Wideband Power Amplifiers in mMIMO Applications

Editorial:
Wi-Fi and Cellular Networks Enable Change in Difficult Times

Hot Products:
• 1 MHz to 44 GHz USB Power Sensor
• 40 GHz CW Signal Source

Featured Products
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<table>
<thead>
<tr>
<th>Connector Series</th>
<th>Frequency Range</th>
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<td>DC-65 GHz</td>
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<td>2.4mm</td>
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<tr>
<td>2.92mm</td>
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http://www.pmi-rf.com/model-pttran-100m18g-sfb-3uvpx-10hp-mah

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- CW Immunity

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https://www.pmi-rf.com/model-no-lcm-7r7gr2g-9p-cd-1
https://www.pmi-rf.com/model-no-lcm-16g100mbw-cd-1

- Customized Frequency Ranges: LCM-7R7GR2G-CD-1: 7.7 to 8.2 GHz
  LCM-16G100MBW-CD-1: 16.0 GHz ± 50 MHz
- IF range of DC to 10 Khz
- Features a 20 dB voltage programmable attenuator and a 360° phase shifter.
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- Operating Frequency Range of 0.5 to 18.0 GHz.
- Built in sets of four, phase and amplitude matched to industry leading levels of ±10º and ±1.5 dB over the frequency range.
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Quad Phase and Amplitude Matched Diplexer Gain Module
DGM-18G40G-229FF-DS
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https://www.pmi-rf.com/product-details/ewdm-8g18g-65-70mv

- Customized Frequency Ranges: EWDM-2G8G-65-70MV: 2.2 to 8.0 GHz
  EWDM-8G18G-65-70MV: 8.0 to 16 GHz
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X-Microwave announced two new mmWave Reference Design Kits, XM-RDK-201 (ADMV1013 Upconverter) and XM-RDK-202 (ADMV1014 Downconverter). These ready-to-use solutions include all of the components needed to successfully up-convert and down-convert mmWave waveforms from low frequency IF (800 MHz – 6 GHz) to RF frequencies (22GHz to 44GHz).

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6: Editorial

Wi-Fi and Cellular Networks Enable Change in Difficult Times

By Tom Perkins

It has been said that we may never go back completely to the way social interaction, business, learning, and commerce was conducted in the past. Perhaps online shopping will accelerate; physical travel to business meetings will decrease as on-line meetings using applications such as Zoom and WebEx increase; virtual care telemedicine becomes practical (aided by wearables); and take-out prepared meals gain in popularity. All of these changes may profoundly affect many industries such as fuel demand, the need for vehicles and airplanes, restaurant and hotel occupancy, parking facilities, the way we vacation, industry trade shows, use of robotics, and artificial intelligence, to name a few. The internet and telecommunications as well as the Internet of Things (IoT) are uniquely intertwined with all of these disruptive changes.

22: Feature Article

Requirements for Wideband Power Amplifiers Used in mMIMO Applications

By Abdulrhman M. S. Ahmed, Zoran Anusic, and Greg Durnan

In this article, some of the requirements of power amplifiers (PA) used for massive multiple-input, multiple-output (mMIMO) applications will be discussed. These requirements are gathered from our experiences in this application. Some of the requirements are related to the PA design and some are lineup requirements. The importance of Amplitude-to-Phase modulation (AM/PM) of an amplifier and the impact of its behavior on linearizability will be presented. Likewise, the impact of the measurement setup configuration on the wideband PA linearizability problems and solutions will be discussed. The focus will be on the design of PAs using Gallium Nitride (GaN) power transistors. We will demonstrate high power 50 Ohm asymmetrical Doherty amplifier lineups with excellent wideband digital predistortion (DPD) correction up to 200 MHz.

16: Featured Products

LadyBug Technologies’ LB479A thermally stable peak and pulse sensor utilizes patented technology to deliver no-drift, high-accuracy statistical pulse information along with average power. No user zeroing is required. The USB sensor offers frequency coverage from 10 MHz to 8 GHz with an 80 dB dynamic range. The product’s broad frequency range, combined with excellent sensitivity, makes it ideal for IoT, satellite, radar, Bluetooth, and defense applications.

Micro Lambda Wireless has released a series of new Product Guides and other resources for its extensive line of YIG oscillators, filters, and synthesizers, including:

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• 2020 Synthesizer Product Guide
• 2020 YIG Filter Product Guide
• MSLP Quick Start Guide
• MLBF Quick Start Guide
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Wi-Fi and Cellular Networks Enable Change in Difficult Times

Tom Perkins
Senior Technical Editor

The coronavirus, aka COVID-19, continues to affect people worldwide, and it is said there is a paradigm shift taking place that will likely establish a “new normal” after things settle down. Many companies in our field are offering free webinars, seminars, and classes on the latest technology that can be readily accessed from home. No doubt there will be pressure to accelerate the 5G rollout to improve data throughput speeds. Thankfully, although perceived as running behind schedule by many, the work on rolling out 5G has been relentless.

Various media such as Zoom video conferencing are proving to be a time- and cost-saving means to conduct business and organizational meetings near and far. Places of worship are holding services via YouTube. Even governments are communicating via the internet. While there are disruptive circumstances created almost beyond our comprehension, aside from terrible loss of life and financial woes, there are also unprecedented opportunities in the recovery. For example, if our failing physical infrastructure is rebuilt, it may proceed more efficiently as some may remain in a work at home mode, relieving stress on necessary traffic detours and backups during highway and bridge construction.

Likely mobile hotspots (aka Wi-Fi tethering) are being set up at rates never encountered before. The best feature of hotspots may be security. Its Wi-Fi network is protected by WPA-2 encryption, making it just as secure as a home router. While most public Wi-Fi networks are considerably less safe, a mobile phone automatically assigns a default service set identifier (SSID) name to a hotspot. Meanwhile hotels, restaurants, airports, and shopping malls are experiencing far less use of public Wi-Fi. No doubt this unplanned human behavior will prompt some reevaluation of how connectivity is deployed and maintained.

Slowing Wi-Fi Internet

During the first week of May, many folks accessing the internet from home via Wi-Fi are experiencing slow, or at times no, connections. This obviously is due to considerable increase in activity -- not only by work-at-home, but also by students fulfilling home assignments, online courses, gaming, and people seeking medical information and advice via telemedicine.

4G networks are reported to be clogged and not functioning. 5G is slowly rolling out, first in major metropolitan areas. With possibly up to 10
gigabits per seconds (Gbps), 5G is 100 times faster than current 4G technology. In practice people are experiencing rates of about 1.7 Gbps, which still quite impressive. As I write this my 4G LTE download speed is less than 1 Mbps and upload is pathetic.

