

# Double Electrically Isolated RF Enclosures

For Industrial, Communication, and  
Research and Development Applications



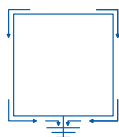
 **ETS·LINDGREN**<sup>™</sup>  
An ESCO Technologies Company

# THE DOUBLE ELECTRICALLY ISOLATED CONCEPT

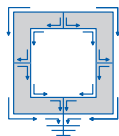
## The Industry's Most Effective Shielding Technology

Introduced by Erik A. Lindgren in the early 1950s, the Double Electrically Isolated (DEI) modular shielded enclosure concept provides the highest level of EMI/RFI shielding available for a variety of industrial, communications, and government applications. ETS-Lindgren's DEI enclosures are designed to meet such high performance requirements as pager, cordless and wireless repair, cellular system production, security, research, and EMI/RFI testing and calibration.

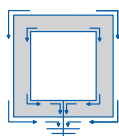
### Construction Principle



Single Shield



Double Shield (Not Isolated)



Double Shield (Isolated)

Figure 1

Our full service capabilities include initial consultation, design, engineering, fabrication, factory testing prior to shipment, on-site installation, and certification testing to ensure that you have a reliable shielding system that stands the test of time.

## The DEI Principle

The principle of isolation in a DEI modular enclosure is based on two completely contiguous metal or mesh shields electrically separated from each other, except at the one point where they are connected together and grounded.

If the two shield surfaces are in contact with each other at numerous points, the effectiveness can begin to diminish to the level expected for a single shield. The graph in Figure 2 shows the difference in shielding effectiveness between single shield, double shield cell-type (not isolated), and double shield isolated construction.

ETS-Lindgren enclosures are the only enclosures that utilize the DEI principle on a single frame. ETS-Lindgren enclosures are constructed using a patented, bolt-together method of assembly that is effective and results in a modular enclosure that is durable, easy to move, and simple to relocate.

ETS-Lindgren's unique resilient clamping system requires no periodic maintenance, and permits enclosures to be assembled and disassembled without losing shielding effectiveness — a problem common to most rigid, compression bolt-together systems.

The Double Electrically Isolated principle is available on enclosures ranging from small tabletop models to enclosures as large as the requirements demand.

## Shielding Effectiveness

The effectiveness of a shielded enclosure is a measure of its ability to attenuate electromagnetic energy, which in its simplest form can be expressed in the following manner:

### Shielding Effectiveness in dB

Copper Screen Construction at 450MHz

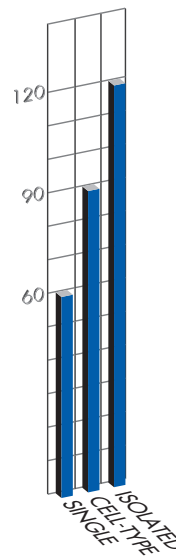


Figure 2

Shielding Effectiveness -

$$S.E. \text{ dB} = 20 \log_{10} \left( \frac{E_1}{E_2} \right) \text{ Decibels}$$

Where  $E_1$  is the properly measured field strength in volts/meter without the shield and  $E_2$  is measured field strength with the shield in place at a fixed test distance. In the case of a homogeneous material, total shielding effectiveness of a material is a function of:

$$S.E. \text{ dB} = (R + A + B) \text{ Decibels}$$

Where R is Total Reflection Loss, A is Total Absorption Loss, and B is Re-Reflection Loss as shown in Figure 3. Reflection Loss occurs due to the impedance mismatch at the air-to-metal interfaces. Absorption Loss is a function of thickness and frequency for a given material. Where Absorption Losses are greater than 10dB, Re-Reflection Loss can be disregarded.

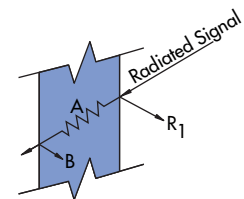


Figure 3

# TYPES OF DEI ENCLOSURES

## Screen Enclosures

Standard modular or custom DEI screen enclosures provide the maximum shielding performance available in a “hear-through, see-through” structure. Copper screen enclosures are used where absence of a sense of confinement or casual observation from the outside is desirable.

The superior shielding characteristics obtained from ETS-Lindgren screen enclosures are primarily the result of DEI construction, which permits the screen to be used where solid double shield construction would ordinarily be used.

