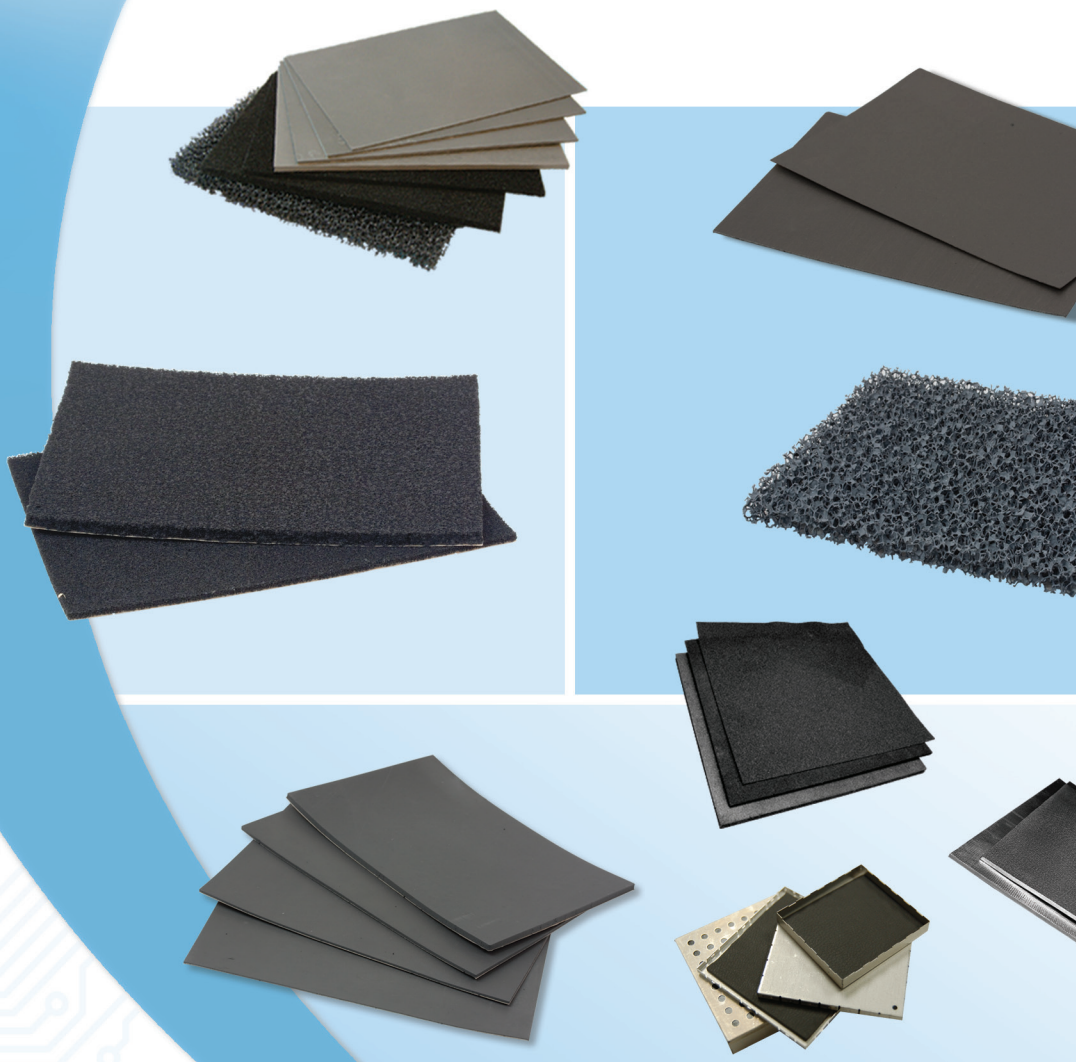
Microwave Absorbing Materials

SOLUTIONS



Laird TECHNOLOGIES®

Innovative **Technology**
for a **Connected** World

www.lairdtech.com

ABOUT **LAIRD TECHNOLOGIES**

Laird Technologies designs and manufactures customized, performance-critical products for wireless and other advanced electronics applications.

The company is a global market leader in the design and supply of electromagnetic interference (EMI) shielding, thermal management products, specialty metals, signal integrity components, and wireless antennae solutions, as well as radio frequency (RF) modules and systems.

Laird Technologies is the world leader in the design and manufacture of customized, performance-critical products for wireless and other advanced electronics applications. Laird Technologies partners with its customers to customize product solutions for applications in many industries including:

- Network Equipment
- Handsets
- Telecommunications
- Data Transfer & Information Technology
- Computers
- Automotive Electronics
- Aerospace
- Defense
- Medical Equipment
- Consumer Electronics
- Industrial

Laird Technologies offers its customers unique product solutions, dedication to research and development, as well as a seamless network of manufacturing and customer support facilities across the globe.

ANTENNAS & RECEPTION
WIRELESS REMOTE CONTROL
EMI SOLUTIONS
THERMAL MANAGEMENT
WIRELESS M2M & TELEMATICS

Laird TECHNOLOGIES®

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DESIGN GUIDE FOR COMMERCIAL MICROWAVE ABSORBERS

Microwave absorbers have been used in military applications for several decades. They have been traditionally used for EMI reduction, antenna pattern shaping and radar cross reduction. More recently with the rise of wireless electronics and the movement to higher frequencies microwave absorbers or "noise suppression sheets" (NSS) are used to reduce electromagnetic interference (EMI) inside of the wireless electronics assemblies.

