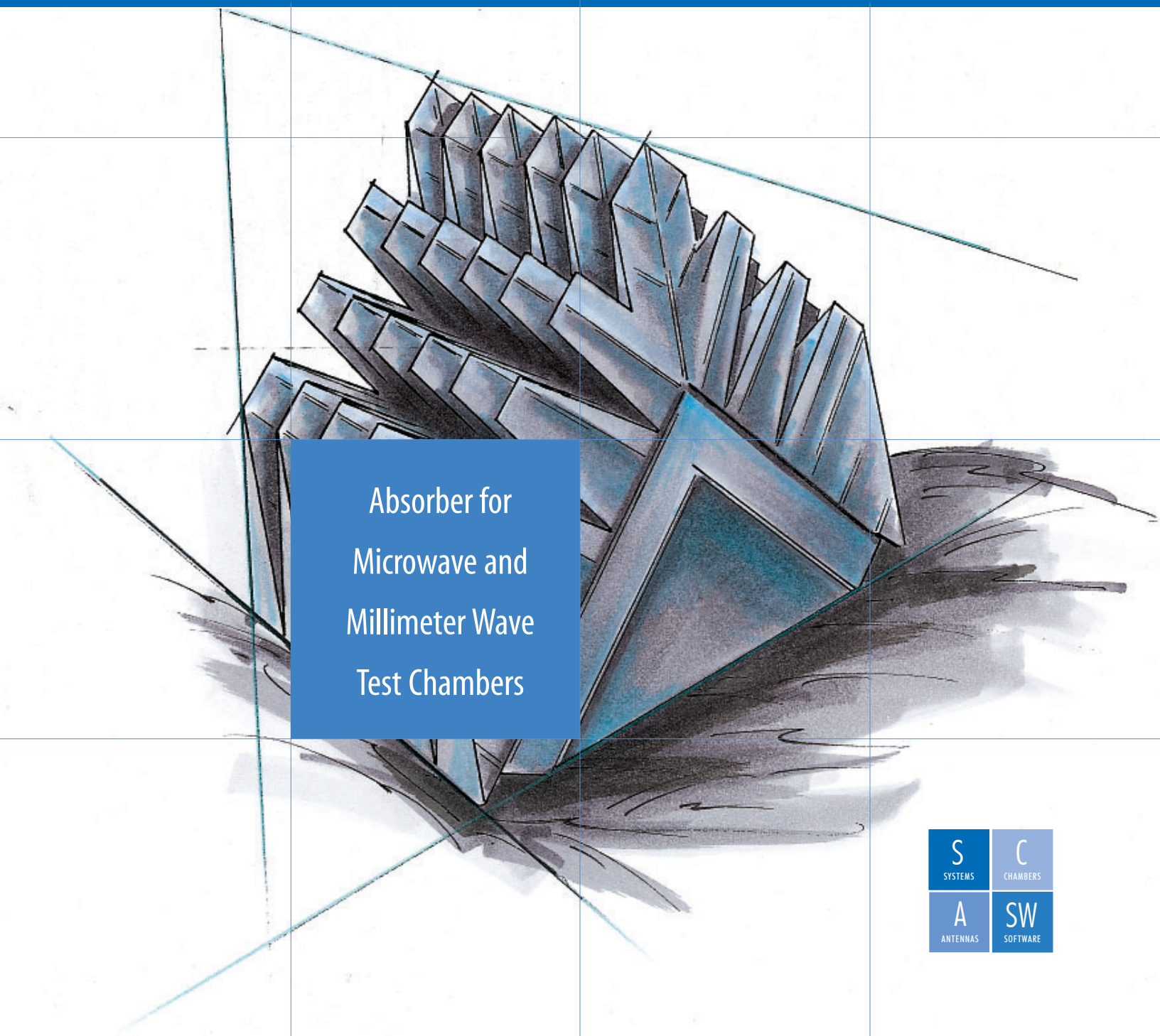
TDK RF Solutions Inc.

Microwave Absorbers



Absorber for Microwave and Millimeter Wave Test Chambers

S SYSTEMS
C CHAMBERS
A ANTENNAS
SW SOFTWARE

History

With a worldwide reputation for high quality and innovative absorber techniques, TDK has established itself as the premier designer of anechoic chambers for use in microwave measurements. As the original inventor of ferrite and ferrite for use in RF suppression techniques, as well as an innovator of subsequent designs involving RF absorbing foams, TDK has benefited from almost seventy years of accumulated experience in the field. With so many years of RF technology expertise and many global installations successfully completed, our team has what it takes to design and validate your anechoic chamber.

1935 – today

Materials

TDK's business began with materials and we have been pioneering materials technology now for almost seven decades. This experience provides a solid foundation for developing specialty materials to suit a range of high-performance applications. Materials research and development is central to our top performing chambers. At our materials research centers, we are studying novel materials such as bioceramics, high temperature foams, and layered media. We are also continuing to develop improved formulations and manufacturing processes for existing materials. The end result: availability of a more technically robust anechoic product for modern chamber designs.

Technical Expertise and Research

TDK is a high-technology company with a strong commitment to ongoing research and development. We continue to refine technologies and know-how accumulated through decades of R&D to create the foundation for the next generation of advanced microwave absorber products. TDK has comprehensive R&D capabilities and a streamlined product development organization. Our three R&D laboratories work closely with the various development departments of each product division to develop high-reliability products.

TDK devotes a considerable amount of energy and finances to maintain its cutting edge research and development centers. With three separate facilities dedicated to R&D efforts, our research and development centers are larger than many manufacturers production spaces. Research is related to computer-aided modeling and design of optimized absorber products (foam, tiles, paints, and rubber), innovative chamber designs, and custom requirements for both ferrite and foam absorbing materials.

Ichikawa Technical Center

One of Three TDK Technical Research and Development Centers.

Manufacturing and Quality Control

TDK is the only company that manufactures both the ferrite tile and the complementary foam absorber. This is both advantageous and critical for both low and high frequency performance, high power dissipation, and broadband behavior. TDK uses very sophisticated manufacturing techniques to create both our ferrite and our foam absorber materials. These techniques allow us to control every parameter of the materials which impact performance and safety. By adhering to strict quality production checks throughout the creation process, we can bypass many time-consuming and unnecessary steps (e.g. having to measure each piece of absorber product for size tolerance and RF parametric compliance). The result is a much more efficient production process with a higher yield rate for absorber products.