In many applications, screen enclosures eliminate the need

for additional ventilation. Where required, exhaust fans or connections to existing air handling systems are easily added. Screen rooms are very easy to assemble because of the inherent flexibility of the shielding material, which requires lower clamping pressures than are generally required with steel and other rigid materials.

Protective paneling or kickplates are used to protect the lower 32" on the inside and outside of each wall panel. Kickplates are made of an attractive wood grain paneling. A color-coordinated vinyl tile is installed over 3/4" plywood panels, which are connected with 1/8" thick, 4" wide aluminum strips to provide an entirely flush modular floor system.



*Solid DEI enclosures provide a quiet, secure environment.*

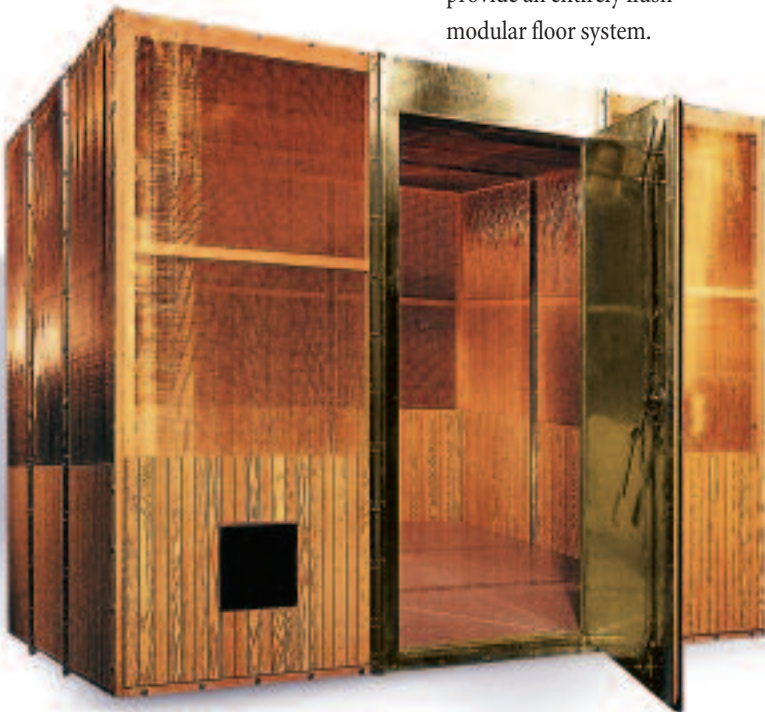
## Solid Enclosures

The sturdy construction and unique assembly of our solid enclosure system allow for repeated disassembly and reassembly without loss of shielding effectiveness.

Solid wall construction, in various combinations of steel and copper, address a range of requirements and provides a quiet, private, and secure environment. The door is constructed of the same shielding materials and specially designed to preserve the DEI principle.

Supplementary sound deadening material can be placed between the inner and outer shields or attached to the exposed wall surfaces. Where optional high frequency (microwave) characteristics are desired, for 1GHz and above, attenuation characteristics can be enhanced with a number of options, including vestibules, microwave absorber door seals, and special treatment of waveguide air vents.

*DEI Screen Enclosures provide maximum shielding performance of any “hear-through, see-through” structure.*





# DEI SHIELDING MATERIALS

## Copper Screen

A heavy 22" x 22" x .015" copper wire mesh is offered for applications which require the "hear-through, see-through" advantages of screen, with the best possible high frequency microwave and improved low frequency magnetic attenuation characteristics.

Copper is recommended when maximum attenuation is required at frequencies of 1GHz and above.

## 22 Gauge Galvanized Steel and 3 Ounce Copper

The combination of 22 gauge galvanized steel and 3 ounce copper provides the best combination of price and performance in a solid modular enclosure. The 22 gauge galvanized steel exterior shield provides good low frequency magnetic field

attenuation characteristics. The 3 ounce copper interior shield contributes to its improved high frequency performance and ease of assembly.

By combining these properties, ETS-Lindgren has satisfied a large requirement for a broader frequency spectrum than either room would offer separately.

A 1/4" wood grain paneling is used on the inside to protect the copper and provides an attractive color-coordinated interior finish.

## 3 Ounce Copper

The 3 ounce copper double shield enclosure offers the best high frequency shielding and aesthetic characteristics available in its price range. The use of 3 ounce copper results in

unusually good shielding effectiveness in the higher plane wave and microwave frequencies.

