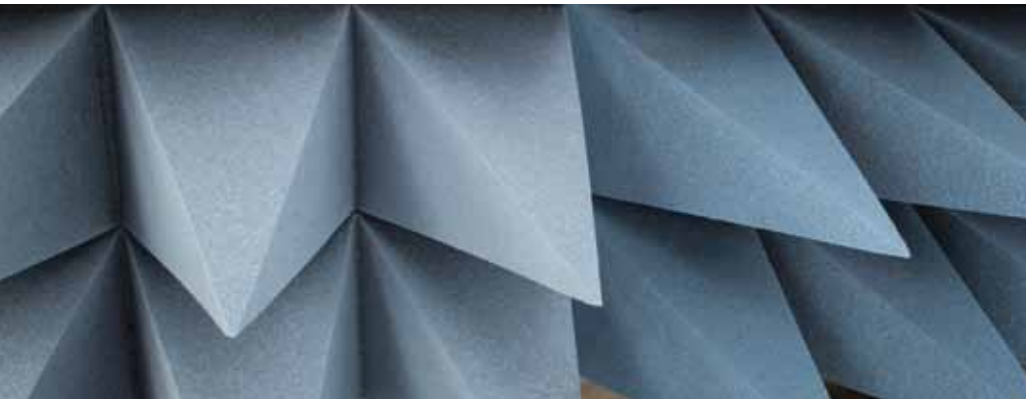


# GTEM!™ Test Cells



*Enabling Your Success™*

 **ETS·LINDGREN™**  
An ESCO Technologies Company

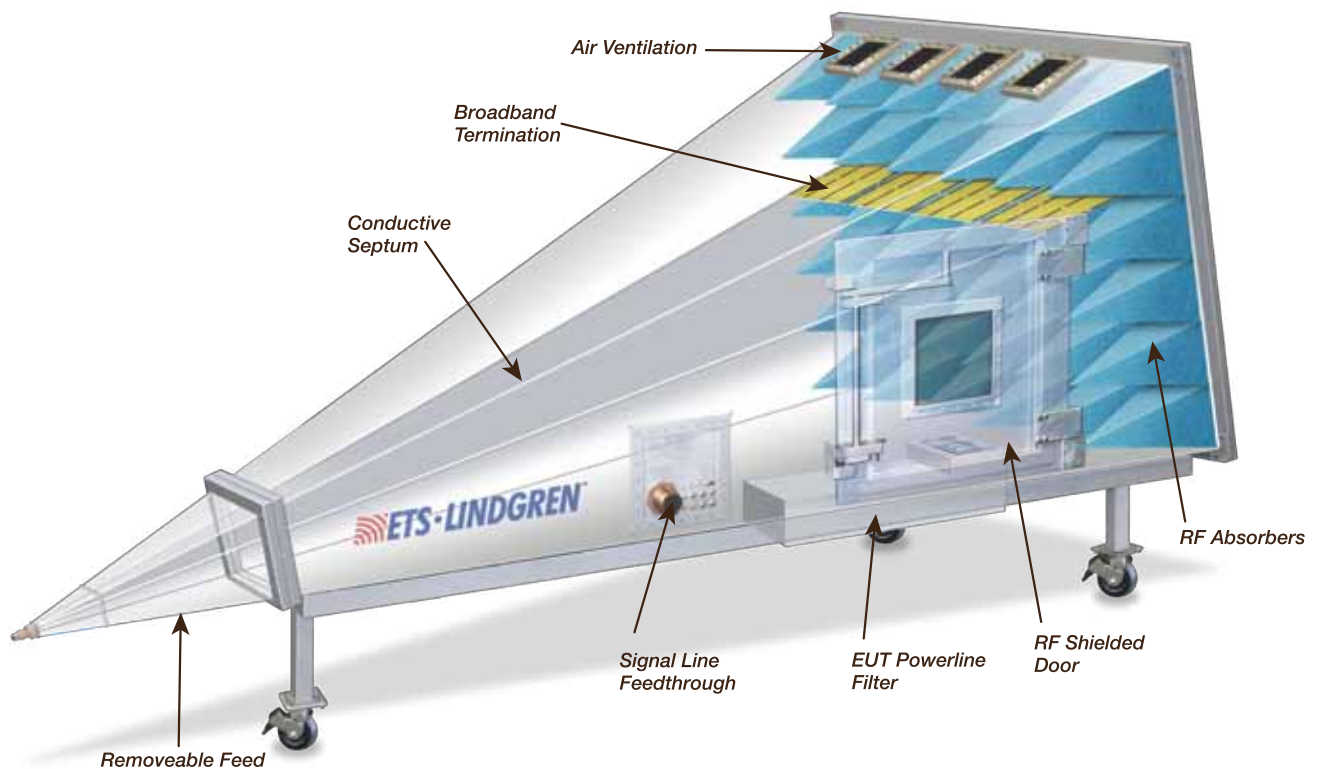
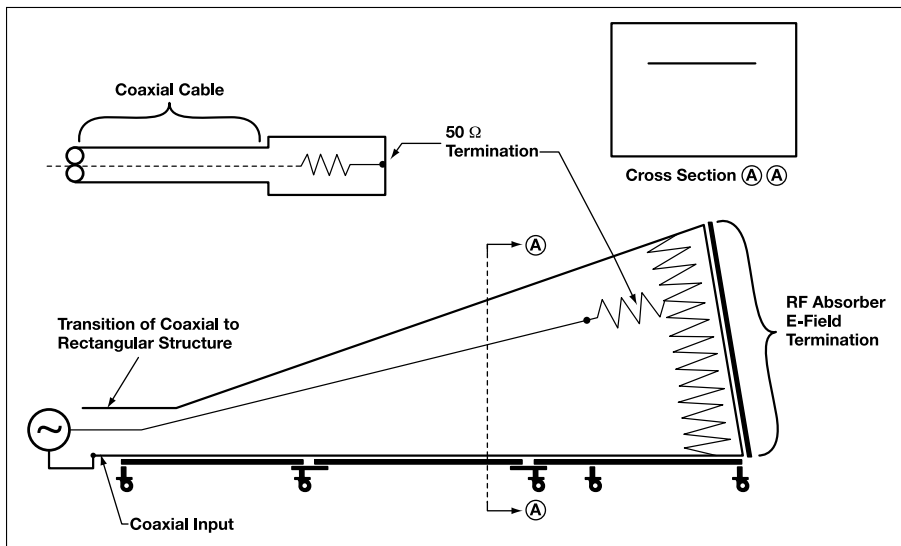
# THE GTEM!<sup>TM</sup> CONCEPT

