



# TC-5062C 6 GHz TEM Cell

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## *Operating Manual*

R121114

<http://www.tescom.co.kr>

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## WARRANTY

TESCOM guarantees that this product will be free from defects in materials and workmanship for a period of six months from the date of shipment. During the warranty period, TESCO will, at its discretion, either repair or replace defective products.

For the warranty service, customer must notify TESCO of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to TESCO or a service center designated by TESCO. Customer shall pay for shipping charges as well as any other charges incurred outside of Korea. TESCO shall pay shipping charge to return the product to customer.

This warranty shall not apply to consumable parts and any failure or damage caused by improper use or unauthorized service. In such cases, TESCO may refuse to furnish service under the warranty.

### ■ **LIMITATION OF WARRANTY**

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by customer, Customer-supplied software or interfacing, unauthorized modification or misuse, accident or abnormal conditions of operations.

TESCOM responsibility to repair or replace defective products is the sole and exclusive remedy provided to the customer for breach of this warranty. TESCO will not be liable for any indirect, special, incidental, or consequential damages, despite any advance notice of the possibility of such damages.

## Safety Considerations

Review the following safety precautions to avoid injury and prevent damage to this product or any product connected to it.

- **Do Not Disassemble any part except replaceable parts**

- **Do Not Operate in Wet/Damp Conditions**

To avoid injury or fire hazard, do not operate this product in wet or damp conditions.

- **Do Not Operate in Explosive Atmosphere**

To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

- **Provided Proper Ventilation**

To prevent product overheating, provide proper ventilation.

- **Do Not Operate With Suspected Failures**

If there is damage to this product, have it inspected by qualified service personnel

- **Environmental Conditions**

Refrain from using this equipment in a place subject to much vibration, direct sunlight, and where the surface is not level. Also, use it where the temperature is between 0 °C to 50 °C and relative humidity is less than 85%.

## Safety Symbols and Terms

### Terms in this manual:

**WARNING:** Identifies conditions or practices that could result in injury or loss of life.

**CAUTION:** Identifies conditions or practices that could result in damage to the product or other property.

### Terms on the product:

**DANGER:** Indicates an injury hazard immediately accessible as you read the marking.

**WARNING:** Indicates an injury hazard not immediately accessible as you read the marking.

**CAUTION:** Indicates a hazard to property including the product.



**DANGER**  
Risk of electric shock



**WARNING / CAUTION**



Indicates earth  
(ground) terminal

## Service and Support

If you have a problem with your TC-5062C, contact Tescom Technical Support specialists.  
Any adjustment or repair of this product must be performed by qualified personnel.

### Contact Information

**Address:** TESCOM Company Limited, #927 Unitechvil 142, Ilsan-ro, Ilsandong-gu, Goyang-si,  
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**Chapter****1**

# General Information

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This section provides a general description of the 6 GHz TEM cell and proper set-up procedures.

## 1.1 Instructions and Key Features

### ■ Instructions

TC-5062C 6 GHz TEM Cell generates the Electro-magnetic field for testing small RF devices such as mobile phones, WLAN, PDA, Bluetooth, DAB/DMB, RFID, etc. Through the RF input/output port, an external test signal may be applied to the TC-5062C to generate a predictable TEM test field inside the cell. The radiation field can also be picked up through the RF input/output port using a test receiver. The unique, compact, economical design is intended for medium accuracy measurements beyond the standard TEM Cell frequency range.

### ■ Key Features

- Reliable High RF Shielding up to 6 GHz
- Designed for long life
- Specifically designed for various types of mobile phones
- Absorbing materials for stable measurement results
- EMI filters on all data ports

## 1.2 Specifications

### General Specification

VSWR	< 1.7, 100 MHz ~ 6 GHz
Effective Cell Height	220 mm
Field Strength at Center of Cell	13 dB $\mu$ V/meter at 1 $\mu$ V input
RF Connectors without module	1 N(f) topside, 1 SMA(f) outside and SMA(f) inside
Dimension	
Inside	240(W) x 205(D)
Outside	344(W) x 380(D) x 675(H) mm
Door Size	176(W) x 130(H) mm
Weight	19 kg
*Packing	
Size	450(W) x 540(D) x 840(H) mm
Weight	approx. 24.8 kg

\*The size or weight of a package may vary on how to pack a package.

