WEBSITE DIRECTORY

MPD MICROWAVE PRODUCT DIGEST

RF TO LIGHT — OCTOBER 2020

New High Power Amplifier Plus Upgrades

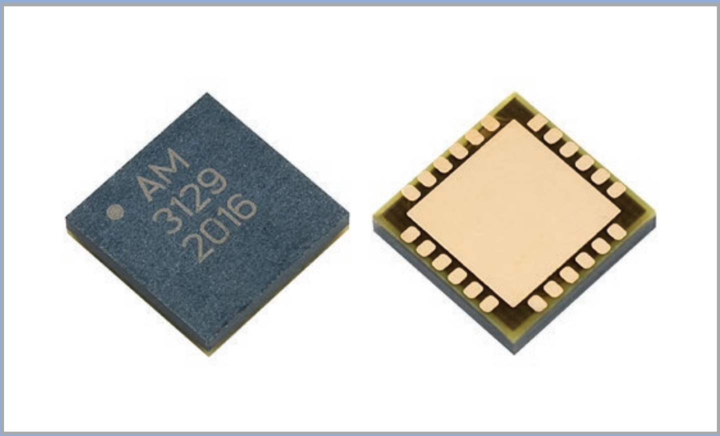
Just introduced, the high power 6000W1000 amplifier provides high power over the 80 to 1000 MHz frequency range. The company has also upgraded three Class A solid-state, broadband amplifiers, models 1000S1G2z5B, 2500A225B, and 5000A225B. The enhanced models power a wide range of applications, including automotive, military, and aviation.

AR RF/MICROWAVE INSTRUMENTATION

Precision NMD Between-Series Adapters

These 2.4 to 2.92mm between-series precision grade NMD connectors are designed for use with microwave applications requiring excellent performance up to 40 GHz. NMD connectors are ruggedized test-port connectors that are specially designed to stabilize the test port cable during testing on many network analyzers.

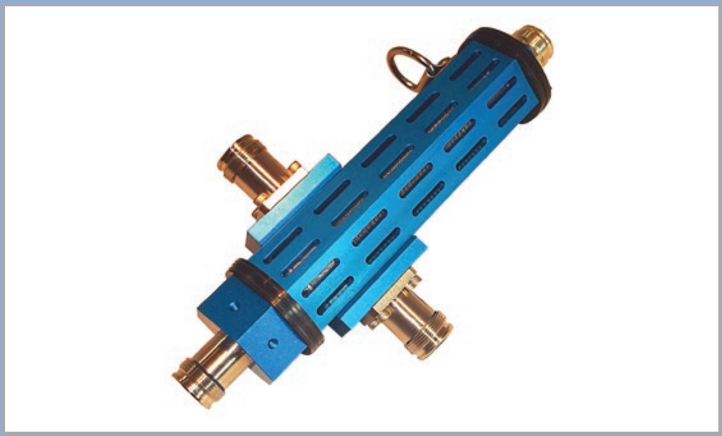
SGMC MICROWAVE



Voltage Tunable Notch Filter Bank

AM3129 is a miniature voltage tunable notch filter bank covering the 1.0 to 6.0 GHz frequency range in a 9mm QFN package. Six notch filters and two bypass paths with SP8T switches on the input and output are contained in the multi-chip module (MCM). Separate tune voltages provide precise control of center frequency and notch bandwidth.

ATLANTA MICRO



PIMOSL Low PIM Calibration Kit

The PIMOSL calibration kit is designed for bench or field sweep tests on low PIM systems. CK-A09 is a single unit with 40W low PIM termination, a 2W resistive termination, and an open and short. Available with female or male type-N, DIN 7-16 or DIN 4.3-10 connectors. It covers the full commercial wireless band (including 5G band) from 300 MHz to 6 GHz.

RD MICROWAVES

Cryogenic-Capable Isolators Improve the Performance of MillimeterWave Systems by Lowering Noise Levels

by Micro Harmonics

NASA-ready technology provides design engineers a new option for lowering received noise in MMW applications.

