METAMAGNETICS®

METAMAGNETICS COMPANY OVERVIEW

U.S. based, and veteran owned, Metamagnetics® develops and markets RF and microwave solutions to enhance the performance and effectiveness of mission-critical security, surveillance, and communication systems. Our unparalleled knowledge of electromagnetics and materials science empowers break-through technologies that can bring significant value to defense and commercial projects. Efficient and agile, our team can help you rapidly design and deploy innovative solutions for current and next-generation radar, sensing, and related systems.

Capabilities

- Revolutionary RF interference mitigation solutions for cosite, jamming, and various other forms of interference
- Low profile, high power handling microstrip ferrite phase shifters for cost effective phased arrays
- Low profile, high power handling, tunable microstrip ferrite filters for systems operating in dense electromagnetic environments
- Micro circulators and isolators that do not require biasing magnets (self-biased)
- Advanced ferrite materials for nonlinear transmission lines and high-power microwave generation
- Low profile, compact, broadband, metamaterial-based antennas

Partnerships

Lockheed Martin
Raytheon
Northup Grumman
Rockwell Collins
Viasat

Office of Naval Research NAVSEA
Army PEO Missiles and Space
DARPA
SPAWAR
CERDEC

Contact

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Director, Business Development
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*ITAR registered and DCAA Compliant

ABOUT METAMAGNETICS®

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METAMAGNETICS®

CONSULTING SERVICES

A spin-out from the Northeastern University Center for microwave Magnetic Materials and Integrated Circuits (CM3IC)—a world leader recognized in microwave and mm-wave ferrite materials, metamaterials, and multiferroics, Metamagnetics®' knowledge and expertise in leveraging ferrite materials and technology in current and next-generation systems is unmatched. Metamagnetics' team has extensive industry experience working with the armed forces, DARPA, and major US defense prime contractors.

Our mission is to optimize existing systems and components or enable entirely new ones by replacing out-of-date, inefficient ferrite devices and materials with new state-of-the-art concepts and compositions. Metamagnetics has demonstrated utilizing the correct materials within a microwave system can directly increase performance due to increased efficiency, reduced size and weight, or reduced cost.

Design Services

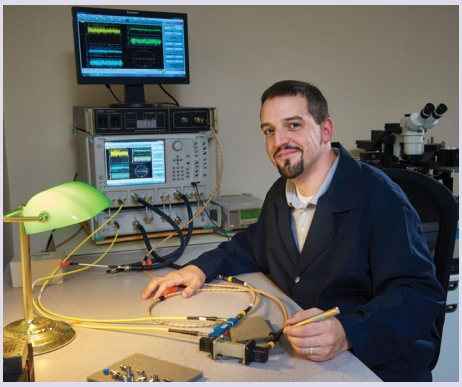
Metmagnetics' expert design staff is comprised of Ph.D., scientists, engineers and consultants who collectively have more than 100 years of experience in the design, prototyping, and manufacturing of current and next-generation microwave devices. Metmagnetics leverages the core competencies of the company's staff and consultants for custom design and prototyping services, and is focused on the optimization of microwave devices such as antennas, circulators, phase shifters and filters.

We take great pride in working collaboratively with our customers and providing responsive, flexible services to ensure each device design meets or exceeds all customers specifications.

TEST, MEASUREMENT, AND FABRICATION SERVICES

Metamagnetics has a wide range of test, prototyping, and measurement equipment, enabling us to offer fabrication, testing, and characterization services of structural, magnetic, and high frequency properties of materials and devices. Upon request, all of Metamagnetics services can be provided with expert analysis of data at competitive rates.