### Typical RF Shielding

100 to 2000 MHz	> 80 dB
2000 to 3000 MHz	> 70 dB
3000 to 6000 MHz	> 60 dB

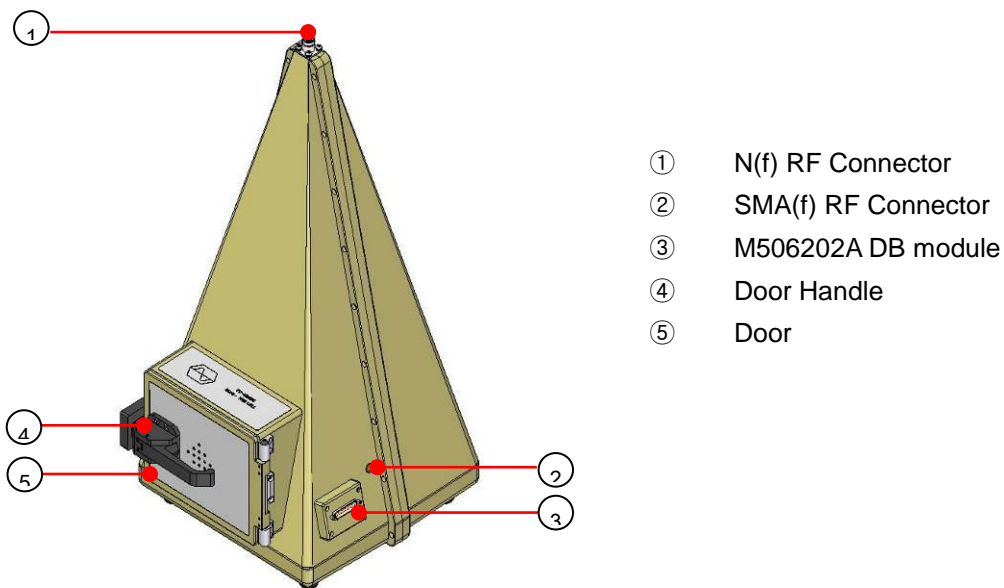
## 1.3 Connectors

This section contains reference information for TC-5062C's connectors.

[Table 1] TC-5062C Connectors

Connector	Specification
N Coaxial Connector	Impedance: 50 ohm Voltage Rating: 1500 Vpeak Dielectric Withstanding Voltage: 2500 Vrms
SMA Coaxial Connector	Impedance: 50 ohm Voltage Rating: 250 Vpeak Dielectric Withstanding Voltage: 750 Vrms

## 1.4 Component Identification

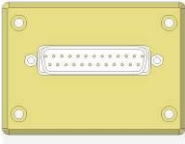
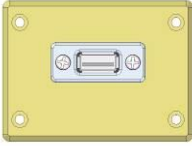


[Figure 1] TC-5062C Component Identification

## 1.5 Initial Inspection

- 1) Upon receipt of the TC-5062C, check for any damages that could have occurred during shipment.
- 2) Verify you have received the accessories supplied with the TC-5062C and module, which are listed in Table 2, 3.

