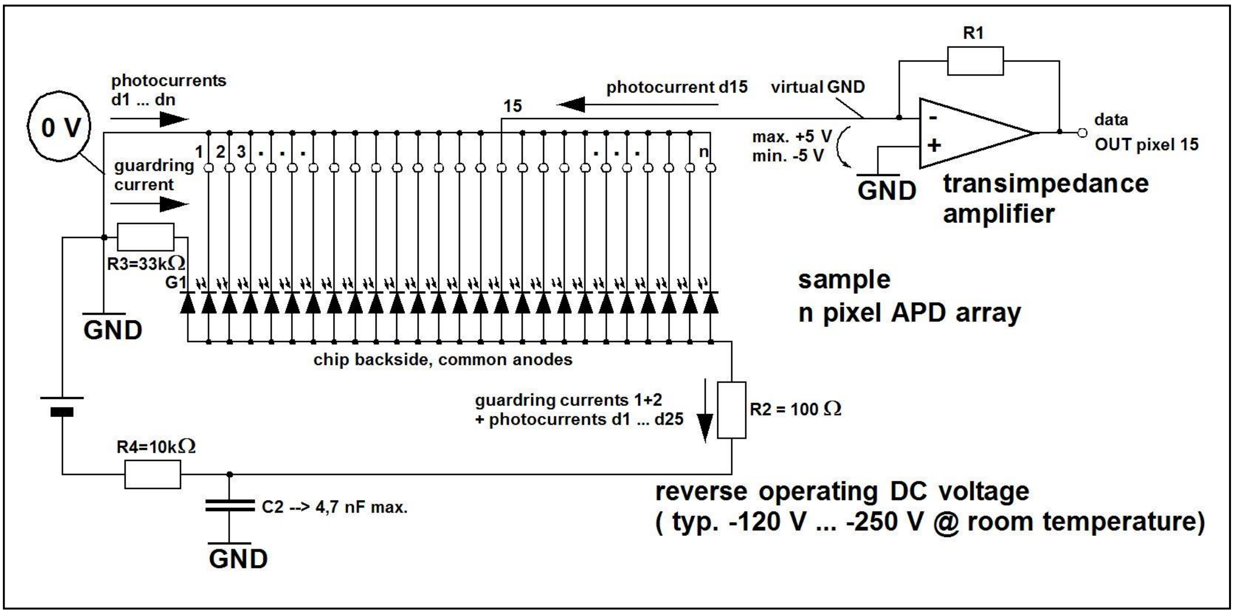


Figure 1: APD Application Circuit DC-Coupling (only one channel output drawn)