Material characterization capabilities include:



- Vibrating sample magnetometry
- Ferromagnetic resonance spectrometry
- Complex permeability and permittivity spectroscopy (0.1 to 50 GHz)
- X-ray diffractometry
- Power core loss characterization (0.1 to 10 MHz)
- Optical particle size analysis (100 to 1000 nm)
- Scanning electron microscopy

Device Characterization facilities include:

- Vector network analysis (0.1 to 50 GHz)
- Impedance analysis (10 kHz to 100 MHz)
- Spectrum analysis (100 Hz to 22 GHz)
- Pulsed and continuous wave power analysis (S and X band)
- Probe station and microstrip/stripline test fixtures

Materials and device fabrication facilities include:

- Compaction presses with and without application of magnetic fields
- Vacuum and gas flow furnaces
- Machining and polishing
- Powder processing
- Photolithography
- Wire bonding

Contact us today to learn more about our services.

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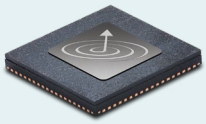
METAMAGNETICS®

AUTO-TUNE FILTER (AtF)



A superior alternative to limiters and filters, Metamagnetics®' Auto-tune Filter provides a broadband, fast-response, simple solution that protects receivers from electromagnetic interference (EMI) and ensures that signals-of-interest are detected. These devices have a power threshold level which no one signal can exceed. If one or more signals exceeds the threshold, the AtF automatically limits it by attenuating the dangerous signal. Simultaneously, desired signals operating below the power threshold pass through the system unaltered. Applications include military EW, radar, and comms along with commercial applications such as wireless communications and satellite broadcasting.

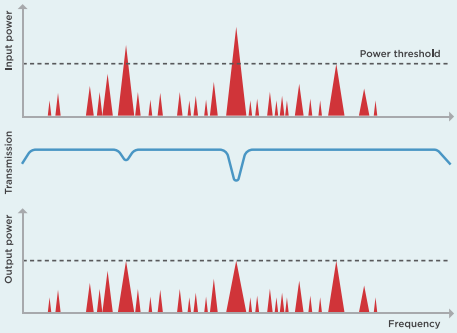


Fig. 1. The AtF provides automatic selective attenuation (aka signal limiting) of above-threshold power signals while all other signals propagate unaltered. This capability allows for the mitigation of EMS threats and interference with improved performance at a fraction of the cost.

Features

PROBLEM

Time Lag: Traditional tunable RF filters have a search-and-respond approach, making the process time consuming. Sophisticated software is required to reduce the power of the detected offending signal. This causes a lag from when the signal hits to when the system reacts, and in that window the system can be compromised.

Protection: Catch-all protection measures shut off the input to the receiver until the threat is gone, preventing harmful signals from damaging your system at the cost of hindering desired signals necessary to communication efforts.

Limited Tones Per Device: Typical RF notch filters are only able to mitigate one tone per device, thereby limiting the user to determine how many, which frequency, and what direction the interference is coming from. This rigidity leaves systems designers to attempt to predict the number of signals their devices will encounter in the field.

SOLUTION

Unlike traditional RF filters, Metamagnetics' Auto-tune Filter does not rely on digital components to slow it down. It has a fast response time and excellent selectivity taking less than 50 nanoseconds to remove the interference.

Metamagnetics' Auto-tune Filter automatically adapts to filter interference above a preset power level without attenuating desired below threshold signals.

Adaptable across multiple platforms for land, sea, and air solutions, Metamagnetics' Auto-tune Filters have no limitations on number of signals that can be attenuated in band, including intermods.

Reflective Auto-tune Filter Specifications

Frequency Range (MHz)	Instantaneous Bandwidth (MHz)	Insertion Loss (dB)	Return Loss (dB)	P1dB Power Threshold (dBm)	Selectivity (MHz)	Peak Power (W)	Package
1400 to 2100	Full Band	2.5	12	-15	5	30	5mm QFN
960-1215	Full Band	3.0	12	-30	5	30	5mm QFN
1200 to 1400	Full Band	1.5	12	-15	5	30	5mm QFN
1400 to 1600	Full Band	1.5	12	-15	5	30	5mm QFN
1000 to 1200	Full Band	3.5	12	-23	5	30	10mm QFN
1300 to 2600	Full Band	5.0	12	-8	5	30	10mm QFN
Custom Designs							
300 to 1000	200	6	12	-30 to -10	5	30	Coaxial
	450	8	10	-30 to -10	5	30	Coaxial
	Full Band	10	10	-30 to -10	5	30	Coaxial
1000 to 3000	300	2.0	12	-30 to -10	5	30	5mm QFN
	500	3	12	-30 to -10	5	30	Coaxial
	900	3	10	-30 to -10	5	30	Coaxial
	1300	5	10	-30 to -10	5	30	10mm QFN

