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INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1
AMENDEMENT 1

Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz –
Part 6: Measurement of conducted emissions – Magnetic probe method

Circuits intégrés – Mesure des émissions électromagnétiques, 150 kHz à 1 GHz –
Partie 6: Mesure des émissions conduites – Méthode de la sonde magnétique

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FOREWORD

This amendment has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices.

The text of this amendment is based on the following documents:

FDIS	Report on voting
47A/781/FDIS	47A/784/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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Add the following new Annex E:

Annex E
(informative)

Advanced magnetic probe

E.1 General

The miniature magnetic probe (advanced magnetic probe) has a high spatial resolution, and it enables accurate measurement of near magnetic fields of IC packages and dense PCBs. It should be made of a low temperature co-fired ceramics (LTCC) board and its detecting part (detecting loop) should be about 2 mm wide and 1 mm thick. The miniaturization may cause a decrease of probe sensitivity of magnetic field, due to the reduction of loop size. The details of probe design are shown in Figures E.1, E.2, E.3 and E.4. However, the lower sensitivity to magnetic field is compensated by the decrease of necessary gain, resulting from the possibility of placement of the new probe loop edge closer to the microstrip line than it was before.

E.2 Advanced magnetic probe fixture

The previous model of magnetic field probe is a shielded loop probe, made by using multilayer FR4-PCB. The loop part of the previous magnetic field probe cannot be made small enough to measure current at short trace on PCB. The new model is made by precise glass ceramic multi-layer board, enabling both compactness and high spatial resolution.

Figures E.1 and E.2 show an external view of the probe. The size of the magnetic detecting loop is reduced to 2 mm width x 1 mm thickness. The advanced magnetic probe should be a tri-plate strip line composed of a three-layer LTCC board. Recommended probe construction details are shown in Figures E.3, E.4, E.5, E.6, E.7 and E.8. In all figures, braces ( ) indicate that the enclosed values are examples. Other dimensions shall be within tolerances described below. If the loop part does not fall within tolerance limits, measurement error will increase. A semi-rigid cable can be attached at the junction area which is shown as Figures E.1 and E.2. Junction for the connection should have characteristic impedance of 50 Ω up to 3 GHz. The connection construction which is shown in the figures is one example of connection between LTCC board and semi-rigid coaxial cable. Other constructions which provide good high-frequency connectivity are acceptable.

In Figures E.4, E.5, E.6 and E.7, the relative dielectric constant of the board material is 7,1, and the printed pattern on an LTCC board is formed with Ag-Pd paste. In these figures, finished dimensions of printed pattern of loop portion may have a tolerance rating of ±2,5 percent. Dimensions with braces also may have a tolerance rating of ±10 percent. The conductors are 15 µm thick with a tolerance of ±5 µm. The insulators (dielectric) are 120 µm thick with a tolerance rating of ±10 percent. The ground pads on the first layer and the fifth layer are coated with about 30 µm (thickness) of gold (Au) plating. Therefore the thickness of the ground pad may be increased, so as to solder the pads to conductor case. Unless otherwise specified, dimensions of printed pattern may have a tolerance rating of ±10 percent.

Shielded loop structure is used for detecting part for magnetic field. This part shall be fabricated precisely using precise LTCC process. Figure E.3 shows the superimposed main pattern of the magnetic field detector made by using a 5-layer glass ceramic board. The second and forth layers are ground layers corresponding to the outer sheath of a coaxial cable; the third layer is the signal layer, equivalent to the core conductor. The loop and lead portion of the multilayer board of the new probe is symmetrical about the third layer except via and signal pattern. The strip line was designed to have a characteristic impedance of 50 Ω, in consideration of impedance matching with the measurement system. The end of the signal line is passed through a via-hole and connected to ground.

The previous probe has apertures in the sides of the tri-plate strip line (lead portion), but both sides of the ground pattern on the second layer are connected to the fourth layer by via-hole as shown in Figure E.3. The via-hole shall be formed with a pitch of 0,25 mm or less. The loop serving as the magnetic field detector is a rectangle 0,2 mm x 1 mm, and the spatial resolution can be raised to 250 μm (typical) at the 6 dB degrading point. If the target of measurement is a straight trace such as a microstrip line, the current calibration coefficient can be used to convert measured magnetic field over a trace into current. About the pattern on each layer of the LTCC board, the amount of deviation from perfect alignment shall be within 10 μm. The performance of the probe will decrease when the alignment error increases, because the characteristic impedance of the strip line of the probe deviates from 50 Ω. Taking screening test by x-rays, nonconforming items where the alignment error exceeds 10 μm shall be rejected. Furthermore, the front end face of the LTCC board shall be precisely cut and polished flat.