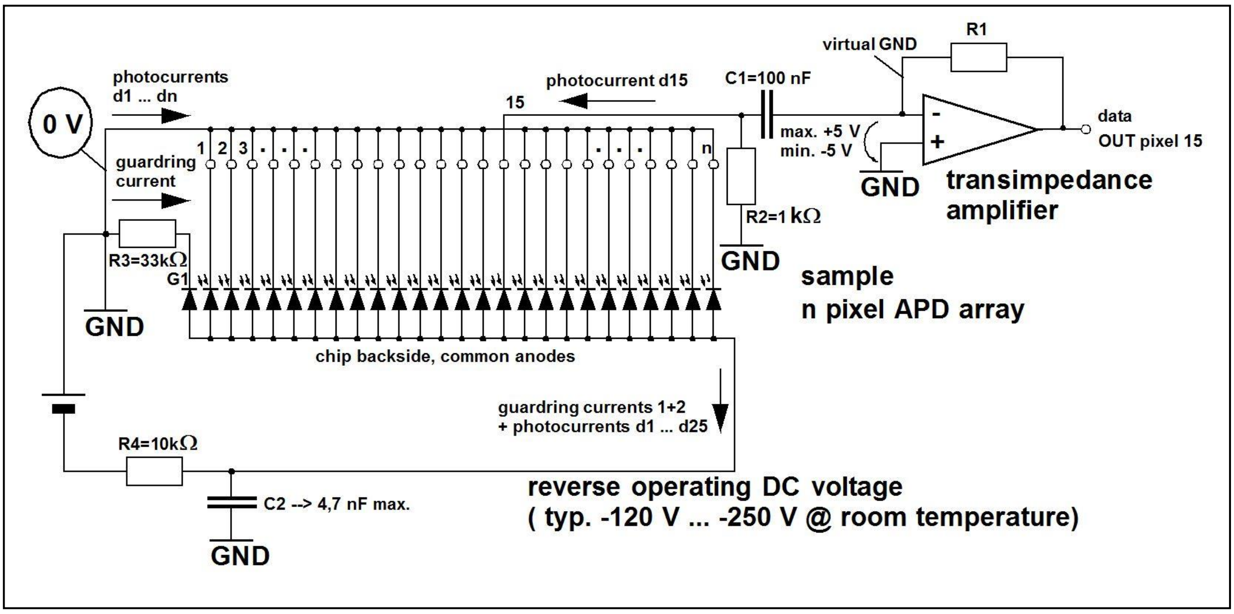


Figure 2: APD Application Circuit AC-Coupling (only one channel output drawn)

1. Operating Modes

APD array devices are often used for monitoring high frequency optical signals or short laser pulse reflections. In this case, a good RF performance up to the MHZ to GHz range is mandatory. Furthermore, DC operating point and additional environmental conditions like device temperature and total radiation power are controlled via DC values at device level. To protect devices from any thermal runaway and a possible fast unrecoverable overload, both properties must be carefully adjusted for a specific application and all expected operating and environmental conditions.

2. Application notes

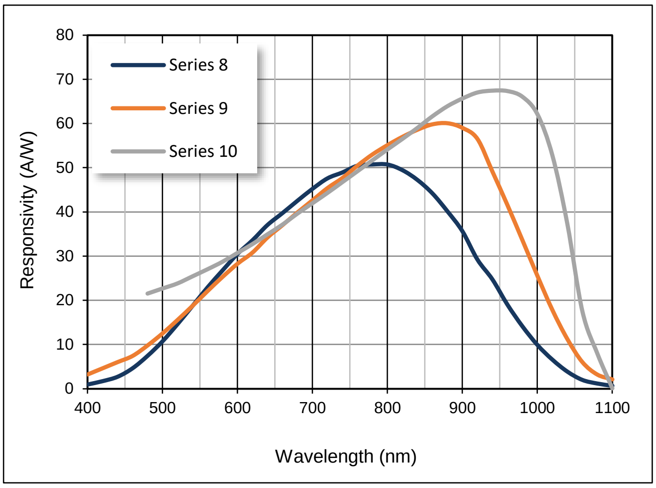
- Keep **all** cathodes including guard rings on virtual or real ground potential [GND = 0 V].
- It is recommended to connect the guard ring diode only at one point.
- A single diode cathode must never float or get disconnected from GND potential.
- The maximum voltage difference between any diode cathode and GND is +5 V / -5 V.