Absorptive Auto-tune Filter Specifications

Frequency Range (GHz)	Instantaneous Bandwidth (MHz)	Insertion Loss (dB)	Return Loss (dB)	P1dB Power Threshold (dBm)	Selectivity (MHz)	Peak Power (W)	Package
2 to 4	Full Band	3.2	12	+5	25	200	0.5" x 0.5" x 2.5" SMA
4 to 8	Full Band	2.6	15	+12	25	200	0.5" x 0.5" x 2.5" SMA
8 to 12	Full Band	3.0	15	+18	25	200	0.5" x 0.5" x 2.5" SMA
9.1 to 9.8	Full Band	1.5	15	+10	25	200	0.5" x 0.5" x 1.5" SMA
9.1 to 9.8	Full Band	1.5	15	+32	25	200	0.5" x 0.5" x 1.5" SMA
9.1 to 9.8	Full Band	1.5	12	+10	Limiter Only	up to 1 kW	1.25 x 0.65 x 3.5" SMA
12 to 18	Full Band	4.0	15	+23	25	200	0.5" x 0.5" x 2.5" SMA
Custom Designs							
2 to 18	500	1.5	12	0 to +30	25	200	Coaxial
	1000	1.5	12	0 to +30	25	200	Coaxial
	2000	2	12	+5 to +30	25	200	Coaxial
	Full Band	4	12	+5 to +30	25	200	Coaxial

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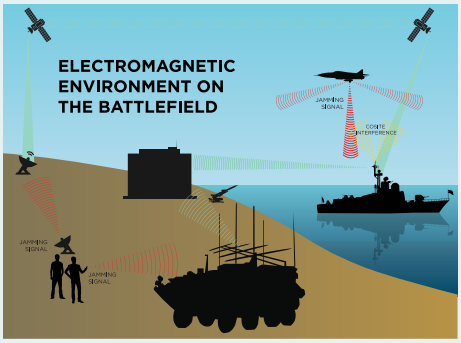

Fig. 2. To the left are some examples of the electromagnetic environment on the battlefield. Secure communications are crucial to maintain communications from land, to sea, to air, to even space. At any moment these systems could be under attack including small handheld systems by insurgents, advanced widespread systems like jet carried jamming systems, and even interference from one's own electronic systems.

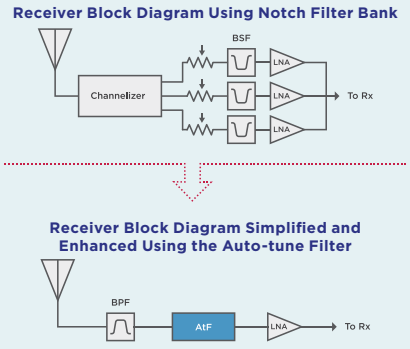

Fig. 3. A single Auto-tune Filter replaces an entire tunable notch filter bank. Since the AtF tunes automatically to any number of notches, this eliminates the need for sensing and control circuitry greatly reducing system complexity.

Contact us today to learn how Metamagnetics' Auto-tune Filters can improve your application.

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METAMAGNETICS®

KA-BAND SELF BIASED CIRCULATORS AND ISOLATORS

Typical Circulator Dimensions

Features

PROBLEM	SOLUTION
Size: The biasing magnet of traditional circulators and isolators can be up to 90% of the component size.	Metamagnetics® circulators have no magnet, producing smaller components, allowing more space to adapt circulators and isolators for higher frequency.
Weight: Missiles, UAV's, and space systems are weight-sensitive to the gram, and the magnets associated with traditional circulators exacerbate this problem.	Metamagnetics has achieved a 95% reduction in component weight with the self-biased design by eliminating the dependency of the rare-earth biasing magnet.
Resistance: To avoid interference with the circuitry, a traditional circulator has its magnet attached by a weak epoxy. This creates a significant problem in any application with high shock or vibration.	Metamagnetics self-biased circulators have been tested to survive over 50,000 Gs enabling new communication platforms for small form factor munitions.
Economical: The manufacturing process can be inefficient and costly.	Metamagnetics has re-engineered the product design enabling the removal of the costly steps in the manufacturing process.