The formability of 3 ounce copper when used in conjunction with our resilient clamping system results in an easy-to-assemble system which has excellent sealing characteristics.

A wood grain finish protects the interior copper and gives standard enclosures an attractive finished appearance on both the interior and the exterior. This construction is used extensively in military, telecommunications, and microwave testing applications because of its superior high frequency shielding characteristics.

## 22 Gauge Galvanized Steel and 24 Ounce Copper

The use of 22 gauge galvanized

steel as an exterior shield and 24 ounce copper for the interior shield results in an enclosure with very good low frequency magnetic and excellent high frequency shielding characteristics.

A big advantage of using heavy copper is its durability and excellent 14 KHz to 10 GHz sealing characteristics.

This construction is recommended for applications requiring maximum attenuation in the microwave frequency ranges or for special military requirements.

## Typical Attenuation Characteristics

Exterior Shield	Interior Shield	Magnetic 14KHz	Electric 14KHz	Plane Wave 450MHz	1GHz	Microwave 10GHz
Copper Screen	Copper Screen	68 dB	120 dB	110-120 dB	90-110 dB	50-80 dB
22 ga. gal. Steel	3 oz. Copper	75-80 dB	120 dB	120 dB	120 dB	100-110* dB
3 oz. Copper	3 oz. Copper	64 dB	120 dB	120 dB	120 dB	110*-120* dB
22 ga. gal. Steel	24 oz. Copper	86-93 dB	120 dB	120 dB	120 dB	106*-120* dB
Four Shield 24 oz. Copper & 24 ga. Si Steel	Four Shield 24 oz. Copper & 24 ga. Si Steel	100-120 dB	120 dB	120 dB	120 dB	120* dB

\*With optional Microwave Absorber on door.

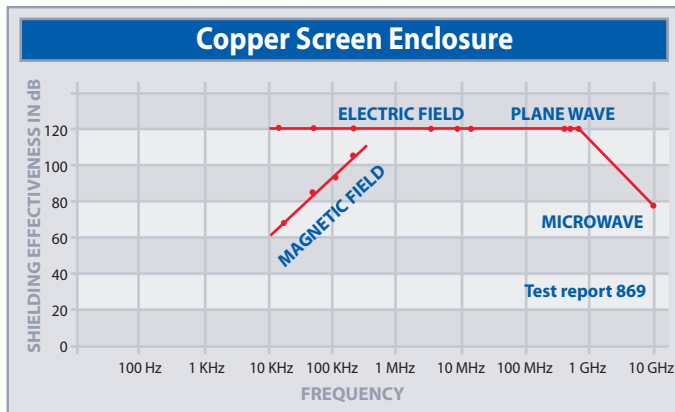
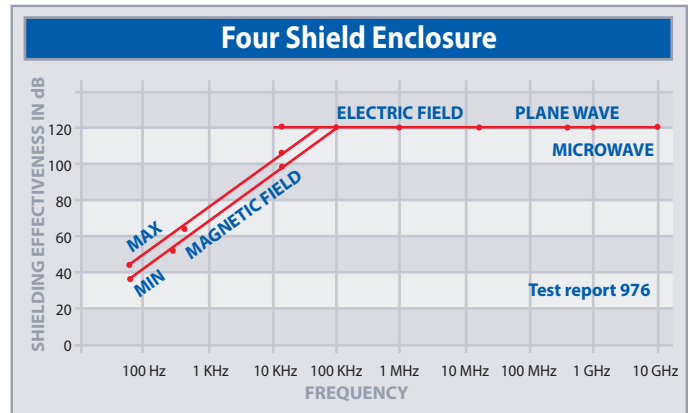
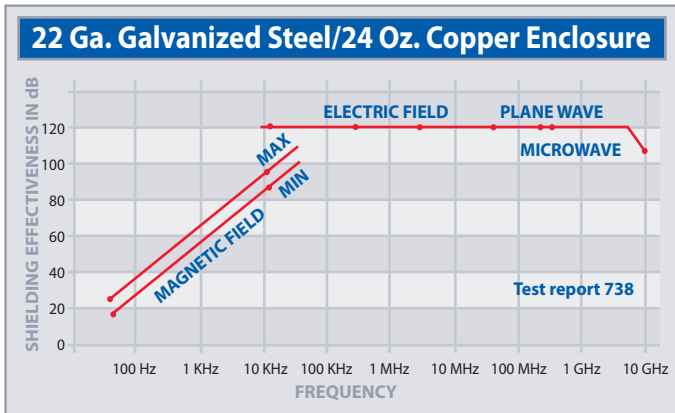
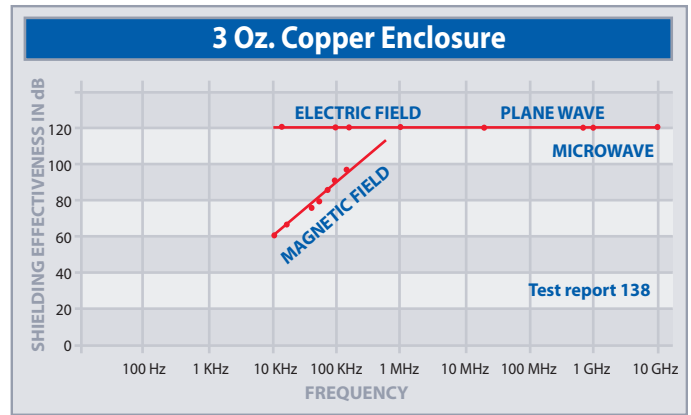
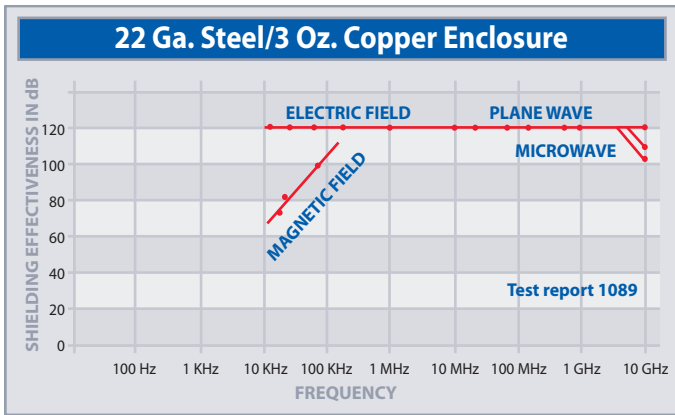
### Four Shield DEI Enclosure