- The photocurrent must be allowed to flow from virtual or real ground. Therefore, DC input resistance of the transimpedance amplifier must not be giga-ohmic (as MOS inputs usually are).
- A single channel input per pixel is the best way to process the output data. Alternatively, an analog switch may be used. The switch matrix must ensure that **all** pixels, except for the actual measured one(s), are connected to GND.
- The use of a reliable current limiter in the reverse operating DC voltage line is recommended. Any overload may produce heat in the APD array device and/or irreproducible breakdowns in the input structures of the transimpedance amplifiers or analog switches.
- Breakdown voltage and hence the chosen operating point varies with temperature (see data sheet temperature coefficient).
- If the operating point voltage is fixed to a certain value at room temperature, then for lower temperatures the operating point amplification factor can easily become several thousand due to the earlier device breakdown. For higher temperatures, the device breakdown moves towards higher voltages and the desired amplification in the operating point may fall below any required value. Therefore, the operating point reverse voltage value should be controlled to compensate environment or device temperature shifts.
- Any avalanche breakdown of any pixel or guard which is supplied by a high external capacitance source with enough stored energy may destroy the device by driving an abnormal high current in a few picoseconds.
- Any outer light shield metal with backside potential may be bonded to backside potential. If this connection is used instead of a true low resistive backside contact, there might be enhanced parasitic resistances in the signal path depending on the chip size.
- Please note: Gap regions in APD type arrays are usually not fully sensitive to light. This behaviour depends on the design. Guard diodes between pixels or metal screens may block or drain any light input in gaps.
- Fig. 1 and 2 show an exemplary n element array with guard ring diode. Quadrant devices have only 4 signal delivery diodes and one surrounding guard ring diode. However, the operation mode is exactly the same as in arrays. It does not change even if no guard ring diode is present in the device.
- For DC coupling resistor R2=100 Ohm and for AC coupling R2=1000 Ohm are limiting the dc current which can flow from C2 into the APD.
- Note, for DC coupling R2 is building a low pass with the APD capacitance and is limiting the bandwidth of the APD. The value for R2=100 Ohm was chosen that 400 MHz of bandwidth will be available still for high capacitances of the APD up to 4 pF.
- It is recommended to limit the capacitance C2 to 4.7 nF. The stored energy in capacitance C2 may reach critical values above 4.7 nF and applied voltages above 200 V.
- For protection of the guard diode, resistance R3 with about 33 kΩ is connected. In general, guard must be connected only at one point. The guard node G1 must not have any additional capacitances to chip backside potential.
- At very high detector temperature, DC currents of all photodetectors and guard diodes may reach 0.5 mA. The voltage drop at the high voltage limiting resistance R4=10 kΩ get about 5 V which reduces the supplied high voltage of the APD (quenching).
- Limitation of about 2 mA for maximum current of high voltage power delivery circuit is recommended.

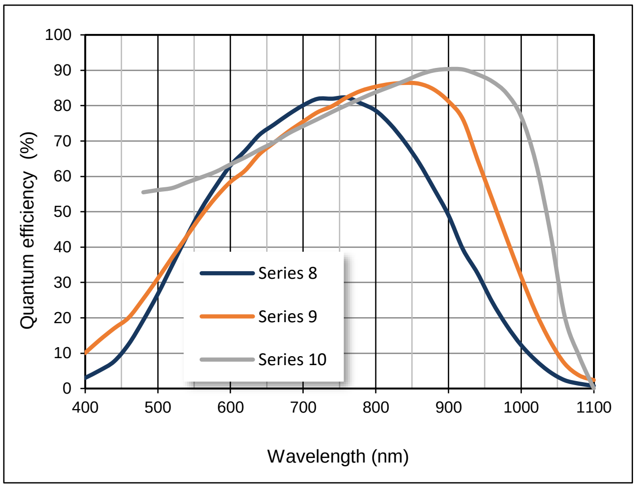
APD Series overview

APD Series	Optimized for	Application	Special features
Series -8	750...820 nm	General purpose, distance measurement, laser scanner, high speed applications, optical fiber and communication	High speed, low temperature coefficient, high gain, high gain bandwidth product
Series -9	750...930 nm	Laser rangefinder, LIDAR, technology for arrays	Low rise time at higher NIR sensitivity, low temperature coefficient, high gain
Series -10	860...1100 nm	Range finder, laser tracker, LIDAR	Sensitivity at 1064 nm is close to physical limits

Responsivity (M=100, 23 °C)



Quantum efficiency (23 °C)



APD part description

From the part description it is possible to conclude the basic geometry of the detector:

Number	Two letter designator : device type
-	AD - Avalanche photodiode
-	QA - Quadrant avalanche photdiode
Pixel count	AA - Avalanche photodiode array

*Package designator:

TO	Metal can type package
THD	Through hole device package
SMD	Surface mount device package
CH	Chip: bare die

Disclaimer: Due to our strive for continuous improvement, specifications are subject to change within our PCN policy according to JESD46C.