THORLABS

Amplified MIR Photodetector

PDAVJ5, PDAVJ8, PDAVJ10
Operation Manual

2018

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Contents

1 General Information

Thorlabs' PDAVJx Series of mid-IR (MIR) detectors combines the uncooled highly sensitive photovoltaic mercury-cadmium-telluride (MCT) sensors of the VMLxT0 series with variable gain ultra-low noise transimpedance amplifiers in a shielded aluminum housing. The PDAVJx detectors are DC coupled and have a frequency response from true DC to the respective cutoff frequency. The gain can be adjusted with 8 steps over 30 dB (PDAVJ8 and PDAVJ10) or 42 dB (PDAVJ5).

The PDAVJx Series for free-space beam setups is provided in different versions with varying wavelength dependent sensitivity: the PDAVJ5 for 2.7 - 5.0 µm detection, the PDAVJ8 for 2.0 - 8.0 µm detection and the PDAVJ10 for 2.0 - 10.6 µm detection. A buffered output drives 50 Ω loads up to 1.0 V with an NEP of 14 pW/Hz$^{1/2}$ for PDAVJ5, or 170 pW/Hz$^{1/2}$ for PDAVJ8, or 210 pW/Hz$^{1/2}$ for PDAVJ10.

The sensors of the VMLxT0 series that are incorporated in the PDAVJx sensors differ in their layers such that PDAVJ5 has a single layer, while PDAVJ8 and PDAVJ10 sensors have multiple layers. For that reason, the responsivities given for PDAVJ8 and PDAVJ10 are inseparable from the sensor width.

The PDAVJx detector housing can be integrated in optical setups using convenient combi-thread mounting holes that are compatible with both imperial and metric mounting. Please see the chapter Mounting 7 for details.

The housing accommodates adapters and accessories from the Thorlabs' SM05-threaded (0.535"-40) series and the SM1-threaded (1.035"-40) series. This allows convenient mounting of external optics, light filters, and apertures. For accessories, please visit our website or contact Thorlabs 17.

A ±12 VDC power supply is included with each amplified photodetector. The appropriate input voltage 3 (100 VAC, 120 VAC, or 230 VAC) can be selected with a switch on the power supply.

The PDAVJx detectors can provide amplification of input powers up to 500 µW (PDAVJ10). Detectors for amplification of higher input powers are available upon request.

Attention

Please find all safety information and warnings concerning this product in the chapter Safety 15 in the Appendix.

1.1 Ordering Codes and Accessories

The following models of the PDAVJx Series and accessories are available:

PDAVJ5	Adjustable-Gain MIR Photodetector, HgCdTe (MCT), 2.7 - 5.0 µm, Combi-Thread Mounting Holes Compatible with 8-32 and M4 Threads
PDAVJ8	Adjustable-Gain MIR Photodetector, HgCdTe (MCT), 2.0 - 8.0 µm, Combi-Thread Mounting Holes Compatible with 8-32 and M4 Threads
PDAVJ10	Adjustable-Gain MIR Photodetector, HgCdTe (MCT), 2.0 - 10.6 µm, Combi-Thread Mounting Holes Compatible with 8-32 and M4 Threads
LDS12B	Power Supply ±12 V, 250 mA, switchable 100 VAC,120 VAC, 230 VAC Line Voltage, LUMBERG RSMV3-657 Connector

2 Getting Started

2.1 Parts List

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents for completeness and tested the PDAVJx Series Detector mechanically and electrically.

Verify that you have received the following items within the package:

1. Amplified Adjustable-Gain MIR Photodetector
2. Metal Cover Cap, Protecting the Sensor
3. Power Supply (±12 V, 250 mA), Switchable 100 V, 120 V or 230 V Line Voltage, Including Location Specific Power Adapters
4. Quick Reference Document

2.2 Preparation

Note

Prior to operation, please check if the selected line voltage range on the power supply matches your local mains voltage.

Please follow these steps for preparation:

- Carefully unpack the unit and accessories. If any damage is evident, do not use the unit and contact Thorlabs 17.
- Mount 7 the unit on your optical table or application. The unit has two combi thread mounting holes, each compatible with both imperial 8-32 and metric M4 screws.
- Remove the metal cover cap that protects the optical input.
- If necessary, mount external optics, filters, or apertures.
- Adjust the power supply to accommodate your local mains voltage (100 VAC, 120 VAC, or 230 VAC).

- Plug the power connector cable into the power supply connection socket 4 on the PDAVJx.
- Plug the power supply into a 50-60 Hz, 100 VAC, 120 VAC, or 230 VAC outlet.
- Turn the power supply on.
- Connect the output BNC connector 4 to your data acquisition device using a coaxial cable. Please note that a 50 Ω impedance device should be used for best RF performance.

Note

If you want to use your own power supply, contact Thorlabs for an appropriate power connector cable.

3 Operating Instructions

3.1 Operating Principle

The Thorlabs PDAVJx Series features an uncooled MIR photovoltaic detector of the VML series combined with a switchable ultra-low noise transimpedance amplifier (TIA). This amplified MIR detector is packaged into a shielded aluminum housing.