The GTEM!<sup>TM</sup> (Gigahertz Transverse Electromagnetic) cell is a self-contained shielded enclosure designed for making both Radiated Immunity (RI) and Radiated Emissions (RE) electromagnetic compatibility (EMC) measurements. The GTEM!'s control of resonances and reflections allows precise signal levels, and the elimination of antennas provides faster test throughput.

Electrically, the GTEM! is an extension of a 50-ohm transmission line. The transmission line's outer conductor flares and expands into a pyramidal form, becoming the GTEM!'s

outer walls and RF shield. The center conductor transforms into a thin, wide conductive plate, becoming the GTEM!'s septum. Current is terminated by a 50 ohm broadband resistive network between the septum and the GTEM!'s backwall. Fields are terminated by RF absorber at the backwall.

For immunity tests, the output of a power amplifier is attached to the input connector located at the GTEM!'s apex. For emissions tests, a receiver or spectrum analyzer is attached to the input connector and replaces the power amplifier.



## Applications

### Product Development – Design Qualification:

- A/B Comparative Measurements
- Pre-Compliance Measurements
- Production Sampling Quality Assurance

### Industry:

- Automotive Component Testing
- Corona Spectrum Measurement
- E-Field Probe Calibration
- Hearing Aid Immunity Testing
- IC and Chip Set Testing
- Shielding Effectiveness Testing
- Wireless Transceiver Design Test

