

A 0 Ohm substitution current probe is used to measure the emission in the power supply of an integrated circuit

Fayu Wan^{*1}, Qi Liu², Jian Shen², Jin Wang², Nigel Linge³

¹ Jiangsu Key Laboratory of Meteorological Observation and Information Processing, NUIST, Nanjing, Jiangsu, 210044, China

² Jiangsu Engineering Centre of Network Monitoring, NUIST, Nanjing, Jiangsu, 210044, China

³ School of Computing, Science and Engineering, University of Salford, Salford, M5 4WT, UK

fayu.wan@gmail.com

Abstract. In this paper, a 0 Ohm substitution current probe is used to measure the emission on the power supply of an integrated circuit (IC). According to the results, current probe works up to 1GHz, whereas the emission source is identified using the short time FFT (STFFT) method. All the wideband emissions are from a DC/DC converter, but no narrowband emissions are found. The measurement method gives great convenience to measure the current emission on printed circuit board (PCB) trace.

Keywords: current probe, emission, integrated circuit.

1 Introduction

The current emission measurement is not only focus on the whole PCB or a cable using the standard IEC or BISS measurement [1-2]. To analyze the emission source, and coupling path, the current emission measurement on a specific trace on printed circuit board (PCB) is necessary. The normal current probe is not easy to be applied in such an application [3]. A 0 Ohm substitution probe is designed to measure the current on a specific trace. It uses pogo pins for connection to the pads.

To obtain the mutual inductance of the current probe, a simple simulation circuit is designed in ADS. The simulation result approaches to the measurement result using the tuning function in ADS.

2 Mathematics method to obtain the mutual inductance of the probe

The mathematics method can be used to calculate the mutual inductance of the current probe which is used to transfer the measurement result to the actual result. The current measurement test bench can be presented using a simple circuit shown in Fig. 1. Here

the two inductors of between port1 and port2 (see Fig. 2) are represented by one inductor, thus the mutual inductance will be the double value of the actual mutual inductance.

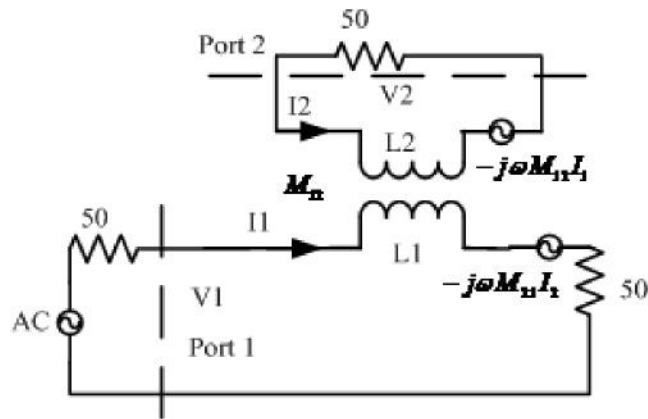


Fig. 1. A simple circuit to present the current measurement test bench using current probe.

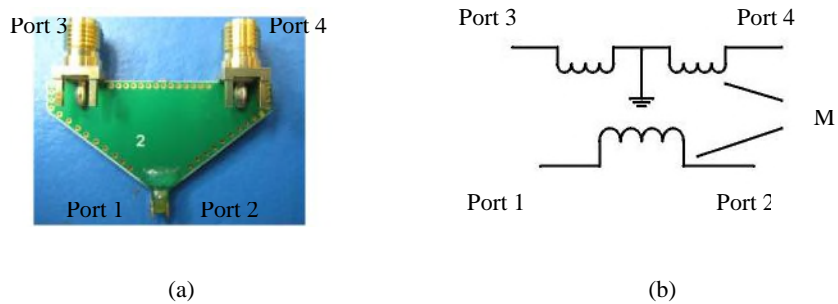


Fig. 2. (a) Current probe and (b) Equivalent circuit of the probe.

As the probe is a 0 Ohm current probe, the self inductance of L1 and L2 are very small which could be neglected. If they are neglected, Then the below equations 1-3 are obtained:

$$S_{21} = V_2/V_1 \quad (1)$$

$$I_1 = V_1/50 \quad (2)$$

$$V_2 = -j\omega M_{12} I_1 \quad (3)$$

Where

I_1 is the current on power supply.

