# Low invasive high-frequency field measurement system using magneto-optical effect

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Measuring magnetic near field is one of the key technologies against the problem of the electromagnetic interference (EMI). However the previous methods generally use metal probes and cables. Therefore the accuracy of the system is poor by the many unexpected couplings between the metals and the measuring magnetic fields [1]. Measurements that use the magneto-optical effect can overcome this problem. The magneto-optical measurements do not use any metallic materials and cables, therefore it has very small invasivness for the magnetic fields. To achieve a high resolution, a stroboscopic method that employs short laser pulses are utilized. To improve the sensitivity, a new modulation system was carried out. Two waveforms having same frequency and different phase are used for modulate the pulsed laser. By switching the waveforms, modulated signal can obtained. Therefore the measured signal can be enlarged using the Lock-in amplifier. As a result, the proposed system can visualized RF magnetic near-field around IC chips.

In the previous works for magneto-optical measurement system [2], the magnetic field have to be burst modulated in order to obtain high sensitivity. However, this is not suitable for real circuit. To overcome this problem, we propose a new modulation schemes that do not require the modulation of the circuit current. That is obtained by a BPSK (Binary Phase-Shift Keying) modulation method. In this method, two signals of same frequency and different phase are switched by the SPDT (Single-Pole Double-Throw), and the generated signal is used as an external input trigger of the laser. As a result, the pulsed laser oscillates while periodically switching in two phase groups. The measuring circuit was shown in Fig.1. By applying these modulation schemes, the detection sensitivity of 0.1mOe (peak to peak) was realized up to 6GHz. Figure 2 shows the measured result of field distribution around an amplifier chip. The measuring condition is as follows; RF input: 1GHz, 10dBm, burst modulation 7.5kHz, measured area: 5x5 mm, 100x100 points. The strong magnetic field was observed at the output port. It is confirmed that the system is suitable for detecting the point to be shielded for EMI.

References

1) M. Takahashi, H. Ota, K. I. Arai and R. Sato: “Magnetic Near-Field Distribution Measurement above a Patch Antenna by Using an Optical Waveguide Probe”, IEICE Trans. Commun., E88-B, pp. 3140-3145 (2005).
2) H. Nasuno, S. Hashi, K. Ishiyama, “Stroboscopic technique for measuring magnetic-field waveforms utilizing magneto-optical effect”, IEEE Trans. Magn., vol. 47, pp.4011-4013 (2011).

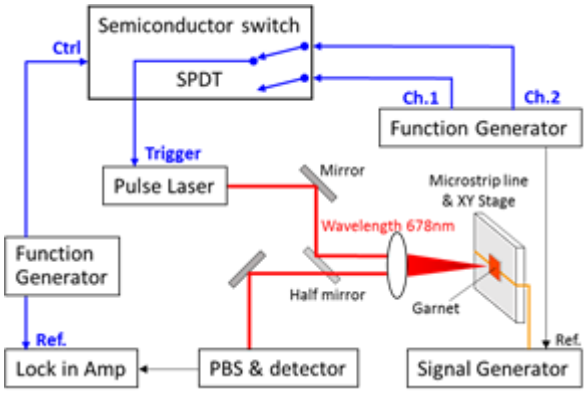


Fig.1 Measuring circuit of the new modulation system

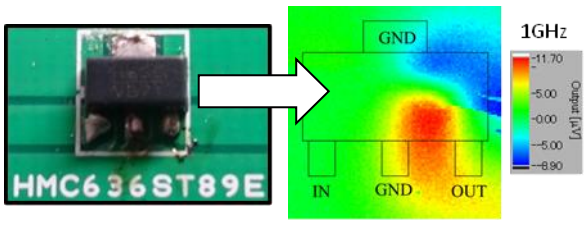


Fig.2 Field distribution around amplifier chip.