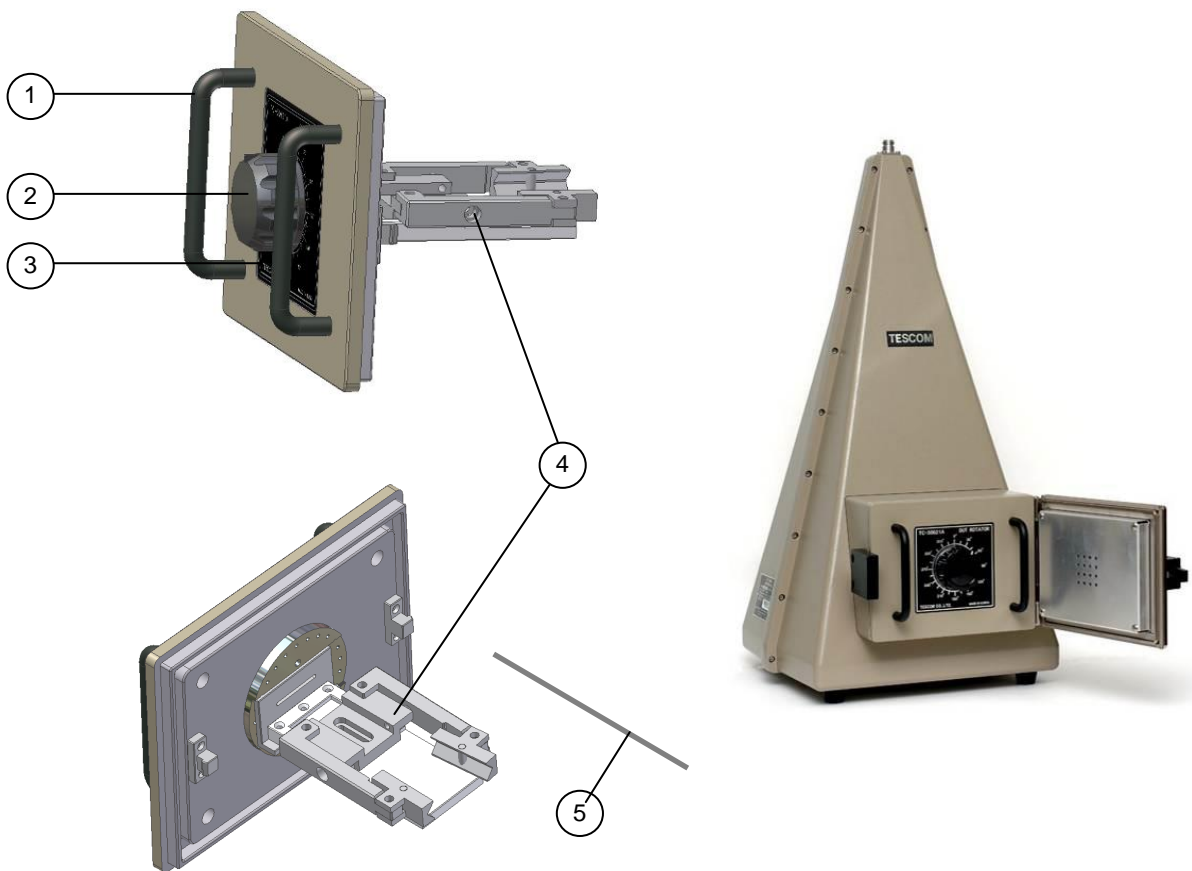
**[Table 2] TC-5062C Optional I/O Panel**

Appliance	Panel Number & Description
	<p><b>M506202A ; DB25 Data Interface Panel</b></p> <ul style="list-style-type: none"> <li>• Shielding Spec. : &gt;70 dB from 0.1 to 2 GHz, &gt;60 dB from 2 to 3 GHz, &gt;55 dB from 3 to 6 GHz</li> <li>• Working Voltage: 100 VDC</li> <li>• Dielectric Withstanding Voltage: 300 VDC</li> <li>• EMI Filter: 1000 pF Pi filter</li> </ul>
	<p><b>M506204A ; USB2.0 Data Interface Panel</b></p> <ul style="list-style-type: none"> <li>• Shielding Spec. : &gt;60 dB from 0.1 to 6 GHz</li> <li>• USB A 2.0 outside and inside</li> </ul>

**[Table 3] TC-5062C Accessories list**

Part Number	Name	Spec.	Quantity
	Operating Manual		1
	Test Report		1
1901-0002	SMA 50 Ω termination		1
4003-0005	DB25(p) to DB25(s) Cable	1 m	1
4011-0019	RF Cable	SS402, N(m)-N(m), 2 m	1

## 1.6 F50621A DUT Rotator Component Identification



**[Figure 2] F50621A DUT Rotator Component Identification**

- ① Handle
- ② Rotary Knob for rotating DUT
- ③ Rotation Angle Plate
- ④ DUT Holder: Fix the DUT in proper position. The DUT can be measured at different direction by rotating the rotator handle.
- ⑤ Stick for the DUT position Control: Measurement result is depend on the position of DUT antenna. To get stable result, the DUT should be properly positioned using this stick. The stick must be removed before install the DUT Rotator.



