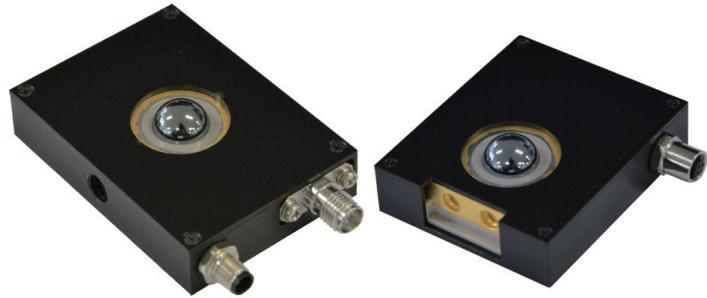


Fermi-level Managed Barrier (FMB) Diodes

Fermi-level managed barrier (FMB) diode is an ultra-low noise THz detector based on InP/InGaAs heterostructure. Instead of metal/semiconductor interface in a Schottky Barrier Diode (SBD), InGaAs/InP hetero-interface (InP barrier ~ 100 meV) is used in an FMB diode. This low barrier height provides a low diode differential resistance (R_d) and good impedance matching between a diode and a broadband bowtie antenna.

FEATURES

- Ultra-low NEP
- High voltage and current sensitivities
- Zero bias operation
- Room-temperature operation
- Self-complimentary bow-tie antenna integrated quasi-optical detector

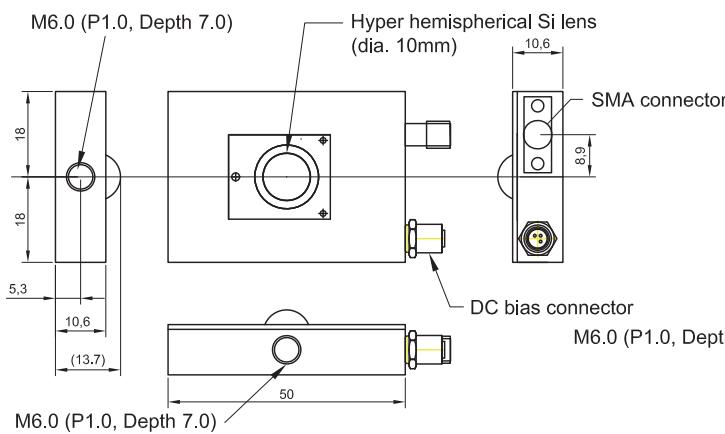


SPECIFICATIONS

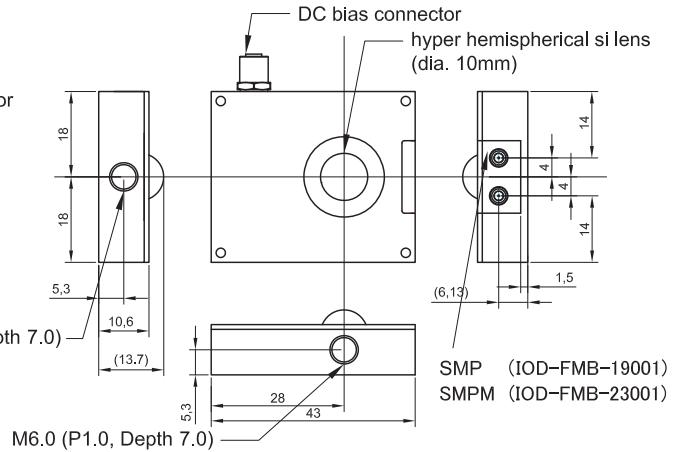
Item	Specifications		
Model	IOD-FMB-18001	IOD-FMB-19001	IOD-FMB-23001
Module configuration	Zero-bias FMB diode with op-amp.	Zero-bias FMB diode with TIA	Zero-bias FMB diode with TIA
Antenna type	Self-complimentary bow-tie	Self-complimentary bow-tie	Self-complimentary bow-tie
Lens type and diameter	Hyper-hemispherical (10mm dia.)	Hyper-hemispherical (10mm dia.)	Hyper-hemispherical (10mm dia.)
Terahertz bandwidth	>200GHz	>200GHz	>200GHz
Pre amplifier type	Low-noise operational amplifier	Transimpedance amplifier	Transimpedance amplifier
Pre amplifier bandwidth	20Hz-15kHz	30kHz-11.8GHz	50kHz-35GHz
Output connector	SMA (Female)	SMP x2 (male, differential output)	SMPM x2 (male, differential output)
Noise equivalent power (NEP)	5 pW/sqrt (Hz) @ 300GHz 45 pW/sqrt (Hz) @ 1000GHz	20 pW/sqrt (Hz) @ 300GHz	50 pW/sqrt (Hz) @ 300GHz
Voltage sensitivity	2 MV/W @ 300GHz 0.2 MV/W @ 1000GHz	15 kV/W @ 300GHz	10 kV/W @ 300GHz
Electrical power supply	DC±5V	DC+3.3V	DC+3.3V

