

# Indium Antimonide (InSb) Detectors

## Indium Antimonide (InSb) Detectors..... (1 - 5.5 $\mu$ )

J10D Series detectors are high quality Indium Antimonide (InSb) photodiodes, providing excellent performance in the 1-to 5.5  $\mu\text{m}$  wavelength region. Single crystal p-n junction technology yields high speed, low noise detectors with excellent uniformity, linearity and stability.

InSb detectors are photovoltaic and generate current when exposed to infrared radiation. Figure below 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, smaller detectors have less shot noise and lower values of NEP.

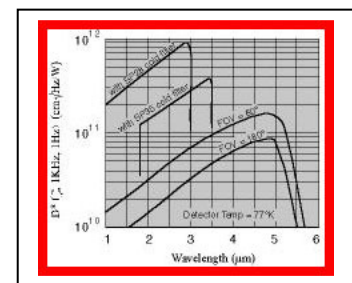
### Applications:

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

**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 IBG 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 (0.5-2.8 $\mu\text{m}$ ) and the SP35 cold filter (1.7-3.5 $\mu\text{m} \pm 0.3\mu\text{m}$ ) is shown in Figure at right. Other band pass filters are available on a custom basis.

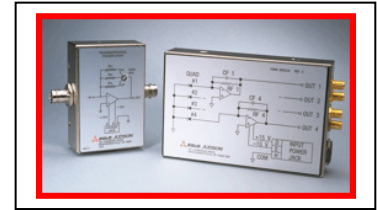
**Dewar Packages:** All J10D Series InSb detectors require 77°K operating temperatures. The detector comes mounted in the standard M204 or M205 metal dewar with a sapphire window and a 60° field of view. Other window and dewar options are available. All InSb detectors can be provided in the LC1 Dewar Cooler Assembly or the RC2 Detector Cooler Assembly for operation without bulk liquid nitrogen.



Detectivity vs Wavelength for J10D Series InSb

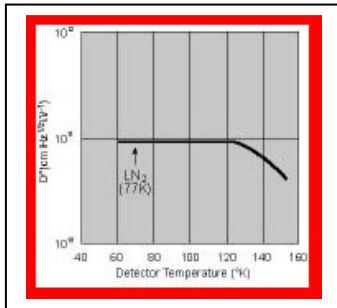
**Preamplifiers:** Optimum performance is achieved when the InSb detector is coupled into a Judson transimpedance gain preamplifier, which converts detector output current to voltage while maintaining the detector at the optimum zero volt bias.

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.

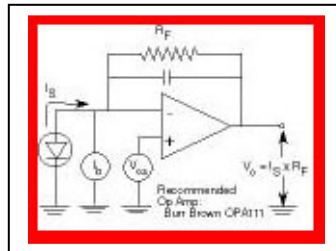


**Preamplifiers**

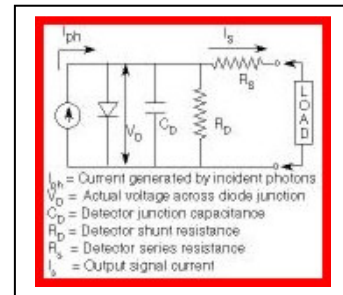
**Example:** The J10D-M204-R01M has a background current ( $I_{BG}$ ) of  $7\mu A$  (from Fig. 5). Choosing  $R_F = 1M\Omega$  would result in a gain of  $10E6$ , for a DC output of ( $7\mu A \times 10E6 V/A$ ) or 7V. This is near the saturation level of both the PA-7 and PA-9. Consequently, a gain of  $10E6$  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.



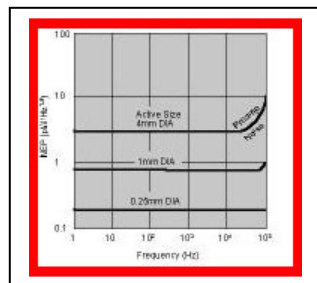
**Detectivity vs Temperature for J10D Series InSb**



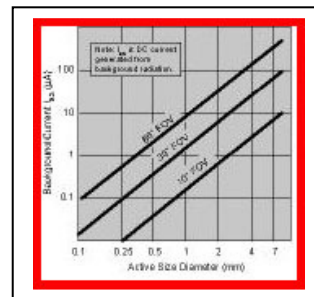
**Basic Operating Circuit**



**InSb Photodiode Equivalent Circuit**



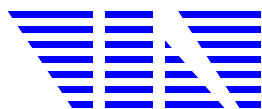
**Noise Equivalent Power (NEP) vs Frequency**



**Background Current vs Active Size**

## Typical Specifications J10 Series InSb @ 77°K, 60° FOV (Field of View)

Model Number	Active Size (dia)	Peak Responsivity	D* @ $\lambda_{peak}$ and 1KHz	NEP @ $\lambda_{peak}$ and 1KHz	Back-Ground Current $I_{BG}$	Shunt Resistance $R_D$ @ $V_R = 0V$	Capacitance $C_D$	Standard Packages	
	(mm)	(A/W)	(cm Hz <sup>1/2</sup> W <sup>-1</sup> )	(pW/Hz <sup>1/2</sup> )	( $\mu$ A)	(ohms)	(nf)	Dewar	Window
<b>J10D-M204-R100U-60</b>	0.10	3.0	$1 \times 10^{11}$	0.08	0.15	>25M	0.01	Side- Looking M204 M200	Sapphire Amtir 1-6 $\mu$ m
<b>J10D-M204-R250U-60</b>	0.25	3.0	$1 \times 10^{11}$	0.2	0.4	>10M	0.03		
<b>J10D-M204-R500U-60</b>	0.50	3.0	$1 \times 10^{11}$	0.4	2	>1M	0.1		
<b>J10D-M204-R01M-60</b>	<b>1.00</b>	<b>3.0</b>	<b><math>1 \times 10^{11}</math></b>	<b>0.8</b>	<b>7</b>	<b>&gt;500K</b>	<b>0.4</b>	Down- Looking M205	AR Silicon
<b>J10D-M204-R02M-60</b>	2.00	3.0	$1 \times 10^{11}$	1.6	30	>150K	1.6		
<b>J10D-M204-R04M-60</b>	4.00	3.0	$1 \times 10^{11}$	3.0	110	>40K	6		
<b>J10D-M204-R07M-60</b>	7.00	3.0	$1 \times 10^{11}$	6	350	>10K	20		
<ul style="list-style-type: none"> <li>Open Circuit Voltage (<math>V_{oc}</math>) for all models is 90-120mV</li> <li>Hold period for M204 LN2 Dewar <math>\geq</math> 8 hrs</li> <li>Hold period for M200 LN2 Dewar <math>\geq</math> 12 hrs</li> </ul>									



**VIN KAROLA INSTRUMENTS**

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