In principle, the photodiode generates a current in response to the optical input. The TIA then converts the current to a voltage and amplifies the signal, reaching a frequency response from true DC to the cutoff frequency. The gain adjustment range is 30 dB for PDAVJ8 and PDAVJ10 and 42 dB for PDAVJ5 (see Technical Data 10) and is regulated over 8 gain steps.

The output is passed through a 50 Ω series resistor before reaching the output connector. The user can apply either a 50 Ω or high-impedance external load depending on the situation.

Note

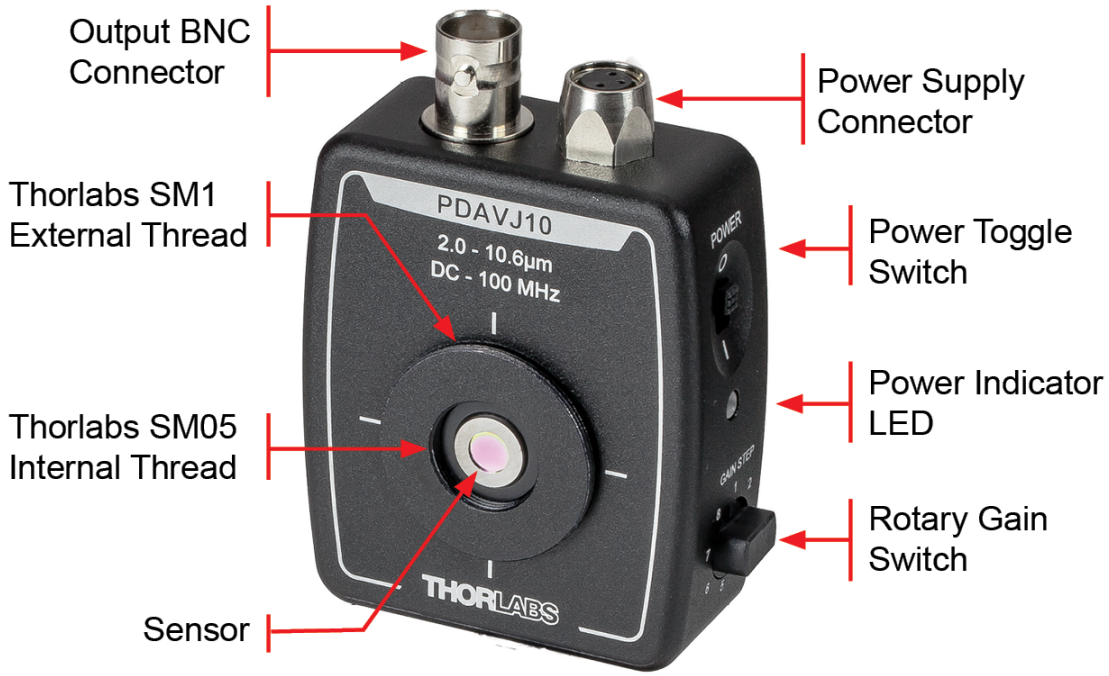
The maximum output voltage is 2.0 V at Hi-Z termination. To avoid electrical saturation, keep the output voltage below this maximum listed in the Technical Data 10. If necessary, use external neutral density filters or attenuators to reduce the input light level.

The PDAVJx is powered by an external power supply (±12 V, 250 mA) with switchable 100 V, 120 V, or 230 V line voltage. The power supply is connected to the PDAVJx via a 250 mA, LUMBERG RSMV3 connector.

3.1.1 Operating Elements

Note

The outer housing dimensions of the PDAVJ5, PDAVJ8, and PDAVJ10 are identical. Please refer to the drawings 14 for detailed dimensions.



3.1.2 Optical Input

The HgCdTe (MCT) sensor material used in the PDAVJx detectors is the same material as used in the Thorlabs VMLxT0 5 MIR photovoltaic detectors. These detectors feature optically-immersed sensors with an effective area diameter of 1 mm x 1 mm, operating from 2.7 - 5.0µm (PDAVJ5), or 2.0-8.0 µm (PDAVJ8), or 2.0 - 10.6 µm (PDAVJ10). Typical responsivity curves for the detectors can be found in the Appendix.

Attention

The optical damage threshold of the PDAVJx detectors is 25 mW. Exceeding this value will permanently destroy the sensor! Beam power limitation for optically-immersed detectors irradiated with CW light or single light pulses longer than 1 µs irradiance on the apparent optical active area must not exceed 2.5 W/cm². The irradiance with light pulses shorter than 1 µs must not exceed 10 kW/cm².

Attention

The sensing element is positioned behind a thin ZnSe window that has an AR-coating for infrared wavelengths. **This ZnSe window is highly fragile.** Please be very careful when cleaning the window.

Note

The maximum output voltage is 2.0 V at Hi-Z termination. To avoid electrical saturation, keep the output voltage below this maximum listed in the Technical Data 10. If necessary, use external neutral density filters or attenuators to reduce the input light level.

Note

Coupling loss may occur due to small detector size which would result in a reduced output signal. For optical alignment use an optical input power below the saturation power while observing the output voltage on a low-frequency measurement device such as a digital voltmeter.

The PDAVJx housing features internal SM05 and external SM1 threads for convenient mounting of lens tubes or cage systems.