## Applicable Standards

- IEC 61000-4-20
- ANSI C63.4 Annex F (2009)
- SAE J1752/3

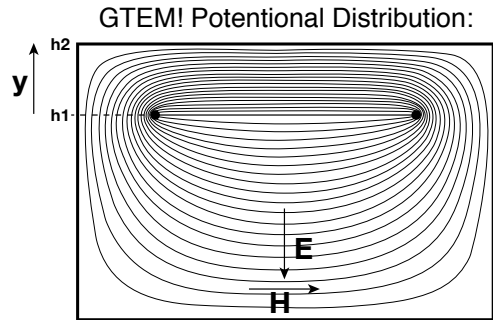
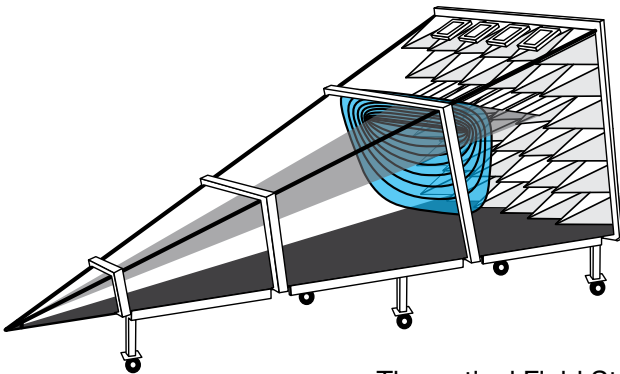
## Benefits

- Can be used to make both Radiated Emissions (RE) and Radiated Immunity (RI) measurements
- Creates high field strengths with relatively modest power input
- Generates fields that are typically homogeneous and uniform
- Operates over a very broad frequency range
- Requires no antennas, antenna setup, or stopping for band breaks
- Provides 50 ohm characteristic impedance
- Exhibits excellent VSWR over frequency
- Requires no facility resources other than power
- Moveable (rolls on wheels)

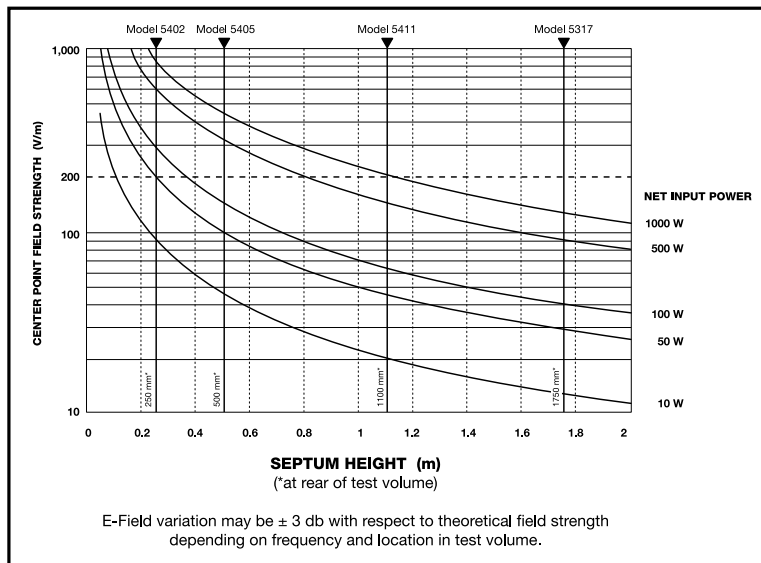
## Field Generation and Uniformity

GTEM!<sup>TM</sup>s generate TEM waves along the septum with signal input. The TEM waves have a field impedance of 377 ohms, the same as free space. The intensity of the field is directly proportional to power input and the distance of the septum to the outer conductor (floor).

GTEM!'s generate fields that are typically homogeneous and uniform.

