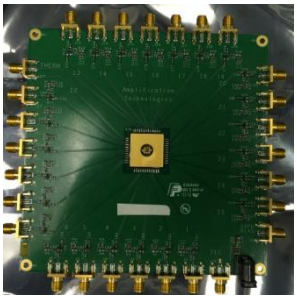
PRELIMINARY

DAPD NIR 5x5 Array+PCB 1550 Series: Discrete Amplification Photon Detector Array Including Pre-Amplifier Board



The DAPDNIR 5x5 Array 1550 series takes advantage of the breakthrough Discrete Amplification method of amplifying low-level electrical signals using multi-channel amplification and a monolithically integrated negative feedback avalanche mechanism, developed and patented by Amplification Technologies. The Discrete Amplification technology with internal amplification offers very high gain (approximately 100,000), which is combined with a very low excess noise factor (lower than 1.05) and a fast response (rise time shorter than 0.4ns). These characteristics enable the DAPD to detect single photons and higher extremely low light levels with a linear response. The output response signal is proportional to the amount of incident photons.

The 5x5 Discrete Amplification Photon Detector (DAPD) array is delivered in a custom hermetically sealed package, which is connected to a printed circuit board with an array of electronic pre-amplifiers, one amplifier for each array element. The custom hermetically sealed Covar package contains a two-stage thermoelectric cooler (TEC) and a feedback thermistor for temperature control. The 5x5 DAPD photon detector array has a square optically sensitive area of 0.5mm by 0.5mm with 25 elements arranged as a 5 columns and 5 rows array. Each element's active area size is 90µm by 90µm, with a pitch of 100µm, and 81% fill factor. Each element is isolated electrically and optically from its adjacent neighbors. The optical window is made of BK7 glass; it is centered on the top side of the Covar package. The DAPD 5x5 Array package is soldered into a 5.5" by 5.5" sized printed circuit board, where a heat sink radiator is attached to the bottom of the custom Covar package. The output of this board is a 50Ω matched analog electric pulse with duration and voltage height proportional to the incident light. Each of the 25 detector elements is connected to a separated pre-amplifier channel that terminates on a SMA connector, one for each of the 25 elements of the 5x5 array.

The array is supplied with an AC power supply for the electronic amplification network. Not supplied, but necessary for operation, are a DC power supply for the DAPD detector array, and a temperature controller that uses a negative temperature coefficient (NTC) feedback thermistor.

Key Features

- $In_{0.47}Ga_{0.53}As$ absorber design for a wide wavelength operation range of 950nm to 1650nm
- Designed to operate at a wide range of ambient temperatures, where the array temperature is cooled to a steady -30°C, using a low power two-stage Thermo Electric Cooler
- Single DC bias for all 25 Array elements, using a single SMA connector
- Very high gain of approximately 100,000 electrons per photon
- Low noise, low jitter, 50Ω, RF analog pre-amplifier board
- Extremely low detector noise-factor

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Applications

The NIR DAPD Ranging series is designed to operate with LIDAR systems, three-dimensional imaging, and environmental monitoring applications. The detector can operate with very short laser pulses, either in triggered, or always-on, modes. Each of the 25 detectors is connected separately to a dedicated SMA connector in the package. The ability to connect to any of the 25 pixels provides multiple levels of flexibility. For example the detector array can be connected in a quadrant configuration or as a single broad area detector. The board is designed to operate with a constant operating bias, in a continuous-mode operation, even when operated at pulse detection mode. This further reduces electrical system design complexity, and offers numerous options to integrate the detector array systems with 50Ω based analog to digital convertor (ADC) sampling systems, frame grabbers, etc.