Hirasawa Production Facility

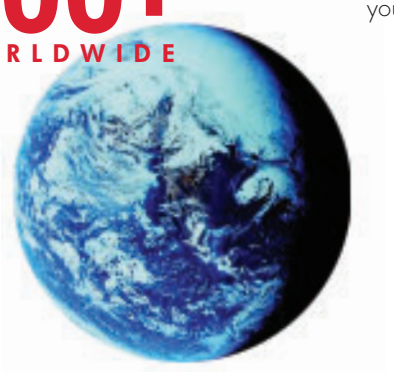
One of Four TDK manufacturing plants.

In addition, the facilities in which these products are manufactured are completely managed under an ISO 9001 quality system and an ISO 14001 environmental management system. With over 300,000 m^2 of production capability, TDK manages the largest such facilities worldwide.

Experience

True experience is developed over time. TDK commenced the first commercial production of ferrite in December of 1935; by September of 1968 our electromagnetic wave absorbers were being introduced. In subsequent years TDK pushed the development of anechoic materials and their applications. Developments including the first wedge-shaped absorber (popular for microwave measurements), the first polystyrene absorber (popular for clean room applications), the first oblique incidence absorber (microwave absorber treatment in specular regions), the first hollow absorber (tensile strength and thermal performance advantages), and a host of other innovations. Today this experience and pioneering innovation is still very much alive in the activities and designs which TDK brings to the table. With over 700 chambers installed globally, we can draw on our experience to make your vision a reality.

INSTALLATIONS
700+
WORLDWIDE



TDK Microwave Pyramidal Absorber

TDK microwave pyramidal material is a conductive, carbon-loaded, closed-cell polyethylene foam absorber designed for use in microwave and millimeter wave test chambers, antenna pattern measurement chambers, and other special anechoic facilities. TDK pyramidal absorber is lightweight yet rigid and durable, with excellent resistance to wear and damage.

FEATURES

- Up to 100 GHz verified operation
- 700 W/m² power handling
- Clean room rated
- Closed cell polyethylene construction
- Numerically optimized shape and carbon loading
- UL Listed
- Fire retardant
- High tensile strength
- Waterproof

APPLICATIONS

- Wireless/Mobile radio/Telecom
- Spacecraft/Satellite
- Antenna/Radar Cross Section
- Military/ECM
- Automotive and Vehicular Technologies
- Near-field and compact ranges

GUARANTEED PERFORMANCE RESULTS AT NORMAL INCIDENCE

Absorber Model	.2GHz – .3GHz	.3GHz – .5GHz	.5GHz – 1GHz	1GHz – 2GHz	2GHz – 7GHz	7GHz – 10GHz	10GHz – 20GHz	20GHz – 40GHz	40GHz – 60GHz	60GHz – 100GHz
IS-012A	–	–	–	–	–25 dB	–40 dB	–50 dB	–50 dB	–45 dB	–40 dB
IS-015	–	–	–	–20 dB	–30 dB	–35 dB	–45 dB	–50 dB	–45 dB	–40 dB
IS-023	–	–	–	–25 dB	–35 dB	–50 dB	–50 dB	–50 dB	–45 dB	–40 dB
IS-030A	–	–	–	–30 dB	–40 dB	–50 dB	–50 dB	–50 dB	–45 dB	–40 dB
IS-045	–	–	–25 dB	–35 dB	–45 dB	–50 dB	–50 dB	–50 dB	–45 dB	–40 dB
IS-060	–	–25 dB	–30 dB	–40 dB	–45 dB	–50 dB	–50 dB	–50 dB	–45 dB	–40 dB
IS-075	–15 dB	–25 dB	–35 dB	–45 dB	–50 dB	–50 dB	–50 dB	–50 dB	–45 dB	–40 dB
IS-100	–20 dB	–35 dB	–40 dB	–45 dB	–50 dB	–50 dB	–50 dB	–50 dB	–45 dB	–40 dB

SPECIFICATIONS

Absorber Model	Clean Room Rating	Fire Retardancy	Tensile Stability	Max. Power Density	Product Life	Humidity Resistance	Absorber Footprint	Absorber Height	Absorber Weight
IS-012A	FS 209E Class 100 ISO 14644-1 Class 5	NRL 8093 Test 1, 2, and 3 UL94HBF	4 kg/cm²	≤ 500 V/m, 700 W/m² Core temperature ≤ 100 ° C	>30 years closed-cell polyethylene	No deterioration from water. No hydrolysis effect.	60 cm x 60 cm	12 cm	1.3 kg
IS-015								15 cm	1.8 kg
IS-023								23 cm	2.0 kg
IS-030A								30 cm	3.0 kg
IS-045								45 cm	4.0 kg
IS-060								60 cm	6.0 kg
IS-075								75 cm	8.0 kg
IS-100								100 cm	10.0 kg

TDK Microwave Oblique Absorber

TDK microwave oblique absorber is a uniquely designed, carbon-loaded polyethylene or polystyrene foam material with exceptional absorption performance for highly oblique incident angles as well as normal incidence. TDK oblique absorber is well-suited for placement in anechoic chamber specular regions to reduce radiated contributions from off-axis scattering.

FEATURES

- Up to 100 GHz verified operation
- 700 W/m² power handling
- Clean room rated
- Closed cell polyethylene construction
- Numerically optimized shape and carbon loading
- UL Listed
- Fire retardant
- High tensile strength
- Waterproof

APPLICATIONS

- Wireless/Mobile radio/Telecom
- Spacecraft/Satellite
- Antenna/Radar Cross Section
- Military/ECM
- Automotive and Vehicular Technologies
- Near-field and compact ranges

GUARANTEED PERFORMANCE RESULTS at 45º INCIDENT ANGLE[1]

Absorber Model	80MHz – .1GHz	.1GHz – .5GHz	.5GHz – .8GHz	.8GHz – 1GHz	1GHz – 2GHz	2GHz – 3GHz	3GHz – 10GHz	10GHz – 40GHz	40GHz – 60GHz	60GHz – 100GHz
IS-SM050	–	–	–10 dB	–35 dB	–30 dB	–40 dB	–45 dB	–50 dB	–45 dB	–40 dB
IS-SM080	–	–	–25 dB	–35 dB	–35 dB	–45 dB	–45 dB	–50 dB	–45 dB	–40 dB
IS-S080	–	–	–20 dB	–25 dB	–25 dB	–35 dB	–40 dB	–45 dB	–45 dB	–40 dB
IP-130BX	–22 dB	–20 dB	–22 dB	–22 dB	–25 dB	–30 dB	–35 dB	–35 dB	–35 dB	–30 dB

1 For angles of incidence ranging from 30° to 60° the performance results are typically within 5 dB of results stated above.