The ground pads on the first layer and the fifth layer are shown in Figures E.4 and E.7. The pad of the first layer is connected to the second layer by via-holes and the pad of the fifth layer is connected to the fourth layer by enough number of vias, respectively. The ground pad on the fifth layer is extended, when compared to that on the first layer. As shown in Figures E.5 to E.6, the trace width is tapered down to a narrow trace. As shown in Figures E.4 and E.7, the ground patterns are also tapered, because the second and fourth layer patterns are tapered. Figure E.8 shows the configuration for connection of the LTCC board and the semi-rigid coaxial cable. The joint construction consists of conductor case, step part of LTCC board and semi-rigid coaxial cable. As shown in Figure E.8, the central conductor of the semi-rigid coaxial cable is connected to the signal pad on the third layer of the LTCC board by solder. LTCC board has a step, so the signal pattern on the third layer is exposed. The central conductor of the semi-rigid cable can be mounted on signal pattern in parallel with signal pattern. The outer conductor of the semi-rigid coaxial cable is contacted with the rear edge of the LTCC board. Further, the conductor case (Cu) is connected to the ground pads on the first and the fifth layers by solder so as to cover and surround a joint part of the central conductor. The conductor case shall be connected to the outer conductor by solder. Here, the ground pad, the outer conductor and the conductor case may preferably be solder-connected to one another without any clearance. The shield performance of the joint section is enhanced by the conductor case, so that electromagnetic interference of a sensor output signal with an outcoming noise or another wiring signal can be suppressed. The characteristic impedance of joint section including conductor case shall be designed by adjusting the dimensions of the signal pads and the conductor case, a reflection loss due to impedance mismatching is suppressed so that a high-frequency signal transmission characteristic can be made satisfactory.