Options

- Lower center frequencies with slightly reduced performance
- Rectangular footprint with Y or T port configurations
- Termination options for isolators include small integrated termination or high-power dc-isolated meander-line terminations
- Ground vias for coplanar waveguide launches
- Surface mount or connectorized

Mounting

These self-biased circulators and isolators can be mounted to a housing or printed circuit board using conductive epoxy or solder. Metamagnetics works with your specific process temperature profiles ensuring magnetic stability of the devices.

Electrical interconnects can be implemented using wire bonds or ribbons. Metamagnetics can design your circulator or isolator to absorb some or all of your bond wire or ribbon inductance.

Self-biased High Frequency Circulators/Isolators

	Frequency Range (GHz)	BW	Insertion Loss (dB)	Isolation (dB)	Avg. Power (W)	Input/Output	Production or Development	Operating Temp (°C)	Storage Temp (°C)	Layout and Dimension
Circulator	27-29	half	0.8	15	4	GSG chip+wire	Production	-25 to +65	-55 to +145	Hexagon: 0.120" Diameter
Circulator	33-37	full	0.8	15	4	GSG chip+wire	Production	-25 to +65	-55 to +145	Hexagon: 0.120" Diameter
Circulator or Isolator	38.4-40	full	1.2	15	4	SMT	Production	-25 to +55	-55 to +145	Square: 0.080" x 0.070"
Circulator or Isolator	26.5-40	up to 15%	Call for info							
Circulator or Isolator	65-110	up to 20%	Call for info							
Circulator or Isolator	26.6-29.2	full	1.2	15	10	SMT	Production	-25 to +55	-55 to +145	Square: 0.120" x 0.120"
Circulator	34-36	full	1.5	15	10	MS chip+wire	Production	-25 to +55	-55 to +145	Square: 0.110" x 0.100"
Circulator or Isolator	26.5-40	up to 20%	Call for info							

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Our team of experts can help you find the best fit with a pre-existing component or a custom designed solution to meet the most rigorous specifications of both DOD and commercial customers.

Contact us today to learn more about our self-biased circulators and insulators.

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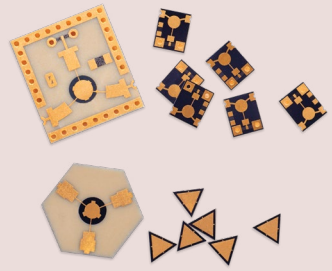
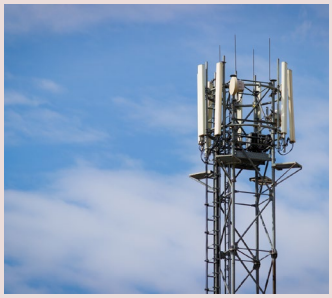
METAMAGNETICS®

SELF-BIASED CIRCULATORS FOR 5G

The next generation in cellular is coming to help the insatiable global demand for data consumption. A singular unifying frequency is not yet established, but several key bands have already been allocated for testing; all of which are in the Ka-band and above frequency ranges. Traditional circulators at these higher frequencies are impractical due to their large physical size and many system engineers are struggling to find alternative solutions for their receivers.

Metamagnetics®' self-biased circulators and isolators are going to be important players in 5G thanks to their revolutionary size reduction technology, ensuring maximum performance at 1/10th the size of a traditional microstrip circulator. Composed of advanced proprietary materials, which do not require biasing magnets, self-biased circulators are ideal for weight, size and cost constrained systems. Other applications include high frequency Wi-Fi, mm wave communications, and other SWAP constrained RF systems.