Changing Paradigm

It has been said that we may never go back completely to the way social interaction, business, learning, and commerce was conducted in the past. Perhaps online shopping will accelerate; physical travel to business meetings will decrease as on-line meetings using applications such as Zoom and WebEx increase; virtual care telemedicine becomes practical (aided by wearables); and take-out prepared meals gain in popularity. All of these changes may profoundly affect many industries such as fuel demand, the need for vehicles and airplanes, restaurant and hotel occupancy, parking facilities, the way we vacation, industry trade shows, use of robotics, and artificial intelligence, to name a few. The internet and telecommunications as well as the Internet of Things (IoT) are uniquely intertwined with all of these disruptive changes.

Finally, there are rumors -- apparently originating in the UK -- that 5G causes COVID-19 by inhibiting oxygen supply in the bloodstream. According to The Guardian, a 70-foot cellphone mast in Birmingham, England, went up in flames in early May. This alleged act of arson is the result of people believing fake science.

IMS 2020

According to a recent statement released by the IMS, “Out of concern for the health and safety of all participants amid the COVID-19 pandemic, the IEEE MTT-S IMS2020 and Microwave Week which was scheduled or 21-26 June 2020 in Los Angeles, CA, USA, is transitioning to a virtual event. The International Microwave Symposium and Microwave Week (IMS, RFIC and ARFTG) 2020 organizers have made this difficult decision after careful consultation and review with government authorities, partners, and venues.

“The timeframe for the virtual event will be August 2020. The program will contain the following activities and will feature both pre-recorded and live events: IMS, RFIC and ARFTG Technical Sessions; IMS, RFIC and ARFTG Plenary Sessions; Technical Lectures; 5G Summit; Panel Sessions; Three Minute Thesis; MicroApps; Industry Workshops; Virtual Exhibition.”

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Meetings and Events

2020 IEEE/MTT-S International Microwave Symposium (IMS)
21 - 26 June 2020  |  Los Angeles, California, USA
Field of Interest: Components, Circuits, Devices and Systems; Communication, Networking and Broadcast Technologies; Components, Circuits, Devices and Systems; Engineering Profession; Fields, Waves and Electromagnetics; Photonics and Electrooptics.

2020 45th International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz)
13 - 18 September 2020  |  Buffalo, New York, USA
Field of Interest: Aerospace; Bioengineering; Communication, Networking and Broadcast Technologies; Components, Circuits, Devices and Systems; Engineered Materials, Dielectrics and Plasmas; Fields, Waves and Electromagnetics; Photonics and Electrooptics; Signal Processing and Analysis

2020 50th European Microwave Conference (EuMC)
15 - 17 September 2020  |  Utrecht, Netherlands
Field of Interest: Communication, Networking and Broadcast Technologies; Components, Circuits, Devices and Systems; Fields, Waves and Electromagnetics; Photonics and Electrooptics

2020 17th European Radar Conference (EuRAD)
16 - 18 September 2020  |  Utrecht, Netherlands
Field of Interest: Aerospace; Communication, Networking and Broadcast Technologies; Components, Circuits, Devices and Systems; Fields, Waves and Electromagnetics; Photonics and Electrooptics

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Healthcare Wearables Shipments in 2020 Will Track, Monitor, and Help Fight Virus Progression

Wearables have become another weapon to track, monitor, and fight the progression of COVID-19 and its symptoms worldwide. New deployments and studies during the pandemic will boost the healthcare wearables market (which includes connected blood pressure monitors, continuous glucose monitors, pulse oximeters, and electrocardiogram monitors) to 30 million shipments in 2020, increasing to 104 million shipments in 2025, at a CAGR of 28.5%, states global tech market advisory firm, ABI Research.

“Wearables have often been used in medical trials and to aid healthcare professionals to monitor the vitals of many patients simultaneously, both in and out of the hospital, with a focus on specific healthcare issues and the onset of COVID-19 is no exception,” says Stephanie Tomsett, Wearables Analyst at ABI Research.

Several wearable, platform, and healthcare companies are working together on different projects that use healthcare wearable devices, smartwatches, or activity trackers to aid with tracking the progress of the virus or monitoring the vital statistics of potential sufferers.

“The wearable trials and deployments that record vitals and monitor symptoms alert medical professionals if a patient’s condition worsens. This becomes particularly important when the number of hospital beds is limited and so many patients are being sent home, ensuring that the seriously ill are cared for in a hospital while the less ill are still monitored when at home,” Tomsett explains. With COVID-19, these wearables also help to reduce the amount of unnecessary contact between the seriously ill and medical staff, who are at serious risk of exposure to the virus while also potentially transmitting it to other vulnerable patients.

“There are some exciting wearable deployments in place which are helping to track and monitor the spread of COVID-19,” Tomsett points out. For example, Masimo SafetyNet is a wearable wristband device with a disposable fingertip attachment that monitors a patient’s pulse, breathing rate, and blood oxygen levels, both in and out of a hospital setting. Scripps Research Translational Institute has in the past tested 200,000 Fitbit wearables over 60 days to determine if they are effective in tracking flu outbreaks, and is now attempting to do the same with wearables in the United States that measure resting heart rate (such as those from Apple, Fitbit, Garmin, and others that share data with Google Fit or Apple HealthKit) to track COVID-19. And, Estimote has developed a workplace safety pebble-like wearable that can be clipped on a lanyard or on the wrist for those that must be at a physical workplace when social distancing during the COVID-19 outbreak.

While there are an increasing number of vital trials, studies, and deployments of wearables aiding the fight against COVID-19, more can always be done. “More wearable and healthcare companies need to look into how a variety of different wearable devices can help either by tracking the spread of the virus in different regions to provide information on locations affected, or by remotely monitoring patients to reduce the amount of interaction between them and healthcare professionals. Not only will this help with the immediate issues with COVID-19 but will also help with any future healthcare related outbreaks and mitigate recurrence of the pandemic in second and even third waves,” Tomsett concludes.

—ABI Research

80 Percent Surge in Wi-Fi Upload Traffic Reaffirms Need for Wi-Fi 6, Wi-Fi 6E

COVID-19 has had an immediate impact on Wi-Fi infrastructure, proving existing infrastructure is inadequate. Wireless networks are now facing a higher capacity with more traffic and users are finding their existing home Wi-Fi network, and the wider broadband infrastructure, is inadequate or incapable of supporting the recent 80% increase in upload traffic, states global tech market advisory firm, ABI Research.

“The outbreak of COVID-19 is creating a need for flexibility that will fuel the future of connectivity,” says Andrew Zignani, Principal Analyst at ABI Research. Many users are still likely to be using outdated Wi-Fi equipment with legacy Wi-Fi standards, such as 802.11n, rather than the latest Wi-Fi 6, which has specifically been designed to deal with better provision in more crowded networks. “There will be renewed incentive for mesh Wi-Fi that can provide sufficient high-speed coverage to multiple users throughout the home,” Zignani explains. At the same time, companies will need to ensure they have the right infrastructure in place so large numbers of employees can concurrently connect to company Virtual Private Networks (VPNs). Many companies may not have VPNs at all, while capacity limitations could put companies at further risk of security breaches or slow down productivity further.