SPECIFICATIONS

Absorber Model	Clean Room Rating	Fire Retardancy	Tensile Stability	Max. Power Density	Product Life	Humidity Resistance	Absorber Footprint	Absorber Height	Absorber Weight
IS-SM050	FS 209E Class 100 ISO 14644-1 Class 5	NRL 8093 Test 1, 2, and 3 UL94HBF	4 kg/cm²	≤ 500 V/m, 700 W/m² Core temperature ≤ 100 ° C	>30 years closed-cell polyethylene	No deterioration from water. No hydrolysis effect.	60 x 60 cm	50 cm	4.8 kg
IS-SM080							84 x 60 cm	80 cm	10.0 kg
IS-S080							84 x 60 cm	78 cm	11.0 kg
IP-130BX	FS 209E Class 10; ISO 14644-1 Class 4			≤500 V/m, 700 W/m² Core temp. ≤ 70 ° C	>30 years closed-cell polystyrene		60 x 20 cm	130 cm	2.7 kg

TDK Microwave Specialty Absorber

TDK microwave specialty absorber is used in those certain cases where particular performance characteristics are desired. Composed of ferrite material and/or closed-cell polystyrene foams, they are used in high power/high temperature applications, low frequency extensions, EMC/antenna hybrid chambers, and custom applications.

FEATURES

- 20 MHz up to 100 GHz operation
- Enhanced power handling
- Clean room rated
- Closed cell construction
- Numerically optimized shape and carbon loading
- UL Listed
- Fire retardant
- High tensile strength
- Waterproof

APPLICATIONS

- Wireless/Mobile radio/Telecom
- Spacecraft/Satellite
- Antenna/Radar Cross Section/High Power
- Military/ECM
- Automotive and Vehicular Technologies
- EMC

GUARANTEED PERFORMANCE RESULTS AT NORMAL INCIDENCE

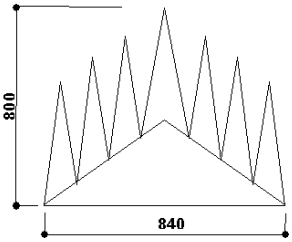
Absorber Model	20MHz – 80MHz	80MHz – 100MHz	.1GHz – .5GHz	.5GHz – 1GHz	1GHz – 2GHz	2GHz – 5GHz	5GHz – 20GHz	20GHz – 40GHz	40GHz – 60GHz	60GHz – 100GHz
IP-100BX	–	–20 dB	–20 dB	–25 dB	–20 dB	–30 dB	–35 dB	–35 dB	–35 dB	–30 dB
IP-250BL	–20 dB	–20 dB	–20 dB	–25 dB	–40 dB	–45 dB	–45 dB	–45 dB	–45 dB	–40 dB
ICT-030	–	–	–	–	–20 dB	–30 dB	–35 dB	–35 dB	–35 dB	–30 dB

SPECIFICATIONS

Absorber Model	Clean Room Rating	Fire Retardancy	Tensile Stability	Max. Power Density	Product Life	Humidity Resistance	Absorber Footprint	Absorber Height	Absorber Weight
IP-100BX	FS 209E Class 10 ISO 14644-1 Class 4	NRL 8093 Test 1, 2, and 3 UL94HBF DIN 4102 Class B	4 kg/cm^2	≤500 V/m, 700 W/m^2 Core temperature ≤ 100 ° C	>30 years closed-cell polystyrene	No deterioration from water. No hydrolysis effect.	60 x 60 cm	100 cm	8.0 kg
IP-250BL							60 x 60 cm	250 cm	12 kg
ICT-030	FS 209E Class 100 ISO 14644-1 Class 5	NRL 8093 Test 1, 2, & 3 UL94HBF	10 kg/cm^2	50 kW/m^2 ≤ 800 ° C	>30 years closed-cell		30 x 30 cm	30 cm	3.0 kg

Data Sheet

IS-SM080 Oblique Absorber



IS-SM080 FEATURES

- 700 W/m² power handling
- Excellent performance at normal and oblique angles
- Clean room rated
- Closed-cell polyethylene construction
- Fire retardant