To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to the equipment.

## 1.7 Storage

The storage temperature range for this equipment is  $-20\text{ }^{\circ}\text{C}$  to  $70\text{ }^{\circ}\text{C}$ . When this equipment is not used for a long period of time, cover with vinyl or place in a cardboard box and store in a dry place away from direct sunlight.

# Operation

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This section provides important information regarding TC-5062C operation

## 2.1 Theory of operation

TC-5062C Pneumatic 6 GHz TEM Cell is made to work well beyond the typical TEM Cell operating frequency range limited by cell resonance. A typical TEM Cell is a 2-port symmetrical device; RF voltage is applied to one port while the other port is terminated at 50 ohm while maintaining 50 ohm characteristic impedance along the cell. Due to the expansion and contraction parts of the cell, the wave propagation beyond a certain frequency is no more propagated by TEM mode alone and creates resonance. To eliminate the resonance problem, half of the cell is replaced by the wave absorbing material. One commercial implementation is G-TEM Cell. The size of the G-TEM design is too large for typical small device applications due to the type of absorber used. Tescom borrowed the concept of G-TEM, but changed the termination implementation scheme, and designed a very compact broad band TEM Cell that can be used on a desktop.

The operation principle is essentially the same as with the TEM Cell. The E-H field inside the test volume is proportional to the input voltage and inversely proportional to the cell height. If a radiating object is inserted inside the cell, the radiated wave toward the input port is guided by the transmission line and picked up at the input with a receiver such as a spectrum analyzer. With this method, RFI from a radiating Device can be measured quantitatively. Since this apparatus is very broadband, it has many applications in the area of EMI, EMS, receiver sensitivity test, etc.

### 2.1.1 Standard E-field Generation (Ref. 1, Figure 3)

Consider a case when a 50 output impedance Signal generator puts out V (Volt) of RF signal into the input connector of a TEM Cell. Then the E-field, E (Volt/meter), developed inside the TEM cell is found by the following formula.

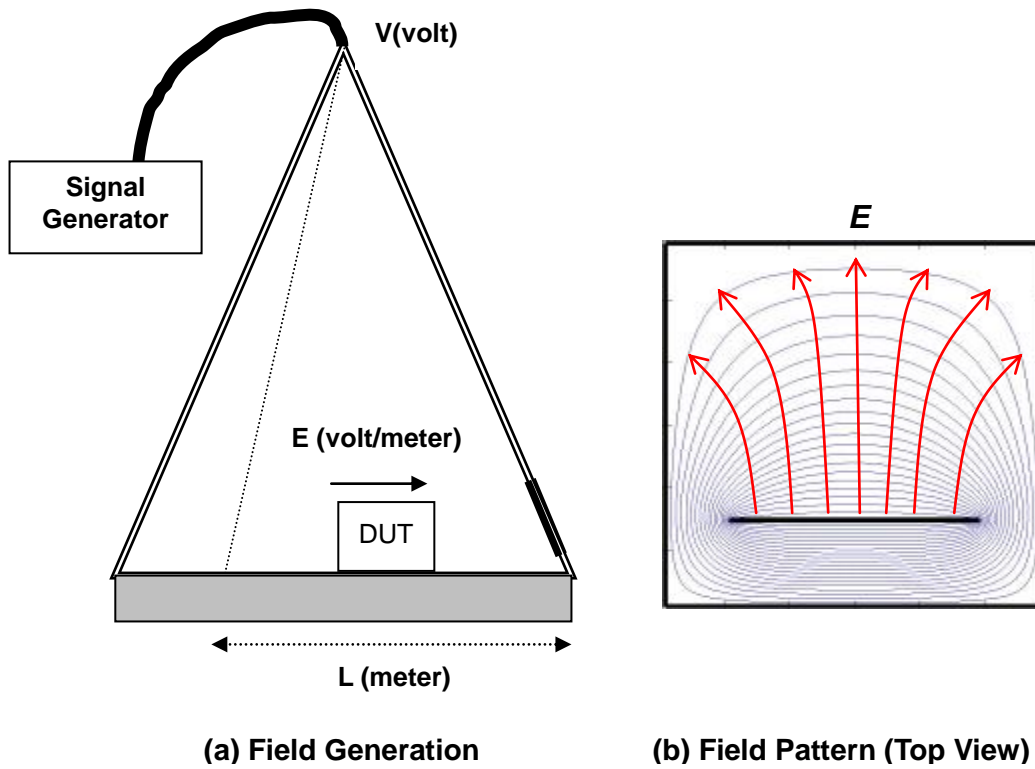
$$E \text{ (Volt/meter)} = V \text{ (Volt)} / L \text{ (meter)} \dots\dots\dots (1).$$