—ABI Research
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Operational Fires Program Kicks Off Phase 3, Highlights Progress toward Maturing Novel Technologies

Phase 3 of DARPA’s Operational Fires (OpFires) program began in earnest recently with government and contractor staff finalizing the system architecture approach, including a plan to use existing components from ground-launched missile systems, along with new booster technologies designed to support future hypersonic weapons. Lockheed Martin Missiles and Fire Control is leading the integration effort for the third phase of the program, which will focus on first stage booster design and maturation, launcher development, and vehicle integration.

Broad participation from the Army’s Combat Capabilities Development Command, range safety offices, and performers from OpFires Phase 2 propulsion teams contributed to success in the early, critical stages of the program. Since 2018, OpFires has made impressive strides developing and demonstrating advanced booster technologies that had never been used in prior systems. Phase 1 and 2 performers Aerojet Rocketdyne, Exquadrum, and Sierra Nevada Corporation continue work towards throttle-able upper stage rocket motors suitable for tactical transport, storage, and engagement.

“The objective of DARPA’s OpFires program is to deliver an intermediate-range surface-to-surface missile in line with the Department of Defense’s push to field hypersonic platforms,” said MAJ Amber Walker (USA), the DARPA program manager for OpFires.

DARPA’s Phase 3 news comes on the heels of learning the Army will no longer provide funding for OpFires integration work. However, DARPA will continue pressing forward with Phase 3 activities to further advance the program goals of affordability and mobility for U.S. and Allied forward forces.

“DARPA enjoys a high level of collaboration among a diverse industry and government team that is critical for meeting the Phase 3 program objectives and eventually demonstrating this critical hypersonic capability,” said Michael Leahy, director of DARPA’s Tactical Technology Office. “In keeping with its charter to demonstrate breakthrough technologies, we will continue to push towards demonstration of an affordable, mobile system that will be compatible with advanced payloads and offer a variety of future strike capabilities across a large engagement zone.”

Next steps for the OpFires program include a series of full-scale static motor firings, as well as further subsystem tests designed to evaluate component design and system compatibility, culminating in integrated end-to-end flight tests.

—DARPA

* * *

Darpa Awards Contracts for Work on Manta Ray Program

DARPA’s Manta Ray Program aims to demonstrate critical technologies for a new class of long duration, long range, payload-capable unmanned underwater vehicles (UUVs). UUVs that operate for extended durations without the need for on-site human logistics support or maintenance offer the potential for persistent operations during longer term deployments.

DARPA has selected three companies to focus on development of an integrated solution for Manta Ray technology and operational areas. They are:

Lockheed Martin Advanced Technology Laboratories
Northrop Grumman Systems Corporation
Navatek, LLC

A fourth company, Metron, Inc., will work toward critical technology and solutions specific to the field of undersea energy harvesting techniques at depths necessary for successful operations.
“The Manta Ray program aims to increase at-sea operational capacity and capabilities for the combatant commander while minimizing disruptions to current operations by remaining independent of crewed vessels and ports once deployed,” said CDR Kyle Woerner, the Manta Ray program manager in DARPA’s Tactical Technology Office. “If successful, this new class of UUVs would allow operational flexibility and relief of workload for both traditional host ships and servicing ports.”

The Manta Ray program plans to advance key technologies that will benefit future UUV designs, including, but not limited to new energy management and energy harvesting techniques at operationally relevant depths; low-power, high-efficiency propulsion; and new approaches to mitigate biofouling, corrosion, and other material degradation for long duration missions. The program also seeks process improvements, including mission management approaches for extended durations while accounting for dynamic maritime environments; unique methods for leveraging existing maritime datasets and new maritime parameters for high-efficiency navigation; and new low-power means of underwater detection and classification of hazards.

Manta Ray is targeting three phases of development, culminating with a fully integrated demonstration vehicle completing an underwater mission in a dynamic, open-ocean environment.

—DARPA

Raytheon Recognizes Lansdale Semiconductor

Lansdale Semiconductor President R. Dale Lillard recently announced that the company was honored for the seventh consecutive year by Raytheon Integrated Defense Systems for Supplier Excellence. This year, Lansdale achieved Raytheon’s highest 5 Star Award for the second time in two years.

Raytheon’s Integrated Defense Systems business instituted the annual Supplier Excellence Awards program to recognize suppliers who have provided outstanding service and partnership in exceeding customer requirements.

Award candidates are judged on certain criteria, including overall quality, on-time delivery and demonstrated commitment to continuous improvement. A 5-Star recognition is the highest level of recognition a Raytheon Integrated Defense Systems business supplier can achieve for excellence in quality and performance, and Lansdale Semiconductor was one of 14 companies selected.

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LadyBug Technologies’ LB479A thermally stable peak and pulse sensor utilizes patented technology to deliver no-drift, high-accuracy statistical pulse information along with average power. No user zeroing is required. The USB sensor offers frequency coverage from 10 MHz to 8 GHz with an 80 dB dynamic range. The product’s broad frequency range, combined with excellent sensitivity, makes it ideal for IoT, satellite, radar, Bluetooth, and defense applications.

The LB480A sensor is similar and includes triggered, time-domain trace based measurement features along with additional statistical information. These triggered measurements provide a visual time domain trace of the pulse power profile.

Both sensors are provided with a package of software that includes programmatic support for ATE builders. Triggering, recorder output and optional connectors are available.

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Product Guides and YIG Resources
Micro Lambda Wireless has released a series of new Product Guides and other resources for its extensive line of YIG oscillators, filters, and synthesizers, including:

- 2020 Oscillator Product Guide
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- 2020 YIG Filter Product Guide
- MSLP Quick Start Guide
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- And much more

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**Frequency Divider**

FBS-N-40 is a custom build 0.5 - 40GHz frequency divider with fixed divide ratio of 2 to 127 (N must be specified when ordering). It is running on single 5V DC power supply with 2.92mm female Input RF Connector and SMA female output RF connector. It is designed for PLL applications. Once a customer specifies the divide ratio, we can ship on the same day order is placed.

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**Frequency Multiplier**

Cernexwave’s CFM series active frequency multipliers cover the frequency range of 10 MHz to 500 GHz. They can be designed to multiply an RF signal 2, 3, 4 or as many as 36 times with our custom multiplier chain assemblies. These multipliers utilize state of the art MIC and MMIC technologies to provide highly stable, reliable and efficient frequency extenders for system applications.