V_2 is the measured voltage on spectrum analyzer.

V_1 is the voltage on power supply.

S_{21} is the S parameter between port1 and port2.

We can get

$$M = \frac{|S_{21}|}{\omega} \times 50 \quad (4)$$

Through the measurement result of S_{21} , the mutual inductance calculation result is 0.2511 nH.

3 Conducted emission measurement using spectrum analyzer

The setup of conducted emission measurement is shown in Fig. 3. The settings of spectrum analyzer: (Frequency: 30 MHz- 1GHz, RBW: 120 kHz, Points: 801, Detector: Peak Display: Max hold).

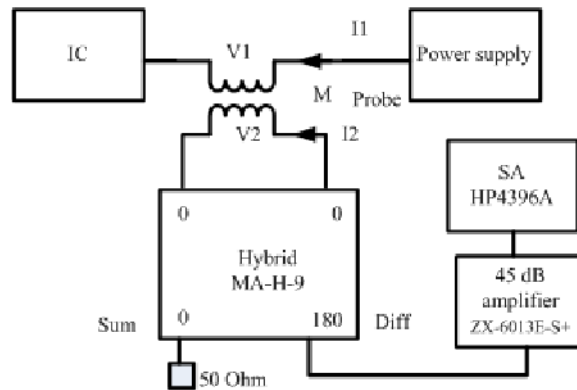


Fig. 3. A simple circuit to present the current measurement test bench using current probe.

The emission on power was measured. As shown in Fig. 4 three significant wide band emissions are around 300 MHz, 500 MHz and 800 MHz. Spectrum itself cannot give the emission source. STFFT method could be used to analyze the emission signal

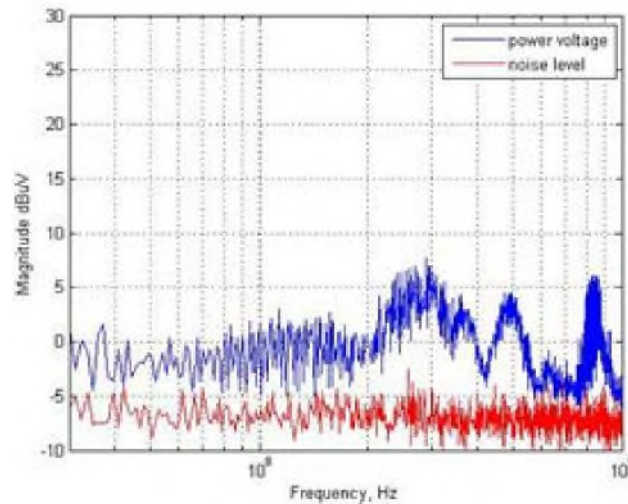


Fig. 4. A simple circuit to present the current measurement test bench using current probe.

4 Conclusions

The method using the substitution current probe to measure the current between the DC/DC and vdd pin of IC module is introduced. The result shows that current probe works up to 1 GHz, and the STFFT result gives the emission source of the current. All the wideband emissions are from DC/DC, and no narrowband emissions are found.

The calibration of current probe, hybrid, cables and amplifiers help to calculate the measurement. The simulation method and mathematic method are used to obtain the mutual inductance which helps to convert the voltage read from spectrum analyzer to current.

Acknowledgments This work is supported by the NSFC (61300238, 61373133), Basic Research Programs (Natural Science Foundation) of Jiangsu Province (BK20131004), PAPD and Huawei technologies Co. LTD.

References

1. IEC, "IEC 61967-4, Integrated circuits – Measurement of electromagnetic emissions 150 kHz to 1 GHz – Part 4: Measurement of conducted emissions – 1 Ω /150 Ω direct coupling method," ed, (2005)
2. BISS, "Generic IC EMC Test Specification Version 1.2," Jan. (2010)

3. S. Bendhia, M. Ramdani, and E. Sicard, *Electromagnetic Compatibility of Integrated Circuits, Techniques for Low Emission and Susceptibility*: Berlin, Germany: Springer-Verlag, 2006
4. Pan, W. Pommerenke D.: 'EMI Failure Analysis Techniques: II. Joint Time-Frequency Analysis', *IEEE EMC Society news letter* vol. 226, pp. 31-34, (2010)