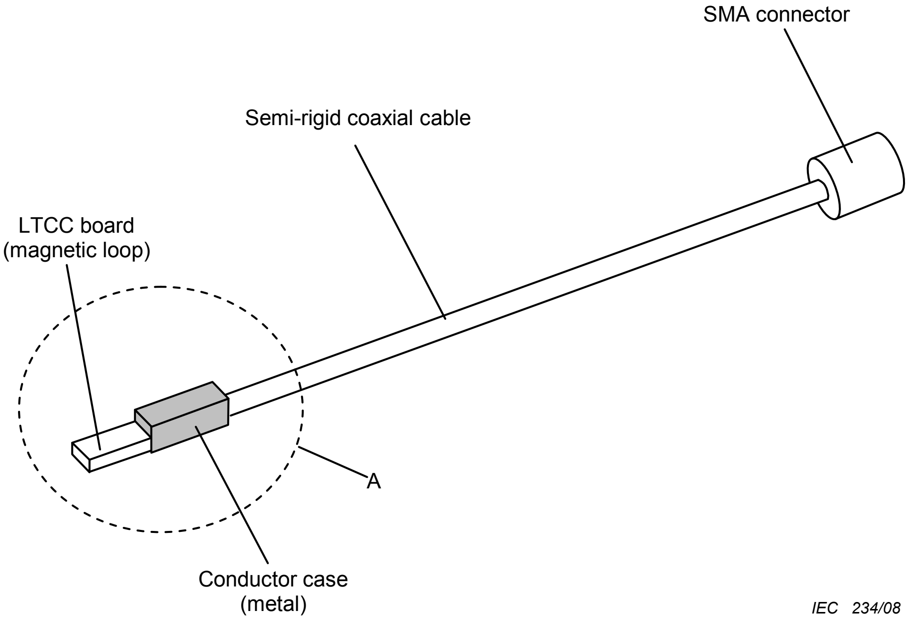


Figure E.1 – Illustration of the assembled advanced magnetic probe

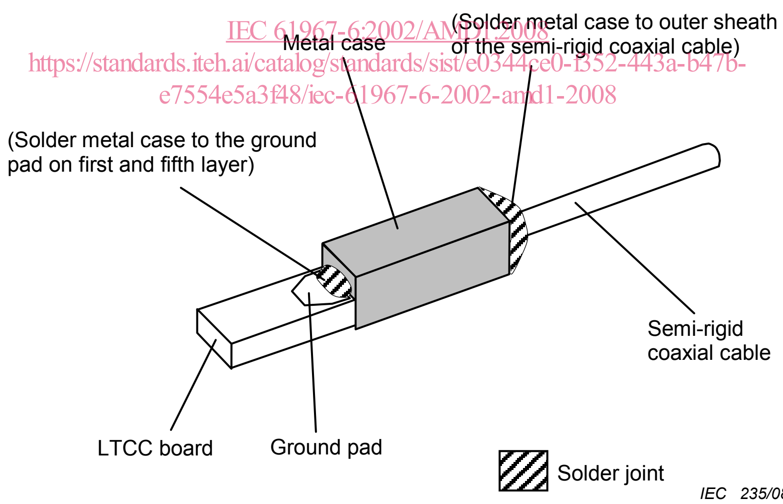


Figure E.2 – Enlarged view of part A of Figure E.1
(an example of connection construction)