Specifications

Frequency	26.6 – 29.2 GHz	38.4 – 40.0 GHz
Isolation	16 dB min	18 dB min
Insertion Loss	1.6 dB max	1.3 dB max
Return Loss	15 dB min	17 dB min
Package Size, Approximate	0.243" X 0.220" X 0.096" (6.2 mm X 5.6 mm X 2.4 mm)	0.085" X 0.069" X 0.007" (2.2 mm X 1.8 mm X 0.2 mm)
I/O Connections	PCB Surface Mount	PCB Surface Mount
Additional Notes	Shielded package	

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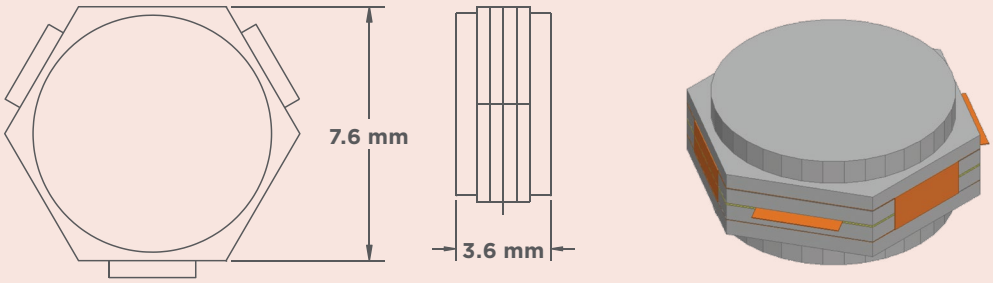
METAMAGNETICS®

LUMPED ELEMENT CIRCULATOR

Typical Circulator Dimensions



Tuning

- The lumped element circulator can be tuned for any center frequency in the range of 0.8—2.4 GHz using external customer-furnished capacitors and inductors. A typical tuning network consists of one shunt capacitor, one series capacitor, and one series inductor.
- Wider bandwidths can be achieved using more complex tuning networks.

Mounting

- These circulators can be mounted to a housing or printed circuit board using conductive epoxy or solder.
- Alternatively, these circulators can be supplied with mounting flanges for screw attachment.
- Electrical interconnects can be implemented by soldering the circulator tabs to a printed circuit board.

Specification

Frequency GHz	Bandwidth %	Isolation dB (min)	Insertion Loss dB (max)	VSWR (max)	Power Handling (Watt CW)	Operating Temp (°C)
0.8 - 2.4	10	20	0.5	1.25:1	10	0 to +70

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METAMAGNETICS®

FERRITE PHASE SHIFTERS

Metmagnetics®' ferrite phase shifters are expertly designed with low insertion loss and high-power handling capability to satisfy the requirements of current and next-generation phased array systems. Available in surface mount or connectorized packages, components are manufactured to fit array spacing and the most demanding performance requirements.

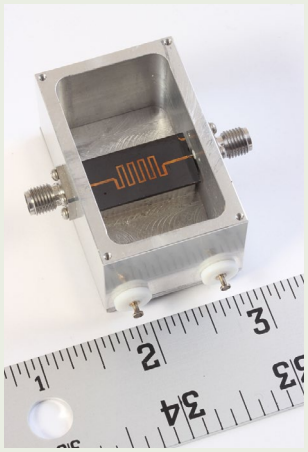

Fig. 1. Ferrite phase shifters manufactured to fit array spacing and the most demanding performance requirements.

Phase shifters can be deployed in surface, shipboard, airborne or space platforms at low cost because they do not require hermetic packaging as they are naturally radiation hardened. Metmagnetics' phase shifters are inherently analog devices, so high bit resolution can be achieved without a linear scale up of losses, a disadvantage of digital semiconductor devices.

Metmagnetics also develops and manufactures high efficiency, low power driver circuitry. The drivers can be assigned to address the most stringent tuning accuracy, response time, and jitter specifications. Continuously driven or latched operation can be realized to meet the power consumption requirements of a wide range of platforms. The result is a broadband, low loss, low cost, and high-power handling component.