Specifications

Specifications are at array temperature of -30°C and package ambient temperature of 23°C

All values are typical

Parameter	DAPDNIR 5x5 Array 1550 series **100** µm Pitch	Unit
Active area dimensions	**500 by 500**	μm^2
Active area single pixel	**90 by 90**	μm^2
Number of pixels	**25**	-
Photon Detection Efficiency @1550nm (PDE)[1]	**15**	%
Spectral response range (λ)	**950 – 1650**	nm
Single photo-electron Gain (M)	**$1x10^5$**	-
Excess Noise Factor	**1.05**	-
Dark count rate (single pixel)	**4**	MHz
Operating bias	**60**	V
Rise time (10% - 90%)	**400**	ps

Single amplification channel Recovery time (at -30°C)	**50**	ns
Linearity range per pulse (10kHz, repetition rate, single pixel)	**600**	photons

(1) Photon detection efficiency includes afterpulsing.

Absolute Maximum Rating

Parameter	DAPDNIR 5x5 Array 1064 series **100** µm pitch	Unit
Damage Threshold	**0.5**	nJ
Operating current (reverse bias)	**40**[1]	µA
Operating voltage	**-(V_{op}+2)**[1]	V

(1) The maximum operating voltage should not cause the current to exceed 40µA. The operating bias V_{op} for best sensitivity is provided by Amplification Technologies after testing

Inputs and Outputs

Inputs

Total of 3 Connectors:

Function	Connector Type
DAPD-Array DC bias	SMA connector
Pre-Amplifiers electronic network power supply	2.0 x 6.5mm jack high current connector
Thermo-Electric Cooler (TEC) bias	SMA connector

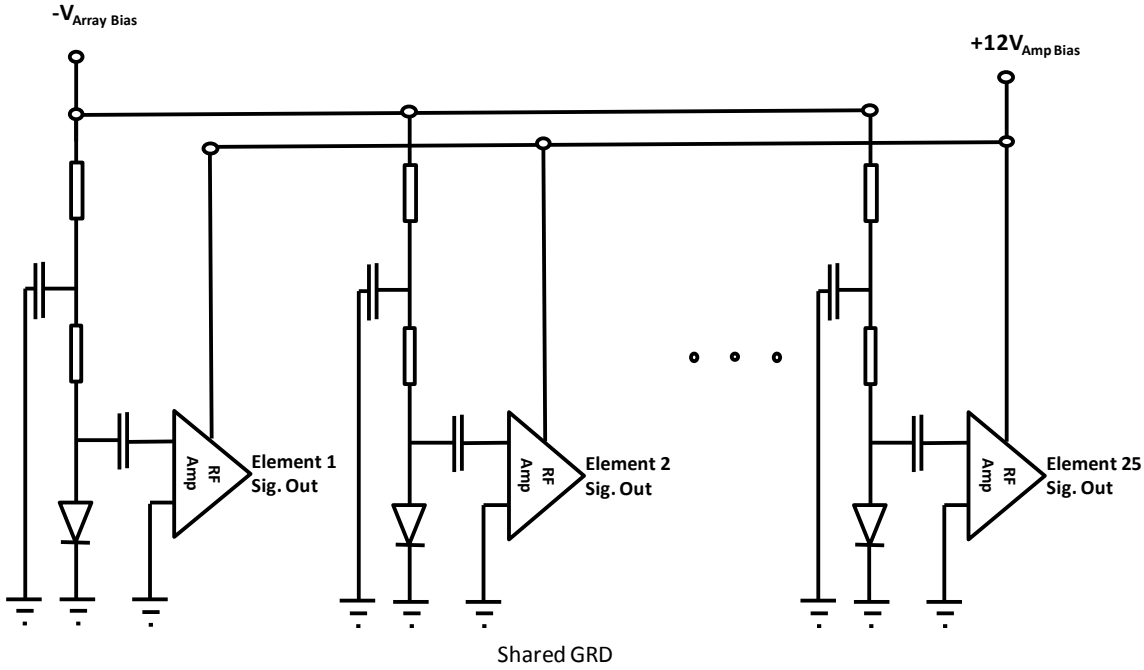
Outputs

Total of 26 SMA connectors:

Function	Connector Type
1 to 25 Array elements; marked with an ID number ranging from ID = 1 to ID = 25	25 SMA connectors
Thermistor output	SMA connector