Silence is golden when it comes to filtering out unwanted reflected noise, especially in extremely high frequency, millimeterWave (MMW) applications. While recent improvements in isolator designs are solving many of these problems, one critical challenge remains: finding isolators that operate optimally under cryogenic conditions.

For manufacturers of ultra-high frequency wireless applications such as 5G and 6G communications, stand-off security scanning, and military defense products, the issue of MMW and cryogenics is relatively new. In fact, some system designers may still be unaware that an isolator built to operate at room temperatures will fail to operate optimally when temperatures are reduced to cryogenic levels.

"That happened to us," says Alexander Anferov, a graduate research assistant in the Schuster Lab at the University of Chicago. "We tried using regular isolators from one vendor. We cooled them down and assumed they would work, but they weren't behaving right."

Anferov, a recent Caltech graduate, looked to NASA and its Jet Propulsion Laboratory just outside of Los Angeles for a solution.

"It turned out they had just commissioned a grant for a company to design isolators specifically for cryogenics," says Anferov. "After talking with them it became obvious from shared experiences that we were actually causing the problem in our setup by utilizing isolators that could not

Figure 1: Some system designers may still be unaware that an isolator built to operate at room temperatures will fail to operate optimally when temperatures are reduced to cryogenic levels. This setup to characterize the quantum properties at the University of Chicago encountered this issue recently, but found a solution in cryo-capable isolators.

Micro Harmonics, Con't on pg 37

Micro Harmonics, Con't from pg 28

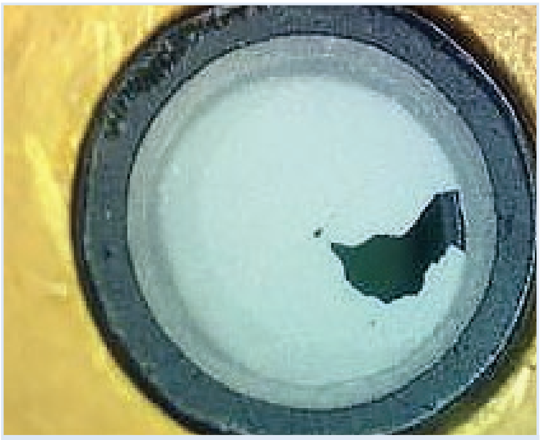


Figure 2: Damage caused by repeated thermal cycling to a thin substrate material spanning a large hole in an aluminum block.

stand up to extremely cold conditions."

Due to the fact that there is no industry standard, MMW manufacturers often, though unintentionally, make components out of metals that, when cooled to cryogenic levels, start superconducting.

"That completely changes the device properties for the worse," adds Anferov. "The real issue is that the results are unpredictable. Surprise resonances and new leakage paths can crop up, and power that used to be absorbed can be

Figure 3: The US Navy asked Plymouth Rock Technologies to decrease the size of the large SATCOM antenna systems on aircraft carriers in order to put them higher up onto the ship's superstructures. However, to do this Plymouth Rock needed cryogenic capable isolators.

reflected instead."

A Universal Challenge

Antenna designers are very familiar with the constant battle of standing waves. Without control, these unwanted waves reflect back into the transmitter to attenuate power output while raising unwanted noise input. Especially in the MMW bands—which cover the frequencies between 30 GHz to 500 GHz—

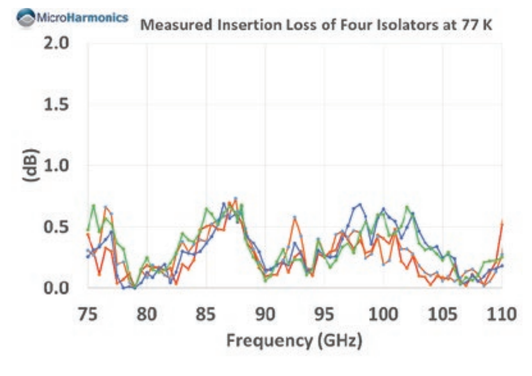


Figure 4: The graph shows measured insertion loss at 77 K for four isolators manufactured by Micro Harmonics Corporation in waveguide band WR-10.

the reduction of transmitted signal strength jeopardizes the battle, almost literally in military applications.

