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Electric field sensing with EO probe and application of RoF
－LeoProbe and ROF-LINK－

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Abstract We present our products, an electric field sensor utilizing electro-optic (EO) effect and device applied to radio over fiber (RoF) transmission. The name of the EO sensor we develop is LeoProbe which features small size, metal free structure and wide detectable frequency range. Products related to RoF technology are ROF-link that is a pair of electrical to optical (E/O) converter and optical to electrical (O/E) converter to transmit RF signal with analogue optical modulation. The standard type of ROF-link operates in the frequency range from 10MHz to 3GHz.

Keywords electro-optic effect, EO sensor, RoF

1. Introduction

This paper consists of two parts. The first part describes an electric field sensor based on EO effect. EO sensors are used to detect electro-magnetic fields in microwave and millimeter wave regions [1]. It is expected to accurately measure an electric field, because they are electrically isolated from the objects to be measured. We develop LeoProbe that is EO probe of compact size and metal free structure. The sensing element of LeoProbe is a bulk crystal such as ZnTe and GaAs [2]. We show examples of measurement at various frequency regions in section 2.

The second part focuses on RoF device. RoF technologies allow efficiently transporting RF signals to remotely located antenna sites using optical fibers. The advantages of optical transmission are lower power loss, greater bandwidth and lighter weight than RF transmission. Our products for the system utilizing RoF technology are ROF-link, E/O and O/E converter. In section 3, we briefly introduce an application of ROF-link.

2. Electric field sensing with LeoProbe

Appearance of EO probes is shown in Fig. 1. One is a standard type probe with a 10mm diameter and a length of 65mm. The other is a slim type probe with a diameter of 1.6mm. The sensor tip is connected to a light source and a signal processing unit via a polarization maintaining fiber (not shown here).

Fig. 1 Sensor tips of LeoProbe. Light source and signal processing unit is not shown.

As the left electrode in Fig. 2(a) was applied with a voltage of 100V (50Hz) from commercial power supply, we measured the output signal of the probe above electrodes. Fig. 2 (b) shows the experimental result of an electric field distribution. The probe detects electric filed in a direction that is perpendicular to the surface of electrodes, so high intensity regions exist on the left electrode.

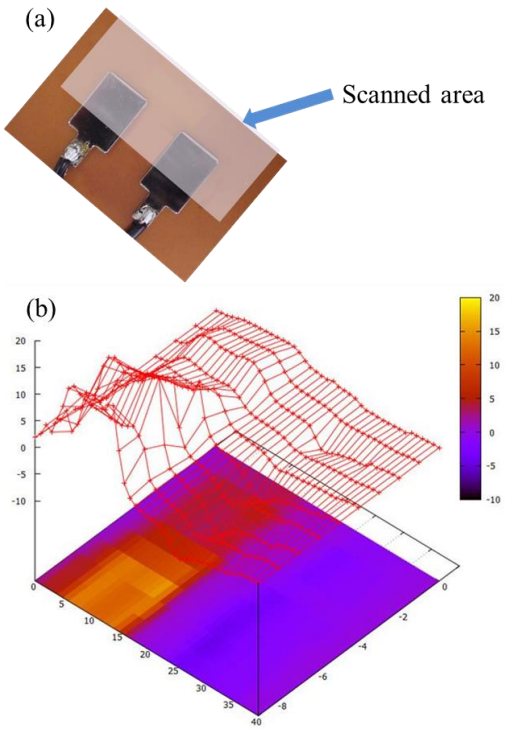

Fig. 2 (a) Device under test for electric field sensing at a frequency of 50Hz from commercial power supply
(b) Electric field distribution of scanned area with applied voltage of 100V (50Hz) to the left electrode

Fig. 3 (a) shows co-planar line for test of electric field sensing in microwave region. It was connected to a signal generator and incompletely terminated, so a standing wave pattern was formed on the line. Fig. 3 (b) shows electric field distribution above the co-planar line at the input RF frequency of 5.8GHz. In this measurement, we used optical heterodyne detection (IF=1MHz). As follows from Fig. 3(b), periodic variation of signal amplitudes can be observed.

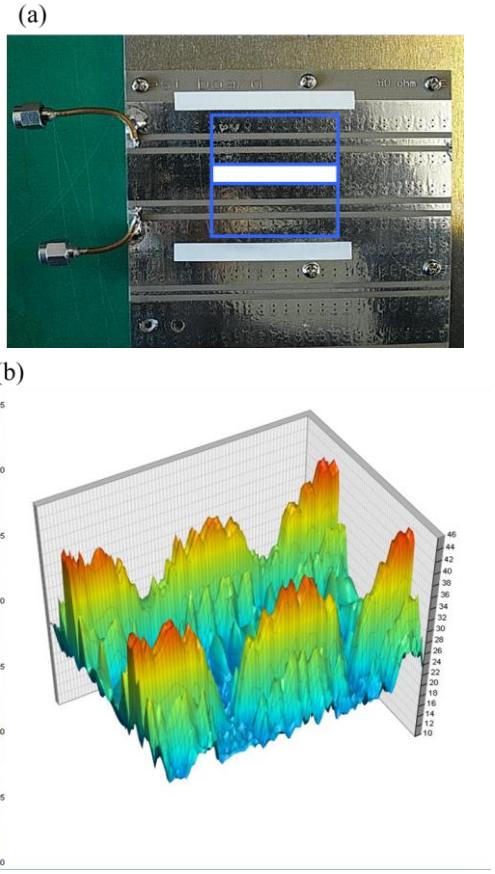

Fig. 3 (a) Co-planar line for test of electric field sensing in microwave region
(b) Electric field distribution above the co-planar line at the input RF frequency of 5.8GHz

3. Application of ROF-link

Product appearance of ROF-link is shown in Fig. 4. It is E/O and O/E converter that is made compact and can be easily used as RoF device. We introduce an installation example to RoF transmission in broadcasting system. Fig. 5 shows digital terrestrial television (DTV) repeater system for underground complex of Osaka. In this case, DTV signal is reradiated from twenty antennas, so the system is designed to satisfy signal quality required by radio law. In addition to those described above, there are applications such as in-building cellular phone system, passive optical relay system and RoF transmission system of microwave FPU signal.

Fig. 4 Picture of ROF-link

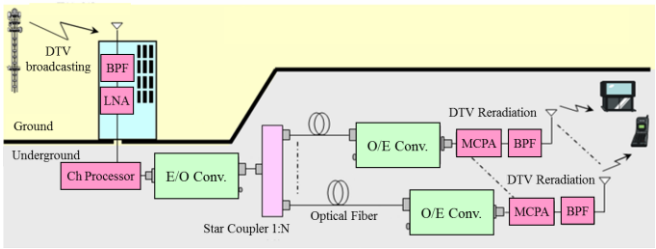

Fig. 5 DTV repeater system for underground complex of Osaka

4. Conclusion

We have presented LeoProbe that is non-invasive electric field sensor and ROF-link of the device for RoF transmission system. First, we have shown two examples of electric field measurement. LeoProbe has a wide frequency bandwidth from 50Hz up to a few tens of GHz. We have also introduced an application example of ROF-link. The specification of the standard product will be presented at the workshop.

References

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