The X12 model CFMV1V1X1210 above has an input frequency of 10MHz and an output frequency of 120MHz. It is powered by +12VDC at 400mA with 10dBm of input and output power at the SMA Female connectors.

**Cernexwave**
cernexwave.com

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**Precision Right Angle Adapters**

Withwave’s Precision Test Adapters with right angle types are designed based on precision microwave interconnection technologies. These adapters are manufactured to precise microwave specifications and constructed with male and female gender on both side. The precision microwave connector interfaces ensure an excellent microwave performance up to 40 GHz.

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Waveguide Shorts, Shims

Fairview’s new line of waveguide shorts and shims includes 36 models offered in waveguide sizes ranging from WR-430 to WR-10. This new line is ideal for use in RF test and measurement applications and provides superior RF performance. Waveguide shims and shorts, or shorting plates, are commonly included in calibration kits and they are used in calibration applications. Waveguide shims can also be used to bridge gaps between waveguide components.

These waveguide shims and shorts are compatible with square and round UG cover and CPR-style flanges and are available in both copper and aluminum versions.

Fairview Microwave
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Skyworks is pleased to introduce the SKY5®-5242-11 a dual 2.4 GHz, 802.11ax high-linearity, high-efficiency front-end module (FEM) designed for Wi-Fi 6 enabled devices including handsets, tablets and mobile devices supporting WLAN and Bluetooth® protocols. This highly integrated FEM includes two transmit and receive chains, an extremely low EVM floor power amplifier, low noise amplifier with bypass, and a SP3T antenna switch. The three transmit modes for high linearity, high efficiency and low gain provide optimal performance. The SKY55242-11 builds on Skyworks’ portfolio of revolutionary products for 5G applications.

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Low Noise DRO
Z-Communications announced a DRO (dielectric resonator oscillator) model DRO12200A for radar system applications. The DRO12200A is designed to cover 12200 MHz while incorporating both electrical and mechanical elements for fine and coarse tuning.

This high performance DRO is optimized to feature superior low phase noise of -105 dBc/Hz @ 10 kHz offset and operates off a 5 Vdc supply while typically drawing only 23 mA of current.

The DRO12200A is designed to deliver a typical output power of 0 dBm into a 50 ohm load and is guaranteed to operate over the industrial temperature range of -40 to 85°C. This oscillator suppresses the second harmonic to better than -30 dBc and covers the optimized frequency with a tuning voltage range of 0 to 12 Vdc while featuring a tuning gain of 0.5 MHz/V.

The DRO12200A comes in Z-Communications’ standard surface mount SDRO package measuring 0.91 in. x 0.91 in. x 0.52 in.
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Requirements for Wideband Power Amplifiers used in mMIMO Applications

By Abdulrhman M. S. Ahmed, Zoran Anusic, and Greg Durnan

In this article, some of the requirements of power amplifiers (PA) used for massive multiple-input, multiple-output (mMIMO) applications will be discussed. These requirements are gathered from our experiences in this application. Some of the requirements are related to the PA design and some are lineup requirements. The importance of Amplitude-to-Phase modulation (AM/PM) of an amplifier and the impact of its behavior on linearizability will be presented. Likewise, the impact of the measurement setup configuration on the wideband PA linearizability problems and solutions will be discussed. The focus will be on the design of PAs using Gallium Nitride (GaN) power transistors. We will demonstrate high power 50 Ohm asymmetrical Doherty amplifier lineups with excellent wideband digital predistortion (DPD) correction up to 200 MHz.

Introduction

To accommodate the immense continued growth in data rates of future wireless communication systems require, PAs should be able to transmit multi-carrier and multi-mode signals that occupy the full frequency span of a given communication spectrum, while also meeting challenging power, efficiency, and linearity requirements. Independent of the signal bandwidth the linearity of PA with the DPD system must meet the linearity requirement in the 3GPP standard. One of the PA linearity requirement is the adjacent channel power ratio (ACLR), which must be $<-45$dBc [1]. In general, if the PA is easy to linearize with DPD system, it will lead to improved system efficiency. Therefore, the PA designer must focus on linearizability of PA and the maximization of efficiency.

In these wideband applications the performance of the PA is envelope and frequency dependent. This envelope and frequency dependence are memory specific phenomenon’s, which means...
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<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Operating Freq. (GHz)</th>
<th>Atten. (max) dB/ft. dB/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1801</td>
<td>30</td>
<td>0.49 / 1.62</td>
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<tr>
<td>1701</td>
<td>38</td>
<td>0.57 / 1.88</td>
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<tr>
<td>1571</td>
<td>40</td>
<td>0.64 / 2.09</td>
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<tr>
<td>1501</td>
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<td>1401</td>
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<td>1.02 / 3.34</td>
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<td>1251</td>
<td>70</td>
<td>2.14 / 7.02</td>
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<tr>
<td>0471</td>
<td>110</td>
<td>4.95 / 16.23</td>
</tr>
</tbody>
</table>

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that the output signal of the active device is not only a function of the instantaneous input signal values, but also a function of previous values [2]. Increased data rates will enable more uses and fast data transfer which lead to better service quality (Fig.1).

To enable Gigabit amplifier capability the frequency of operation of the amplifier must move to higher frequencies since the fractional bandwidth for operation at high frequency is smaller than operation at low frequencies. The basic relations of data rate and bandwidth are:

\[
\text{Data rate} = 2 \times \text{bandwidth} \log_2(N) \text{ bits per second}
\]

Where \(N\) is the number of coding states.

\[
\text{Bandwidth} = \frac{(\text{Upper frequency} - \text{lower frequency})}{\text{center frequency}}
\]

Requirements

In today’s sub 6 GHz mMIMO applications the required bandwidth is in the range of 200 MHz. High power levels, 5-10W average, are another amplifier requirement for such applications. GaN on Silicon Carbide (SiC) is the only technology which can provide such operation at high frequency and power.

Wolfspeed also is only supplier which has a fully vertically integrated materials and device business specifically targeted at world class GaN devices. This enables a reliable supply of GaN Front-End Modules from the bulk crystal, epitaxy, wafer die, device design and hence the resulting PA (Fig.2).

In 4G, PAs were designed for relatively narrowband applications (~60 MHz). In such applications, the linearizability problems were caused mainly by the final stage Doherty PA.

Massive multiple-input, multiple-output (mMIMO) system is a technology for 5G. It is basically the parallelization and optimization transmitters with antennas and receivers (\(2^N\), where \(N=1,2,...\)) to provide better throughput and better spectrum efficiency. These group of transmitters and receivers are working together to give high speed, capacity, security and other benefits for 5G as shown in Figure 3.

For 5G mMIMO applications, the required instantaneous bandwidth is 160 MHz or more. With such wideband signals, the linearizability problems are not caused by the final stage PA only; rather, they are caused by the combination of PA lineup, wideband transceiver, and DPD system. Hence, wideband linearizability is limited by different parts of the whole system.