Two types of NSS are used for these types of applications. They are described below:

MAGNETIC ABSORBERS

These are thin (.1 to 3 mm) polymeric materials filled with magnetic particles. These materials have both high permeability (magnetic loss properties) and high permittivity (dielectric loss properties). This combination of properties makes these materials very effective in eliminating high frequency EMI

Laird Technologies has two product types that are used for commercial applications:

- Q-Zorb HP (high permeability) uses novel magnetic fillers to achieve extremely high permeabilities at low frequencies. This allows for relatively thin materials to provide EMI reduction at frequencies below 2 GHz. This material comes in thicknesses of .15 mm and .5 mm.
- Q-Zorb HF (high frequency) is the optimum choice for cavity resonance problems from 2-18 GHz and higher. The material is available in thicknesses from .5mm to 3.2 mm and is supplied in sheets or as die cut components. Both materials are UL-VO and ROHS compliant. They can be supplied with pressure sensitive adhesive (PSA) for ease of installation.

FOAM ABSORBERS

These absorbers are based upon open celled foam impregnated with a carbon coating. The carbon coating makes the resultant product lossy at microwave frequencies, indeed acting like a free space resistor to incoming electromagnetic energy. These foam products range from 3.2 mm to 6.4 mm for internal cavity applications and can be several centimeters thick for outdoor applications. Two main product types are offered by Laird Technologies

- RFLS- Lossy sheets are uniformly loaded with the carbon coating and used at 3.2 mm and 6.4 mm thick. They are supplied as sheet materials and may have PSA applied and fire retardant coatings.
- RFRET- is a reticulated foam based absorber. The materials are thicker ranging from 3/8" to 2" in thickness. They can be used for air filtration and EMI, or on the inside of cabinet doors for broadband EMI attenuation.

ABSORBER APPLICATIONS

Electronic operating at high frequencies can have problems with emission of high frequency noise. Once put inside an enclosure, the energy will add in phase at certain frequencies to cause resonances which will hinder the performance of the device. A good example of this phenomenon is seen in Figure 1. The amplifier was measured in the condition shown and subsequently remeasured inside of its enclosure. When put inside the enclosure the performance was severely degraded due to cavity resonances inside of the enclosure. The measured data is shown below in Figure 2.

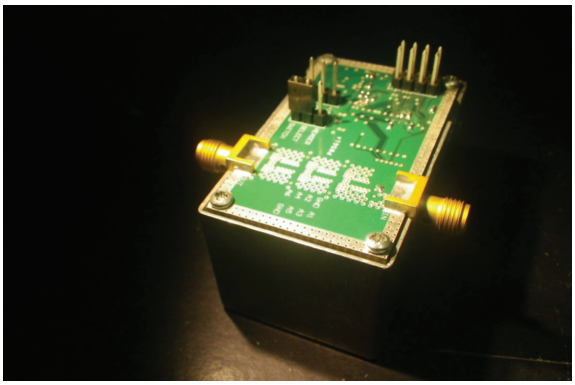


Figure 1. Variable Gain Broadband Amplifier 100 MHz to 12 GHz

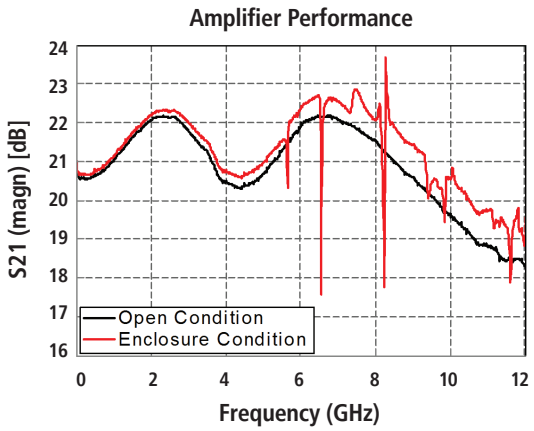


Figure 2. Performance of Amplifier in Open Condition and Inside Enclosure

DESIGN GUIDE FOR COMMERCIAL MICROWAVE ABSORBERS

To improve the performance of the device, Laird Technologies Q-Zorb microwave absorber was put on the inside cover of the enclosure. This is a standard way in which absorbers are used. Q-Zorb is supplied with a pressure sensitive adhesive to allow for ease of installation. The cover is shown below in Figure 3.

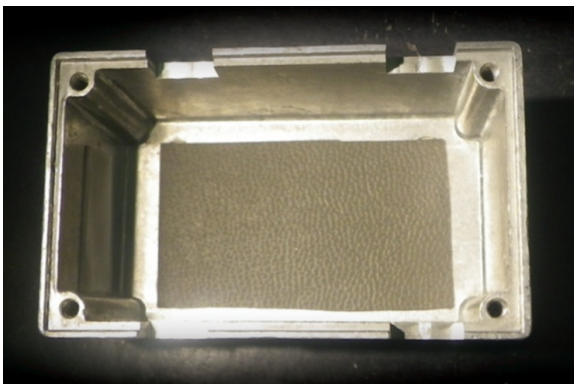


Figure 3. Enclosure with Q-Zorb PN 2238 Installed

The amplifier was then measured inside the enclosure with the Q-Zorb in place. The performance of the amplifier now mirrored the open condition by absorbing the internal reflections and surface currents. Figure 4 shows this measurement.