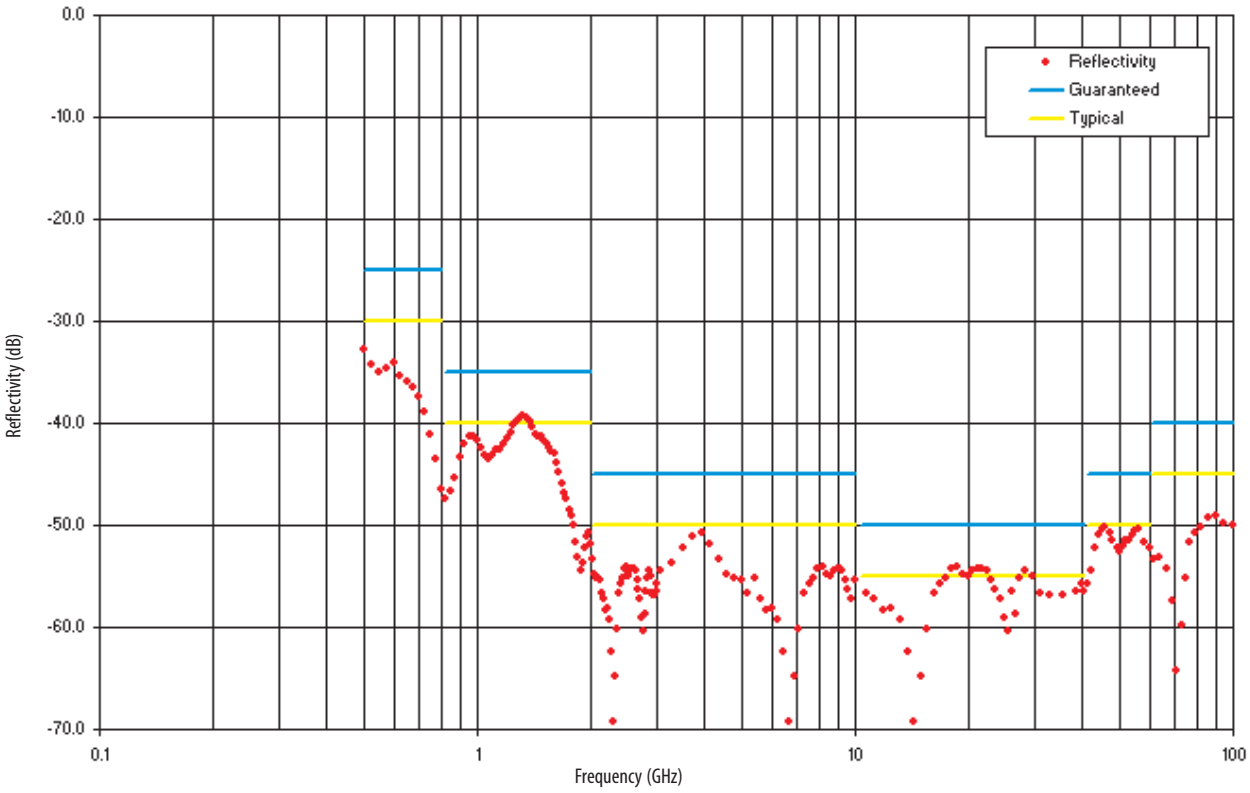
IS-SM080 SPECIFICATIONS

Clean Room Rating	FS 209E Class 100; ISO 14644-1 Class 5
Fire Retardancy	NRL 8093 Test 1, 2, and 3; UL94HBF
Tensile Stability	4 kg/cm²
Product Safety	UL Listed
Humidity Resistance	No deterioration from water. No hydrolysis effect.
Chemical Stability	Not readily attacked by acids, alkalines, or petroleum-based liquids
Product Life	> 30 years
Footprint	84 cm x 60 cm x 80 cm (L x W x H)
Weight	10.0 kg

IS-SM080 PERFORMANCE at 45° INCIDENT ANGLE

Frequency Range	Reflectivity (Typical)	Reflectivity (Guaranteed)
.5GHz – .8GHz	–30 dB	–25 dB
.8GHz – 1GHz	–40 dB	–35 dB
1GHz – 1.5GHz	–40 dB	–35 dB
1.5GHz – 2GHz	–40 dB	–35 dB
2GHz – 3GHz	–50 dB	–45 dB
3GHz – 10GHz	–50 dB	–45 dB
10GHz – 20GHz	–55 dB	–50 dB
20GHz – 40GHz	–55 dB	–50 dB
40GHz – 60GHz	–50 dB	–45 dB
60GHz – 100GHz	–45 dB	–40 dB

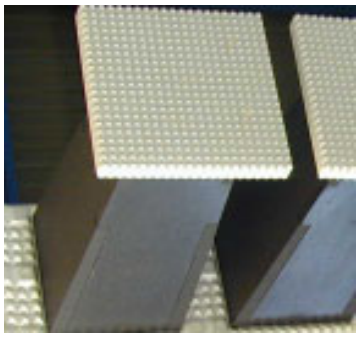
IS-SM080 MEASURED REFLECTIVITY at 45° INCIDENT ANGLE[1]

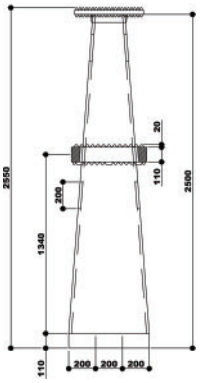


1 For angles of incidence ranging from 30° to 60° the performance results are typically within 5 dB of results stated above.

Data Sheet

IP-250BL Specialty Absorber





IP-250BL FEATURES

- 700 W/m² power handling
- Normal & oblique performance
- Clean room rated
- Closed-cell polystyrene construction
- Fire retardant

