TELEDYNE
JUDSON TECHNOLOGIES
Everywhereyoulook™

# Indium Antimonide Detectors

***Teledyne Judson Technologies LLC***
221 Commerce Drive
Montgomeryville, PA 18936 USA

Tel: 215-368-6900
Fax: 215-362-6107

Visit us on the web.
www.teledynejudson.com

*ISO 9001 Certified*

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

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### 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 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. 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 F/1 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 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 J508 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 Teledyne Judson transimpedance gain preamplifier, which converts detector output current to voltage while maintaining the detector at the optimum zero volt bias (Fig. 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. 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) | Teledyne Judson P/N | Peak Respon-sivity (A/W) | D* @ peak and 1KHz (cm $Hz^{1/2}W^{-1}$) | NEP @ 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 ( ) | 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**

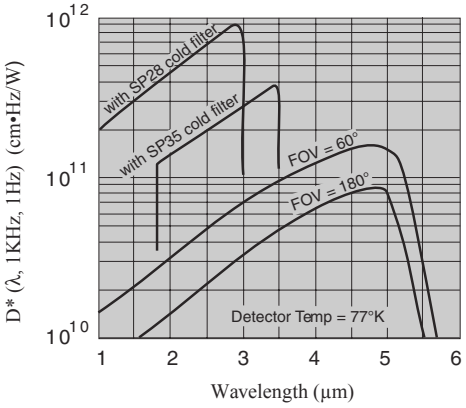
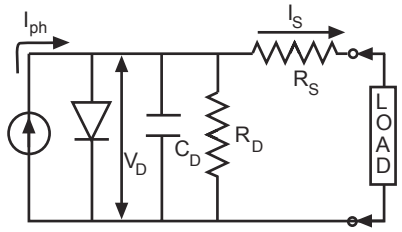
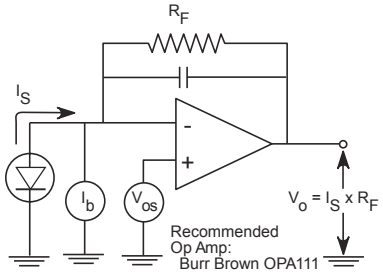



**Figure 2**
**InSb Photodiode Equivalent Circuit**




$I_{ph}$ = 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**

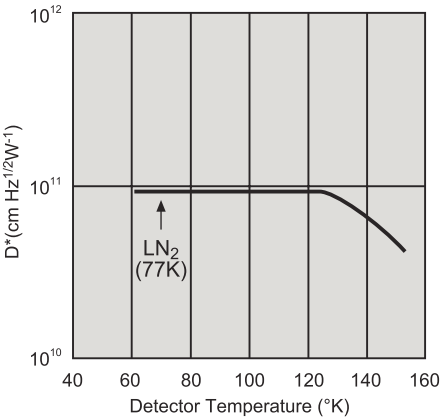



**Figure 5**
**Background Current $I_{BG}$ Current vs Active Size**

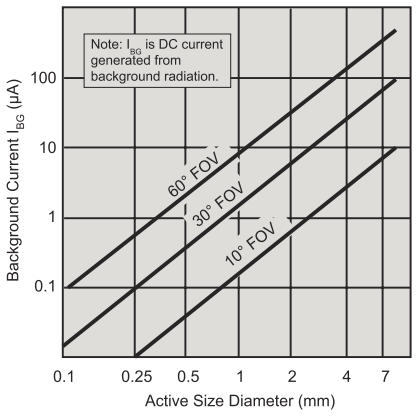
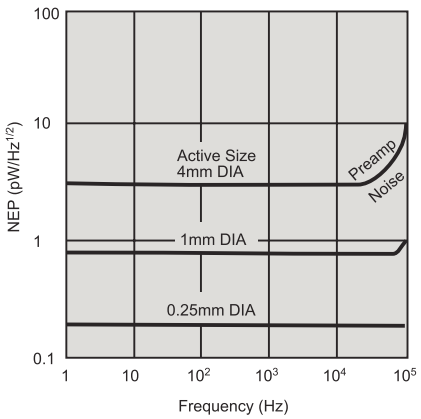



**Figure 6**
**Noise Equivalent Power (NEP) vs Frequency**



In addition to our Indium Antimonide product line, Teledyne Judson Technologies offers a wide range of high performance standard, custom and space qualified detector products and accessories.

Germanium detectors and arrays
Indium Arsenide detectors and arrays
Mercury Cadmium Telluride detectors and arrays
Lead Selenide detectors and arrays
Lead Sulfide detectors and arrays
Dewars, backfill and vacuum packages
Thermoelectric, Joule Thomson and closed cycle linear and rotary coolers
Preamplifiers
Temperature controllers and readout electronics

Please contact us for more information on these products at 215-368-6900 or on the web at www.teledynejudson.com.

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March, 2003