In these 4G narrow band applications we see the system operating in more or less SISO (Single Input / Single Output) and the PA designs required the high linearity for these applications.

Figure 2. Vertically Integrated GaN Front-End.
Output configurations known as Macro systems which are typified by single antennas at the Base station and handset. Having said that, handset diversity may also be in use – switching between two handset antennas for example for best Signal-To-Noise Ratio (SNR). Its throughput is limited in general by the channel bandwidth in use and the propagation condition. Equation 1 shows the basic channel capacity relationship.

\[ C_{SISO} = B \log_2(1 + \frac{\text{SNR}}{N}) \]

Equation 1 • The traditional Macro SISO relationship as a function of Bandwidth, B and SNR.

The 3GPP standards, particularly at level 13 & 14 (LTE Advanced Pro) and 15 (5G) offer many of technologies that rely on this additional bandwidth by parallelizing channel carriers. This includes Channel Aggregation (CA) and Dynamic Spectrum Sharing (DSS) in the sub 6GHz channel space. Both technologies directly increase the throughput (Gbps) by either using extra TDD (or FDD) channels of up to 20 MHz in bandwidth. In 3GPP level 15 we also have the ability to use both LTE and 5G channels simultaneously (DSS) to increase throughput. And with this we also see increases in the complexity of the available modulation methods i.e. in LTE we may see 64 QAM versus 256 QAM at level 3GPP level 15. This then further increases in 3GPP levels 16 and above.

Further to bandwidth increases, we have seen with LTE Advanced Pro and 5G (Sub 6 GHz) standards the ability of operators to employ multiple antennas at the transmit (tower) end of the link. This leads to linear increases in data rates as the mMIMO operates in a MISO (Multiple Input – Single Output) mode, often with a pair of sub 6 GHz antenna’s in the handset also offering switched diversity to overcome hand placement and signal loss in the handset. The mMIMO tower will then adjust its phase and amplitude components for the individual customer to beamform towards that handset or at least to peak throughput as well as is possible in a heavy multipath environment. Whereas 4G LTE Advanced Pro Chipsets were operating in the 1 GSPS range (although improving) the use of mMIMO has allowed sub 6 GHz handsets to obtain data rates in the 2.5-3 GSPS range. The channel capacity relation for such contemporary 5G Systems at the time of writing is given by Equation 2.

\[ C_{MISO} = N \log_2(1 + \frac{\text{SNR}}{N}) \]

Equation 2 • The current sub 6 GHz 5G MISO relationship as a function of Base Antennas Numbers (N), Bandwidth (B) and SNR. This arrangement is currently leading to possible throughputs in the range of several Gbps.

Such handset chipsets as the recently released Qualcomm X60 achieve these record throughput improvements and as a result need ever wider band PA’s for cellular systems.

In addition to the wideband requirements of the PA for mMIMO, high efficiency is very important. The required efficiency is a must-meet metric to fit the size and weight requirements of mMIMO systems (Fig. 1). To achieve high efficiency power amplifiers, asymmetrical Doherty architectures are generally used. Unfortunately, this kind of architecture is highly nonlinear. Since linearity and efficiency are trade-off parameters in PAs, to maximize the efficiency, the PA should be designed with the minimum required linearity; “only as much as we need.” For example, using a Class-A amplifier in back-off as a driver is not the most efficient solution for the lineup.

In addition to the as-current MISO configuration of the base station – handset arrangement, the true throughput of mMIMO as suggested by the Qualcomm X60 (and X50 solutions paired with a 4G LTE Modem) will likely move to higher spectrum allocations to achieve the bandwidth necessary for speed improvement. The second advantage of moving to these higher spectrum allocations is the reduction in size of the necessary antennas for both handsets and base stations. However, there are some tradeoffs at the present time. One is in the choice of system configuration. In built up areas, these higher fre-
Frequency allocations do not propagate nearly as well as low frequency macro base stations, particularly the very low UHF bands such 617/619 MHz. In addition, another tradeoff due to complexity is the extended period for development of 5G base station systems based on expense, size and weight that it brings to the cellular base station solution. And this must be traded against the relative simplicity of high power Macro cellular base stations. In particular, in 5G we are looking at close integration of the antenna system with front end amplification and switching. In addition, since most practical systems will use phase and amplitude control in the digital domain for each customer slot, extensive processing power is necessary to achieve this.

Wolfspeed is enabling these solutions via the naturally higher efficiency at these higher frequencies using GaN on SiC technology. LDMOS is not a viable solution at these higher frequency allocations, simply due to poor device efficiency. We have talked about 3GPP levels 14 (4G LTE Advanced Pro) and level 15 (5G) however 5G will continue in development for several additional 3GPP releases before we finally get to 6G concepts. It is worth having a look at the present 3GPP roadmap, considering that not all chip vendors of cellular modems may implement all features of any one release level. Figure 4 from the 3G Partnership Project shows the expected development as we work towards 6G systems. At the time of writing 3GPP are working on additions to 5G via releases 16 and 17 and these will place a heavier focus on the higher frequency allocations (mm Wave).

As can be seen the standards the industry is developing at present (3GPP levels 14 and 15) have been frozen. From 2020 onwards, we will be looking through to release 18 by 2022 [3].

One example where, cellular modem makers may deviate from published standards is in vehicular communications where it may be omitted in a 4G LTE Advanced Pro solution or even a 5G modem development if the target market is handsets rather than vehicles. From a marketing perspective vehicular sales opportunity may be dwarfed by those of handsets. On the other hand, modem chipset makers may make tradeoffs in other areas of the chip design to service vehicular communications (slated for the 4.9 GHz band). One such example would be the Qualcomm 9150 4G LTE chipset that supports V2V (Vehicle to Vehicle) communications but lacks the speed perhaps of some of the later non V2V solutions. Consequently, it is fair to assume we will see a rich ecosystem in the coming years of macro and mMIMO modem chipsets to serve urban, regional and special applications.

Finally, when vendors do move to true mMIMO solutions with a multitude of antennas on both the base stations and the handsets (possible at higher frequencies due to their smaller dimensions) we will see the power of MIMO speed improvement move from a linear increase – as is the case in MISO systems to an exponential increase, theoretically edging upwards of 10 Gbps at 28.8 GHz. The mMIMO channel capacity equation then reformulates as a complex equation determined by the Channel Matrix between many users, $U$, and the base station antenna array size, $BS$. A detailed derivation of the mMIMO channel capacity equation is not possible within the scope of this paper due to the variations in implementation and whether the system is TDD or FDD based. The result
however is dependent on the multiplexing gain (gain due to algorithmic addition of multipath components) and the antenna gain under those conditions (due to the number of elements in play) [4].