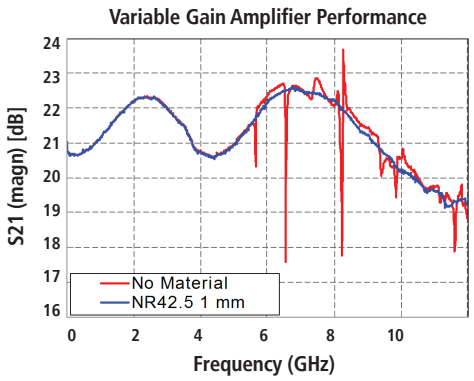


Figure 4. Performance of amplifier inside enclosure showing performance of Absorber Material (PN 2238)

MAGNETIC ABSORBER VS. LOSSY FOAM

In these enclosure applications the designer needs to understand the tradeoffs between using the magnetic absorber vs the lossy foam type absorber. The foam absorber is a much more cost effective solution, provided it will meet the performance goals. However there are a couple major reasons to use the magnetic sheet absorbers (Q-Zorb)

- Foam absorbers can breakdown over time causing resistive particles to drop onto to circuit traces
- Energy along the side walls of cavity are H field (magnetic) dominated currents. The E field is at a minimum along the walls and materials with only dielectric loss (resistive foams) will not perform very well in these applications. The magnetic absorbers have high H field loss and attenuate these currents.

Figures 5 and 6 below do show the use of a lossy foam absorber inside of an amplifier cavity.

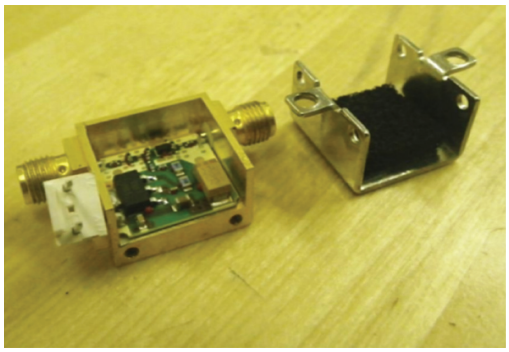


Figure 5. Amplifier and Enclosure with Lossy Foam Inside

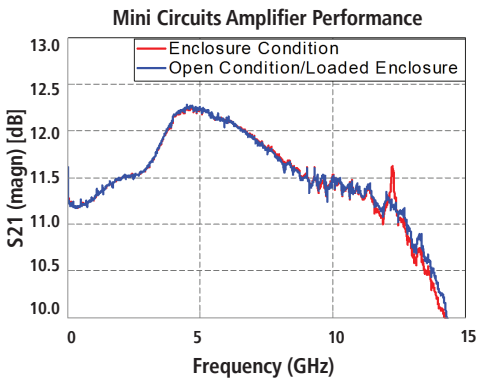


Figure 6. Performance in Enclosure and Using Foam Absorber

DESIGN GUIDE FOR COMMERCIAL MICROWAVE ABSORBERS

TUNED FREQUENCY VS SURFACE WAVE ABSORBERS

Laird Technologies offers two types of Q-Zorb materials: tuned frequency and surface wave absorbers. Tuned frequency materials are used in far field applications such as direct radar reflections off of an object. Surface wave absorbers are used for high angle of incidence applications and for cavity noise suppression. Many design engineers that have a cavity noise problem at a certain frequency want to use a tuned frequency absorber tuned to that frequency. However that is not the best performance they can achieve. Note that the tuned frequency materials offer good performance at normal angles of incidence, but perform more poorly at higher angles of incidence. Inside the cavity noise generated is at a number of angles of incidence and also a significant of surface wave energy. The surface wave materials offer better performance in these applications. The curves below compare a tuned frequency absorber at normal incidence and at all angles of incidence. Note the improved bandwidth of the surface wave loading especially at higher angles of incidence. The Q-Zorb samples in the Laird Technologies Absorber sample kit are the surface wave absorber type. They are the best solution for solving cavity noise problems.

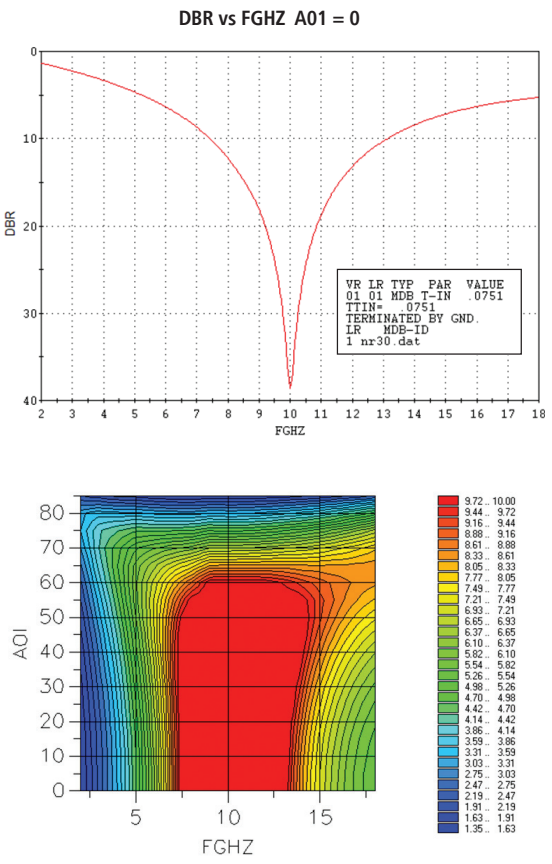


Figure 7. Tuned Frequency Q-Zorb at 0 degrees Angle of Incidence and at all angles. Red area shows best performance