To reduce the voltage standing wave ratio (VSWR) and help increase the signal-to-noise (S/N) ratio, microwave engineers typically rely on isolators (aka Faraday rotation isolators). These discrete components allow electromagnetic signals to pass in one direction but absorb them in the opposite direction, thus reducing noise.

However, Dana Wheeler, CEO of Massachusetts-based Plymouth Rock Technologies, explains how standard isolators often become problematic with next-gen electronics that require components that must withstand more extreme environments.

"We received an SBIR grant from the Navy to decrease the size of the large SATCOM antenna systems on aircraft carriers in order to put them higher up onto the ship's superstructures because the jet-blast from the new fighter planes was damaging the radomes," began Wheeler. "The challenge was to lower the weight and size, without losing any performance."

Plymouth Rock Technologies is comprised of a team of scientists and engineers formed to develop the technology required to meet the challenges in security screening and threat detection.

Wheeler explained that for any antenna system, if you shrink the size of the antenna aperture, gain (G) drops by a logarithmic amount, which is in contrast to the goal. But if you can lower the noise temperature (T), then you can get back the gain that was lost.

"Our solution was to cryogenically cool the low noise amplifier," concludes Wheeler.

"We can get down to less than 100 Kelvins with commercially available cryo-coolers," he continues. "Our biggest challenge was finding an isolator that could perform at those temps. Fortunately for us, a company called

Micro Harmonics, Con't on pg 40

Micro Harmonics, Con't from pg 37

Figure 5: The Schuster Lab at the University of Chicago conducts experiments at temperatures near absolute zero (1 Kelvin). At the extremely high frequencies used in this setup, their work required a specialized cryogenic isolator from Micro Harmonics which did not over-rotate the field and create unwanted issues.

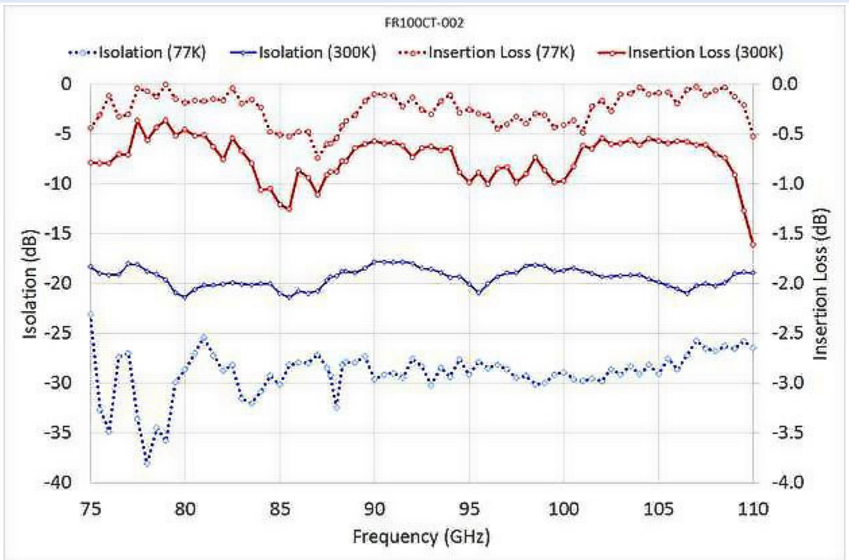


Figure 6: Cryogenic Tradeoff Performance WR - Cryogenic Tradeoff (CT) performance testing was done at the National Radio Astronomy Observatory (NRAO) Central Device Laboratory (CDL). The results for Micro Harmonics WR-10 (75-110 GHz) isolators show the average insertion loss at room temperature (300 K) was 0.7 dB, and drops to 0.3 dB when cooled to 77 K. The maximum insertion loss at 77 K was 0.7 dB. The isolation is greater than 17 dB across the band at 300 K and improves to 25 dB at 77 K.