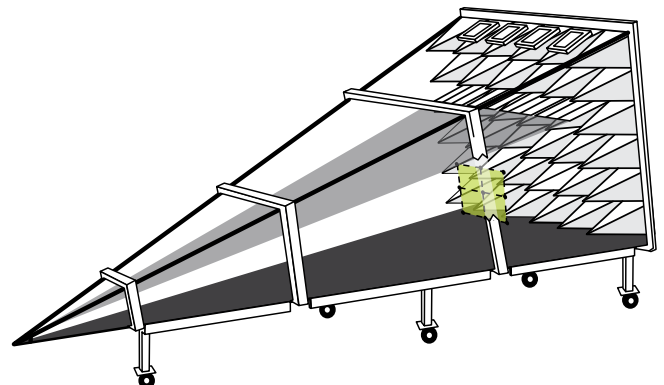


Theoretical Field Strength vs CW Input Power

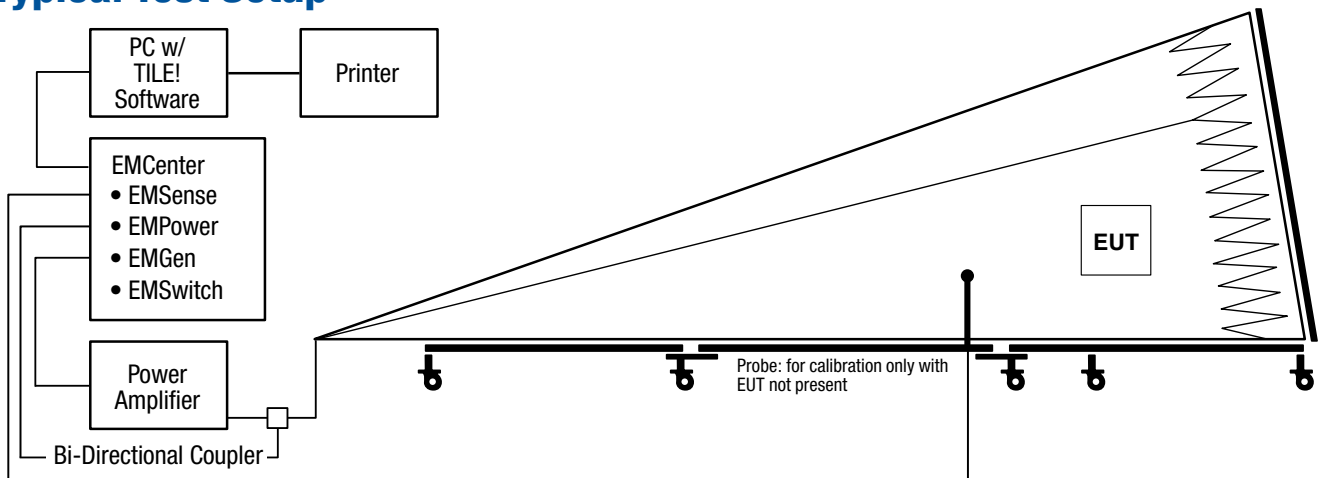


## Field Calibration

Making a field uniformity calibration in a GTEM! is similar to make one in an EMC chamber. The procedure given in IEC 61000-4-20 calls for a field generating setup using an isotropic 3-axis field probe, like one from the ETS-Lindgren HI-6xxx series. The number of points to be tested and their position will be determined by the size of the GTEM!. The procedure determines the size of the uniform field area and the maximum size of the EUT to be tested. It also provides the power required for a given field strength.



## Typical Test Setup



- TILE!™ Lab Management Software
- PC
- EMCenter™ with Signal Generator, Power Meter, and Probe Controller
- Power Amplifier
- Bi-Directional Coupler
- Field Probe (typically used for calibration procedure only)
- GTEM!

## Estimating the power required for obtaining a given field strength in a GTEM!™

$(E \cdot h)^2 / R \cdot \text{Flatness} \cdot \text{Allowance}$

Using the parallel-plate electric field approximation, the estimated field strength halfway between the septum and the floor of the GTEM! is given by the ratio of the RF voltage on the septum to the spacing of the septum above the GTEM! floor, or:

$$E(\text{Volts/meter}) = V(\text{Volts}) / h(\text{meters})$$

RF voltage is obtained from the drive power by the equation:

$$P_{in}(\text{Watts}) = V^2(\text{Volts}^2) / Z_0(\text{Ohms})$$

Where  $P_{in}$  is input RF Power (Watts),  $V$  is RF voltage on the septum at height  $h$ , and  $Z_0$  is the GTEM! characteristic impedance (50 ohms).

A simple solution is:

$$E = \left(\frac{1}{h}\right)(P \times Z_0)^{1/2} \quad P = \frac{(Eh)^2}{Z_0}$$

Actual power needed for a given electric field strength will vary by frequency and location in the GTEM!.

