Mach-Zehnder Interferometric Electro-optic sampling device

Description

THz E-field sensor uses Mach-Zehnder modulators made from lithium niobate thin films for sensing of electric fields. The sensors can achieve high spatial resolution and can operate form near DC frequencies up to several THz. The sensor is made from all dielectric materials. Hence it does not perturb measurand electric field. Also, since fiber optic cables are used no alignment is needed and the sensor can be readily placed in THz beam path for sampling of THz signals. The sensor operates at an eye safe wavelength of 1550nm. The device can be used to replace bulky electro-optic sampling crystals in THz time domain spectroscopy applications.

Theory of operation:

THz electric field sensor consist of a fiber coupled Mach-Zehnder modulator with an input fiber and two output fiber for balanced detection. The optical circuit for the sensor is schematically shown below. The sensor consist of an input grating coupler and two output grating couplers. Between the input and output couplers, there is a Mach-Zehnder modulator section. The two arms of Mach-Zehnder modulator are poled in opposite direction. When the electric field impinges on the device, the refractive index of one arm increases, while the refractive index of the other arm decreases due to the poling of the modulator. Hence the electric field modulates the optical signal. Since thin film lithium niobate is used there is good phase matching between the RF signal and the optical signal. Hence high bandwidth up to several THz is achieved.

Photos of packaged electro-optic sensor

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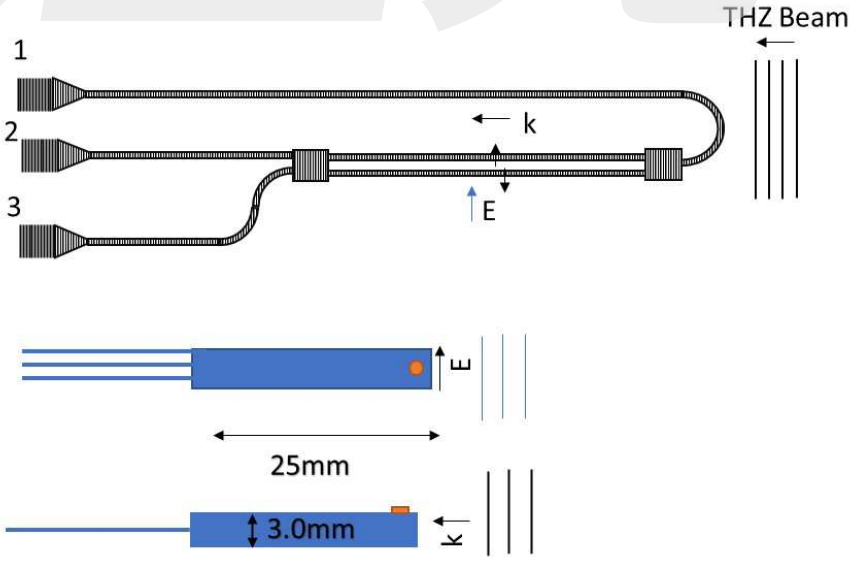
Mach-Zehnder THz sensor, P/N MZ-XX-Q-B-YY

Parameter	High Bandwidth	High sensitivity
Dynamic range	**10V/m-2MV/m**	**1V/m-200kV/m**
Sensitivity	**10V/(m. Hz $^{0.5}$)**	**1V/(m.Hz$^{0.5}$)**
Selectivity (Orthogonal components rejection)	**>30 (dB)**	**>30 (dB)**
Optical insertion loss of the sensor	**-12 (dB)**	**-12 (dB)**
Operating wavelength	**1550 (nm)**	**1550 (nm)**
Measurement Direction (YY) With respect to fibers	**PL: Parallel**	**PL: Parallel**
-3dB Bandwidth of optical coupler	**50nm**	**50nm**
-3dB modulation bandwidth*	**600GHz**	**60GHz**
Active interaction length XX	**600 microns**	**6000microns**
E_π	**23 MV/m**	**2.3MV/m**
Packaged sensor size	**3(mm)x25(mm)**	**3(mm)x25(mm)**
Fiber length	**1(m)**	**1m**
Fiber type, connector	**3 PM, FC/APC**	**3PM,FC/APC**

***Measured using THz time domain spectroscopy**



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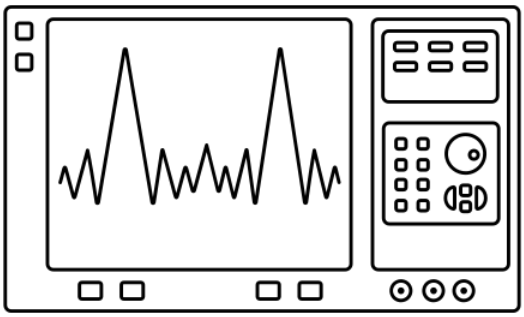
Typical spec and setup for electric field measurement up to 2.5 GHz

E-field sensor controller system P/N: L-1550-40-D-XX-B

Parameter	*High Bandwidth*	*High Sensitivity*
Laser power	***40 (mW)***	***40 (mW)***
Operating wavelength	***1550 (nm)***	***1550 (nm)***
Balanced detector bandwidth (XX)	***2500:1-2500(MHz)*** ***400:50Hz-400MHz***	***1-2500(MHz)*** ***50Hz-400MHz***
Typical response gain	***0.1(μV/(V/m))***	***1(μV/(V/m))***
Rise time	***0.87(nsec)***	***0.14(nsec)***
Interrogator dimension	***200x275x40(mm)***	***200x275x40(mm***
Interrogator weight	***1(kg)***	***1(kg)***
Interrogator output	***SMA-50 ohm***	***SMA-50 ohm***
Input power	***110V-220V,50-60Hz***	***110V-220V,50-60H***

Controller unit

Mach-Zehnder sensor element



Spectrum analyzer, oscilloscope, or other data acquisition system (not provided by Partow)

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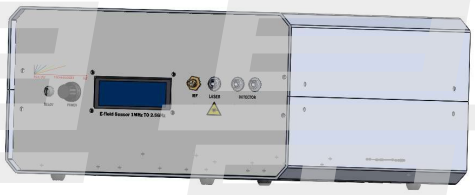
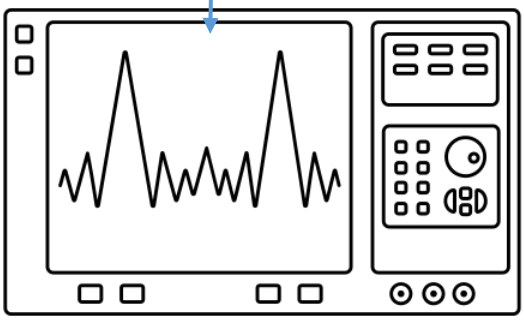
Typical spec and setup for electric field measurement up to 1 THz

E-field sensor controller system P/N: L-1550-THz-D-400-B

Parameter	*Value*	*Optional information*
Laser power	***10 (mW)***	
Operating wavelength	***1550 (nm)***	
Measurement range	***1GHz-1THz***	***Depending on the sensor used***
Typical response gain	***0.4(μV/(V/m))***	***0.04(μV/(V/m)) for 600micron devices***
Max output frequency	***100MHz***	
Interrogator dimension	***300x264x134(mm)***	
Interrogator weight	***1(kg)***	
Interrogator output	***SMA-50 ohm***	
Input power	***110V-220V,50-60Hz***	



Controller unit ***Mach-Zehnder sensor element***



Low frequency (<100MHz) Spectrum analyzer, oscilloscope, or other data acquisition system (not provided by Partow)

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