The combination of high peak and average power handling capability with low insertion loss and low power consumption makes Metmagnetics' phase shifters well suited for both passive and corporate feed phased arrays and other radars. Metmagnetics has the manufacturing capacity in place to fill both small and large orders, and our team works diligently to ensure your product is expertly designed to meet all specifications.

Contact us today to learn more about our ferrite phase shifters.

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METAMAGNETICS®

HIGH POWER RADIO FREQUENCY PULSED SOURCE

The US Military relies on directed energy weapons to disrupt, damage or destroy adversary electronic equipment at a distance while maintaining collateral damage. Directed energy weapons of interest include high-energy lasers and high-power microwave/ radio frequency (HPM/HPRF) sources.

Metamagnetics®' ferrimagnetic Nonlinear Transmission Line (NLTL) offers an effective alternative solution to large and expensive traditional vacuum-based HPRF sources. Unlike traditional HPRF systems, Metamagnetics' ferrimagnetic NLTLs are drastically smaller and light weight; enabling employment of practical HPRF systems on ground vehicles and aircraft- increasing mobility. Metamagnetics' NLTL provides the added benefit of frequency tunability which reduces costs compared to large and expensive traditional HPRF systems.

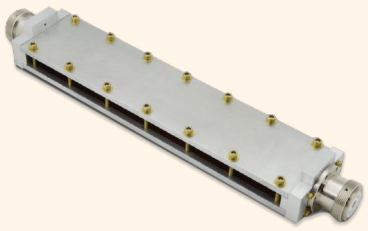

Fig. 1. Metamagnetics Ferrimagnetic non-linear transmission line (NLTL) is an all solid-state solution comprised of a planar design and compact footprint.

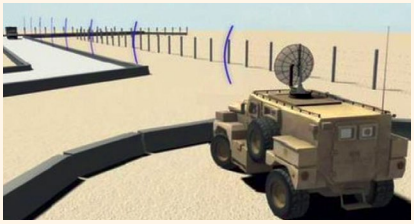

Fig. 2. NLTL allow for ground penetrating radar technology and the detection of IED's, to disrupt/destroy electronic triggers, initiate premature detonation, and inhibit radio-controlled detonation.

Features

Frequency Agility: The frequency radiated from the NLTL can be altered in real time enabling one system to be used for a broad range of targets and operational scenarios on the battlefield.

Solid-State Technology: Solid-state components allows for improved reliability and longevity of the NLTLs.

Mobility: Metamagnetics' use of cost-effective solid-state componentry increases reliability and eliminates expensive and bulky vacuum components utilized in legacy HPRF systems. As Such, Metamagnetics systems are compact, lightweight, reliable and suitable for incorporation on ground vehicles as well as aircraft- increasing mobility.

Dynamic Tuning, Innovative Waveforms: Signals can be tailored to more effectively disrupt targets enabling dynamic adaption and higher success rate per system.

Reduced Heat Generation And Electrical Energy Consumption: To improve the power efficiency and further reduce the weight and size of the system, Metamagnetics' planar NLTL features permanent magnetic biasing system instead of current-driven solenoids.

Power: Capable of levels of 10 MW power, at a minimum, and rep-rates on the order of kHz in the frequency range of VHF to S band.

Mounting

The HPRF system is composed of three major sections. The HV source generates the power, the RF source (NLTL) converts the power to microwaves, and the antenna which radiates those microwaves out at the target. Metamagnetics' NLTLs can be coupled directly to a variety of high voltage sources (spark gap, solid state) and antennas using high voltage connectors.

Options

- Coaxial Ferrimagnetic NLTL
  - Higher ranger of frequency tuning
  - Custom sizes available
- Planar Ferrimagnetic NLTL
  - Smaller footprint
  - Higher peak power
  - Custom sizes available

Contact us today to learn more about our ferrimagnetic NLTLs.

*This item is ITAR controlled

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