

**GigaDevice Semiconductor Inc.**

**IEC61967-2 Chip-level RE Testing**

**Application Notes**

**AN125**

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# Table of Contents

<b>Table of Contents.....</b>	<b>2</b>
<b>List of Figures .....</b>	<b>3</b>
<b>List of Tables .....</b>	<b>4</b>
<b>1. Foreword .....</b>	<b>5</b>
<b>2. Overview.....</b>	<b>6</b>
<b>3. Chip-level RE testing devices.....</b>	<b>7</b>
<b>4. PCB for testing.....</b>	<b>8</b>
<b>5. Test conditions .....</b>	<b>10</b>
<b>6. Test steps .....</b>	<b>11</b>
<b>7. Revision history .....</b>	<b>12</b>

## List of Figures

Figure 3-1. TEM cell testing equipment and environment .....	7
Figure 4-1. PCB for MCU testing .....	8
Figure 4-2. Design of PCB for MCU testing .....	9

## List of Tables

Table 7-1. Revision history .....	12
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## 1. Foreword

The MCU coupling methods that generate electromagnetic disturbance mainly include: conducted emission, magnetic near-field radiation, electric near-field radiation, and direct radiation. The IEC61967-2 standard (SAE J1752-3) recommends the process and method of using the TEM (transverse electromagnetic wave) cell for 150 kHz to 1 GHz radiated emission (RE) testing of the MCU (integrated circuit). With the rapid development of MCU systems towards miniaturization, high density, and high speed, the operating frequency of integrated circuits continues to increase, and RE testing has become a general testing requirement for present MCU products. The TEM cell method is suitable for MCU RE testing, which can help to better understand the EMI performance of the MCU.

## 2. Overview

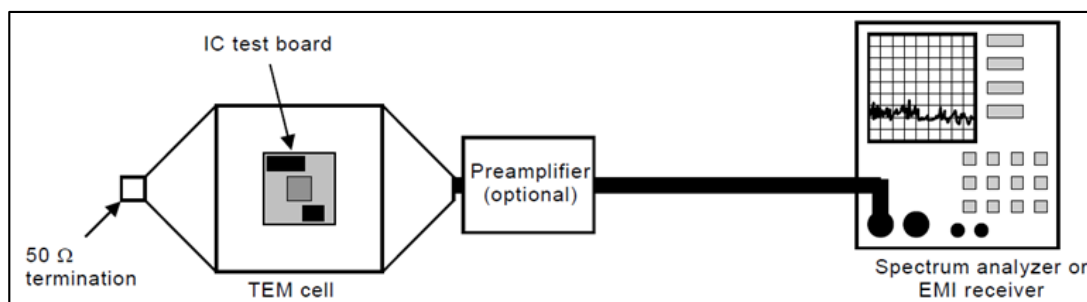
The IEC61967-2 standard provides an overview of the testing methods of electromagnetic radiation from integrated circuits (ICs). Install the MCU under test on a printed circuit board (PCB) for MCU testing. The PCB is fixed to a matching port (called housing port) cut out on the top or bottom of the TEM cell or the GTEM cell. The PCB is not located in the cell as usual, but is part of the wall of the cell. The radiation voltage under test might be affected by many factors, and the main factor is the distance between the partition and the PCB (cell housing) for MCU testing. Chip-level RE testing uses a 1 GTEM cell. During the testing, adjust the location of the PCB to change the geometric location and direction of the MCU relative to the cell. Connect one 50  $\Omega$  port of the TEM cell to a 50  $\Omega$  load, and connect the other 50  $\Omega$  port to the input terminal of the spectrum analyzer or receiver to measure the radiation generated by the MCU and transmitted on the core board of the cell.

### 3. Chip-level RE testing devices

**Figure 3-1. TEM cell testing equipment and environment** shows the MCU RE testing systems and devices, which mainly include the following types:

1. Shielding equipment: Use double-shielded or semi-rigid coaxial cables for shielding according to the electromagnetic environment around the testing. If necessary, perform the testing in a shielded room;
2. Spectrum analyzer or EMI receiver: The IEC61967 standard specifies the performance requirements for spectrum analyzers and receivers, including their frequency coverage, peak detection, resolution bandwidth, etc.;
3. Preamplifier: Use a 50  $\Omega$  coaxial adapter to connect the low-noise preamplifier directly to the port of the TEM cell without cable connection;
4. The size of the TEM cell meets the requirements in the standard, and the operating frequency is not higher than its cut-off frequency. The voltage standing wave ratio (VSWR) within the test frequency range is not more than 1.5;
5. The VSWR of the load matching the 50  $\Omega$  terminal is less than 1.1;
6. System amplifier or attenuator.