Four shield enclosures use 24 ounce copper as an over layer on both inner and outer shields to provide the best combination of high frequency microwave and

low frequency magnetic field attenuation characteristics in a modular enclosure. Coupled with an additional layer of 24 gauge silicon steel placed behind the copper, this material application

maximizes the low frequency magnetic shielding characteristics. The enclosure achieves over 120 dB of shielding effectiveness from 14 KHz to 10 GHz. This material application permits the

enclosure to achieve over 120 dB of shielding effectiveness from 14 KHz to 10 GHz. The special 24 gauge silicon steel maximizes the low frequency magnetic shielding characteristics.



Note: The performance characteristics shown in all the above charts are from test reports performed by an independent testing company in accordance with MIL-STD-285, which are available on request.

# DEI CONSTRUCTION DETAILS

## Standard Construction

The basis of ETS-Lindgren's DEI construction is its unique patented design, which permits double shield enclosures to be assembled from individual panels. Panels are designed to accommodate a variety of shielding materials which

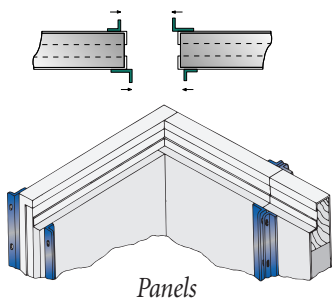
are attached to a strong, nonconductive wood frame. When the shielding is overlapped and the panels bolted together, a resilient — as opposed to rigid — clamping pressure is applied, making it easier to achieve and maintain an RF tight seal.

strengthened to accommodate heavier loads when required.

Modular construction permits nonstandard enclosure requirements to be met with a minimum number of special panels. The customer's size requirements determine the number of panels in the room. Special size enclosures, mobile rooms, and portable enclosures are also available.

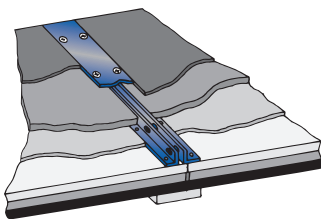
## Modular Panels

Standard DEI enclosures are of modular construction and assembled from panels which are interchangeable to facilitate expansion or modification.