Here, L is the distance between the septum and the top wall. In TC-5062C, L is 22 (cm). Since TEM Cell produces a TEM wave, an orthogonal H-field (ampere/meter) proportional to E-field exists. They are related by the free space wave impedance 377 .

$$H \text{ (Ampere/meter)} = E \text{ (Volt/meter)} / 377 \text{ (Ohm)} \dots\dots (2)$$

Field distribution inside the cell is shown in Figure 3.





[Figure 3] Field Generation and Field Pattern

**<Example>**

Connect the RF output of a signal generator to the input port of TC-5062C with a cable. Set the signal generator frequency (between 100 MHz to 6 GHz) and the signal level to 220 mV. The E-field developed at the test point inside TC-5062C is then:

$$E = 0.22(V) / 0.22(\text{meter}) = 1 (\text{Volt/meter}).$$

If the signal generator output is decreased to 2.2 uV, the E-field inside TC-5062C becomes 10 uV/meter at the center of the test volume.

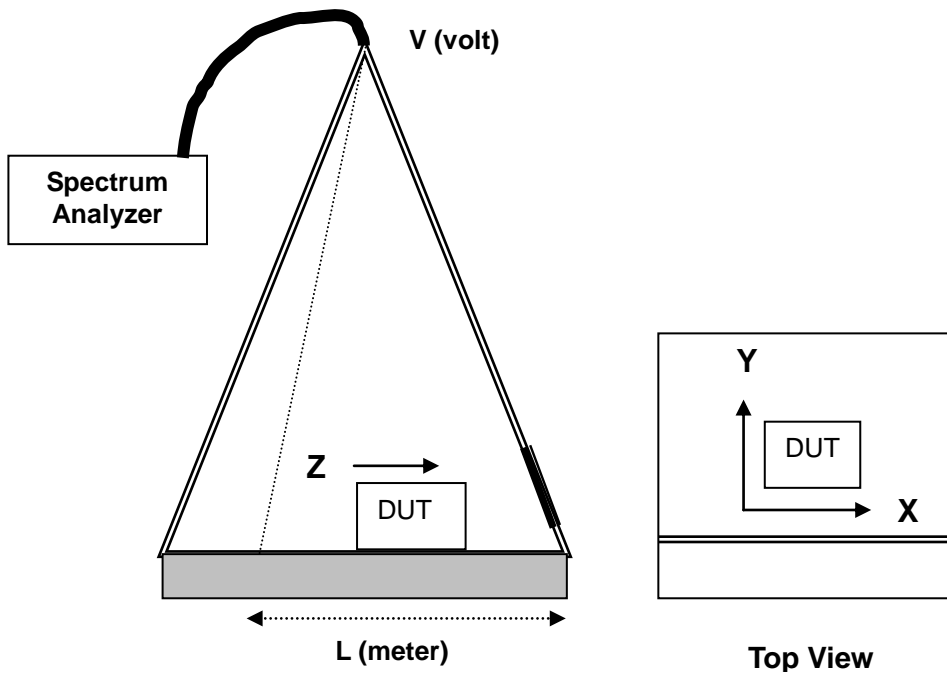
**2.1.2 Radiation Power Measurement (Ref.2, Figure 4)**