**Figure 3-1. TEM cell testing equipment and environment**



## 4. PCB for testing

Design the PCB for MCU testing in accordance with the requirements of the IEC61967-1 and IEC61967-2 standards. The basic requirements for PCB for MCU testing are as follows. [Figure 4-2. Design of PCB for MCU testing](#) shows a 100 cm<sup>2</sup> PCB with four metal layers; the first layer is the earthing layer, and the second layer is the power layer. For details, refer to "IEC 61967-2:2005". Theoretically, any size or shape of PCB can be used as long as it matches the housing port of the TEM cell. However, design the PCB to 100 cm<sup>2</sup> whenever possible, so that it can well match the 100 cm<sup>2</sup> housing port. According to the requirements for the use of signal and power paths, the PCB can also contain additional inner layers. The test report should describe the PCB configuration, including PCB photos or process drawings, schematic diagrams, and list of components, as shown in [Figure 4-1. PCB for MCU testing](#). Make the device under test (DUT) side of the PCB (the layer with the MCU) face the inside of the TEM cell, so that when it fits with the TEM cell or housing port, an earthing plane layer will be formed. No other PCB wiring is allowed on this surface, because the wiring might produce additional radiation. The peripheral window earthing layer should use the ENIG process to enhance the capacity of contact with the edge of the cell housing port. PCB wiring and other necessary components (such as crystal oscillators) should be located in or connected to the TOP layer of the PCB, that is, the outside of the TEM cell. Select power decoupling capacitors for the MCU according to the manufacturer's recommendations, and install them in a way matching the shortest lead length. Keep all the wiring as short as possible, and meet the PCB design requirements. Configure pins not listed in the classification according to their functions and provide a description in the report.