Information on MIR photodetector Series (VMLxT0)

For the MIR photovoltaic detector series VMLxT0, integrated in the PDAVJx Series, optical immersion is used to produce a 1 mm x 1 mm effective detector area.

This technique is performed by integrating the sensor element with a GaAs hyperhemispherical microlens, which has a high refractive index (n = 3.3) and is transparent to mid-IR (MIR) wavelengths. While a hemispherical lens focuses light onto the sensor plane and produces an image with dimensions larger than the physical sensor by a factor of n, the hyperhemispherical lens forms an image on a virtual focal plane located behind the sensor. This image has dimensions larger than the physical sensor by a factor of n^2. While using the hyperhemispherical lens enables substantially better performance by forming a larger image, a cost of using it is the reduced 35° acceptance angle, which is in contrast to the 180° acceptance angle given by the hemispherical lens. For that reason, please align your light source carefully prior to starting experiments.

3.1.3 Electrical Output

Thorlabs PDAVJx detectors deliver an output voltage Vout, proportional to the optical input signal. The maximum output voltage of the PDAVJx is 2.0 V for high impedance loads and 1.0V for 50 Ω loads. The system signal bandwidth ranges from DC to the cutoff frequency: 1 MHz for PDAVJ5 and 100 MHz for PDAVJ8 and PDAVJ10. Please note that this is true DC coupling.

The maximum output voltage should stay below 2.0 V to avoid saturation. Adjust the gain accordingly or reduce the input light level with the help of external neutral density filters.

The BNC output signal is buffered with an amplifier capable of driving 50 Ω loads. A 50 Ω series resistor is included on the output to impedance match a 50 Ω coax cable. For best performance, we recommend operating the PDAVJx detector with a 50 Ω terminating load located at the end of the coax cable. While this is not necessary, it eliminates ringing and distortion due to impedance mismatches.

For terminators with low resistance, please apply the Scale Factor 6.

Gain Adjustment

Each PDAVJx detector includes a low-noise, low-offset, gain amplifier that allows gain adjustment over a 30 dB range (42 dB for PDAVJ5) in 8 gain steps. The gain is adjusted by rotating the gain control knob located on the side of the unit below the POWER toggle switch to one of the 8 gain steps. Please note that the gain steps are not perfectly equidistant as shown in the Typical Output Frequency Response 12.

To achieve full output amplitude for PDAVJ8 and PDAVJ10, set the gain knob to position 8. The amplitude will be reduced with either lower gain or lower input power.

To adjust the gain, follow the steps below.

1. Set the Gain Switch to 8.
2. Turn on the light source.
3. Adjust the gain setting so the output voltage of the detector is below the electrical saturation level as indicated in the Technical Data 10.

Light-to-Current Conversion - Calculating V_{out}

Thorlabs PDAVJx detectors deliver an output voltage V_{out}, which is a function of the input optical power P_{opt}, the MIR-detector's responsivity $\Re(\lambda)$ at a given wavelength and the transimpedance gain G.

$$V_{out} = P_{opt} \times \Re(\lambda) \times G$$

The spectral responsivity $\Re(\lambda)$, can be obtained from the Typical Responsivity Curve to estimate the amount of output voltage. Please note that the given responsivity curves represents typical values - individual responsivity may deviate.

Since the product of the responsivity at a given wavelength and the transimpedance gain G is the Conversion Gain (CG) in [V/W], the output voltage is given by the input optical power multiplied by the Conversion Gain $CG_{(\lambda)}$.

$$GC_{(\lambda)} = \Re(\lambda) \times G$$

$$V_{out} = CG_{(\lambda)} \times P_{out}$$

Please note that the conversion gain depends on the wavelength and the gain settings. See the Technical Data 10 and Typical Output Frequency Response 12 to estimate the Conversion Gain and calculate the theoretical maximal output voltage.

Note

Please be aware that changing the final load resistance on the PDAVJx changes the conversion gain of the system. This is due to the internal 50 Ω series resistor (R_S). For terminators with

low resistance, an additional factor needs to be included in the above formula. The output load creates a voltage divider with the 50 Ω series resistor as follows:

$$ScaleFactor = \frac{R_{Load}}{R_{Load} + R_S}$$

Where R_{LOAD} is the terminating resistor and R_S= 50 Ω. For a standard 50 Ω terminator, the gain will be scaled by 1/2 as shown below:

$$ScaleFactor = \frac{50\ \Omega}{(50\ \Omega + 50\ \Omega)} = 0.5$$

The PDAVJx is optimized for 50 Ω final load resistance.

3.2 Mounting

The PDAVJx Series is housed in a rugged 70.9 mm x 54.1 mm x 22.5 mm shielded aluminum enclosure.

For mounting flexibility the PDAVJx has two tapped mounting holes 14 on the side and bottom to mount the unit to a Thorlabs TR series post or pedestal. The combi thread mounting holes are each compatible with both imperial 8-32 and metric M4 screws.

The PDAVJx housing 4 accommodates Thorlabs' SM05-threaded (0.535"-40) series and SM1 threaded (1.035"-40) series of adapters and accessories. This also allows convenient mounting of lens tubes or cage systems. For accessories, please visit our website or contact Thorlabs 17.

The electrical connectors, the gain switch and the ON/OFF switch are located on the side walls of the housing for easy access and to minimize the thickness of the PDAVJx so it can fit into tight spaces.

