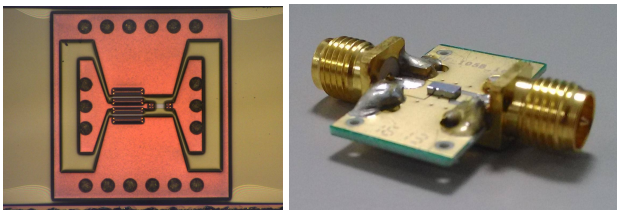

Fig. 2. Photographs of: (a) the 1Ω network in IPD technology, and (b) the current probe with flip-chip 1Ω network.

TABLE I
1 Ω Current Probe Specifications in IEC 61967-4

Frequency range	DC - 1 GHz
Output impedance	40 Ω - 60 Ω
Insertion loss	34 dB ±2 dB

and it makes the probe difficult to be realized with wider bandwidth than the IEC 1 GHz specification.

In order to minimize the parasitic of SMD resistors, the chip resistors are adopted. The semiconductor technology used in this work is the integrated passive device (IPD). It is a passive only process for wireless communication systems or RF applications. It has three metal layers with low dielectric constant material, and a NiCr layer is used for implementation of resistors. As shown in Fig. 2(a), the 1 Ω resistor is shunted to ground planes of the coplanar-waveguide (CPW) structure with a reduced inductance. And the fabricated IPD 1 Ω network chip is then flipped on a PCB with 50 Ω SMA connectors as shown in Fig. 2(b). The performance of the proposed probe will be examined in the following section.

3. Experimental Results

The IEC standard specifies the characteristics of 1 Ω current probe in detail with the measurement bandwidth of 1 GHz as listed in table I. The most critical item is the insertion loss with a calibration circuit. The measured insertion loss is referred to the sensitivity of the probe. The sensitivity is desired to exhibit a flat frequency response over the test bandwidth. A tolerance of ±2 dB from -34 dB is allowable in the IEC specification. The proposed current probe achieves an extended bandwidth of 2.4 GHz as show in Fig. 3. Besides, the impedance looking from the test receiver side should be near 50 Ω. Fig. 4 shows the output impedance complies within the limited range up to 3 GHz. With the significant improvement, the conducted emission of high speed/frequency IC can be characterized with a wider bandwidth.

4. Conclusion

The design of 1 Ω current probe to measure the conducted electromagnetic emission of IC above 1 GHz is proposed. To achieve a wider bandwidth measurement, the conventional SMD resistors of the current probe are replaced by an IPD chip with the embedded 1 Ω resistive network. The parasitic

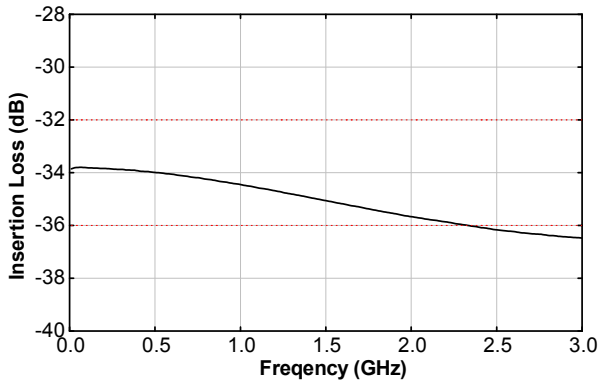

Fig. 3. Measured insertion loss of the 1Ω probe.

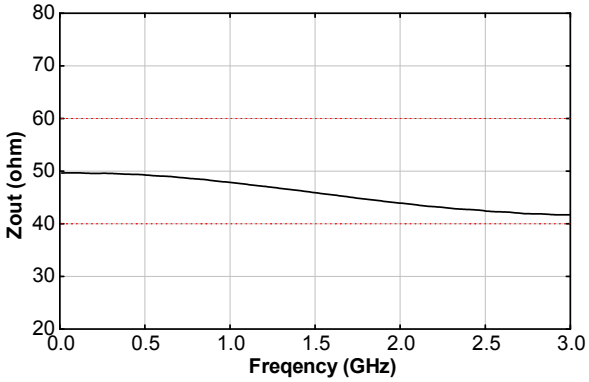

Fig. 4. Measured output impedance of the 1Ω probe

effect of chip resistor is reduced effectively compared with the SMD one with larger package. Therefore, the applicable bandwidth of current probe is sufficiently enhanced. Referring to the IEC 61967-4, the proposed 1 Ω current probe is verified and the experimental results show the capability of investigating the interference of IC up to 2.4 GHz.

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