**Solutions**

To design wideband PAs with a given linearity requirement, the optimization of the design should not only focus on the final-stage PA alone, but also the whole amplification lineup. In addition to this, the lineup should be optimized with the transceiver system as well as the DPD system in mind. The DPD system used to linearize mMIMO power amplifiers must be simple and highly efficient itself, compared to DPD systems used in traditional macro base-station applications. This will make the design of the PA lineup more challenging.

Furthermore, based on our expertise, different causes of wideband linearizability problems have been identified (Fig.5). These include:

- Input source/ pre-driver: Nonlinearity, harmonics, noise level, and bandwidth.
- Measurement setup: Calibration, isolation, filtering, load, thermal management, and dynamic range.
- Memory effects of the amplifier: Bias network, trapping effect, mismatch of even harmonics, and power supply modulation.
- Transceiver: Nonlinearity of up/down converters, LO leakage / spurs, image / harmonics, dynamic range, and / or noise level.
- DPD: For wideband applications (> 20 MHz), the DPD should include memory. Complex algorithms will consume much power; this is not acceptable for mMIMO application.

Figure 6 shows different shapes of a static amplitude modulation to amplitude modulation (AM/AM) and amplitude modulation to phase modulation (AM/PM) characteristics as metrics for wideband linearizability. As an example, the absolute nonlinear phase value of the amplifier is proportional to the amount of the nonlinearity in the amplifier. However, this phase is a good linearizability indication only for narrowband linearizability, <20 MHz Instantaneous Bandwidth (iBW).

- As shown in the Fig. 6, good indicators for wideband, > 60 MHz iBW, linearizability:
  - < 1-2 degrees AM/PM inflection in any static AM/PM shape within the frequency band.
  - Static AM/PM dispersion across the frequency band. Low dispersion lead to good linearizability
  - Low peak power capability of the amplifier at any frequency.

**Power Amplifier Design Example**

Wolfspeed’s high power multi-chip asymmetrical Doherty PA module (PAM) is designed using GaN on SiC HEMT dies for 5G massive MIMO base station applications. PA Modules are compact and in a much smaller surface mount package than discrete components. These modules require minimum external components to build fully functional high-performance Doherty PAs. The asymmetrical Doherty power amplifier Module is designed for 5G /4G/LTE standards with a 28 V supply voltage and with 50-ohm input and output matching within 6 x 10 mm Surface Mount Package. Two stage internally matched...
Figure 6 • Different shapes of a static AM/AM and AM/PM characteristics as metrics for wideband linearizability.

Figure 7 • ADI DPD result with 10 LTE signal at Pout=37dBm@ 8dBPAR.
Doherty PAs can deliver up to 30 dB of the gain, and high saturated power of up to 46 dBm. This PAM covers mobile frequency band from 3.4 to 3.6 GHz. Using the ADI (Analog Devices Inc) DPD system with 200 MHz iBW and 8 dB Peak to Average Ratio (PAR) signal, the PAM provides excellent linearizability of -50 dBc ACPR at average output power of 37.5 dBm. Fig. 7 and 8 show respectively the DPD data for narrowband, 20 MHz, as well as wideband, 200 MHz signals measured by ADI.

**Conclusion**

Different challenges and solutions of wideband massive MIMO applications were discussed and it’s clear that the linearizability problem in 5G is caused not only by the PA lineup but the whole system. Therefore, the system should be optimized with DPD in mind. Different shapes of static AM/AM and AM/PM characteristics are proposed as metrics for wideband linearizability. For mMIMO systems, higher efficiency semiconductor devices like GaN should be used to achieve size and weight limitations. As an example, Wolfspeed’s multi-chip asymmetrical Doherty 50 Ohm PAM has shown excellent wideband linearizability using the ADI DPD system.

**About the Authors**

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**References**


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VCO

Z-Communications, Inc. is pleased to announce a new high performance, RoHS compliant VCO (Voltage Controlled Oscillator) model CRO3700K-LF. The CRO3700K-LF covers the frequency range of 3600 to 3800 MHz within a tuning voltage range of 0.5 to 18 Vdc. This innovative VCO features a spectrally clean signal of -106 dBc/Hz @ 10 kHz offset while covering the band with a typical tuning sensitivity of 18 MHz/V.

The low cost CRO3700K-LF is designed to deliver 3±3 dBm of output power into a 50 ohm load while operating over the extended commercial temperature range of -40 to 85°C. This unmatched VCO operates off an 8 Vdc supply while drawing typically 30 mA of current and features a typical second harmonic suppression of -20 dBC. The CRO3700K-LF comes in Z-COMM’s standard MINI-16-SM package measuring 0.5 in. x 0.5 in. x 0.22 in. and it is available in tape and reel packaging for production requirements making it ideal for automated surface mount assembly and reflow.

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Radio tower image courtesy of Tom Rauch, W8JI

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Dr. John Dunn is a senior engineer/EM technologist with Cadence and spearheads the AWR software training programs. Before entering the commercial electronics industry, Dr. Dunn was a professor of electrical engineering at the University of Colorado, Boulder, for 15 years. He earned his M.S. and Ph.D. degrees in applied physics from Harvard University, Cambridge, MA.

Where:
Current customers can visit awr.com/events/awr-software-web-training-pa-design to learn more and to register.

Cadence AWR
awr.com
Hi-Q/Low ESR Capacitors

Passive Plus, Inc. (PPI) is known for its outstanding customer service, high quality product line, competitive pricing, and quick delivery times.

While other companies are pushing out their product delivery lead-times, PPI is committed to being able to deliver customers’ needs as quickly as possible.

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PPI is a manufacturer of high-performance RF/Microwave passive components for the Medical, Semiconductor, Military, Broadcast, and Telecommunications Industries.

PPI specializes in High-Q, Low ESR/ESL Capacitors, Broadband Capacitors, Single Layer Capacitors, Non-Magnetic Resistors (High Power and Thin Film) and Trimmer Capacitors.

Passive Plus
passiveplus.com

New Cost-Effective Enclosures Provide NEMA-Rated Durability and Protection

Transtector Systems has expanded its comprehensive line of NEMA-rated, weatherproof equipment enclosures with the addition of a broad range of fiberglass-reinforced polyester (FRP) models. These new enclosures join a wide range of rugged Transtector solutions for housing and protecting sensitive equipment in harsh environmental conditions.

Transtector's new rugged, lightweight, cost-effective, FRP NEMA enclosures provide excellent protection in high temperature and corrosive environments, as well as isolation from live conductors and electrical shock. Available in a standard 30x24x11-inch size, each enclosure is easily configurable by using standoffs, blank aluminum and starboard accessory plates (sold separately).

Ideal for wireless networks, small cells, industrial, utility and other dynamic applications.