Dimensions in millimetres

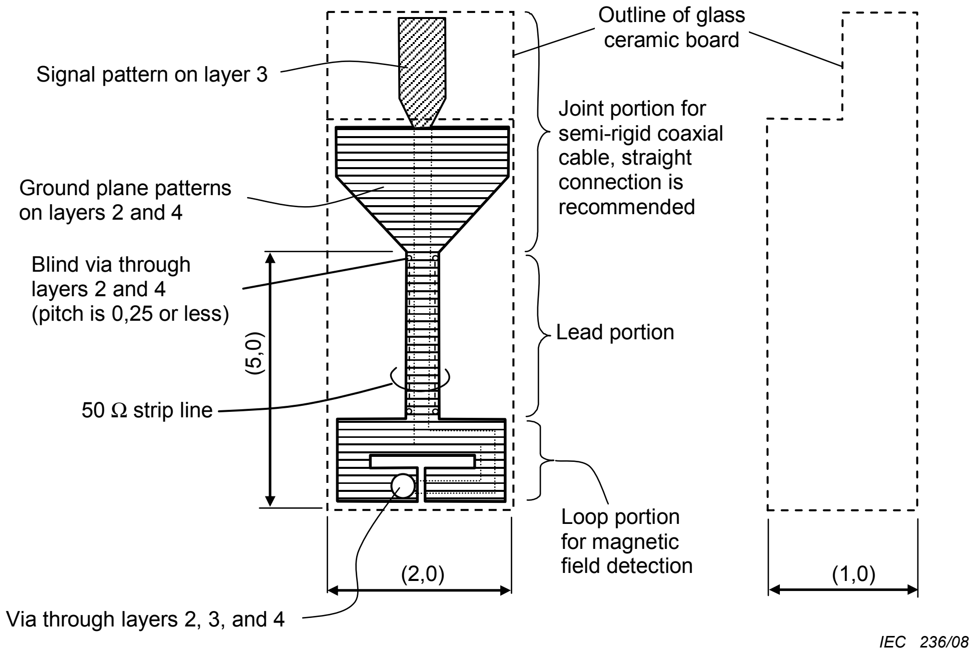


Figure E.3 – Main pattern (layer 2 to 4) of advanced magnetic probe

Dimensions in millimetres

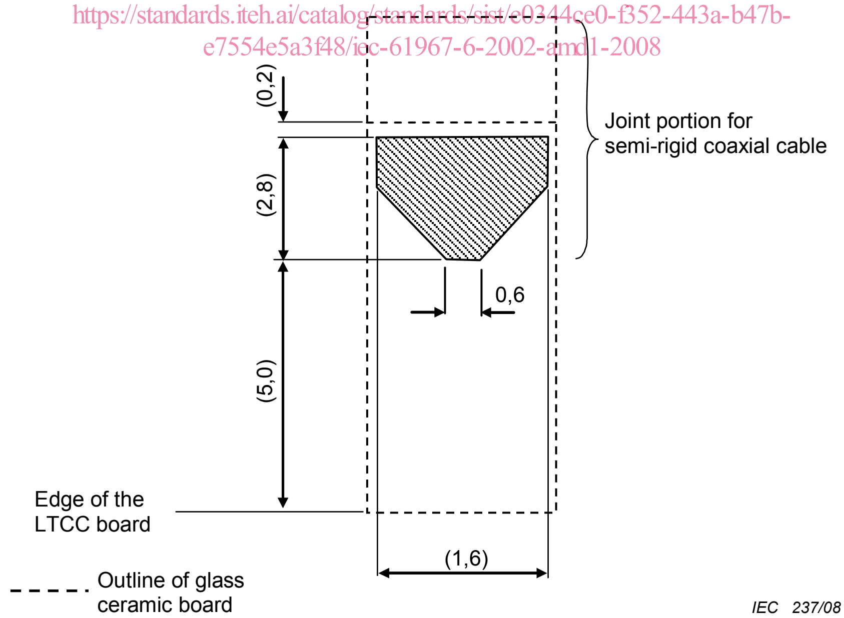


Figure E.4 – Layer 1 (ground pattern) of advanced magnetic probe

Dimensions in millimetres

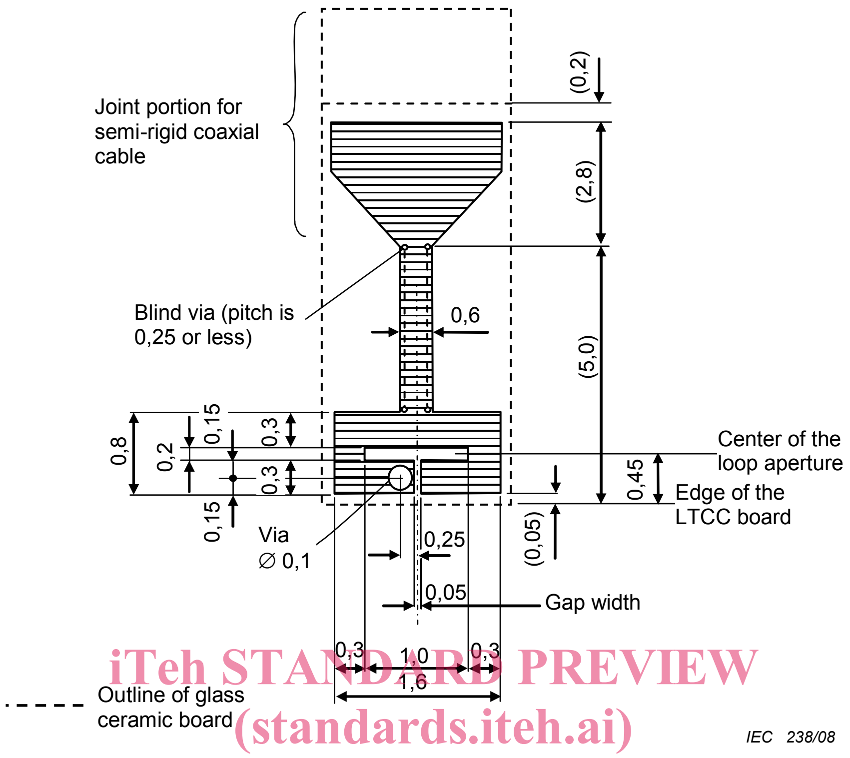