3.3 Operation

- Mount 7 the detector using the combi-thread mounting holes on the side and bottom of the device.
- Connect the detector to the power supply and data acquisition device following the steps in section Preparation 3.

  Attention

  Ensure that the correct mains voltage is selected on the power supply prior to connecting the power supply to the mains power. Wrong settings for the mains voltage may damage the power supply.
- Set the Gain knob to position 8.
- Turn the power switch to I. The green LED on the PDAVJx indicates the correct power supply.
- For best performance, attach a 50 Ω BNC-type cable to the Output BNC connector of the PDAVJx detector. When running cable lengths longer than 12", we recommend terminating the opposite end of the coax with a 50 Ω resistor (Thorlabs T4119 BNC in-line terminator) for maximum performance. Connect the remaining end to a measurement device.
- Align the light source with the optical input. The max V_{out} is 2.0 V for high impedance loads (1.0 V for 50 Ω loads). To avoid electrical saturation, keep the output voltage below

this maximum listed in the Technical Data 10. External neutral density filters or attenuators are recommended to reduce the input light level in critical cases.

- The gain can be adjusted to set the output voltage.
- Turn the power switch to O after finishing the measurements.

Attention

The optical damage threshold of the PDAVJx detectors is 25 mW. Exceeding this value will permanently destroy the sensor! Beam power limitation for optically immersed detectors irradiated with CW or single light pulses longer than 1 µs irradiance on the apparent optical active area must not exceed 2.5 W/cm². Irradiance with light pulses shorter than 1 µs must not exceed 10 kW/cm².

4 Maintenance and Service

Protect the PDAVJx from adverse weather conditions. The PDAVJx is not water resistant. The unit does not need a regular maintenance by the user. There are no serviceable parts in the PDAVJx optical head or power supply. The housing may be cleaned by wiping with a soft damp cloth.

If you suspect a problem with your PDAVJx, please read the section Safety 15 and contact Thorlabs 17 tech support and an engineer will be happy to assist you.

Attention

The window of the detector should only be cleaned using optical grade wipes. This ZnSe-window is highly fragile. Please be very careful when cleaning the window.

Attention

To avoid damage to the instrument, do not expose it to spray, liquids, or solvents!