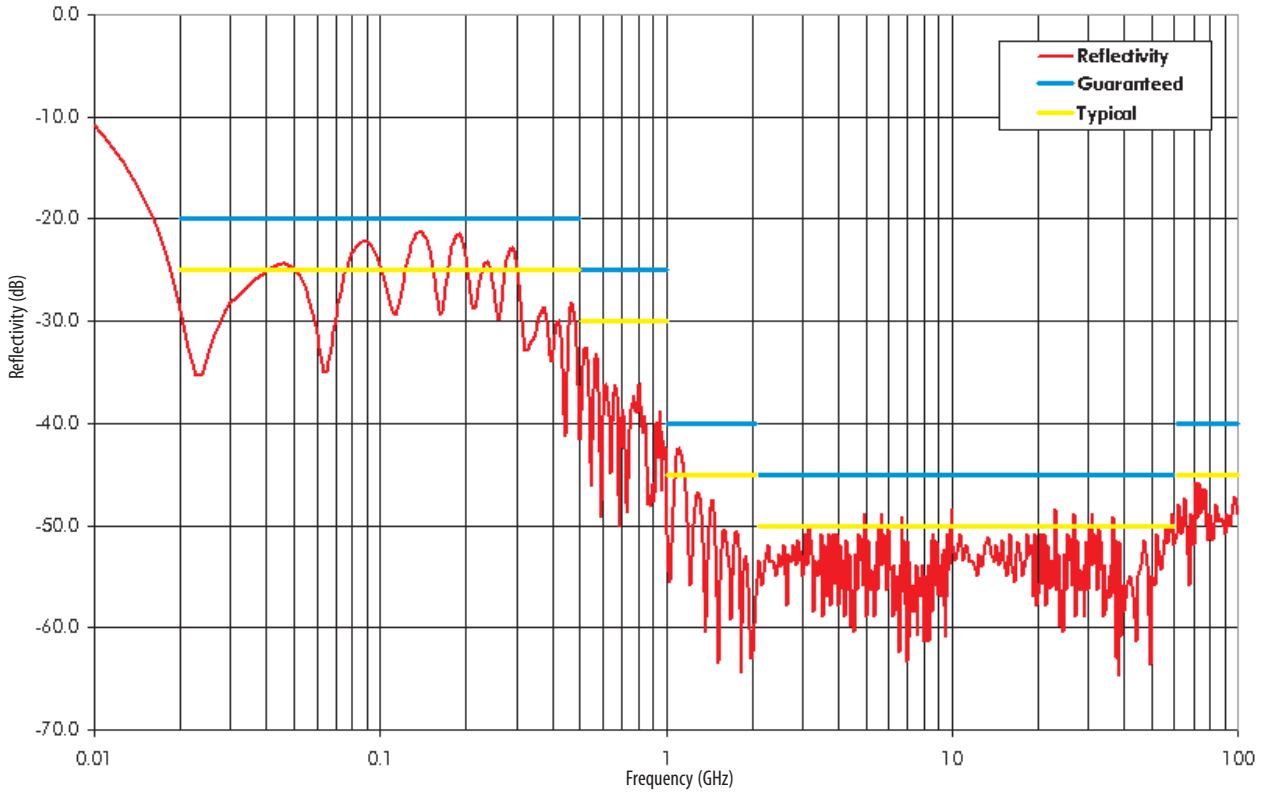
IP-250BL SPECIFICATIONS

Clean Room Rating	FS 209E Class 10; ISO 14644-1 Class 4
Fire Retardancy	NRL 8093 Test 1, 2, and 3; UL94HBF
Tensile Stability	4 kg/cm²
Product Safety	UL Listed
Humidity Resistance	No deterioration from water. No hydrolysis effect.
Chemical Stability	Not readily attacked by acids, alkalines, or petroleum-based liquids
Product Life	>30 years
Footprint	60 cm x 60 cm x 250 cm (L x W x H)
Weight	12.0 kg

IP-250BL PERFORMANCE

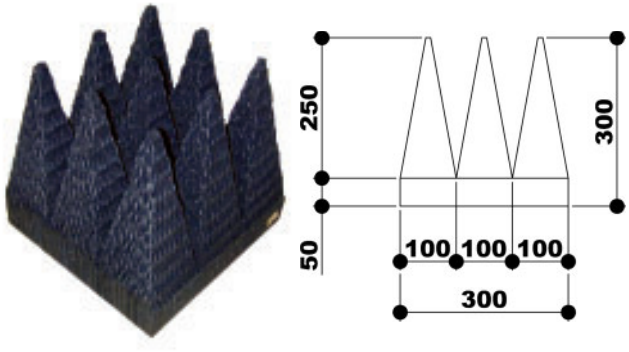
Frequency Range	Reflectivity (Typical)	Reflectivity (Guaranteed)
20MHz – 80MHz	–25 dB	–20 dB
80MHz – 100MHz	–25 dB	–20 dB
.1GHz – .5GHz	–25 dB	–20 dB
.5GHz – 1GHz	–30 dB	–25 dB
1GHz – 2GHz	–45 dB	–40 dB
2GHz – 5GHz	–50 dB	–45 dB
5GHz – 20GHz	–50 dB	–45 dB
20GHz – 40GHz	–50 dB	–45 dB
40GHz – 60GHz	–50 dB	–45 dB
60GHz – 100GHz	–45 dB	–40 dB

IP-250BL MEASURED REFLECTIVITY at NORMAL INCIDENCE



Data Sheet

ICT-030 High Power Absorber



ICT-030 FEATURES

- 50 kW/m² power handling
- Heat handling ≤ 800 ° C
- Clean room rated
- Good high frequency performance
- Fire retardant

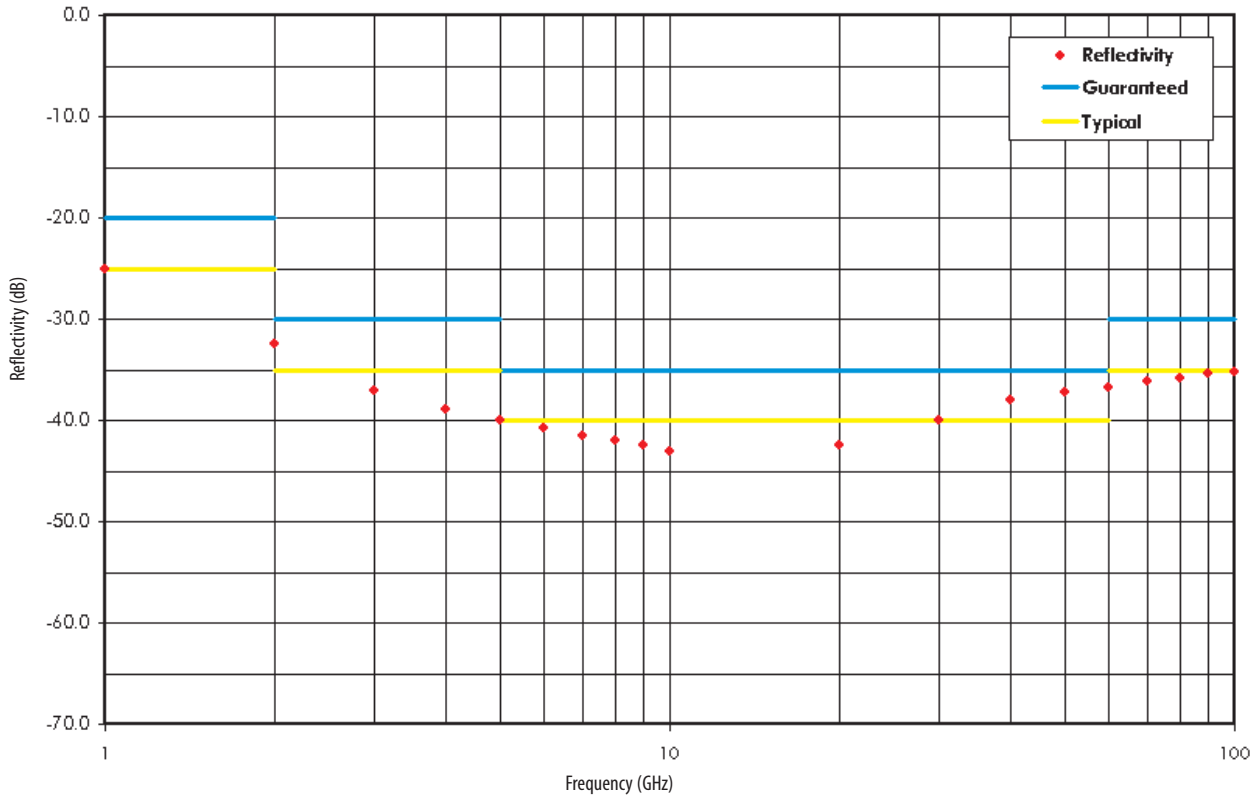
ICT-030 SPECIFICATIONS

Clean Room Rating	FS 209E Class 100; ISO 14644-1 Class 5
Fire Retardancy	NRL 8093 Test 1, 2, and 3; UL94HBF
Tensile Stability	10 kg/cm²
Humidity Resistance	No deterioration from water. No hydrolysis effect.
Chemical Stability	Not readily attacked by acids, alkalines, or petroleum-based liquids
Product Life	>30 years
Footprint	30 cm x 30 cm x 30 cm (L x W x H)
Weight	3.0 kg