When a radiating object is placed inside the TEM cell, the radiated power  $P_o$  (Watt) travels equally to both ends of TEM cell. The voltage measured,  $V_m$  (Volt) at one end can be expressed as follows:

$$V_m \text{ (Volt)} = \text{SQRT} (P_o \times Z_o/2) \dots\dots\dots (3) \text{ or}$$

$$P_o \text{ (Watt)} = 2 \times (V_m)^2 / Z_o \dots\dots\dots (4)$$

Here,  $Z_o$  is 50 Ohm, the characteristic impedance of the TEM cell.



**[Figure 4] Radiation Power Measurement**

Now, we can calculate the E-field radiation from the object, assuming the object is in a free space and has antenna gain G. We also assume that in our measurement the radiator size is sufficiently small compared to the TEM cell such that there is no significant effect on radiation due to the TEM Cell. Then the hypothetical maximum EMI field  $E_r$  at distance D (meter) from the radiator would be:

$$E_r \text{ (Volt/meter)} = 60 \times (G / Z_o) \times (V_m/D) \dots\dots\dots (5)$$

$V_m$  is the maximum measured voltage which is the vector sum of the 3 voltages measured by rotating DUT in x, y, and z-axis inside the TEM Cell.

(Ref.1) NBS Technical Note 1319, US Department of Commerce, NBS

(Ref.2) NBS Technical Note 1013, US Department of Commerce, NBS

# Maintenance

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This section contains information for keeping the instrument in good working order and checking its overall performance.

## 3.1 Maintenance of TC-5062C

The TC-5062C is designed and built to last for a long life and with minimal and easy maintenance.

Optimal RF shielding is obtained using a shield form gasket between the case and door. It must be checked periodically for any damage or excessive wear that would compromise the seal. Pressure on the gasket by the door results in a proper RF seal.

**NOTE**

Preventive maintenance requires you check the RF gasket regularly for excessive wear. Also check the gasket cavity for any black oxide build-up.

### 3.1.1 Cleaning

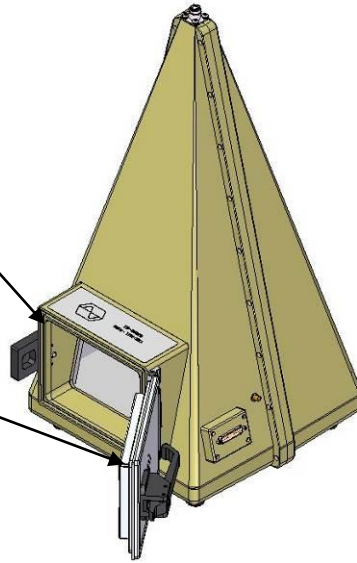
Periodically wipe the case with a damp cloth mild detergent; do not use abrasives or solvents.

### 3.1.2 Check List for Maintenance

- 1) Check for loose screws and tighten with proper tools, if necessary.
- 2) Check for a loose connection. If a loose connector is found, tighten the connector with proper tools.
- 3) Check for a damaged cable, especially near the connector-cable neck. Replace any damaged cables found.
- 4) Visually inspect the RF seal between the TEM Cell and door for excessive wear.
  - A worn gasket will not have as much height protruding from the cavity as a new or good gasket.
  - A worn gasket may exhibit a frayed mesh. Replace the gasket if excessive wear is observed.

The RF gasket is an important element of optimum shielding. It must be checked periodically for damage or wear.

Periodic cleaning of the aluminum contact surface where the gasket touches is important for optimum shielding performance.



**[Figure 5] TC-5062C RF Gasket**



**CAUTION**

Do not clean this equipment with organic solvents such as benzene, toluene or acetone as they will damage the plastic parts. Use alcohol to clean and maintain parts of the equipment.