Figure E.5 – Layer 2 and 4 (ground pattern) of advanced magnetic probe

Dimensions in millimetres

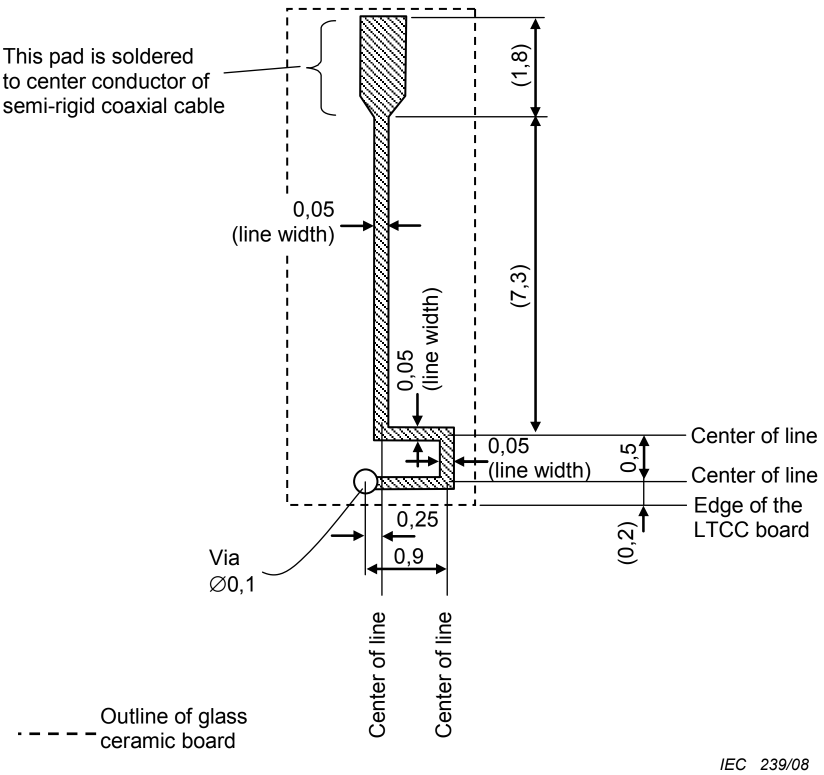


Figure E.6 – Layer 3 (signal pattern) of advanced magnetic probe

Dimensions in millimetres

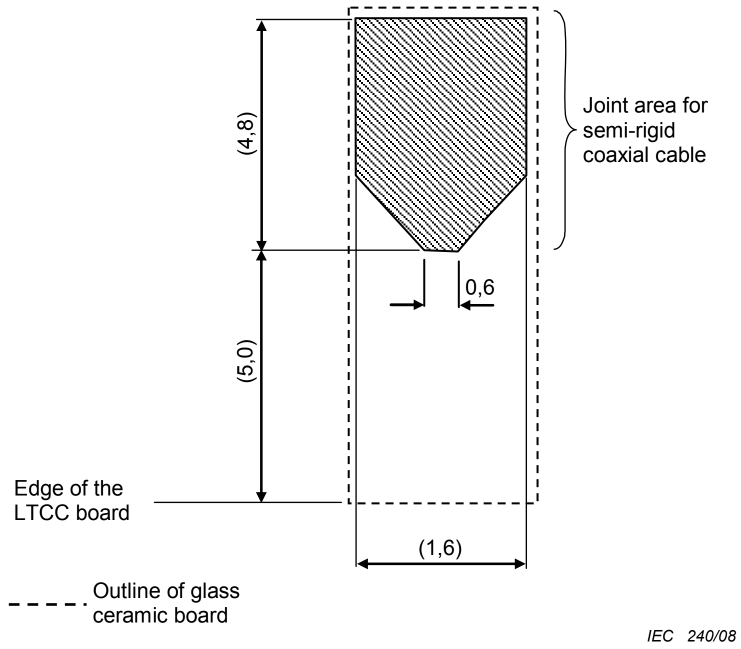
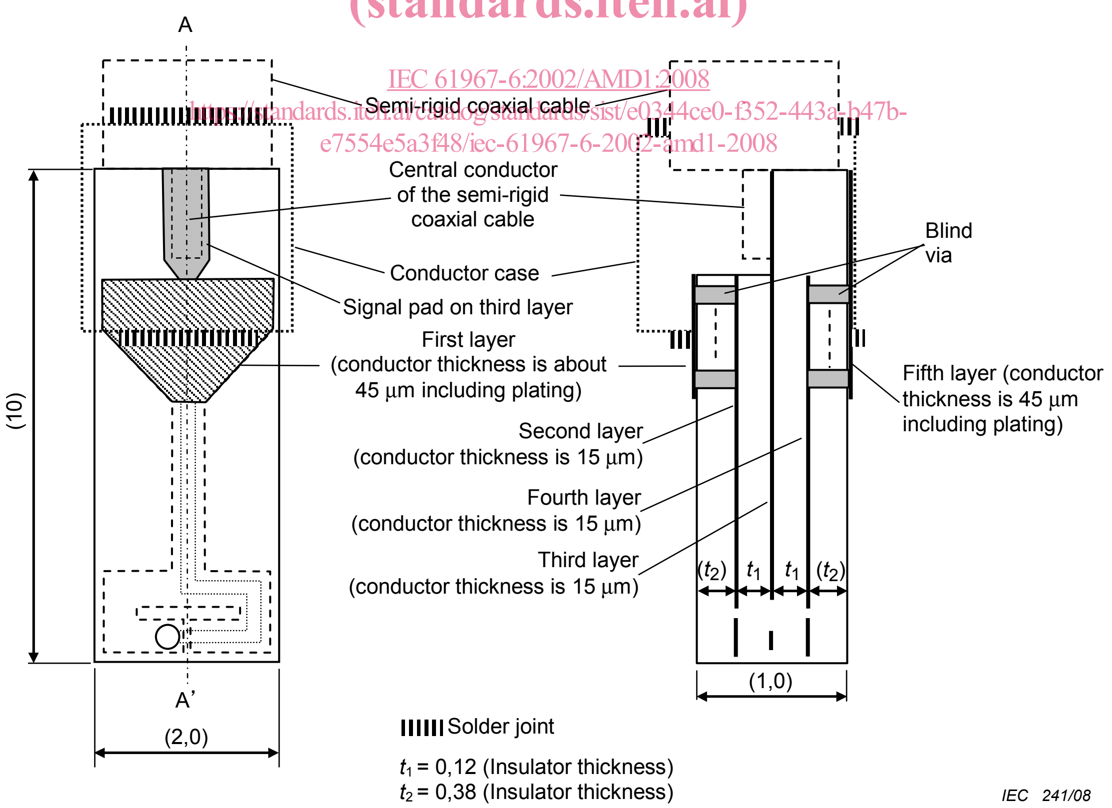