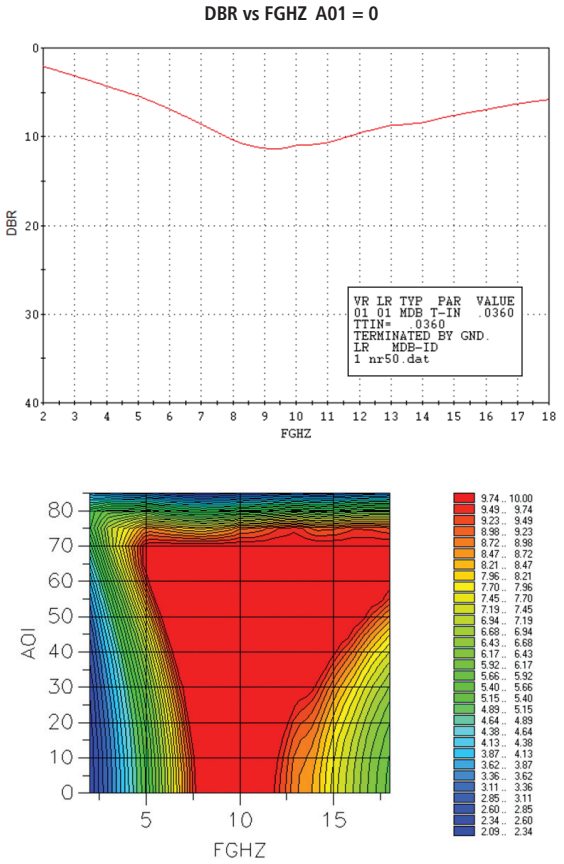


Figure 8. Surface Wave Q-Zorb; note broader area of highest absorption in red

DESIGN GUIDE FOR COMMERCIAL MICROWAVE ABSORBERS

EMI MODELING

Laird Technologies is a member of the EMC Consortium at Missouri Science and Technology School, Rolla Missouri. As part of this consortium Laird Technologies is modeling the use of absorbers for a variety of applications. The cavity application discussed above is one of the key areas of investigation. Other areas include directly placing absorbers on noisy chips, coating cables to reduce conducted EMI, and use on antennas. Laird Technologies is working on modeling these applications using 3D modeling software including HFSS, Microwave Studio, and EZ-FTDT. The Q-Zorb can be modeled as a Debye Oscillator and directly input into the codes. Laird Technologies can supply these models to customers for their own computer modeling. A few examples of this work are shown in the figures below.