ICT-030 PERFORMANCE

Frequency Range	Reflectivity (Typical)	Reflectivity (Guaranteed)
1GHz – 2GHz	–25 dB	–20 dB
2GHz – 5GHz	–35 dB	–30 dB
5GHz – 10GHz	–40 dB	–35 dB
10GHz – 20GHz	–40 dB	–35 dB
20GHz – 40GHz	–40 dB	–35 dB
40GHz – 60GHz	–40 dB	–35 dB
60GHz – 100GHz	–35 dB	–30 dB

ICT-030 MEASURED REFLECTIVITY at NORMAL INCIDENCE

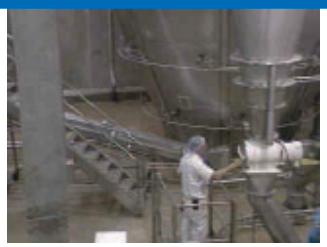


TDK Manufacturing – ISO Certified from Start to Finish

Zero defects. That's our ultimate quality goal to you. All of our quality-affecting technical, administrative, and human resources are directed towards continuous improvement and the prevention of quality deficiencies. Because quality is so important at TDK, the ultimate responsibility for, and commitment to quality belong to top management. Our Corporate Quality Assurance Department coordinates and implements all managerial quality directives.

This time line and the table below specify each step of the production process, the characteristic or control point monitored for quality purposes, the frequency of sampling for quality control, and the inspection or control method used to verify quality standards.

1	2	3	4	5	6	7
Raw Materials	**Mixing**	**Foam Inspection**	**Coating**	**Drying**	**Foam Press** **• Pressure** **• Temp.** **• Time**	**Drying**



8 **Slicing**

9 **Assembly**

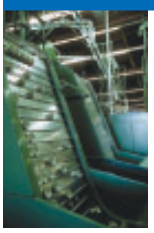
10 **Dimension Inspection**

11 **Appearance Inspection**

12 **Flammability Inspection**

13 **Outgoing Inspection**

14 **Packaging**



THE TDK ISO-CERTIFIED MANUFACTURING

Process	Control Point	Freq. Sample Size	Control Method
Raw Material	Supplier's Inspection Data	Every Purchasing Lot	Check Suppliers
Mixing	Mixing Ratio	Every Mixing Lot	Electric Balance
Incoming Foam Inspection	Supplier's Inspection Data	Every Purchasing Lot	Check Supplier's Data
Coating	Coating Volume	Every Coating Lot	Electric Balance
Drying	Drying Temperature	Every Lot	Thermometer
Foaming (Presses)	Vapor Pressure	Every Lot	Pressure Gauge
	Pressing Temperature	Every Lot	Thermometer
	Pressing Time	Every Lot	Timer
Drying	Drying Temperature	Every Lot	Thermometer
Slicing	Dimension	Every Lot	Scale
Assembly	Dimension	Every Lot	Scale
Inspection	Dimension	n/N=1/20	Scale
	Appearance	100%	Visual
	Fire Retardancy	1/Year	NRL, UL94HBF, DIN
Outgoing Inspection	Reflectivity	n/N=1/6	Tri-plate, Strip Line, VSWR
Packaging	Marking	Every Lot	Visual

TDK Absorber Testing Procedures

TDK absorber undergoes a rigorous battery of tests to guarantee electrical performance, clean room ratings, and flammability requirements.

Performance Test Procedures 10 MHz - 100 GHz

Test methodologies include the tri-plate strip line method, parallel plate strip line, NRL Arch, and the VSWR method. TDK evaluates RF absorbers in accordance with the following evaluation procedures. In all cases, the absorber reflectivity performances are given by comparing the reflection from the absorber under test and from a reference metal plate at equal distance (and equal physical cross section).

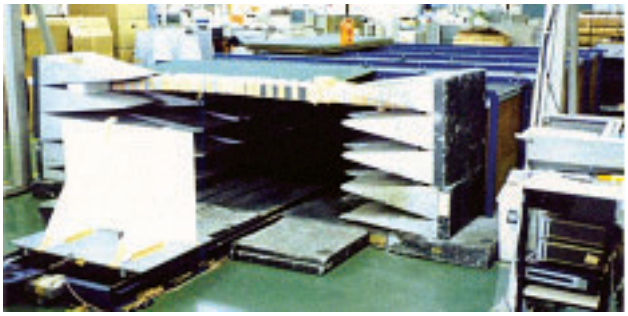
	Frequency Range	Evaluation Method
1	10 MHz to 200 MHz	Tri-plate Strip Line
2	200 MHz to 500 MHz	Parallel Plate Strip Line
3	80 MHz to 10 GHz	NRL Arch and VSWR Method
4	1 GHz to 100 GHz	Free Space VSWR Method

Tri-plate Strip Line Method from 10 MHz to 200 MHz

TDK uses the tri-plate strip line system (left) to conduct reflectivity measurements for the frequency range from 10 MHz to 200 MHz. The reflectivity of RF absorbers is obtained from the reflection coefficient measured by the network analyzer at the input port of the tri-plate strip line.