Figure E.7 – Layer 5 (ground pattern) of advanced magnetic probe

Dimensions in millimetres

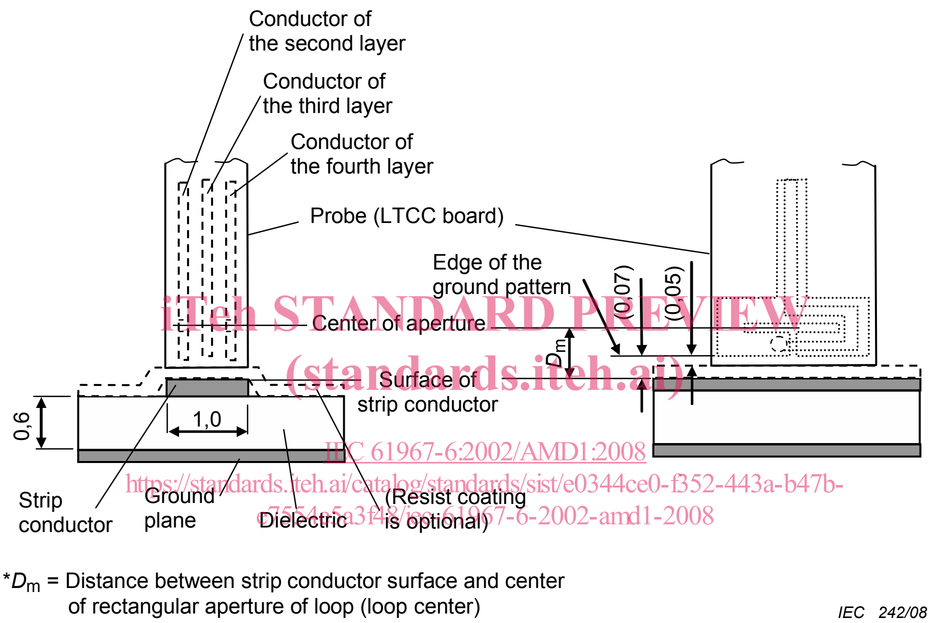


(a) Top view (b) Section A-A'

Figure E.8 – Construction of advanced magnetic probe

The output voltage of the magnetic probe (V_p) depends on the distance (D_m) between the loop center and the surface of the strip conductor under measurement. In Figure E.9, the strip conductor width is 1,0 mm, when the insulator thickness of the test board is 0,6 mm. The characteristic impedance is 50 Ω ± 5 Ω. The thickness of copper film (strip conductor) shall be standardized. The film could be standardized to a thickness between 18 µm to 35 µm, while 35 µm is recommended. As shown in Figure E.10, the loop center is defined as the rectangular aperture of the ground patterns on the second layer and the fourth layer. This makes it very critical to maintain a 0,47 mm (470 µm) ± 20 µm distance between the strip conductor and the center of the aperture of loop during the measurement. Therefore, a probe spacing fixture should be used to maintain 0,07 mm spacing between the bottom of the rectangular loop portion of the probe and the probe tip. The value of D_m is 0,47 mm.