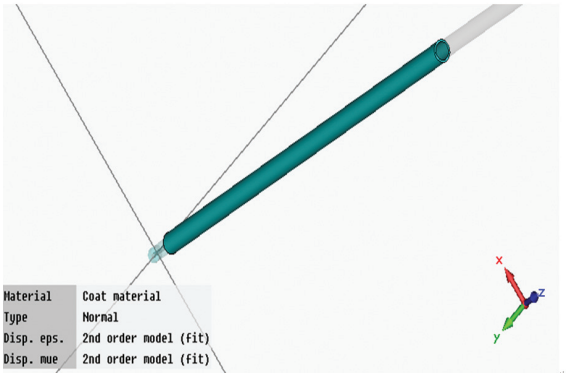


Figure 7. Microwave CST Model of Cable with Q-Zorb Coating

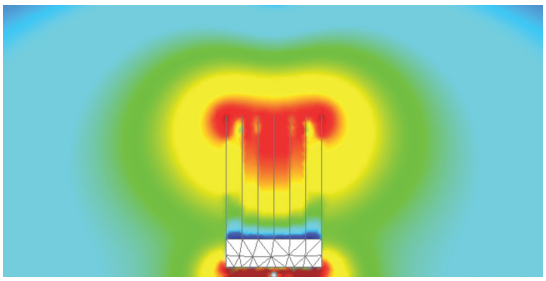


Figure 8. Simulated Electric Field of Heat Sink on Noisy Chip

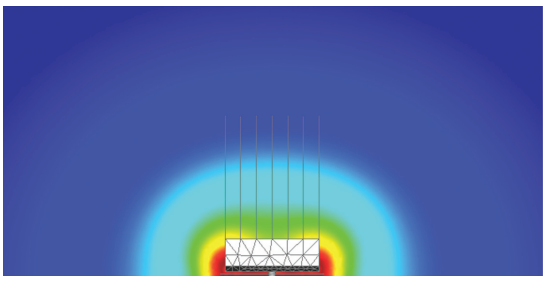


Figure 8. Simulated Electric Field of Heat Sink on Noisy Chip with Q-Zorb

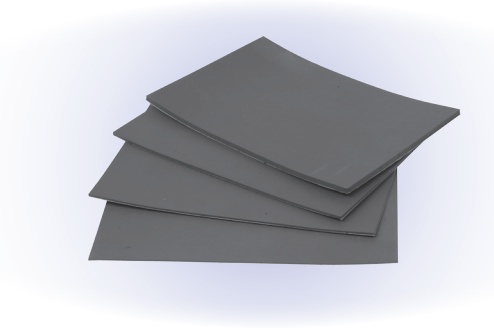
SAMPLE KIT

To assist the microwave design engineer in the use of Laird Technologies absorbers, a sample kit containing the different types of microwave absorbers is offered. The kit contains all three types of materials including Q-Zorb HF, Q-Zorb HP, and RF Foam. A description of the sample kit is listed below.

The samples are 6"x4" in size and can be easily cut into specific shaped pads. There are various thicknesses to evaluate. Generally speaking the thicker the sample the better it will work at low frequency. However if you are constrained by thickness, evaluate the one that will meet the thickness requirements and then test the electrical properties of the sample. To make even thicker test samples the samples can be bonded together. This will allow the designer to evaluate thickness vs performance.

PART NUMBER	DESCRIPTION	THICKNESS	FREQUENCY RANGE
2388	Q Zorb™ - RFSW	.020" (0.5 mm)	>10 GHz
2238	Q Zorb™ - RFSW	.040" (1.0 mm)	> 8 GHz
2240	Q Zorb™ - RFSW	.060" (1.5 mm)	> 4 GHz
2242	Q Zorb™ - RFSW	.125" (3.1 mm)	< 4 GHz
3535	CA-19	.006" (0.15 mm)	< 2 GHz
3536	CA-19	.020" (0.5 mm)	< 2 GHz
5206	RF Foam - RFLS	.125" (3.1 mm)	Insertion Loss Broadband
5092	RF Foam - RFLS	.250" (6.25 mm)	Insertion Loss Broadband
4106	RF Foam - RFRET	.50" (12.5 mm)	Insertion Loss Broadband

Q-ZORB® HF (HIGH FREQUENCY) SURFACE WAVE ABSORBERS



RoHS

Q-Zorb® HF surface wave absorbers are thin, magnetically loaded elastomeric sheets designed to provide attenuation at high angles of incidence for surface wave attenuation. They are nominally manufactured in the thickness range of 0.015" to 0.125" (0,4 mm to 3,2 mm). Q-Zorb® is silicone-based, meets the UL V0 fire retardant requirement and is RoHS compliant. Laird Technologies can provide the material die-cut and with a pressure-sensitive adhesive for ease of installations. Sheets are offered in nominal sizes of 24" x 24" (609,6 mm x 609,6 mm), although custom sizes and molded components are available.

APPLICATIONS

The material can be used inside of microwave housings to reduce internal resonance and to lower the "Q" of the microwave cavity. They are also effective in isolating antennas from ground plane reflections. Q-Zorb® can be used with board-level shielding and other types of EMI shielding to enhance the shielding effectiveness at frequencies from 2-40 GHz.

FIGURE 1.

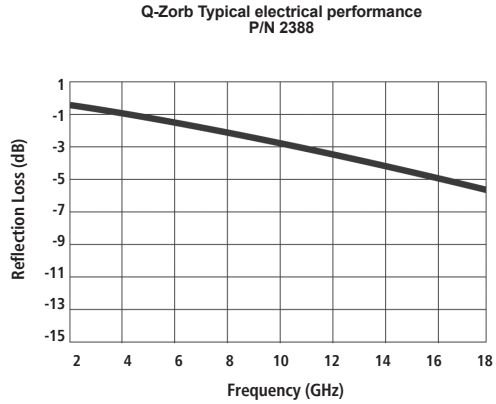


FIGURE 2.

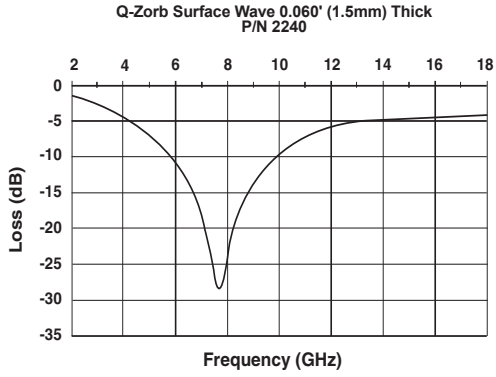


FIGURE 3.

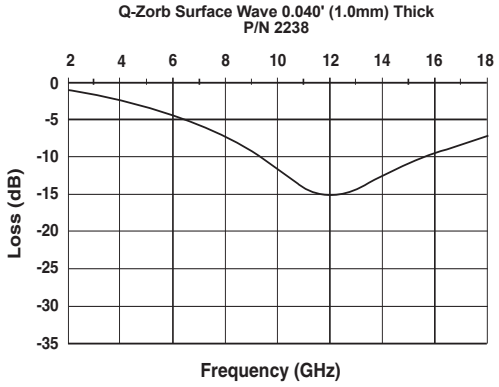
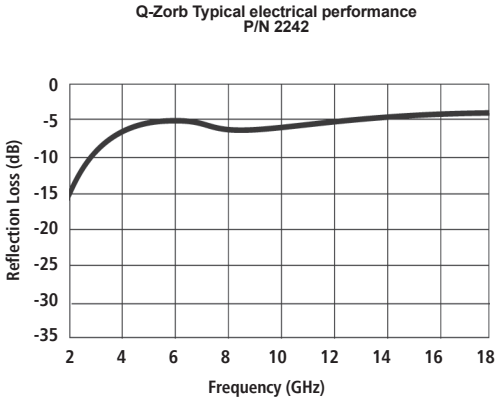


FIGURE 4.

