

Mach-Zehnder Interferometric Electro-optic sampling device

Description

Partow 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 from 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:

Partow 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.

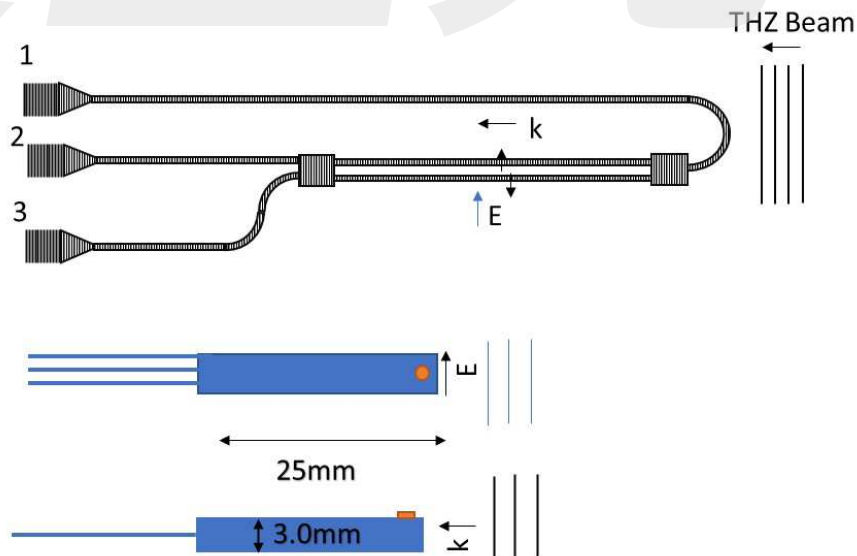


Photos of packaged electro-optic sensor

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



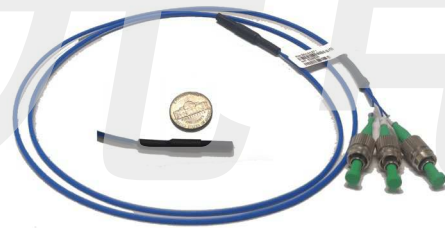
Typical spec and setup for electric field measurement up to 2.5 GHz

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

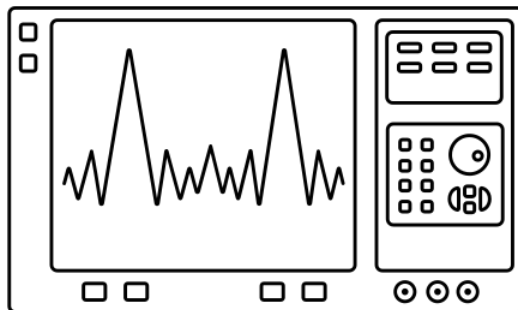
Parameter	High Bandwidth	High Sensitivity
Laser power	40 (mW)	40 (mW)
Operating wavelength	1550 (nm)	1550 (nm)
Balanced detector bandwidth (XX)	2500:1-2500(MHz) 400:50Hz-400MHz	1-2500(MHz) 50Hz-400MHz
Typical response gain	0.1(μ V/(V/m))	1(μ V/(V/m))
Rise time	0.87(nsec)	0.14(nsec)
Interrogator dimension	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

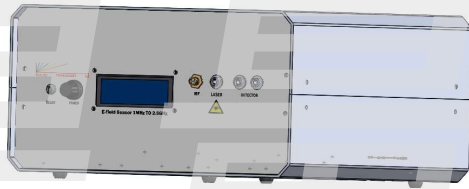


Spectrum analyzer, oscilloscope, or other data acquisition system (not provided by Partow)

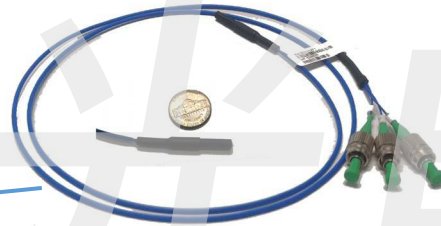
Typical spec and setup for electric field measurement up to 1 THz

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

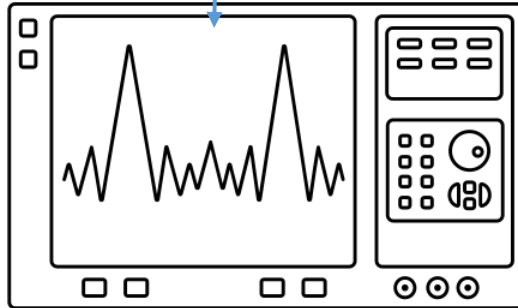
Parameter	Value	Optional information
Laser power	10 (mW)	
Operating wavelength	1550 (nm)	
Measurement range	1GHz-1THz	Depending on the sensor used
Typical response gain	0.4($\mu\text{V}/(\text{V}/\text{m})$)	0.04($\mu\text{V}/(\text{V}/\text{m})$) for 600micron devices
Max output frequency	100MHz	
Interrogator 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)