Transtector Systems
transtector.com

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terahertzark.edu
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Product Highlights

VNA Extension Modules
OML offers three configurations of the VNA Frequency Extension Module to expand your existing Keysight or Anritsu vector network analyzer to millimeter frequencies: T/R, T, and S. Depending on your S-parameter needs, refer to the following block diagrams to configure our module(s) with your existing VNA test port(s). With flexible ordering configurations, we can satisfy your preferences for economical and high performance needs.

OML
omlin.com

mmWave Solution
Analog Devices introduced a solution for millimeter wave (mmWave) 5G with the highest available level of integration to reduce design requirements and complexity in the next generation of cellular network infrastructure. The new mmWave 5G chipset includes the 16-channel ADMV4821 dual/single polarization beamformer IC, 16-channel ADMV4801 single-polarization beamformer IC and the ADMV1017 mmWave UDC.

Analog Devices
analog.com

Get info at www.HFeLink.com
Cable Assembly: Low Loss

Samtec announced a new flexible low-loss cable assembly with performance up to 67 GHz. The RF047-A cable assembly, using 1.85 mm male and female connectors, operates to 67 GHz with a maximum VSWR of 1.4:1 or better. The connectors are solder clamp designs with fully captivated center contacts. The body components are passivated stainless steel with gold plated brass solder ferrule and beryllium copper contact. Other connector options offered include male and female 2.92 mm series, as well as male and female SMPM series. Custom connector options are also available. These high-performance assemblies are ideal for space-limited applications requiring high flexibility.

Samtec
samtec.com

Socket: Burn-in and Test

Ironwood Electronics recently introduced a new socket addressing high performance requirements for Burn-in and Test applications - SBT-BGA-6562. The contactor is a stamped spring pin with 30 gram actuation force per ball and cycle life of 125,000 insertions. The self-inductance of the contactor is 0.95 nH, insertion loss of < 1 dB at 18.1 GHz and capacitance 0.284pF. The current capacity of each contactor is 3 amps (free air). Socket temperature range is -55C to +180C. Socket features a floating guide for precise ball to pin alignment. Socket also features 30 watt heat sink screw for power dissipation.

The specific configuration of the package to be tested in the SBT-BGA-6562 is BGA, 21x21mm body size, 0.8mm pitch and 25x25 ball array. To use, drop IC into the socket, place compression plate and swivel the lid. Down force is applied by turning heat sink compression screw with axial fan. This socket can be used for hand test and quick turn custom burn-in applications with the most stringent requirements.

Ironwood Electronics
ironwoodelectronics.com
DLVA

PMI Model No. DLVA-50M18D5G-40-LIN-LOG-CD-1 is a dual 40 dB Detector Log Video Amplifier (DLVA) designed to operate between 50 MHz to 750 MHz (LO) and 0.75 to 18.5 GHz (HI) frequency ranges. Employs planar diode detectors and integrated video circuitry for high speed performance and outstanding reliability. It is of superior construction and uses state of the art MIC/MMIC technology.

Planar Monolithics Industries, Inc. has been set up to manufacture and market various MIC/MMIC (Microwave Integrated Circuits and Monolithics Microwave Integrated Circuits) Components, Supercomponents, and Subsystems for applications in Telecommunications, Terrestrial, Satellite, and Mobile-Radio Communications, Defense (ECM, ECCM, ESM, Radars, and Electronic Warfare), Cable-TV, Navigation and Marine Electronics, FAA/ DOT-Avionics, Ground Based Systems, and Microwave Landing Systems.

Planar Monolithics Industries

pmi-rf.com
Permanent Magnet YTOs

Permanent magnet technology delivers our lowest DC voltage (prime power) available and is offered in 2 to 44 GHz standard models and in high performance models up to 44 GHz using frequency doublers. Our surface mount MLSMO and MLOTF series and TO-8 MLTO oscillators are extremely small and offer excellent phase noise and frequency stability. They’re the perfect choice for next generation PXI and compact PCI synthesizer applications.

Our MLPB Series offers a plug-in board design; our MLPM series offers 2 GHz tuning range; our MLPF series is a fixed-frequency design; our MLPW series offers a 4 GHz tuning range; and our MLPX series uses frequency doublers to take MLPW models to 44 GHz. All these oscillator models utilize either a bi-polar, FET or the latest SiGe transistor technology, making them excellent choices for PC Board, PCI, PXI, VME & VXI applications. Commercial and extended temperature range models are available throughout the permanent magnet line.

Micro Lambda Wireless
microlambdawireless.com

Waveguide Band Adjustable Attenuator

The 08MA30 is a full WR08 waveguide band (90 to 140 GHz) adjustable attenuator. Patented (US7952450B2) technology assures a monotonic attenuation function in its attenuation adjustment across the entire operating frequency range.

In addition, RF leakage is mitigated at higher attenuation values.

Located in the high tech Silicon Valley, the staff at OML are pioneers in microwave and millimeter wave products. Our test equipment expertise is traceable to the pioneering spirit at Varian Associates (Solid State Microwave Division), which is globally recognized for the innovative design and manufacture of many of the first microwave products.

OML
omlinc.com
2 Way Power Dividers

Pulsar Microwave manufactures a large selection of 2-way power dividers in narrowband and broadband configurations, covering frequencies from 225 MHz to 70 GHz. They are designed to handle from 10 to 30 watts input power in a 50-ohm transmission system. Microstrip or stripline designs are utilized, and optimized for best performance.

Units come standard with SMA or N female connectors, or 2.92mm, 2.40mm, and 1.85mm connectors for high frequency components.

Pulsar Microwave
pulsarmicrowave.com

Cables, Cable Assemblies, and More

Microwave Components, Inc., was established in 1980 as a specialized RF/Microwave and more recently, millimeter wave stocking distributor. We specialize in interconnect products and low loss cable/cable assemblies and several other RF components from antennas to board level components. More recently, we offer customers an avenue to integrated microwave assemblies for a custom designed solution for evolving market needs for miniaturized multi-function devices. The markets we serve include aerospace/defense, telecommunications, test & instrumentation and others. We hold preferred status from many Government Prime Contractors and support their contractual flow downs passed on.

Microwave Components
mwc-llc.com
Continuing Education: Your Key to Success

Studies reveal that within each 3-5 year period, one-half of an engineer's technical knowledge becomes obsolete. New graduates soon discover that university education provides only the foundation of knowledge that is realistically needed to perform well in the industry. Continued education is a must for survival in today's competitive market. Application of modern computer-aided engineering to RF and microwave circuit and system design is vital to manufacturing products with high quality and yield. Modernization of the design laboratory and production floor is critical to maintaining a competitive edge.

A well-planned continuing education program will enable your company to meet these goals. As a recognized international leader in continuing education, Besser Associates is dedicated to serving the needs of RF and wireless professionals.