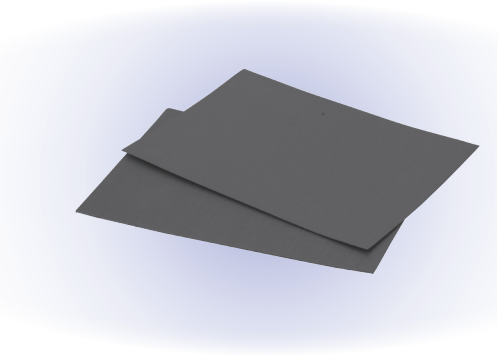


All dimensions shown are in inches (millimeters) unless otherwise specified.

Q-ZORB® HF (HIGH FREQUENCY) SURFACE WAVE ABSORBERS

PART NO.	SIZE	THICKNESS	WEIGHT	TEMPERATURE MAXIMUM	ELECTRICAL PERFORMANCE	COLOR		BONDING	FIRE RETARDANT RATING
2388	24" x 24" (Standard)	0.20" nominal (.5mm)	.50 lb/sq ft	300 °F	12-18 GHz	Gray	RoHS Compliant Sulfur-free	Supplied with 3M 9485 PSA	UL V0
2388 -.25	12" x 12"								
2388 - S	4" x 6"								
2238	24" x 24" (Standard)	.040" nominal (1mm)	.94 lb/sq ft	300 °F	8-18 GHz	Gray	Good general weather and chemical resistance Sulfur-free	Supplied with 3M 9485 PSA	UL V0
2238 -.25	12" x 12"								
2238 - S	4" x 6"								
2240	24" x 24" (Standard)	0.60" nominal (1.5mm)	1.2 lb/sq ft	300 °F	4-18 GHz Excellent for surface current attenuation	Gray	Good general weather and chemical resistance Sulfur-free	Supplied with 3M 9485 PSA	UL V0
2240 -.25	12" x 12"								
2240 - S	4" x 6"								
2242	24" x 24" (Standard)	.125" nominal (3.2mm)	2.75 lb/ sq ft	300 °F	1-18 GHz Excellent for surface current attenuation	Gray	Good general weather and chemical resistance Sulfur-free	Supplied with 3M 9485 PSA	UL V0
2242 -.25	12" x 12"								
2242 - S	4" x 6"								

Q-ZORB® HP (HIGH PERMEABILITY) ABSORBERS CA-19



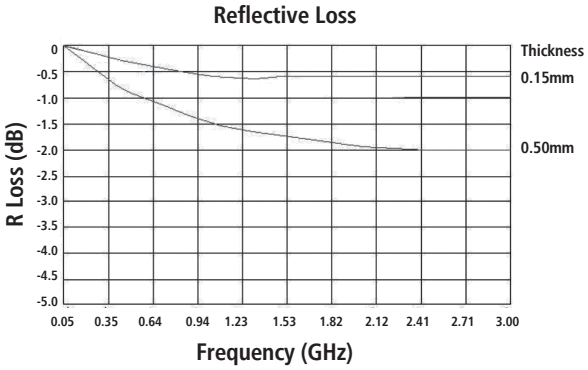
Q-Zorb HP product line utilizes special shaped magnetic fillers in a polymeric binder to produce thin sheets with excellent low frequency performance. The product has very high permeabilities along with low frequency magnetic loss. This allows relatively thin sheets of material to perform at frequencies below 2 GHz. CA 19 comes in thickness ranges of .006" .15 mm to .020" .5mm. and is very flexible. The product is available in rolls 13" wide and any length available. It can be die cut into specific shapes and is supplied with a pressure sensitive adhesive backing for ease of use.

Two standard part numbers of CA 19 are available in the absorber sample kit. This allows the engineer to see if this product will help solve any specific EMI problem.

APPLICATIONS

CA 19 is used in situations where low frequency (< 4 GHz) noise problems are occurring. Some applications include:

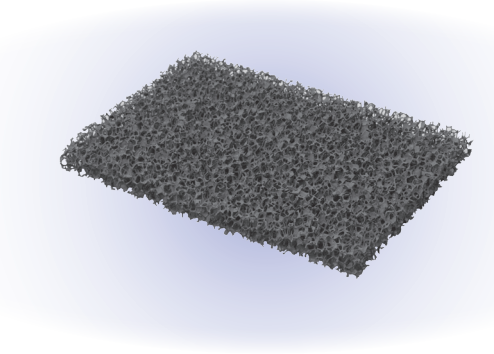
- Die cut components placed in microwave cavities
- Place on top of noisy chip to reduce emissions
- Wrapped around cables to reduce conducted emissions
- Used inside of board level shields to improve shielding performance



TYPICAL PHYSICAL PROPERTIES		
Size	3535	.006" x 12" x 13"
	3535-S	.006" x 4" x 6"
	3536	.020" x 12" x 13"
	3536-S	.020" x 4"x 6"
Permeability μ' (1MHz)		37
Electrical resistivity (Ω / □)		6×10^{10}
Specific gravity		3.1
Tensile strength (MPa)		1.9
Hardness (DurometerA)		70 ± 10%
Thermal conductivity (W / mk)		1.0
Flammability		UL94 V-0

All dimensions shown are in inches (millimeters) unless otherwise specified.

