J10D Indium Antimonide Detector Operating Notes (1.0 to 5.5 µm)

Description

J10D Series detectors are high quality Indium Antimonide (InSb) photodiodes, providing excellent performance in the 1 to 5.5 µm wavelength region. Single crystal p–n junction technology yields high speed, low noise detectors with excellent uniformity, linearity and stability.

Applications

- Thermal Imaging
- Heat-Seeking Guidance
- Radiometers
- Spectrometry
- FTIR

Operation

InSb detectors are photovoltaic and generate current when exposed to infrared radiation.

Figure 23-2 shows the equivalent circuit for InSb, including the shunt resistance R_D, junction capacitance C_D and shot noise. The shot noise results from the DC current I_{BG} produced by the background infrared radiation. Because I_{BG} is proportional to the detector active area (Fig. 23-5), smaller detectors have less shot noise and lower values of NEP.

Field of View

A standard cold field of view (FOV) is provided at no extra charge. A custom field of view can be supplied for a small extra charge. Detectivity can be improved and I_{BG} reduced by restricting the FOV angle. The FOV cold stop angle should be chosen to restrict unwanted background radiation while still accepting all desired radiation from the optical system.

A 60° (full-angle) FOV, corresponding to 1/F optics, is provided unless otherwise specified.

Cold Filters

Optional cold filters can improve detectivity by eliminating background radiation in unwanted wavelength regions. The D* performance with the SP28 cold filter (0.5-2.8µm) and the SP35 cold filter (1.7-3.5µm ±0.3µm) is shown in Figure 23-1. Other bandpass filters are available on a custom basis.

Dewar Packages

All J10D Series InSb detectors require 77°K operating temperatures. The detector comes mounted in the standard M204 or M205 metal dewar with a sapphire window and a 60° Field of View. Other window and dewar options are also available.

All InSb detectors can be provided in the LC1 Dewar Cooler Assembly or the RC2 Detector Cooler Assembly for operation without bulk liquid nitrogen.

Custom Detectors

Specifications for linear position sensors, quad cells, and two-color (sandwich) detectors are given in our catalog. InSb detectors in any size up to 7mm diameter and in any configuration

can be provided on a custom basis.

Preamplifiers

Optimum performance is achieved when the InSb detector is coupled into a Judson transimpedance gain preamplifier, which converts detector output current to voltage while maintaining the detector at the optimum zero volt bias (Fig. 23-3).

The PA-9 preamplifier is specifically matched to each InSb detector to provide maximum sensitivity, gain and bandwidth. The lower-cost, adjustable gain PA-7 preamplifier is suitable for lower frequency applications (DC-10KHz).

When selecting preamp gain, choosing the largest practical value of R_F results in the lowest overall noise. However, the detector I_{BG} must be considered to avoid DC saturation of the preamp.

Example: The J10D-M204-R01M has a background current (I_{BG}) of 7µA (from Fig. 23-5). Choosing R_F= 1MW would result in a gain of 10^6, for a DC output of (7µA x 10^6 V/A) or 7V. This is near the saturation level of both the PA-7 and PA-9. Consequently, a gain of 10^6 is the maximum useable DC gain with this detector. An AC-coupled second stage may be added for further amplification.

The background current I_{BG} may be reduced by adding a cold filter or reducing the field of view.