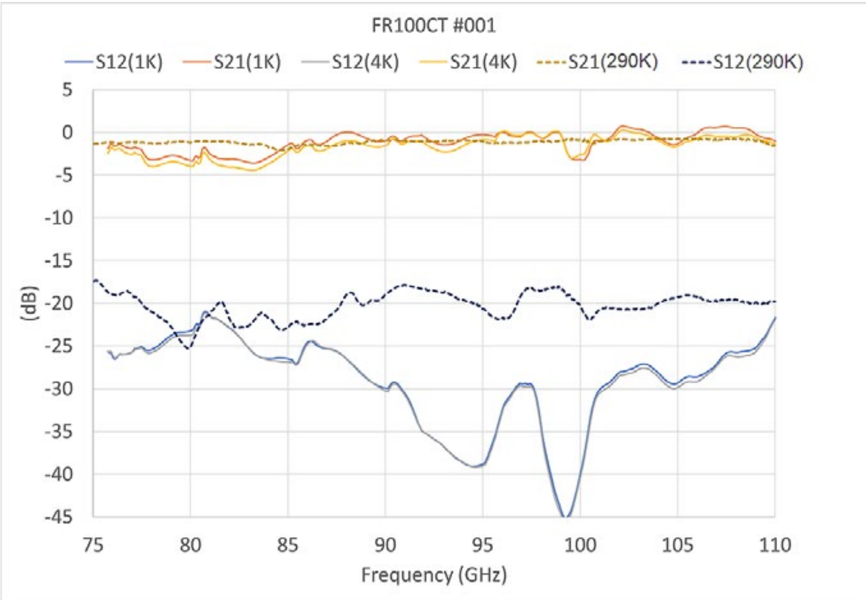


Figure 7: Cryogenic test results carried out at the University of Chicago at 4 K and 1 K compared with room temperature (290 K) data. S21 shows transmission through Micro Harmonics cryogenic isolator, while S12 represents the transmission in the reverse direction. At cryogenic temperatures, forward transmission remains high while reverse transmission decreases, demonstrating low insertion loss and high isolation. Precise measurement of the insertion loss was not possible due to calibration issues in the cryostat. The isolator insertion loss is thought to be less than 0.5 dB across the full WR-10 band.

Micro Harmonics had just designed some specifically for NASA."

Headquartered in Virginia, Micro Harmonics specializes in design solutions for components used in MMW products. Under a NASA contract awarded in 2015, the company successfully developed an advanced line of isolators for 50 GHz to 330 GHz applications. That successful project led NASA to award the company a subsequent grant to address the issue of isolators at cryogenic temperatures.

"Low-noise integrated circuit amplifiers work because of the nature of a Schottky diode or a FET transistor, in that as it gets cooler, it has lower noise," says Wheeler. "However, cryogenic low noise amplifiers are not cheap. With ferrite isolators you get more bang for the buck: a better gain over noise figure at room temperatures, and even more so at cryogenic temps."

There are numerous material issues that must be addressed to ensure that an isolator is able to withstand the rigors of thermal cycling. The substantial temperature dependence of the ferrite magnetization is also a challenge. Ferrite magnetization follows a modified Bloch law, increasing by more than 20% when cooled from room temperature down to 4 K. As the temperature decreases, there is less thermal energy and it is easier to align magnetic dipoles in the ferrite.

The design used by Micro Harmonics compensates for the change. It also uses magnetic armatures designed to achieve a focused, uniform bias field in the ferrite. This strong magnetic saturation allows the shortest possible length of ferrite—hence a small footprint—while achieving a low insertion loss of less than 1 dB at 75-110 GHz and only 2 dB at 220-330 GHz.

Proven Results in Research and Practice

While manufacturers are now realizing the benefits of isolators for cryo applications, on the research side, Anferov and his team at the University of Chicago are on a mission to see just how low they can go.

"Our lab does experiments at 1 Kelvin, and there are components that can function at temperatures close to absolute zero," says Anferov. "However, at the extremely high frequencies demanded by today's applications, it takes a specialized ferrite isolator to perform consistently under such extremes. A ferrite that won't over-rotate the field and create unwanted issues."

It is essential for any MMW application that each isolator is tested over the full frequency band on a vector network analyzer to ensure compliance. This includes reliability testing (Belcore) and cryogenic cycling tests. Comprehensive VNA test data should back up every component since there are often signatures in the data that can be missed.