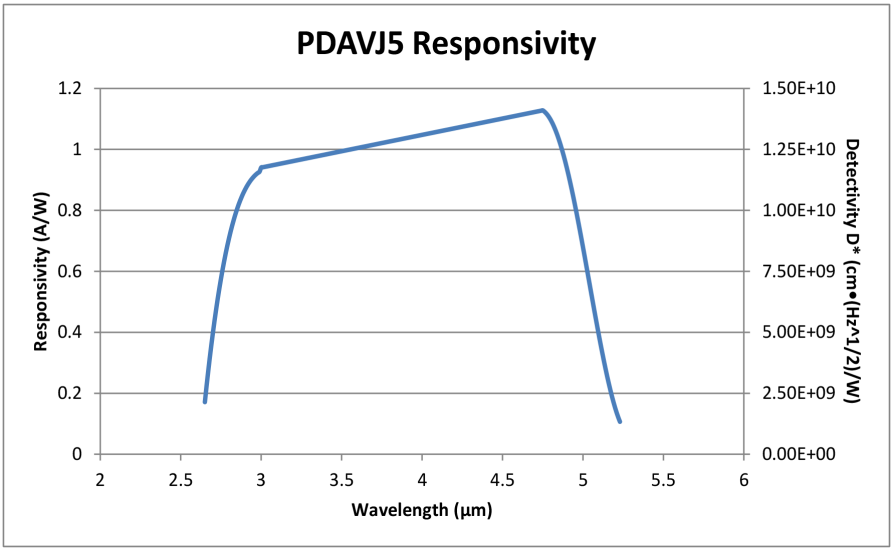
5 Appendix

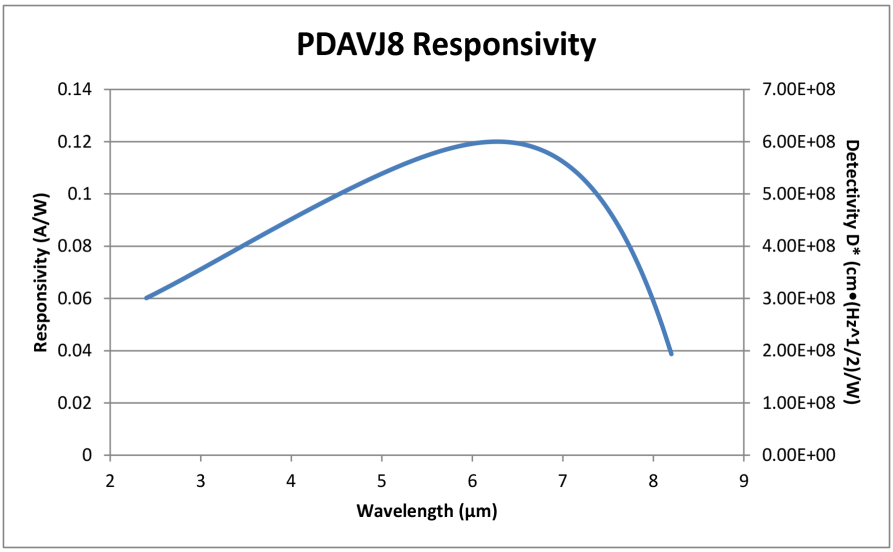
5.1 Technical Data

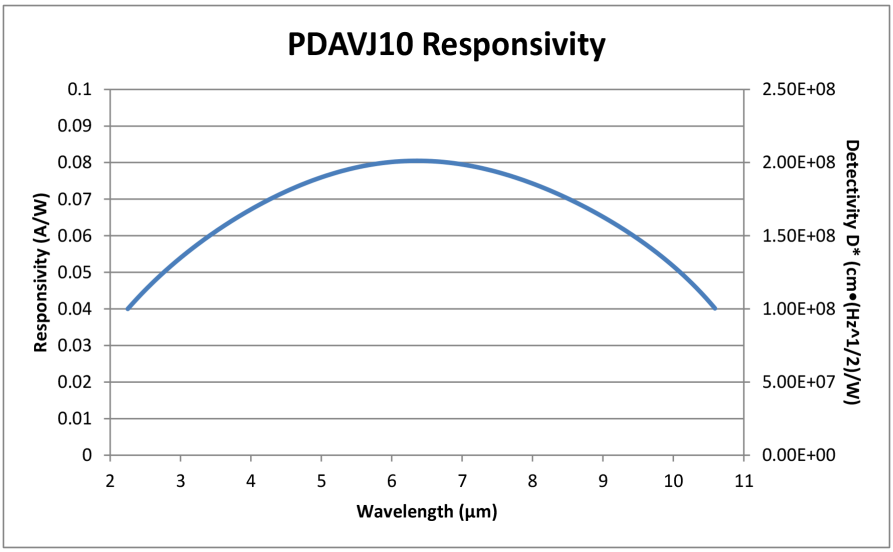
Item #	PDAVJ5	PDAVJ8	PDAVJ10
Common			
Optical Input	Free Space		
Electrical Output	BNC		
Optical Specifications			
Detector Material/Type	MCT, Optically Immersed		
Window Material	ZnSe		
Wavelength Range	2.7 - 5.0 µm	2.0 - 8.0 µm	2.0 - 10.6 µm
Peak Wavelength (λ_{peak})	4.75 µm	6.5 µm	
Current Responsivity @ λ_{peak}	≥ 1 A/W	-	-
Assured Responsivity[a] @ λ_{peak} x Width of the Detector	-	≥ 0.04 A*mm/W	≥ 0.01 A*mm/W
Assured Detectivity D* @ λ_{peak}	≥ $1.5*10^{10}$ cm*$Hz^{1/2}W^{-1}$	≥ $6.0*10^{8}$ cm*$Hz^{1/2}W^{-1}$	≥ $2.0*10^{8}$ cm*$Hz^{1/2}W^{-1}$
Effective Sensor Area	1 mm x 1 mm, Single Layer	1 mm x 1 mm, Multilayer	1 mm x 1 mm, Multilayer
Depth of Housing Surface to Detector Chip	4.3 mm		
Depth of Housing to Protective Window	1.1 mm		
Saturation Input Power	200 µW	250 µW	500 µW
Max Input Power (Damage Threshold) CW or Long Pulse > 1 µs: Short Pulse < 1 µs:	 2.5 W/cm^2 10 kW/cm^2		
Electrical Specifications			
Output Bandwidth (3 dB)	DC - 1 MHz[b]	DC - 100 MHz[c]	
Gain Adjustment Range	42 dB	30 dB	
Gain Steps	8		
Conversion Gain CG(λ) @ Gain = 8, λ_{peak}	200 000 V/W	6000 V/W	4000 V/W
Conversion Gain CG(λ) @ Gain = 1, λ_{peak}	1500 V/W	185 V/W	120 V/W
Minimum NEP (DC - Cutoff Freq.)	14 pW/$Hz^{1/2}$	170 pW/$Hz^{1/2}$	210 pW/$Hz^{1/2}$
Max. Output Voltage (50 Ω / Hi-Z)	0 - 1.0 V / 0 - 2.0 V		
Electrical Output, Impedance	BNC, 50 Ω		
Max Output Current	50 mA		
Output Offset Voltage	< ± 25 mV		
General			
Operating Temperature Range	15 to 30 °C		
Storage Temperature Range	0 to 45 °C		
Dimensions of Housing 14 (WxHxD)	54.1 mm x 70.9 mm x 22.5 mm		
Weight (Detector / Power Supply)	0.18 lbs / 1.6 lbs (80 g / 530 g)		
Power Supply	± 12 V, 250 mA, 100 VAC, 120 VAC, or 230 VAC 50 – 60 Hz		

All technical data are valid at 23 ± 5°C and 45 ± 15% rel. humidity.
[a] Due to the multilayer construction of the sensor chips used in these detectors, the responsivity is inseparable from the sensor width.
[b] Specified at Gain Step 1; Bandwidth Varies with Each Gain Step
[c] Independent of Gain Step