Ex 1

for 20 V/m Test in a  
5405 (Septum = 0.5m)

Power Required =>  

$$(20 \times 0.5)^2 / 50 = 2 \text{ Watts}$$

Ex 2

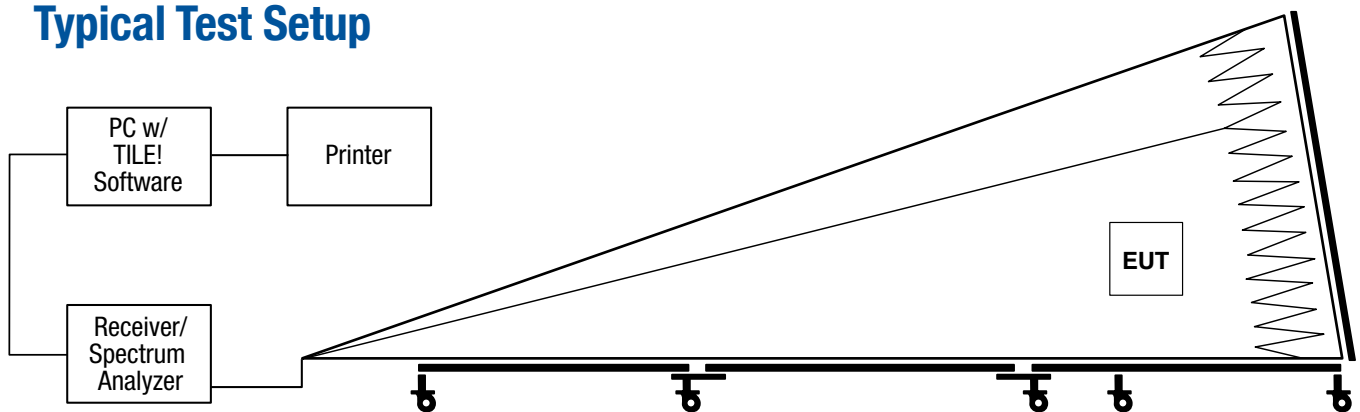
for 100 V/m cw  

$$P_{in} = (100 \times 0.5)^2 / 50 = 50 \text{ Watts}$$

for 100 V/m with 80% AM  

$$P_{in} = 50 \times 3.24 = 162 \text{ Watts}$$

## Typical Test Setup



- TILE!<sup>TM</sup> Lab Management Software
- PC
- EMCenter<sup>TM</sup> with Positioning Controller
- Receiver/Spectrum Analyzer
- EUT Positioner
- GTEM!<sup>TM</sup>

To make an emission measurement in a GTEM!, a receiver is attached to the input connector at the cell's apex. The input connector flares to become the GTEM!'s septum. Electrically, the septum functions as a broadband receive antenna for the RF voltage generated by the EUT.

A principle of GTEM! measurement is that the EUT can be modeled as a sum of electric and magnetic dipole moments, and the sum can be correlated to OATS measurements made in the far field. To make the correlation, the EUT is rotated. Measurements taken at each orthogonal position (X,Y,Z), and the sum of the measurements are converted using an algorithm, with the result compared to the applicable test limit.

## The GTEM! correlation algorithm performs the following computations:

- Calculates the vector sum of the three or more measured voltages at X, Y, Z axes
- Computes the total radiated power emitted by the EUT
- Computes the gain of an equivalent dipole
- Places the hypothetical dipole at a specified height over a perfect ground plane
- Computes the horizontally and vertically polarized field strength at appropriate height intervals, measured at the specified test distance
- Selects the maximum values of the horizontally or vertically polarized field strengths
- Presents the maximum value for comparison to the chosen EMC limit



## TILE!™

TILE! (Total Integrated Lab Environment) is a software environment for performing Electromagnetic Compatibility (EMC) Tests in any environment – GTEM!™ cell, SMART™ reverb chamber or FACT™ and SpaceSaver™ semi-anechoic chambers. An optional library of predefined test routines called “Profiles” perform executive test functions and control instrumentation in the hardware loop. Test-specific Profiles are available for most common tests (ANSI, IEC, CISPR, etc.) and can be password protected to prevent unauthorized modification. In a systems environment, TILE! runs on a PC that is connected to and controls an EMCenter™ RF test platform.