Parallel Plate Strip Line from 200 MHz to 500 MHz

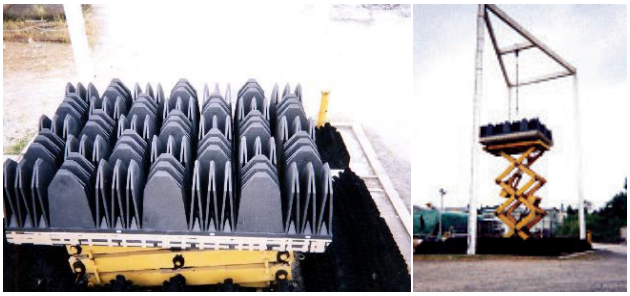
The parallel plate strip line system (below) is used for a higher frequency range than the tri-plate strip line system. This system is utilized for the measurement of frequencies from 200 MHz to 500 MHz. The reflectivity of RF absorbers is obtained by varying the sample distance from the strip line feed.



NRL Arch and VSWR Method from 80 MHz to 10 GHz

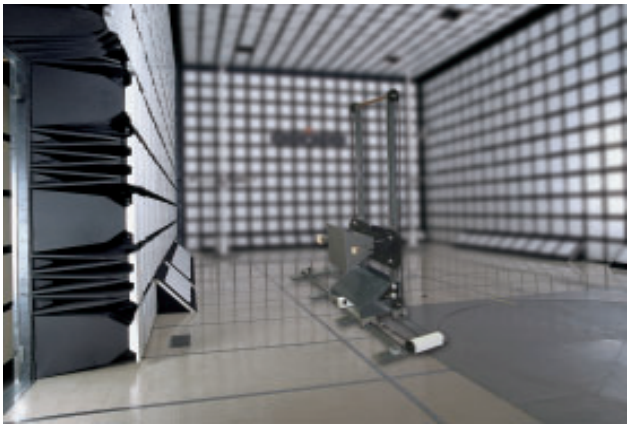
The reflectivity performance of the absorber from 80 MHz to 10 GHz is measured by the NRL method by comparing the difference between the reflection from a reference metal plate and that of the absorbers, which are positioned by the lifting system. The normal incident angle test setup is shown below.

The oblique (off-angle) incident reflectivity performance can be evaluated by the VSWR procedure using broadband biconical, log periodic, and horn antennas. The incident angle is adjusted by the height of the lifting system and the position of the transmit and receive antennas.



Free Space VSWR Method from 1 GHz to 100 GHz

To test reflectivity from 1 GHz to 100 GHz, a pair of standard gain horn antennas (receive and transmit) are placed parallel to a wall of absorbers under test (shown below). Special consideration has to be taken into account for high frequency measurements. Time gating techniques as well as additional absorber may be used to eliminate secondary reflections from exposed surfaces.



Clean Room Ratings

The clean room classification standards FS 209E and ISO 14644-1 require specific particle count measurements and calculations to classify the cleanliness level of a clean room or clean area. TDK absorber is a closed cell material that is well suited for FS and ISO clean room requirements.

FS 209E Class 10, 100 and ISO 14644-1 Class 4, 5

TDK IS material complies with an FS 209E Class 100 clean room rating. This is equivalent to an ISO 14644-1 class 5 rating.

TDK IP material is a completely closed cell polystyrene material. The IP material has even better clean room performance than the IS material with clean room ratings of FS 209E Class 10. This is equivalent to an ISO 14644-1 class 4 rating. TDK materials do not need to be painted or coated to achieve these ratings.

Fire Retardancy and Safety Ratings

NRL 8093 Test 1, 2, 3; DIN 4102 Class B; and UL94HBF

TDK IS and TDK IP materials pass the requirements of the following flammability tests:

- NRL 8093 Test 1,2,3
- DIN 4102 Class B
- UL94HBF

TDK IP and TDK IS materials are UL Listed:

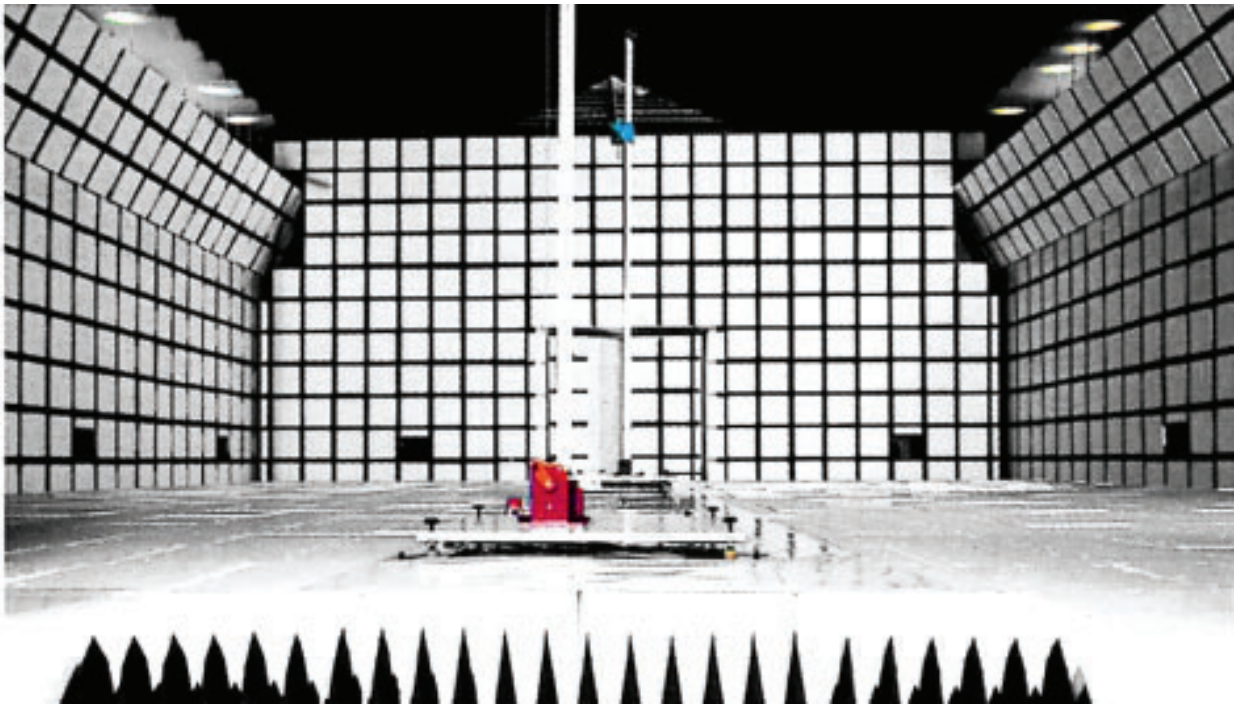
- IP Electromagnetic Polystyrene Foam (QMFZ2)
- IS Electromagnetic Polyethylene Foam (QMFZ2)

Because of the quality manufacturing process in place at TDK and the fact that all components of the TDK base material are under TDK's control, we can guarantee that all materials meet flammability requirements.