Panels

On midwall and ceiling panels, an angle bar clamping system is used which also provides additional structural support. Individual panels can be easily modified to accommodate accessories and special enclosure size requirements.



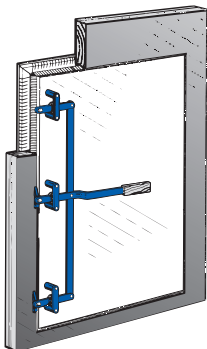
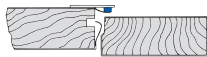
Floor

## Inside Bolting Construction

This optional construction style enables the enclosure to be completely assembled from the inside, employing separate clamping strips to interconnect panels. In other aspects, it is similar to standard construction and maintains the DEI principle.

## Floor

Special care is taken to protect the inside floor shield by covering it with a layer of 3/8" plywood. A separate walking surface consists of 1/8" vinyl tile on 3/4" A-C plywood panels, which are interconnected with 1/8" aluminum strips to ensure a flush, durable floor capable of supporting 1,000 pounds per square foot. Floors can be



Door

## Standard Enclosure Sizes (Outside Dimensions)

Model	W	L	H	Metric Dimensions
8	3' 8 1/2"	7' 8 1/2"	8' 1 3/4"	1.13 m x 2.34 m x 2.48 m
12	7' 1/2"	7' 1/2"	8' 1 3/4"	2.15 m x 2.15 m x 2.48 m
14	7' 1/2"	10' 4 1/2"	8' 1 3/4"	2.15 m x 3.16 m x 2.48 m
18	10' 4 1/2"	10' 4 1/2"	8' 1 3/4"	3.16 m x 3.16 m x 2.48 m
22	13' 9"	10' 4 1/2"	8' 1 3/4"	4.19 m x 3.16 m x 2.48 m
26	17' 1"	10' 4 1/2"	8' 1 3/4"	5.21 m x 3.16 m x 2.48 m
30	20' 5"	10' 4 1/2"	8' 1 3/4"	6.22 m x 3.16 m x 2.48 m
34	23' 9"	10' 4 1/2"	8' 1 3/4"	7.75 m x 3.16 m x 2.48 m
38	27' 1"	10' 4 1/2"	8' 1 3/4"	8.26 m x 3.16 m x 2.48 m
42	30' 5 1/2"	10' 4 1/2"	8' 1 3/4"	9.28 m x 3.16 m x 2.48 m

## Larger Panel Enclosure Sizes (Outside Dimensions)

Model	W	L	H	Metric Dimensions
8W	4' 4 1/2"	8' 4 1/2"	8' 1 3/4"	1.33 m x 2.55 m x 2.48 m
12W	8' 4 1/2"	8' 4 1/2"	8' 1 3/4"	2.55 m x 2.55 m x 2.48 m
14W	8' 4 1/2"	12' 4 5/8"	8' 2 7/8"	2.55 m x 3.77 m x 2.51 m
18W	12' 4 5/8"	12' 4 5/8"	8' 2 7/8"	3.77 m x 3.77 m x 2.51 m
22W	16' 4 3/4"	12' 4 5/8"	8' 2 7/8"	4.99 m x 3.77 m x 2.51 m
26W	20' 4 7/8"	12' 4 5/8"	8' 2 7/8"	6.22 m x 3.77 m x 2.51 m
30W	24' 5"	12' 4 5/8"	8' 2 7/8"	7.44 m x 3.77 m x 2.51 m
34W	28' 5 1/8"	12' 4 5/8"	8' 2 7/8"	8.66 m x 3.77 m x 2.51 m
38W	32' 5 1/4"	12' 4 5/8"	8' 2 7/8"	9.88 m x 3.77 m x 2.51 m
42W	36' 5 3/8"	12' 4 5/8"	8' 2 7/8"	11.10 m x 3.77 m x 2.51 m

Note: Replacement panels and parts are available for any ETS-Lindgren standard enclosure built within the last 35 years and for most custom enclosures.

# COMPONENTS AND ACCESSORIES

## Doors

The ETS-Lindgren DEI door employs a number of unique proprietary and patented features which contribute to its superior performance characteristics and durability. All hardware and door seals are designed to maintain electrical isolation between the inner and outer shields. Doors are side hinged and supported by three heavy duty hinges to provide sag-free mounting, and have been cycle tested up to 25,000 operations.