TILE!’s unique visual interface also offers the ability to create your own test Profiles with drag-and-drop simplicity in a familiar Microsoft Windows® environment. Each step in the test sequence is represented as a unique icon. Right clicking on the icon opens a dialog box for customizing the settings of that particular action. Icons are dragged and dropped into place on the screen, with the entire test sequence resembling a flowchart.

## Unique TILE! Features

### TILE! Executive

Executive is an easy-to-use interface which enables administrative level users to run predefined Profiles with a few clicks of a mouse. This allows engineering resources to focus on more high value tasks.

### TILE! Simulator

This powerful tool enables users to create simulated test environments without tying up valuable lab resources. Users select virtual instruments to substitute for actual instruments, then develop Profiles, see how various instrument configurations might interact, perform training and customer demos or validation testing – all without using (or damaging) valuable equipment.

## TILE! Report Generator

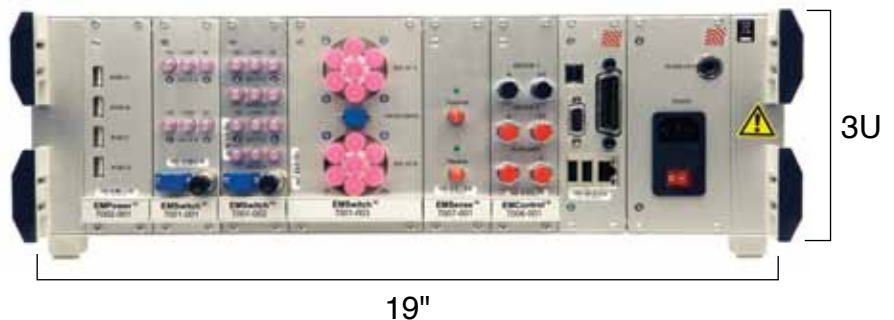
The new report generator has expanded capabilities, including a fully customizable, predefined MS Word® document template with test data, tables, and both graphics and photographs of the test set-up. Reports produced are customer-ready within seconds.



## TILE! User Support

TILE! users have 24/7 access to a web portal exclusively for them. Users can ask questions, submit service requests, download the latest software enhancements, or access our equipment driver library. Users can connect to the TILE! LinkedIn page, where ideas can be exchanged with other TILE! users. TILE! users are also invited to attend the TILE! User’s Group (TUG) meeting held annually during IEEE EMC Symposium.





## EMCenter™

EMCenter is a flexible RF test platform that includes an integrated microcontroller, touch screen, and space for up to seven mix-or-match plug-in card modules. Each card module is an instrument that has been optimized for RF measurement. Card modules are easily inserted into the chassis' rear card bay, and are recognized when the system initializes. Included I/O capability expands EMCenter's connectivity with ports for Ethernet, RS-232, USB, and IEEE-488<sup>2</sup>. For even more expansion, EMCenters can be linked together to form a scalable system.

The EMCenter can be manually controlled through a front panel TFT touch screen. For automated testing, EMCenter can be controlled with RF test software, including TILE!<sup>™</sup>.

### Included Plug-in Card Modules:

- I/O Card Module with
  - Ethernet (1)
  - RS-232 (1)
  - USB (3)
  - IEEE-488 (1)<sup>1</sup>
- Power Module with:
  - Safety Interlock
  - Power Switch
  - IEC Power Cord Receptacle

### Optional Plug-In Card Modules:

- EMGen™ Signal Generator
- EMPower™ RF Power Meter
- EMPower Pulse™ RF Burst/Pulse Power Meter
- EMSwitch™ Switch Matrix
- EMLink™ Analog Fiber Optic Link
- EMControl™ Tower and Turntable Controller
- EMSense™ E-field Probe Controller

<sup>1</sup> IEEE-488 is available as an option



## Instrumentation

Your RF test system can be ordered with our suggested list of EMC instrumentation, outfitted with your particular brand preference, or integrated with equipment you may already have. Our large library of equipment drivers supports most new and legacy instrumentation.

Because we support so many varieties of instrumentation, you have the flexibility to choose from a range of solutions, picking the instrumentation that's best for your needs.