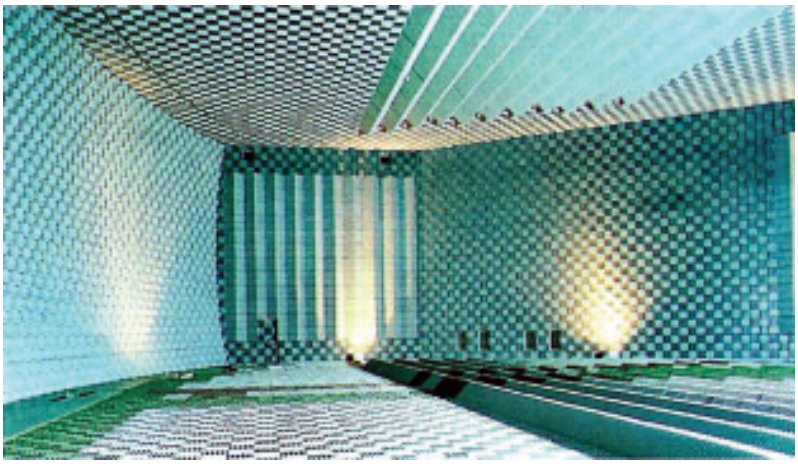
This guarantee is enforced by monitoring the chemical mix and ratio of the absorber structure and content. Unlike open cell foam products, our manufacturing process is tightly controlled. By doing this we can ensure that the absorber has the correct chemical and material mix that retards fire and does not produce poisonous materials as a by-product of combustion.

TDK Chamber Installations

Automotive Test Facility

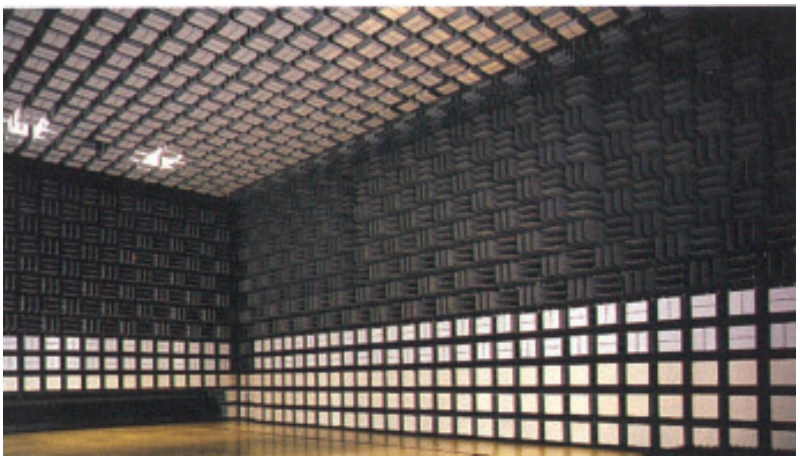


Fully Anechoic Antenna Chamber



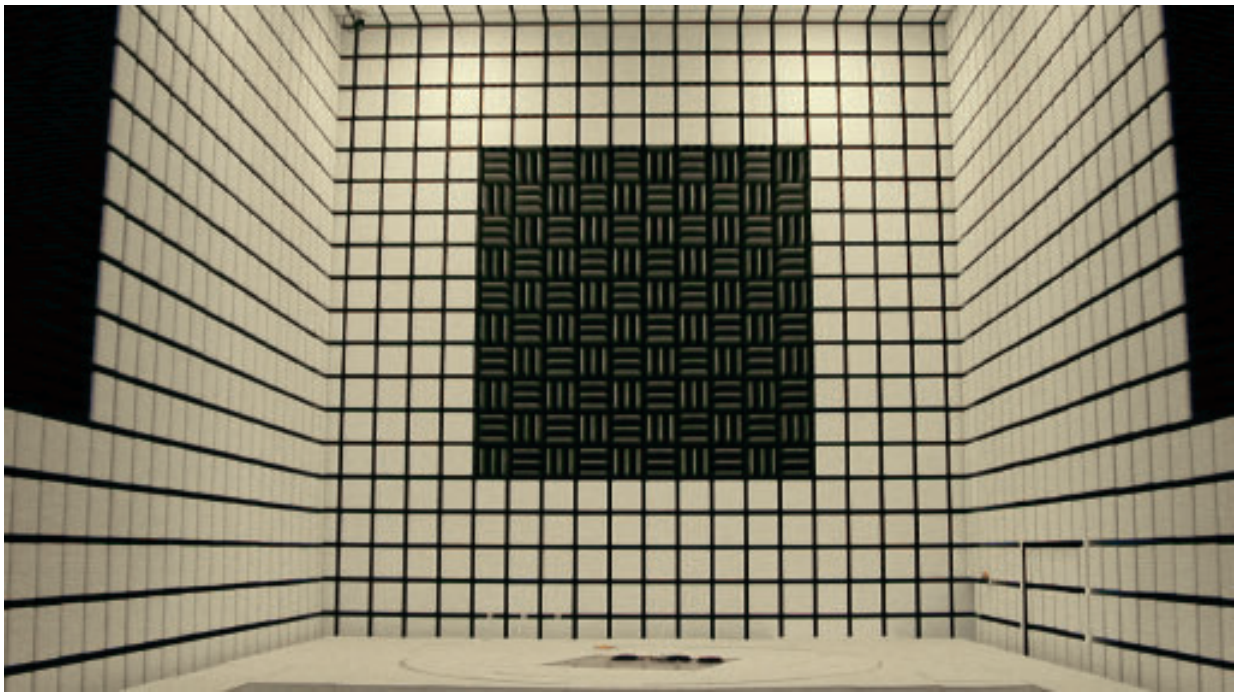
Parabolic Antenna Test Chamber

Automotive Antenna Evaluation Chamber



Antenna Evaluation Chamber

TDK Chamber Installations



Satellite and Array Antenna Measurement Chamber

Antenna Measurement Facility with Floor Absorber Detail