A three-point, roller-bearing latching system applies uniform pressure to two sets of spring temper, phosphor bronze contact fingers to provide leakproof seals for both the inner and outer shields.

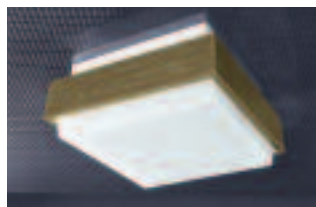
The three-point clamping system draws the door into a closed position when the 28" panic type handle is pulled up with a force of less than 30 pounds. A positive opening pressure is applied to the door when the handle is pushed down to open. The handle and lever arms, which apply clamping pressure, are adjustable, as are the contact fingers. Single, double, and vestibule door systems are available in most sizes and a variety of options, including color-coordinated or wood-grained veneer finishes, view

windows, access openings, ramps, locks, alarms, interlocks, and microwave absorber seals. Flush floor systems are also optional.



## Duo-Shield RF/Line Filters

A filter is required for all wires penetrating an RF enclosure to prevent conducted signals from entering or leaving. ETS-Lindgren uses two filters in series to take full advantage of the shielding effectiveness provided by DEI construction. Any RF interference bypassing the first filter must enter the second filter/shield combination and be attenuated, resulting in maximum effectiveness for the overall system.



## Lighting

Incandescent lighting must be used where an interference-

free environment is required. Special RFI suppressed fluorescents are offered for the applications which require fluorescent lighting. Where the shielded enclosure is designed to contain a radiating source, conventional fluorescent lighting can be used.

## Waveguide Feedthrus

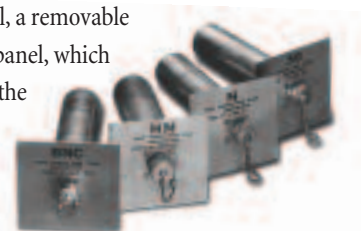
Waveguide feedthrus which preserve the DEI construction are available for water, gas, or air. Specially designed waveguide feedthrus can transport non-conductive gases or liquids into an enclosure. These assemblies are available in brass or steel, in sizes ranging from 1/4" to 4" in diameter.



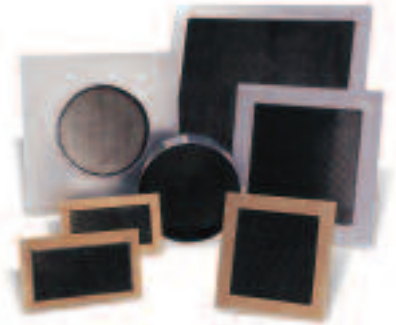
## Feedthru Connectors

DEI enclosures use ETS-Lindgren's EL5100 Series of RF Uni-ground Connector assemblies, allowing RF energy to be brought into an enclosure without shorting the inner and outer shields.

Where Uni-ground construction is not practical, a removable brass service panel, which also serves as the single point interconnection and



ground for the enclosure, can be used to mount a variety of standard or special multi-pin connectors.



## Ventilation Air Vents

ETS-Lindgren honeycomb waveguide air vents are manufactured by an exclusive solder fusion process for absolute reliability and RF performance. Air vents are available in standard 12" x 12" sizes as well as a range of other sizes. Air vents are solder-fused honeycomb construction with either a solderable flange or heavier screw mounting frame.



1/2" O.D. COPPER  
WATER TUBING  
(TYPE K) x 1' LG.

## About ETS-Lindgren

The ETS-Lindgren Group is the world's largest and most experienced supplier of shielding solutions for electromagnetic and radio frequency interference (EMI/RFI). With over 6,000 proven MRI installations, we are the worldwide leader in MRI Shielding Systems.

We have installed over 25,000 successful shielded enclosures within a variety of industrial, governmental, and medical environments around the world.

Call upon ETS-Lindgren for our unequalled understanding of both practical and theoretical shielding principles. ETS-Lindgren is highly skilled at applying these principles with a breadth and depth of technical expertise in architectural, mechanical, structural, acoustical, and security related areas.

Because controlling electromagnetic energy is our only business, you can be assured of our commitment to the highest quality and product reliability that stand the test of time.

Our products, materials, and workmanship are backed by a comprehensive warranty and a commitment to customer satisfaction.

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