**Figure 4-1. PCB for MCU testing**

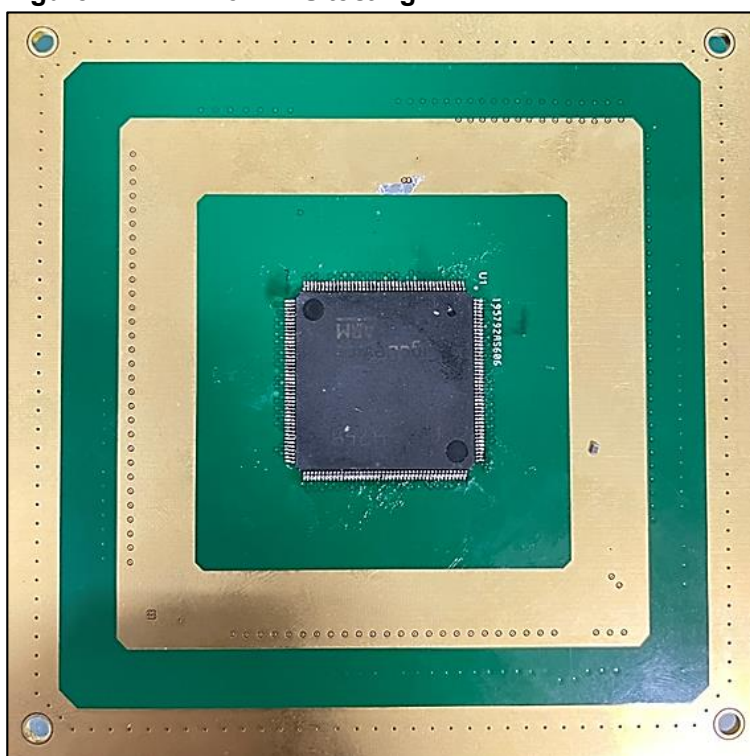
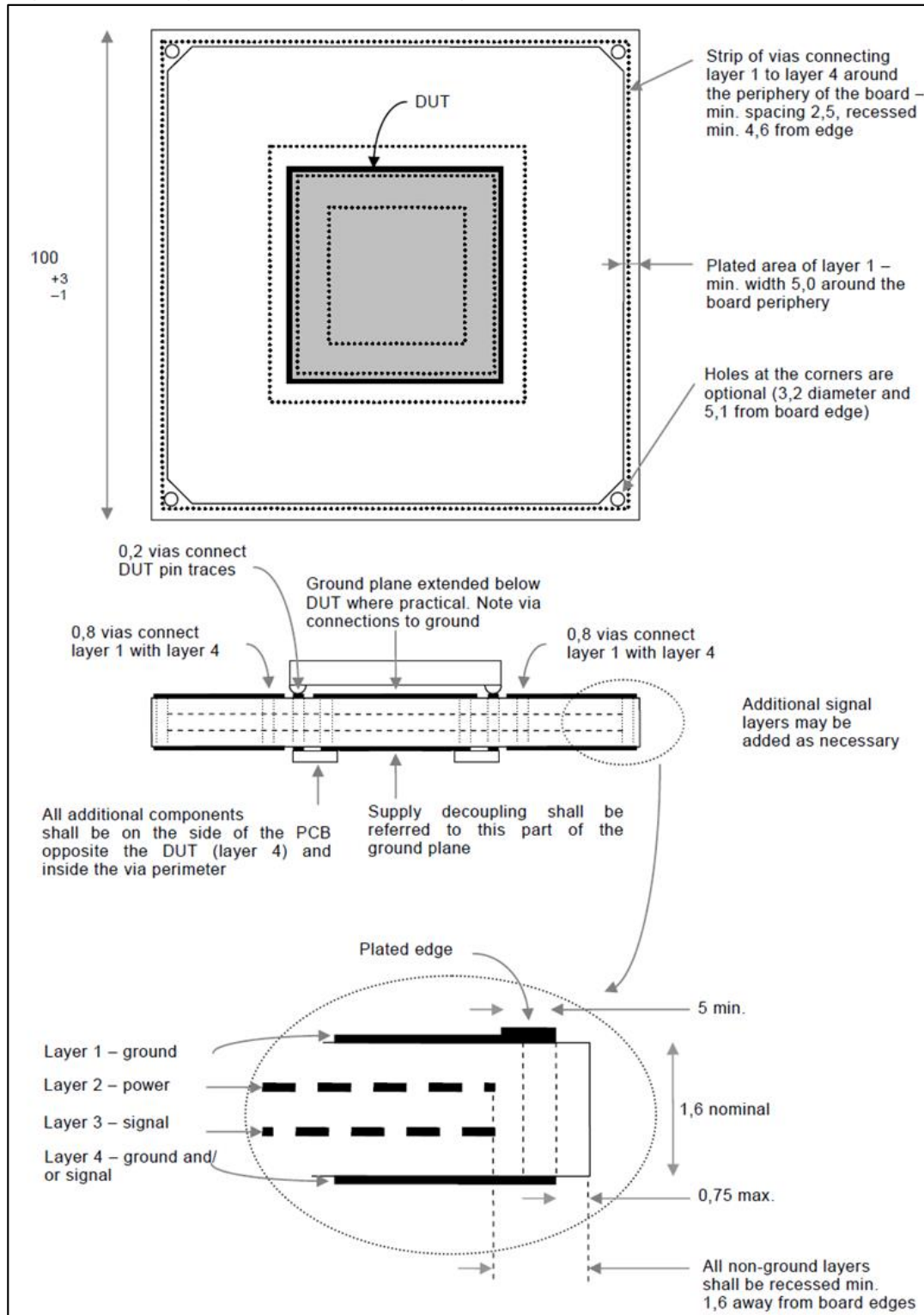




Figure 4-2. Design of PCB for MCU testing



## 5. Test conditions

This application development guide mainly introduces how to test the radiated emission of MCU integrated circuits through the TEM cell method. According to the IEC61967-2 standard, the test conditions should meet not only the IEC61967-1 standard, but also the following two requirements:

1. The supply voltage of the MCU integrated circuit under test should meet the requirements of the MCU chip manufacturer; otherwise, give an explanation in the test report;
2. The frequency of the MCU integrated circuit under test is limited by the TEM cell. According to the standard, the test frequency requirement of MCU is between 150 kHz and 1 GHz, while the frequency for testing can reach up to 3 GHz.

## 6. Test steps

The test steps mainly include the following three points: inspection of the test environment, inspection of MCU operation, and MCU RE testing. If the testers add other test steps, they should describe them in the test report.

1. Check the test environment. To evaluate the electromagnetic environment of the test system, test electromagnetic interference signals in the environment. The specific method is as follows: Power off the MCU under test, and supply power to other test devices normally, and then obtain the radiated emission in the test environment;
2. Check MCU operation by supplying power to the test board and checking whether each part works normally;
3. Perform MCU RE testing by supplying power to the test board and testing the radiated emission of MCU through the TEM cell method;
4. Prepare the test report in accordance with the IEC61967-1 standard. In addition, it should contain a description of the test conditions and a reference standard for the MCU radiation amount. The IEC61967-2 standard recommends acceptable MCU radiated emission. The recommended value should meet the requirements of both the manufacturer and user of MCU integrated chips.

## 7. Revision history

**Table 7-1. Revision history**

Revision No.	Description	Date
1.0	Initial release	July 1, 2023

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