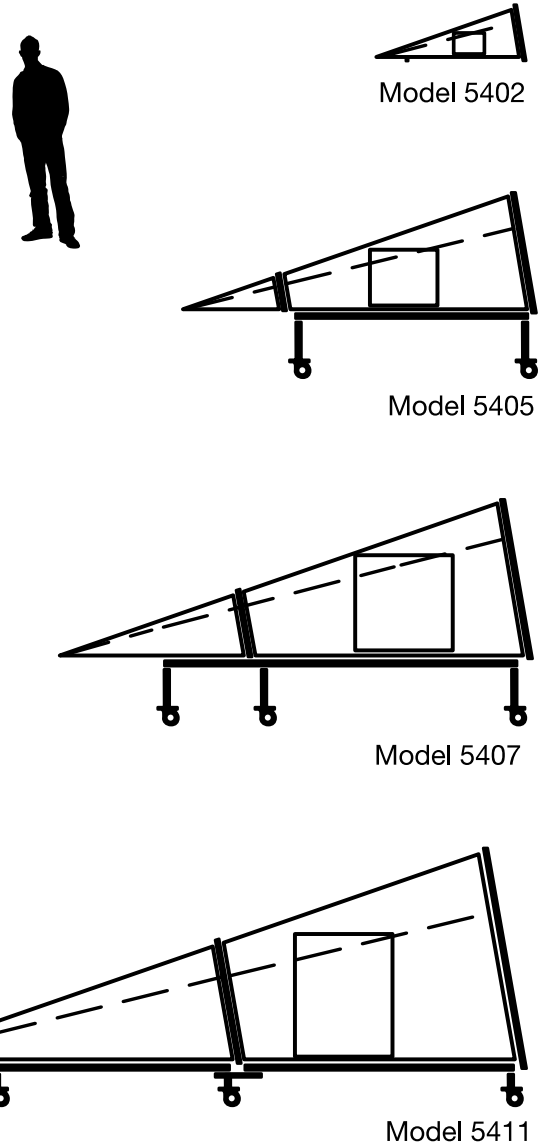
## Partial List of Supported Brands

- Agilent
- Amplifier Research
- Anritsu
- Milmega
- Rohde & Schwarz
- TESEQ

System	EMC-5402
Cell/Chamber	GTEM! Model 5402
Recommended EUT Size	100mm W x 88mm H
Radiated Emissions	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards <sup>2</sup>	IEC 61000-4-20 Annex A ANSI C63.4-2009 Annex F
Radiated Immunity	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards	IEC 61000-4-20 Annex B
Specifications	10 V/m (80% AM)
System	EMC-5405
Cell/Chamber	GTEM! Model 5405
Recommended EUT Size	250mm W x 167mm H
Radiated Emissions	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards <sup>2</sup>	IEC 61000-4-20 Annex A ANSI C63.4-2009 Annex F
Radiated Immunity	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards	IEC 61000-4-20 Annex B
Specifications	10 V/m (80% AM)
System	EMC-5407
Cell/Chamber	GTEM! Model 5407
Recommended EUT Size	400mm W x 300mm H
Radiated Emissions	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards <sup>2</sup>	IEC 61000-4-20 Annex A ANSI C63.4-2009 Annex F
Radiated Immunity	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards	IEC 61000-4-20 Annex B
Specifications	10 V/m (80% AM)
System	EMC-5411
Cell/Chamber	GTEM! Model 5411
Recommended EUT Size	550mm W x 366mm H
Radiated Emissions	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards <sup>2</sup>	IEC 61000-4-20 Annex A ANSI C63.4-2009 Annex F
Radiated Immunity	
Frequency Range	30 MHz to typical 18 GHz
Applicable Standards	IEC 61000-4-20 Annex B
Specifications	10 V/m (80% AM)

## Scalability

GTEM!<sup>TM</sup>s are available in sizes ranging from 250 mm to 1750 mm measured at maximum septum height. The smallest GTEM! is perfect for microelectronics: the largest will test a workstation.



2	GTEM EUT measurements <= 1 GHz	Test an EUT with attached cables	Test a battery powered EUT with no attached cables
	C 63.4 Annex F	Yes	Yes
	61000-4-20	Yes	Yes
	GTEM EUT measurements > 1 GHz	Test an EUT with attached cables	Test a battery powered EUT with no attached cables
	C 63.4 Annex F	No	No
	61000-4-20	Yes	Yes

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