Dimensions in millimetres



(a) Front view (b) Side view

Figure E.9 – Measurement set-up

Dimensions in millimetres

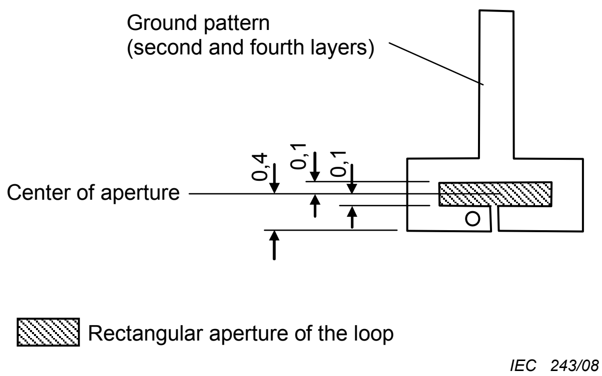


Figure E.10 – Definition of loop center

Dimensions in millimetres

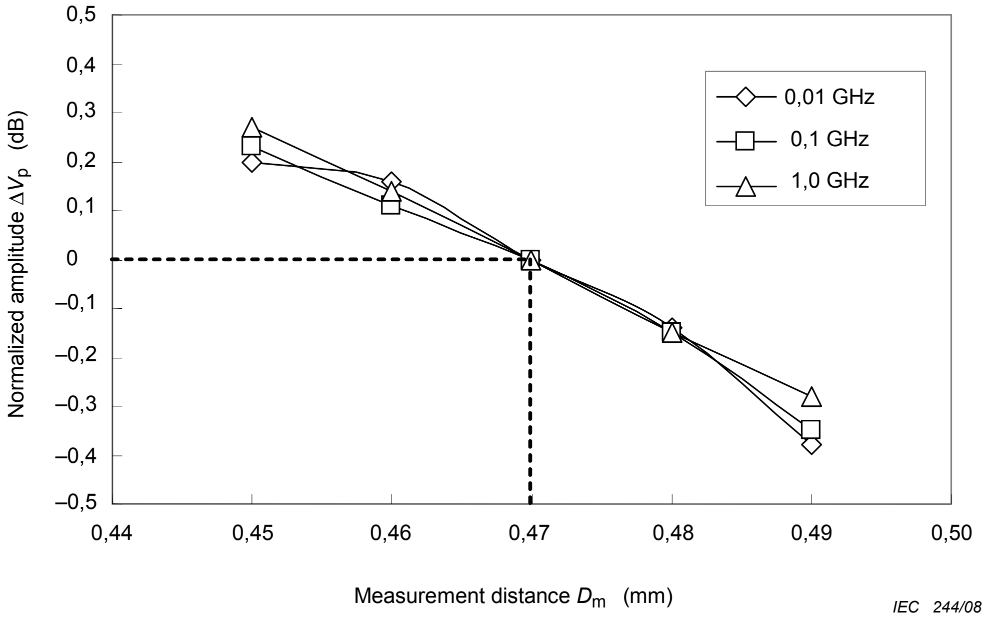


Figure E.11 – Error graph of the measured voltage versus measurement distance

E.3 Spatial resolution of magnetic probe

The set-up for measuring of the magnetic field distribution across a microstrip line is shown in Figure E.12. As seen in Figure E.13, it achieves high spatial resolutions. The spatial resolution is 0,7 mm (–6 dB drop point), measured at D_m = 0,47 mm and f = 1 GHz. Therefore, the magnetic field from an adjacent trace has little influence and can be neglected when the probe is placed at the centre of the strip conductor. The test board is the same as that in Figure E.9.