OUTSIDE DIMENSIONS

IOD-FMB-18001



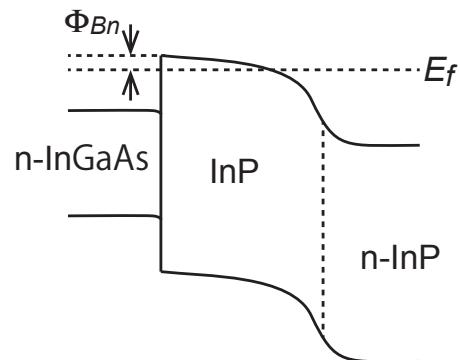
IOD-FMB-19001, IOD-FMB-23001



KEY CONCEPTS OF FMB DIODE

The heterobarrier structure consists of n-InGaAs, undoped-InP, and n-InP layers. The Fermi level in highly doped n-InGaAs can be located far above the conduction band edge depending on the carrier density (referred to as the "band filling effect"). On the basis of this characteristic phenomenon, the barrier height at the InP/InGaAs heterointerface (ϕ_{Bn}) can be lowered to 100meV or less. Due to a low differential resistance achieved by such a small barrier-height, the FMB diode integrated with the broadband fan-shaped 90° bowtie antenna results in a good NEP of about 5.0 pW/sqrt(Hz).

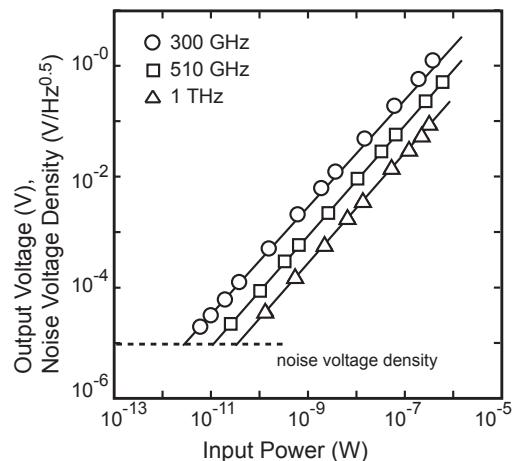
H.Ito et. al., *Jpn. J. Appl. Phys.*, 56(1), pp. 014101-1-014101-7, 2017



SQUARE-LAW DETECTION

The IOD-FMB-18001 module is ideal for applying square-law detection with ultra low noise. The voltage sensitivity obtained was as high as 2 MV/W at 300 GHz, and 0.2 MV/W at 1 THz. The figure on the right shows the relationship between the input power and the output voltage for IOD-FMB-18001. The dynamic range at 300 GHz was more than five decades. The noise equivalent powers (NEPs) were estimated to be as low as 3.0 pW/sqrt(Hz) at 300 GHz, and 33 pW/sqrt(Hz) at 1 THz.

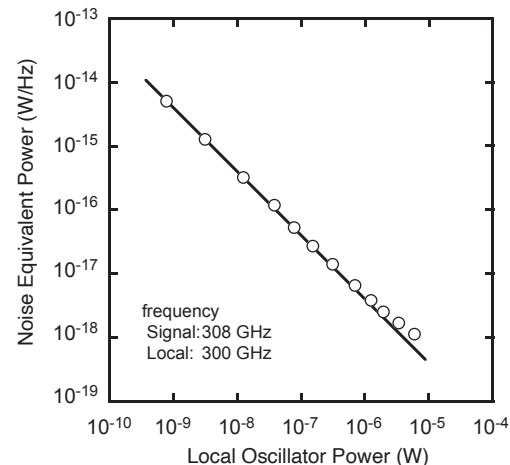
H.Ito et. al., *Jpn. J. Appl. Phys.*, 56(1), pp. 014101-1-014101-7, 2017



HETRODYNE DETECTION

The heterodyne detection scheme is most useful technique for achieving low noise measurement. The IOD-FMB-19001/-23001 is designed for the heterodyne detection, and is the quasi-optical FMB diode module with a broadband transimpedance amplifier (TIA). For IOD-FMB-19001, the module exhibited a differential voltage sensitivity of about 21 kV/W at 300 GHz in the square-law detection mode and an IF bandwidth of about 11 GHz in the heterodyne detection mode. The figure on the right shows the relationship between the NEP and the LO power at around 300 GHz. The lowest NEP obtained here was about 1.1×10^{-18} W/Hz with an LO power of only about 6 μ W.

H.Ito et. al., *Electron. Lett.*, 54(18), pp.1080-1082, 2018



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Sensing application
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