5.2 Typical Responsivity and Detectivity

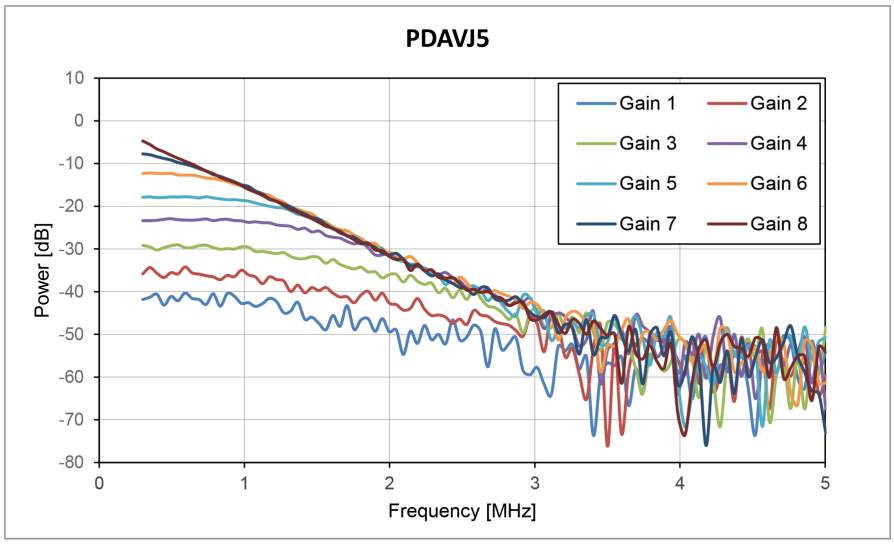


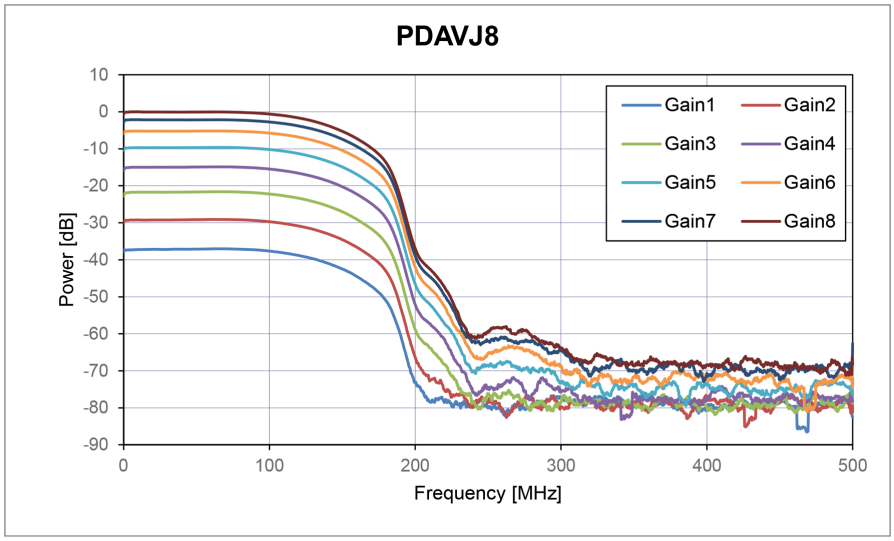


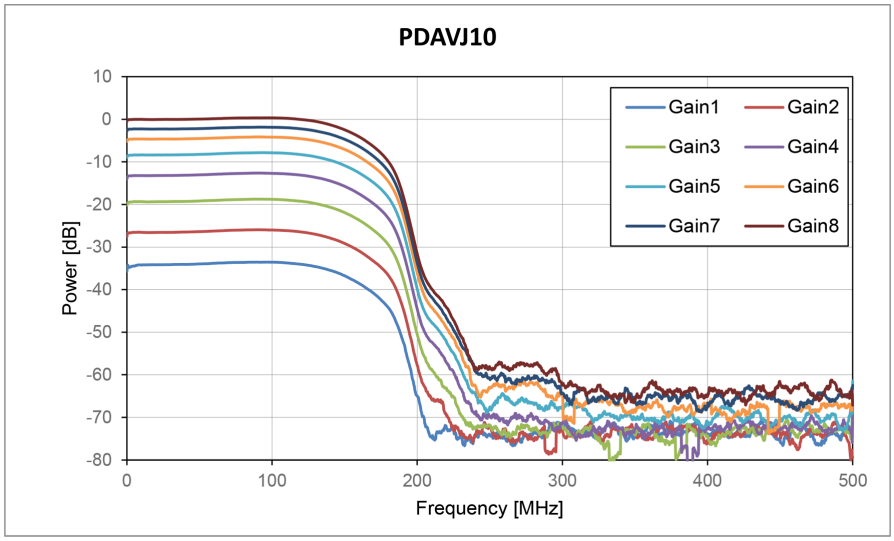


5.3 Typical Output Frequency Response

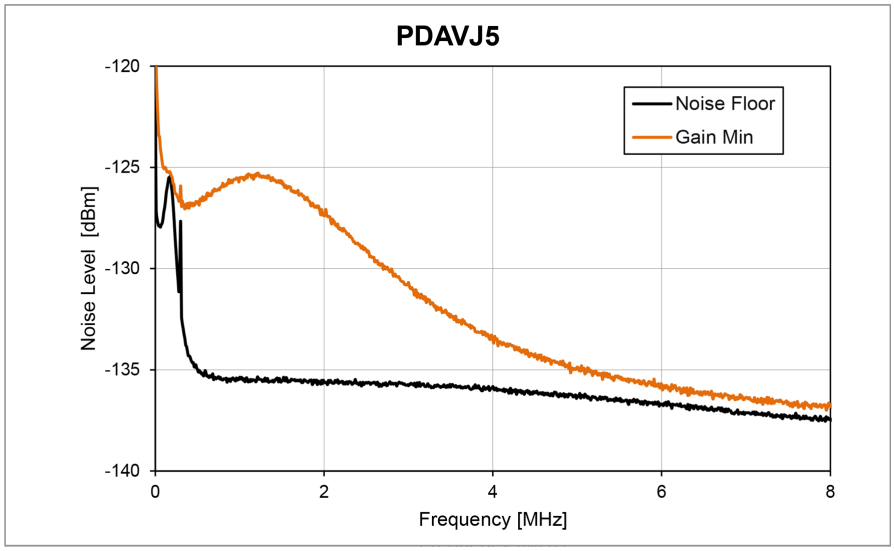