## 3.2 Performance Test

The 6 GHz TEM Cell is a precision RF device which is built very sturdy. Their electrical performance can, however, deteriorate with mechanical damages. Worn out shielding gaskets, as well as metal corrosion or oxidation at the lid contact, can significantly reduce the effectiveness of the TEM Cell. This section describes the test and calibration procedure for the TC-5062C.



**NOTE**

You must performance test and verify the 6 GHz TEM Cell specifications every time maintenance is performed on a 6 GHz TEM cell such as replacing the gasket during routine maintenance. Also performance tests the 6 GHz TEM Cell if you suspect mechanical damage.

### 3.2.1 Calibration Period

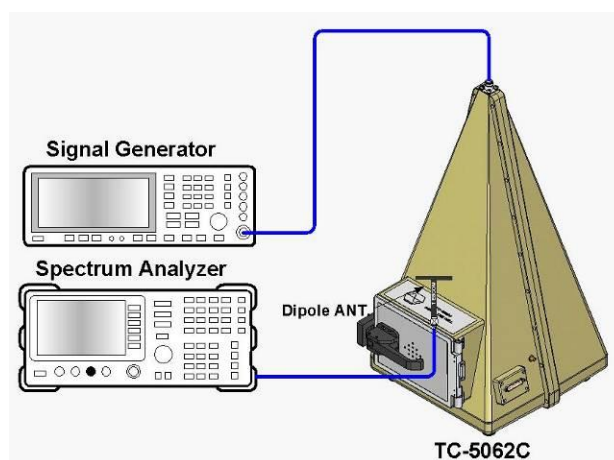
- Shielding Effectiveness : < 6 months
- VSWR and Insertion Loss: 1 year

### 3.2.2 Required Equipment

- Spectrum Analyzer: 6 GHz
- Network Analyzer: 6 GHz
- Signal Generator: 6 GHz
- Dipole Antenna: Tescom 900 MHz, 1.8 GHz, 2.4 GHz, 5.8 GHz

### 3.2.3 Test Procedure

- Shielding Effectiveness Measurement Specification:  
 > 80 dB up to 2 GHz, > 70 dB 2 GHz ~ 3 GHz, > 60 dB 3 GHz ~ 6 GHz



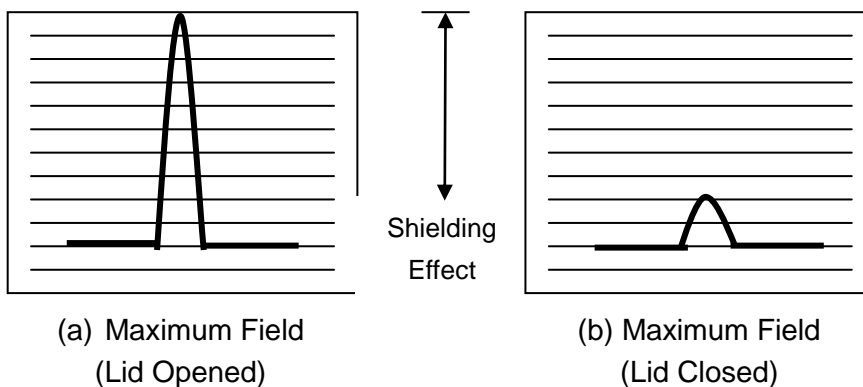
**[Figure 6] TC-5062C Shielding Measurement Test Set Up**



**NOTE**

Before making a measurement, visually inspect the shielding gasket around the lid. Replace the gasket if there is any visible damage or excessive wear. Look for a black oxide deposit on the aluminum contact surface around the gasket. If an oxide deposit is found, remove the oxide with a cloth or 3M household scrubber saturated with alcohol.