RFRET RETICULATED FOAM ABSORBERS

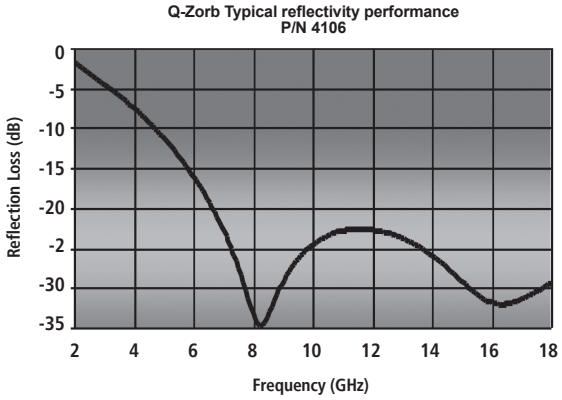


RFRET is a reticulated foam absorber. Reticulated foam is an urethane-based foam with a well-defined open-cell structure. The cell size can be chosen to optimize penetration of the conductive coating to which it is adhered. Laird Technologies uses two separate processes to produce its reticulated foam absorber. This unique spray process applies a coating that is graded through the thickness of the foam. The grading of the coating also produces an electrical grading that results in a material with excellent broadband reflectivity reduction.

Laird Technologies also dips RFRET-CV, a convoluted egg-crate shaped foam. This shaping allows for graded impedance, which provides broadband reflectivity reduction. RFRET-CV is produced in thicknesses from 1.5" to 4" (38,1 mm to 101,6 mm) and is used when broadband performance from 2 to 18 GHz is required. The product can be supplied with a bonded-on ground plane and pressure-sensitive adhesive.

APPLICATIONS

RFRET broadband foam is commonly used around antennas to provide isolation or side lobe reduction. It can be die-cut into components for EMI reduction inside microwave cavities and is used to manufacture antenna hats and test boxes. It can be encapsulated into a textile cover for use outdoors and fabricated into blankets, covers and other components. Recently, it has been used for a combination air/EMI filter in networking equipment. The product can be made UL 94 HF1 for such applications.



TYPICAL PHYSICAL PROPERTIES		
Size	4106	24″ x 24″ (Standard)
	4106 -.25	12″ x 12″
	4106 - S	4″ x 6″
Thickness		0.50″ nominal
Weight		.092 lb/sq ft
Temperature Maximum		250 °F
Color		Gray
Environmental		Withstands intermittent exposure to water without degradation

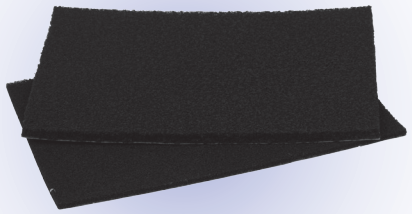
All dimensions shown are in inches (millimeters) unless otherwise specified.

RFLS SINGLE LAYER
"LOSSY" FOAM ABSORBERS

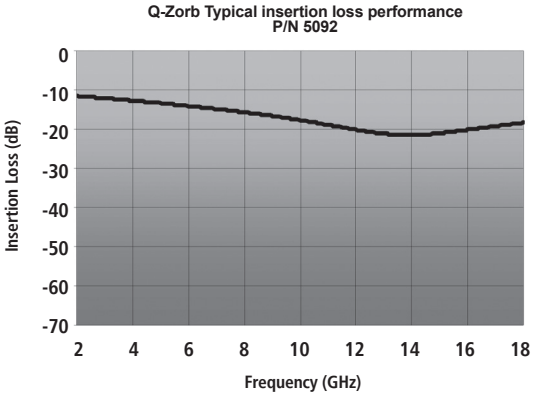
RFLS is a series of single layer "lossy" sheets produced by dipping lightweight open-celled urethane foam into a resistive solution. The end product is a uniform, lightweight, loaded sheet material with a specified insertion loss at a given frequency. RFLS offers the lowest cost in microwave absorber products. Thickness of the sheets range from 0.125" to 1.5" (3,2 mm to 38,1 mm) and are generally 24" x 24" (609,6 mm x 609,6 mm). Custom sizes and components can be fabricated. The insertion loss of the product is measured in an insertion tunnel over the 2 to 18 GHz frequency range. Specifications are generally given at 3 or 10 GHz. The material can be die-cut into components and supplied with a pressure-sensitive adhesive for ease of application.

APPLICATIONS

RFLS sheets are used to lower noise or cavity Q's in microwave components such as amplifiers, oscillators, computer housings and wireless equipment. Fire retardant versions to UL 94 HF1 are also available.