Electronic Basic Connection Diagram

The electronic bias and signal-out diagram is designed to bias all the 25 array elements with **the same constant voltage bias**. In addition, it is designed to extract the photon-detection charge pulse using 25 separated pre-amplifiers, one for each array element. The DAPD array bias is thus a negative voltage that is applied to the anodes and the ground is connected to the common cathode, as well as the ground plane of the 25 pre-amplifiers network. The pre-amplifiers and the board, including the SMA output ports, are matched to 50Ω impedance. Thus, a 50Ω termination Analog to Digital Converter (ADC) is required to be used at the output.



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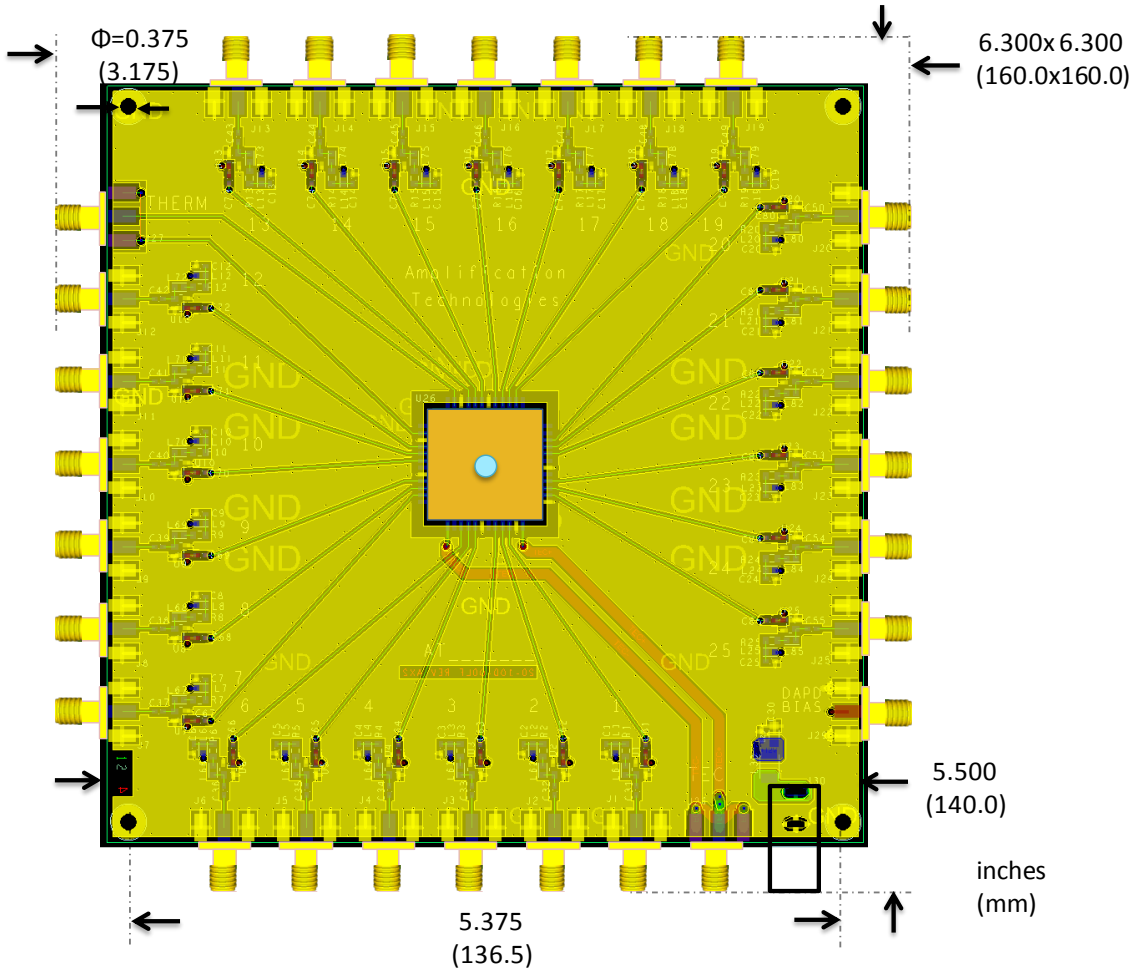
Printed Circuit Board Dimensions