Effect of the gain switch setting on the respective Typical Output Frequency Response:

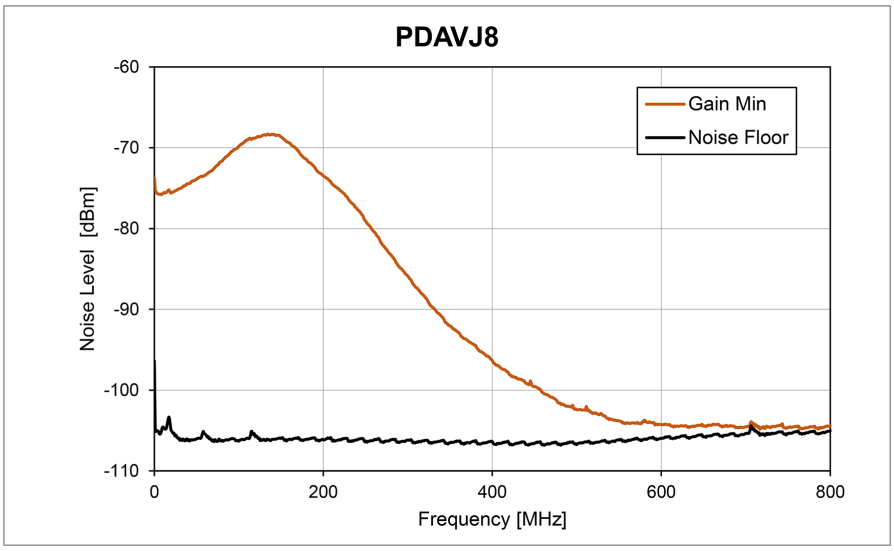


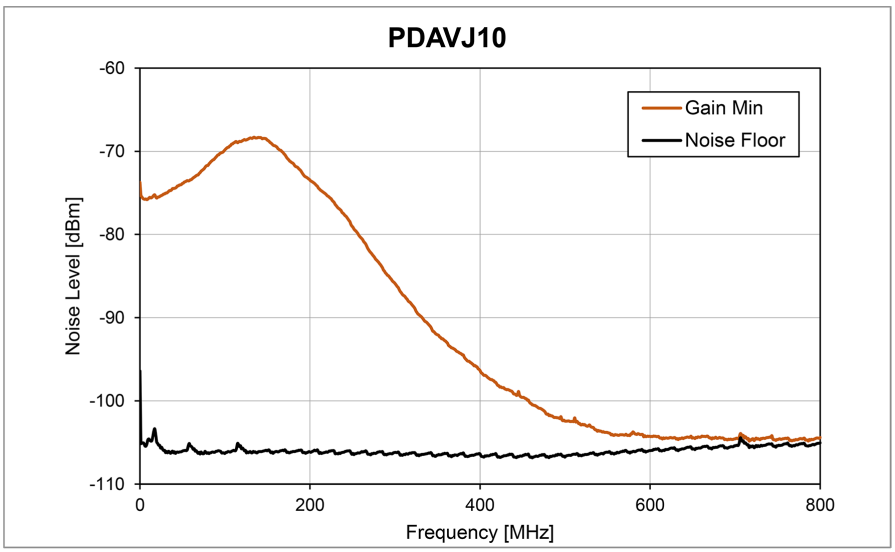




5.4 Typical Spectral Noise







5.5 Drawings

Note

The housing dimensions of the PDAVJ5, the PDAVJ8, and the PDAVJ10 detectors are identical.