RoHS



PART NO.	SIZE	THICKNESS	TEMPERATURE RANGE	COLOR	ENVIRONMENTAL	BONDING
5092	24" x 24" (Standard)	0.25" nominal	-85 – 250° F	Black	RoHS Compliant	Supplied with 3M 9485 PSA
5092 -.25	12" x 12"					
5092 - S	4" x 6"					
5206	24" x 24" (Standard)	0.125" nominal	-85 – 250° F	Black	RoHS Compliant	Supplied with 3M 9485 PSA
5206 -.25	12" x 12"					
5206 - S	4" x 6"					

NOTES

The physical properties and electrical performance property above are typical for the material, but not intended for use in specifications or for the acceptance inspection criteria because of variations in testing methods, conditions and configurations.

ANALYSIS, TEST AND PROTOTYPE DEVELOPMENT

Laird Technologies has exceptionally strong research and development capabilities. Staying at the forefront of microwave absorber technology requires the ability to perform accurate measurements of absorber performance and material properties, the ability to perform computer analysis of new absorber designs and, finally, the ability to build and test prototype absorbers and components. Laird Technologies works on internal product development programs to combine absorbers with EMI shielding.

CUSTOM ABSORBERS

R&F Products develops a number of custom absorbers especially for military applications. These applications can be discussed with the R&F Products applications engineering team at +1-760-736-7007

RFRIGID - Foam

RFRIGID is a rigid foam absorber. It is based upon RFRET as the active absorbing material. The RFRET is subsequently filled with closed cell foam to make a rigid material. It is generally used as in antenna applications as a housing or barrier from other electronic systems. Thicknesses from .25" to 2" are available in flat sheets or custom molded shapes

RFHC - Honeycomb

Laird Technologies can treat a wide variety of honeycomb to make broadband absorbers optimized for reflectivity or insertion loss. These are typically used in antenna applications or where lightweight structural properties are desired.

Millimeter Wave Absorbers

As both military and commercial systems move to higher frequencies, there is a growing need for absorbers that work to 100 GHz. Laird Technologies has designs for specific resonant frequencies in the millimeter wave band, as well as broadband designs. Laird Technologies is working on several military programs at these frequencies, as well as automotive radars and millimeter wave communications programs.

Transmission tunnel and microwave test equipment for material property measurement.

Computer controlled network analyzer provides amplitude and phase measurements on microwave absorbers.

ABSORBER BOARD-LEVEL SHIELDING (ABLS)

Increasing use of printed circuit boards in complex electronics requires unique shielding solutions. Laird Technologies has developed a near field measurement to accurately determine the effectiveness of board-level shielding. Several Laird Technologies board-level shields have been characterized using this technique.

Laird Technologies has further enhanced performance at greater than 2 GHz by adding a microwave absorber to the board-level shield. Further work has been completed on Flomerics™ FLO-EMC to analytically investigate board-level shields performance improvement using absorbers at high frequency.

THERMALLY CONDUCTIVE ABSORBERS – KOOL-ZORB

Laird Technologies is developing thermally conductive microwave absorbing materials. These can be used as thermal pads between chips and heatsinks, allowing conduction of heat and dissipation of EMI. Initial testing and modeling has shown this to be an effective solution to heat sink radiation from noisy chips.

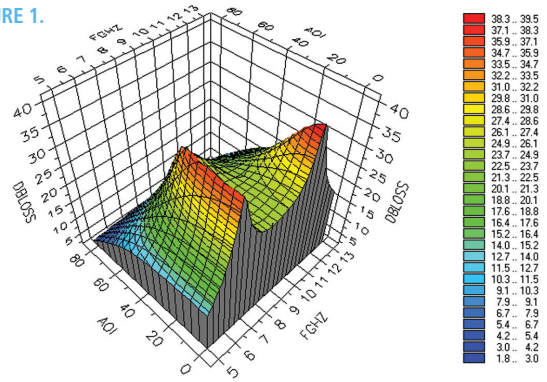
MU EPSILON MEASUREMENT CAPABILITIES

Laird Technologies has a network analyzer to make amplitude and phase measurements from 130 MHz to 20 GHz. Laird Technologies also has a reflectivity arch, transmission tunnel and a variety of coaxial, wave-guide and other test equipment to determine intrinsic electrical properties of absorber materials. This ability has enabled Laird Technologies to build a database that customers can use to design new absorbers and analyze their performance in different situations.

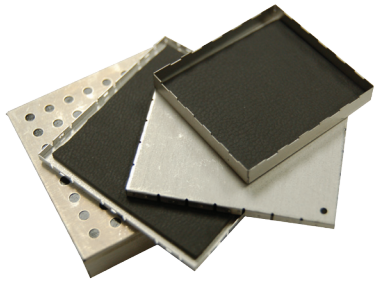
ANALYTICAL SOFTWARE VBROP

VBROP is a versatile Windows® 95/98/NT-based optimizer of multi-layered stacks for reflection or maximum transmission at specified frequencies, angle of incidence and polarization. The visual basic front-end makes the software extremely user friendly, with interactive analysis of layer properties versus performance. It is useful for the design, optimization and detailed performance analysis of RAM, RAS, radomes and microwave windows.

FIGURE 1.



VBROP can optimize absorber performance at various frequencies and angles of incidence.



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