Dimensions in millimetres

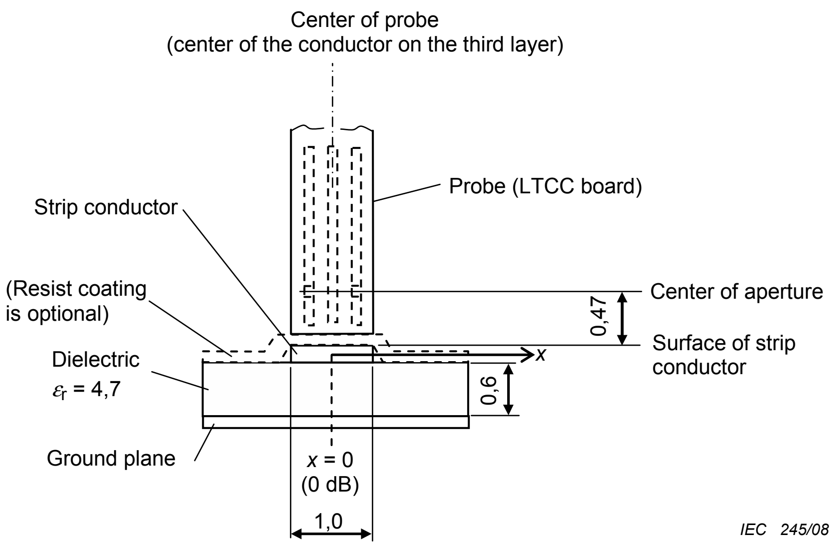


Figure E.12 – Set-up for measuring magnetic field distribution

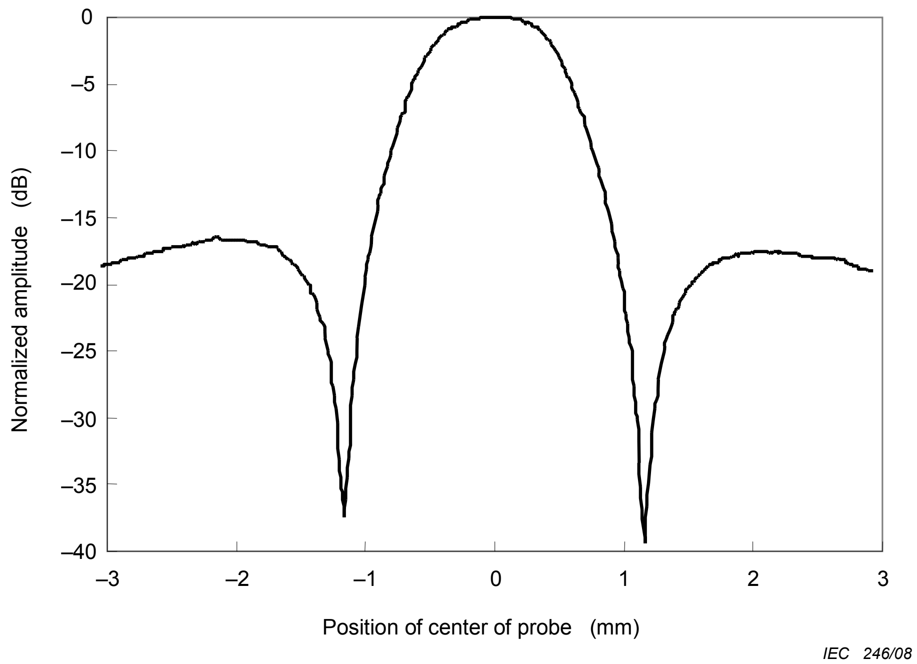


Figure E.13 – Magnetic field distribution across microstrip line (1 GHz)

E.4 Angle pattern of probe placement

The set-up for measuring a magnetic probe placement angle (φ) with respect to the direction of a microstrip line is shown in Figure E.14.

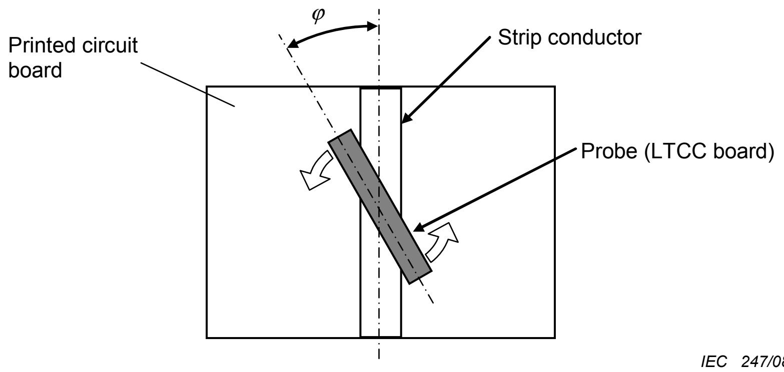


Figure E.14 – Set-up for measuring an angle pattern of probe placement

The output voltage of the magnetic probe (V_p) slightly depends on the probe placement angle (φ) to the direction of a microstrip line under measurement as seen in the following Figure E.15. The microstrip line is the same as that shown in Figure E.9. The distance between the strip conductor and the loop center (D_m) is 0,47 mm.