Typical Specifications **J10 Series InSb @ 77°K, 60° FOV**

Model Number	Active Size (dia.) (mm)	Judson P/N	Peak Respon-sivity (A/W)	D* @ λ_{peak} and 1KHz (cm $Hz^{1/2}W^{-1}$)	NEP @ λ_{peak} and 1KHz (pW/$Hz^{1/2}$)	Back-ground Current I_{BG} (µA)	Open Circuit Voltage V_{OC} (mV)	Shunt Resistance R_D @ V_R = 0V (Ω)	Capaci-tance C_D (nf)	Standard Packages	
										Dewar	Window
J10D-M204-R100U-60	0.10	400151	3.0	1 x 10^{11}	0.08	0.15	90 to 120	>25M	0.01	Side-	
J10D-M204-R250U-60	0.25	400007-2	3.0	1 x 10^{11}	0.2	0.4	90 to 120	>10M	0.03	Looking	Sapphire
J10D-M204-R500U-60	0.50	400038-2	3.0	1 x 10^{11}	0.4	2	90 to 120	>1M	0.1	M204	Amtir
J10D-M204-R01M-60	1.00	400005-1	3.0	1 x 10^{11}	0.8	7	90 to 120	>500K	0.4	M200	1-6µm
J10D-M204-R02M-60	2.00	400016-1	3.0	1 x 10^{11}	1.6	30	90 to 120	>150K	1.6	Down-	AR
J10D-M204-R04M-60	4.00	400010-1	3.0	1 x 10^{11}	3.0	110	90 to 120	>40K	6	Looking	Silicon
J10D-M204-R07M-60	7.00	400057-1	3.0	1 x 10^{11}	6	350	90 to 120	>10K	20	M205	

Figure 1
Detectivity vs Wavelength for J10D Series InSb

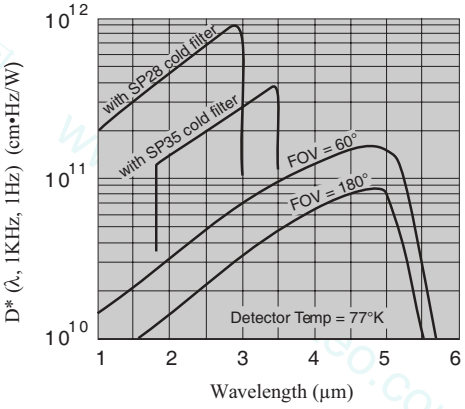
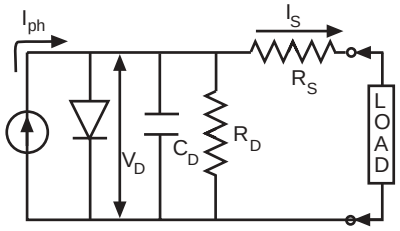
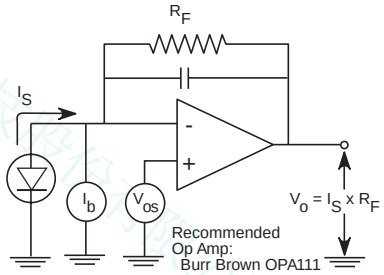


Figure 2
InSb Photodiode Equivalent Circuit



I_{ph} = Current generated by incident photons
V_D = Actual voltage across diode junction
C_D = Detector junction capacitance
R_D = Detector shunt resistance
R_S = Detector series resistance
I_S = Output signal current

Figure 3
Basic Operating Circuit for InSb



Max. R_F for InSb determined by (I_{BG}) Fig. 19-5.
Max. recommended DC voltage is 5 volts.
V offset = I_{BG} x R_F

Figure 4
Detectivity vs Temperature for J10D Series InSb

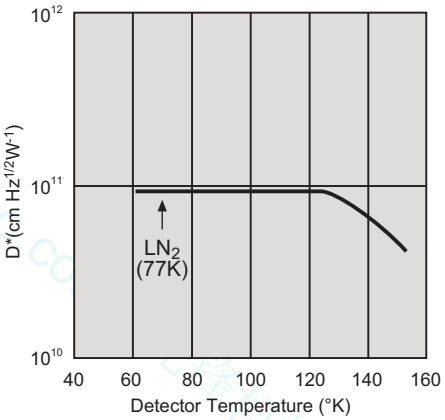


Figure 5
Background Current I_{BG} Current vs Active Size

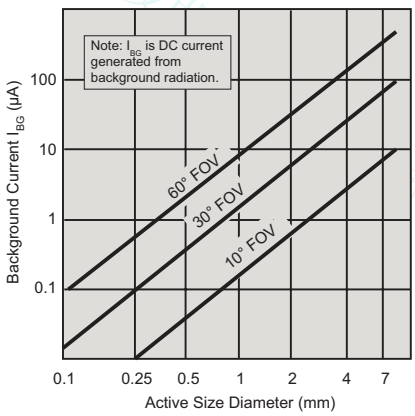


Figure 6
Noise Equivalent Power (NEP) vs Frequency