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Product Highlights

Video Series: How to Use VSS
A new four-part AWR software e-learning video series demonstrates how to use Visual System Simulator™ (VSS) system simulation software and its impedance-mismatch aware, linear and nonlinear RF/microwave behavioral models to perform budget analysis. These design tools are useful for system architecture development and RF component specification for communications system design. The tutorials demonstrate how to:

- Build a basic RF chain
- Define the characteristics of the amplifier, filter, and mixer components using behavioral models based on parameter-defined, data file and subcircuit implementations
- Perform budget analysis, including cascaded noise figure (NF), third-order intercept point (IP3), 1 dB compression point (P1dB), and more
- Use spectral analysis to simulate spurious tones due to device nonlinearities

Cadence AWR
https://www.awr.com/support/current-users/e-learning

Military-Grade Interconnects
Junkosha is launching two interconnects, the MWX3 series and the MWX161. The MWX3 series is designed for high end military communication and radar systems and features characteristics including excellent temperature phase and amplitude stability, meaning it has the strongest properties for use in the harshest of environments. In addition, the new MWX161 interconnect reaches up to the 67 GHz range, and has been designed for connecting to a 16-port VNA. This is due to the small diameter of the interconnect. To add to its ease of connection, a torque driver is available to mount it onto the narrow pitch connector arrangement board.

Junkosha
junkosha-mwx.com
Product Highlights

High Power Amps
High power pulsed amplifiers are capable of providing over 1KW of peak power above 10GHz. These SWaP-optimized, high-reliability products have been designed to withstand the toughest environments. For custom requirements, Mercury leverages its proven building-block design approach to rapidly deliver a solid-state power amplifier (SSPA) for your application.

Mercury Systems
mrcy.com

Frequency Converters
Norden Millimeter has extensive experience in design and manufacturing of frequency converter and custom assemblies products for both the military and commercial markets. Norden understands that the vast majority of requirements for these types of products involve custom design and packaging per individual customer specifications.

Norden military converters and custom assemblies are used in Airborne (fixed and rotary wing), Shipboard, and Ground Mobile platforms. Military applications include Avionics, Electronic Warfare including (ECM, ESM, ELINT, SIGINT), RADAR applications, radar environment simulation systems, and intelligence, surveillance and reconnaissance (ISR) systems. Norden’s commercial converters and custom assemblies are used in Microwave Communications, Astronomy, and Test Equipment. Whatever the customer requirement, Norden can design and deliver a product that will fulfill the customer’s specifications.

Norden Millimeter
nordengroup.com

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- WR62, WR75, WR117
- WR169, WR226, WR430

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Ducommun offers a diverse array of design, engineering and manufacturing capabilities that service the aerospace and defense market, oil & gas exploration, test and measurement, telecommunications, space and medical markets. With over 50 years of heritage in custom product solutions, the Ducommun team can support your Human Machine Interface, Motion Control Device, RF and custom electronics manufacturing needs.

Ducommun serves the avionics, communications, defense, industrial, intelligent traffic systems, medical, and test equipment markets with millimeter wave products. We design and manufacture products including amplifiers, antennas (horn and patch), mixers, oscillators, multipliers, radar sensors, industrial grade phase shifters, lab components, up/down-converters, along with sub-systems and integrated assemblies.

Ducommun
ducommun.com

Get info at www.HFeLink.com
Pocket Signal Source

Saelig Company, Inc. announces the availability of Triarchy Technologies’ VSG2G5C RF Vector Signal Generator - a cost-effective pocketable USB-connected RF signal source with capabilities that provide standalone and PC-controlled functions comparable to full-size analog RF signal generators. Offering frequencies from 100Hz to 1MHz (low-band) and 100MHz to 2.5GHz (RF Band) with a frequency resolution of 1Hz, this handy unit’s features include frequency sweep, frequency hopping using I&Q modulation, and arbitrary signal generation.

Saelig
saelig.com

Measuring System

The Measuring Division of Kaman Precision Products announced availability of its KD-5100 differential measurement system, which provides resolution to a nanometer of positional change. With its proven stable design, extremely small size, and low power consumption, the KD-5100 is ideal for night vision systems, precision telescope positioning, fast steering mirrors (FSM) for space-based and airborne applications, and image stabilization systems. Kaman engineers work closely with customers to understand their specific application and optimize the KD-5100 to meet custom requirements.

Featuring a small package size – only 2 x 2.12 x 0.75 inches thick – the KD-5100 is a good choice for applications where space is a limiting factor. It is manufactured to MIL-H-38534, with MIL-SPEC components used throughout the electronics module wherever possible. The KD-5100 features rugged construction, with a mean time between failures of better than 238,000 hours in a space flight environment and 55,000 hours in a tactical environment. Kaman also offers the DIT-5200, a commercial version of the KD-5100 for applications where mil-spec requirements, size, weight and power consumption are not critical.

Kaman Precision Products
kamansensors.com
5G: Connector Selection Guide

Amphenol RF released its Wireless Infrastructure Solutions Guide, a digital short-form catalog designed to streamline the interconnect selection process within the wireless vertical. This comprehensive guide provides customers with an overview of the next generation of mobile networks, 5G, and a breakdown of the core applications, alongside valuable product information required for developing the necessary infrastructure to support the increased data rates.

RF technology is crucial for mobile and fixed wireless networks. It plays a key role in the next generation of mobile network standards established by 5G technology in order to enable low-latency applications including safe autonomous driving and 4K video streaming to smartphones. Amphenol RF connectors, cable assemblies and adapters provide high density, low cost solutions to support wireless connectivity.

Amphenol RF
amphenolrf.com

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Custom Capacitor Assemblies

Passive Plus, Inc. (PPI) offers Custom Capacitor Assemblies for high power requirements. Typical assemblies are configured in series and/or parallel combinations, producing higher voltage/current handling capabilities, extended capacitance range and tighter tolerances.

PPI works with requesting engineers to determine best assembly for their applications.

Passive Plus
passiveplus.com
Product Highlights

TEMPEST PC

Equipto Electronics’ TEMPEST PC concept allows customers to choose an up-to-date ATX motherboard, or an HP or Dell i7 PC repackaged for the ultimate in secure operation. The system delivered will be certified to the strictest standard in the industry for devices operating in NATO Zone 0 environment, the NATO SDIP-27 Level A. And because the base PC is a commercial product, the package is very cost-effective.

Each system is fully customizable and typical features include (but not limited to) an Intel i7 processor, ATX motherboard to your specifications, 32 GB memory, storage options, latest Windows operating system, USB 3.0 ports, a card reader for extra security, fiber port options, DB9/DB37 connectors, and a high-performance power line filter. The system measures: 18.50” high x 6.65” wide x 17.50” deep.

Equipto Electronics
equiptoelec.com

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Herotek
herotek.com

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