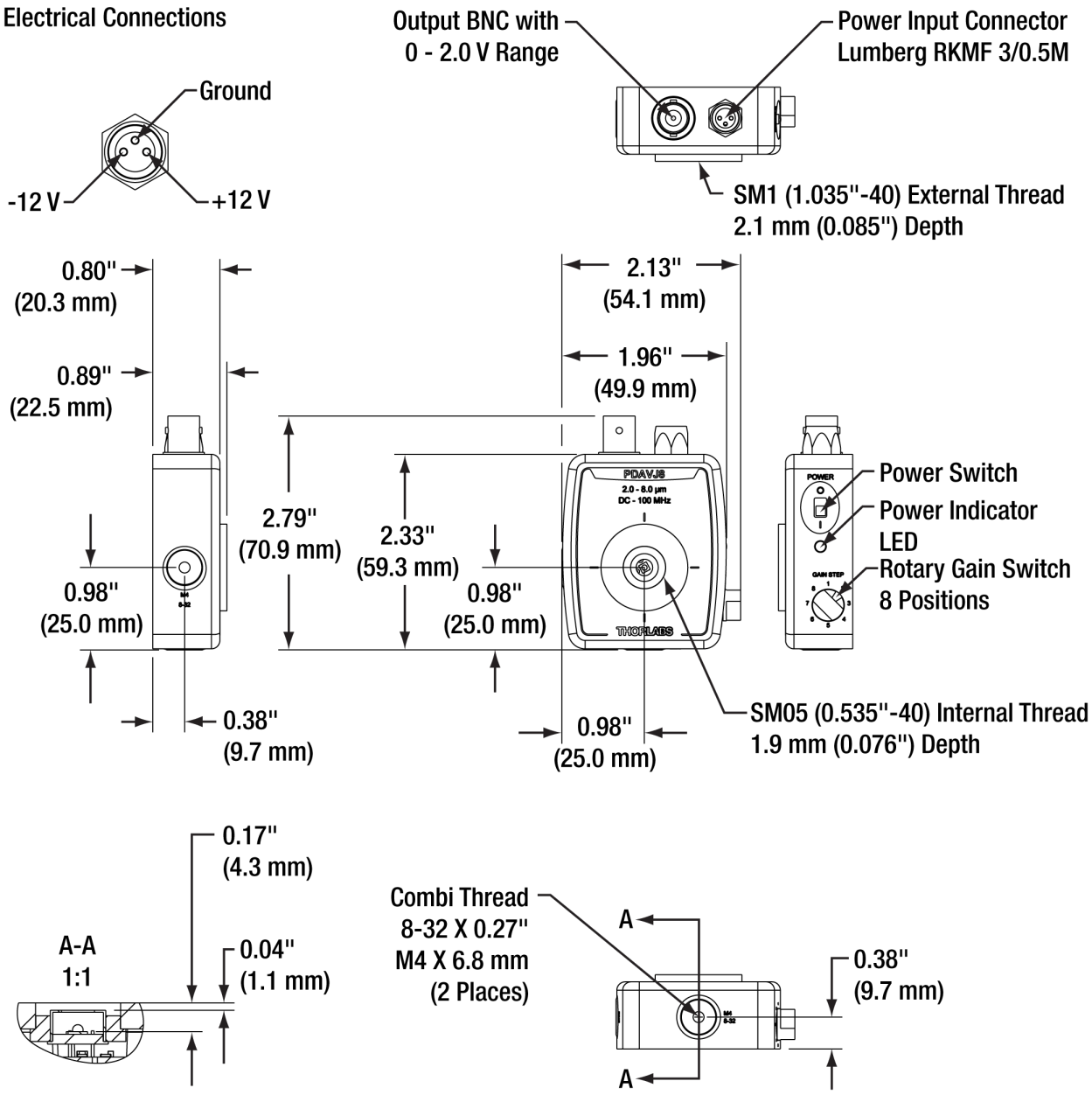


Diagram of PDAVJ8

5.6 Safety

Attention

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated under the conditions it was designed for.

The PDAVJx must not be operated in explosion endangered environments!

Do not open the housing. There are no user-serviceable parts inside!

This precision device is only serviceable if returned and properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for replacement packaging. Refer servicing to qualified personnel!

Changes to this device cannot be made nor may components not supplied by Thorlabs be used without written consent from Thorlabs.

Attention

Prior to applying power to the PDAVJx, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet! Improper grounding can cause electric shock resulting in damage to your health or even death!

Ensure that the line voltage setting of the fuse holder at the power supply agrees with your local supply and that the corresponding fuses are inserted. If not, please change the line voltage setting.

To avoid risk of fire, only the appropriate fuses for the corresponding line voltage must be used.

All modules must only be operated with properly shielded connection cables.

Users that change or modify the product described in this manual in a way not expressly approved by Thorlabs (party responsible for compliance) could void the user's authority to operate the equipment.

Thorlabs is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs. The correction of interference caused by such unauthorized modification, substitution, or attachment will be the responsibility of the user.

Attention

Mobile telephones, cellular phones, or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

5.7 Warranty

Thorlabs warrants material and production of the PDAVJx for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs. The customer will carry the shipping costs to Thorlabs, in case of warranty repairs Thorlabs will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs warrants the hard- and/or software determined by Thorlabs for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs is not liable for consequential damages.

Restriction of Warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs reserves the right to change this instruction manual or the technical data of the described unit at any time.

5.8 Copyright and Exclusion of Reliability

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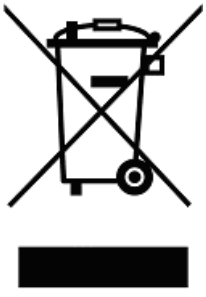
Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return “end of life” Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out “wheelie bin” logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. “End of life” units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.



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