- 1) Connect the Signal Generator output to the RF connector of the TC-5062C.
- 2) Set the Signal Generator to CW 900 MHz, 10dBm output.
- 3) Set the Spectrum Analyzer as follows:
  - CF: 900 MHz
  - Span: 1 MHz
  - Resolution BW: 10 kHz
  - Scale 10 dB/div
- 4) Connect the 900 MHz Dipole antenna to the Spectrum Analyzer with RF cable.
- 5) Open the door of the TC-5062C and move the antenna around the TC-5062C to find the location where the maximum field is found. Fix the location of antenna for maximum field.
- 6) Adjust the spectrum analyzer input range and set the signal level to the top display line.
- 7) Close the lid and probe around the lid gasket seams, RF connections and cable joints. Look for RF leakage.
- 8) Maximum field should not be greater than -80 dB from the top reference line.
- 9) Change frequency to 1.8 GHz and repeat the test described above.
- 10) Change frequency to 2.4 GHz and repeat the test described above.
- 11) Change frequency to 5.8 GHz and repeat the test described above.

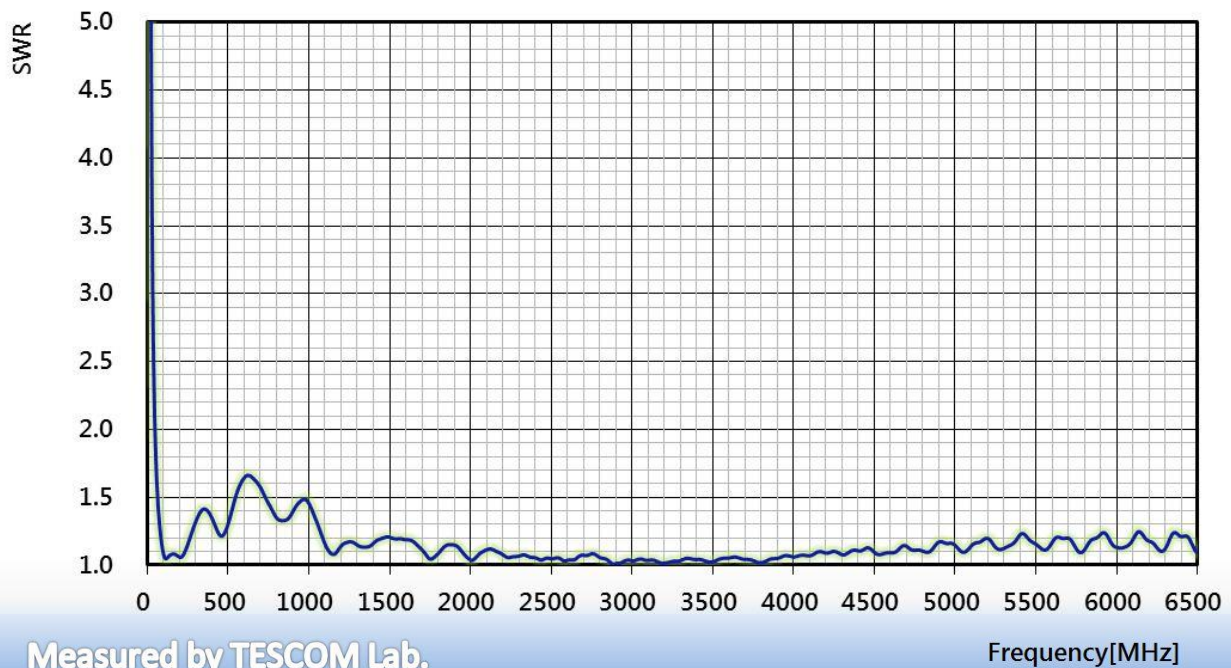


**[Figure 7] Spectrum Analyzer Display**

- **Input VSWR (unloaded) Specification: < 2.5 800 MHz ~ 1 GHz, 1.5 GHz ~ 6 GHz**
  - 1) Set the Network Analyzer as follows:
    - Start: 30 kHz
    - Stop: 6000 MHz
    - Measure: S11
    - Format: SWR
  - 2) Calibrate the Network Analyzer in order to measure S11.
  - 3) Connect the calibrated cable to the input port of TC-5062C and measure SWR.
  - 4) Verify S11 SWR of-5062C meets its specification.

### 3.2.4 Typical VSWR of TC-5062C

VSWR (30 KHz to 6000 MHz), Scale 1/Div



[Figure 8] Typical VSWR of TC-5062C