm-F to 2.92mm-F Connectors

Mini-Circuits’ 185F-KF+ is a coaxial 1.85mm-F to 2.92mm-F adapter, supporting a wide range of applications from DC to 40 GHz. This model provides 1.05:1 VSWR, and 0.13 dB insertion loss with flat response over its full frequency range. The unit features rugged, passivated stainless steel construction and measures 0.82” in length.
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Attenuator

PMI Model DTA-2G18G-60-CD-2-OPT-1G18G is a non-reflective, 10 BIT, programmable 60 dB, pin diode attenuator with step resolution as low as 0.06 dB over the frequency range of 1.0 to 18.0 GHz. Specifications include insertion loss of 4.5 dB; VSWR 2.0:1 maximum; attenuation accuracy of ±1.0 dB @ 0 to 20 dB, ±1.5 dB @ 20 to 40 dB and ±2.0 dB @ 40 to 60 dB; typical attenuation flatness of ±1.0 dB @ 20 dB, ±1.25 dB @ 40 dB and ±3.0 dB @ 60 dB; switching speed 1.0 µs and This model is offered in a slim line housing measuring 2.0” x 1.8” x 0.5” with SMA female connectors and a 15 PIN Micro-D-Female control connector. Mating Micro-D Male connector supplied.

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