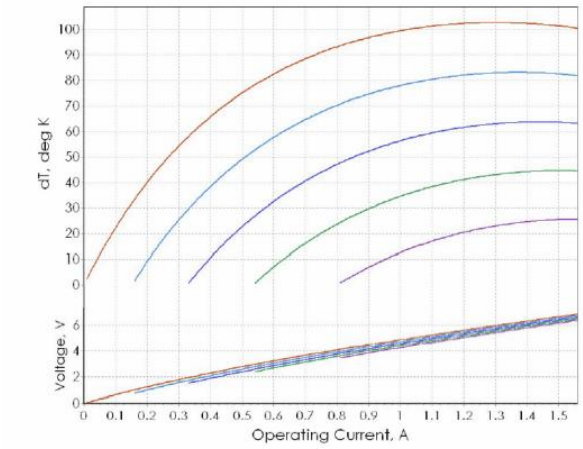


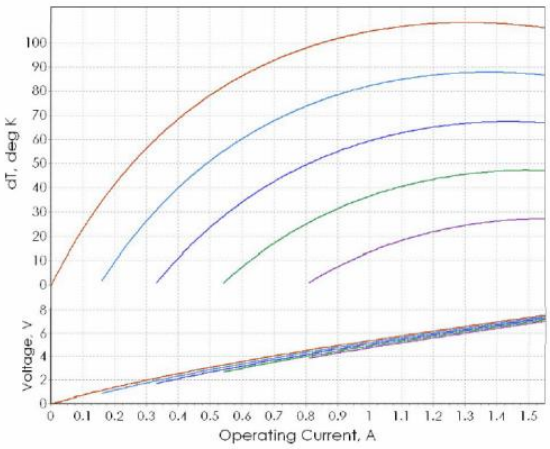
Thermo-Electric Cooler (TEC) Parameters

The Thermoelectric cooler is a two-stage cooler that is designed to cool the detector array to -30°C at ambient temperature, with proper heat sinking applied to the bottom of the array package.

@ 27°C, Vacuum	ΔTmax K	Qmax W	Imax A	Umax V
2MC04-059-05AN	103	1.70	1.2	5.9

@50°C, N2	ΔTmax K	Qmax W	Imax A	Umax V
2MC04-059-05AN	108	1.87	1.2	6.6





Maximum recommended current: 1.0A
Maximum recommended voltage: 4.0V

Note: proper heat sink is required to achieve cooling of the detector array to -30°C.

Thermistor

The thermistor is a glass beaded negative temperature coefficient (NTC), with 5% accuracy. The 20°C resistance is 2.2kΩ. The Steinhart-Hart coefficients, as well as the definition of the coefficients based on the equation, are provided below. The Steinhart-Hart equation is given as follows:

$$1/T = (A * 10^{-3}) + (B * 10^{-4})(\ln R) + (C * 10^{-7})(\ln R)^3$$

Where: the temperature, T, is expressed in °K; the thermistor resistance, R, in Ω

The Steinhart-Hart parameters for this thermistor are:

A = 0.775
B = 3.425
C = 0.002

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Precautions for Use

The device is ESD sensitive. The use of grounding straps, anti-static mats and other standard electrostatic discharge protective equipment and methods are mandatory when handling or testing these devices.

Operating the TEC without a proper heat sink will cause overflow of current and irreversible damage to the detector array and the TEC.

Quality Vision

Amplification Technologies is committed to providing products with the highest levels of quality and reliability using best available manufacturing processes. Our top priority is total customer satisfaction. Amplification Technologies maintains a strict quality control program to ensure that all products meet or surpass published specifications.

Ordering Information

When ordering, please specify the following information: DAPDNIR-5x5 Array-1550-100.

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