"Knowing that isolators would now perform in the MMW bands at single-digit Kelvin temperature was good news for us because that was one less component we had to worry about," says Anferov.

For Wheeler's mil-spec work, the cryogenic isolators will help ensure the reliability of Plymouth Rock's technology and products.

"In harsh environments, the contaminates on the radome of the antenna can really add to the system noise figure due to reflections (VSWR)," says Wheeler. "By integrating a cryogenic isolator in front of your low noise receiver you will realize a reduction in the noise and increase the gain ratio."

For more information on cryogenic isolators contact: Micro Harmonics Corporation, Ph:540.473.9983, Ph: 833.473.9983 (toll free in the U.S.), Fax: 844.449.1561 (toll free) email: sales@mhc1.com, www.MicroHarmonics.com

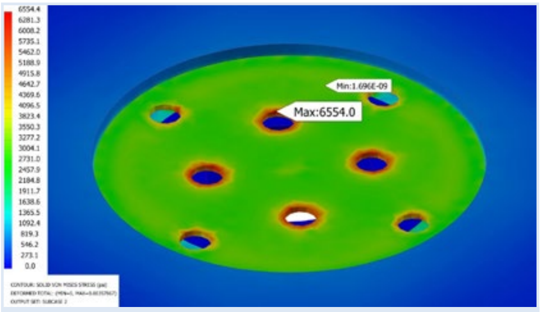


Figure 8: The interior view of a Micro Harmonics' isolator shows the result from a thermal stress simulation. The structure is an aluminum plate with a large hole in the center (other holes are for outgassing). A Mylar disc spans the hole and is epoxied along the periphery to the aluminum plate. The Mylar and the aluminum have different rates of thermal expansion, so when the isolator is cooled, thermal stresses are imparted to the structure.

• MICRO HARMONICS •

IN THE NEWS

Attopsemi's I-fuse™ Memory Solution Now Qualified and Available on X-FAB's 130nm RF-SOI Technology

X-FAB Silicon Foundries, the leading analog/mixed-signal and specialty foundry, together with Attopsemi, innovator of I-fuse™ one-time programmable (OTP) IP solutions, have entered into a collaboration to satisfy the memory requirements of 5G technology. The companies have announced successful qualification of Attopsemi's I-fuse OTP memory in relation to X-FAB's XR013 open-platform foundry 130nm RF-SOI technology. This qualification will allow customers to benefit from the incorporation of a compact (<0.2mm2 surface area) and robust OTP block into the core XR013 technology module, but without requiring additional or custom processing. Read operation is possible at both 2.5V and 1.8V for MIPI compatibility.

X-FAB's XR013 is a feature rich, open-platform, 130nm technology that is optimized for RF applications. These include cellular infrastructure, Wi-Fi connectivity, automotive V2X communications, IoT, etc. The cooperation between Attopsemi and X-FAB presents greater scope for designers to integrate digital content with analog trimming or data storage into next generation deployments, such as 5G New Radio (NR). A key benefit of using Attopsemi I-fuse OTP memory on the XR013 RF platform is the flexibility with which RF products can address different regional market requirements via a single chip design (as different configurations can be stored). This will lead to project development cost savings, as well as facilitating inventory management.

"We're very excited about the prospect of our I-fuse™ IP now being qualified for incorporation into the X-FAB XR013 process," said Shine Chung, Chairman of Attopsemi. "We're very pleased that our OTP was chosen by X-FAB's customers for 5G applications. Thanks to the high reliability, high quality and fully testable IP, our I-fuse™ has been proven to meet X-FAB's stringent demands in their advanced processes."

"Close collaboration with Attopsemi has created a cost-effective OTP memory solution for our customers using XR013," Dr. Greg U'Ren, Director of RF Technology at X-FAB, added. "This will be pivotal in enabling our customers to increase their on-chip functionality, giving them a strong foundation for further innovation and allowing the requirements of different geographic locations to be attended to."

The qualified Attopsemi I-fuse OTP solution is available for clients from X-FAB's customer portal "My X-FAB". For more information, please contact at X-FAB at https://www.xfab.com/about-x-fab/contact-overview/sales-world-wide/