

# InGaAs APD Preamplifier Module with TEC



CMC Electronics' 264-339814 series use an InGaAs APD with a low k-factor of 0.2, with a built-in preamplifier and a thermoelectric cooler (TEC), enabling optimum signal-to-noise performance.

The APD is coupled to a GaAs FET input transimpedance amplifier (TIA) in a 12-lead TO-8 package with an integrated thermoelectric cooler (TEC) allowing temperature control of the APD and easing stabilization of gain and optimized sensitivity.

The internal temperature can be monitored via an embedded thermal sensor close to the APD. The module is designed with either a 10 or 50  $\Omega$  output impedance which can be AC- or DC-coupled.

The amplifier has an overload input protection circuit that sustains high optical power exposure with a very fast recovery time.

Customizations such as bandwidth tuning, NEP screening, responsivity optimization and different temperature sensors are available upon request.

## Features

- 80 – 200  $\mu\text{m}$  InGaAs APD
- 100 – 200 MHz Preamplifier Module
- Spectral Response: 1050 – 1600 nm
- Low k-factor InGaAs APD
- Low Noise Equivalent Power (NEP)
- High Efficiency TEC
- Hermetically Sealed TO-8 Package
- ITAR-Free
- ROHS compliant
- Optional: Fiber Receptacle

## Applications

- Range Finding
- LiDAR
- Instrumentation
- Free-Space Communications
- Industrial
- Photometry
- Distributed Temperature Sensing (DTS)
- Distributed Acoustic Sensing (DAS)
- Structural Health Monitoring (SHM)

**Table 1. Electro-Optical Characteristics for 200  $\mu\text{m}$  Active Area (-001)**

Unless otherwise specified:  $T_A = 25^\circ\text{C}$ ,  $V_{\text{POS}} = 5.0\text{ V}$ ,  $V_{\text{NEG}} = -5.0\text{ V}$ ,  $R_L = 100\ \Omega$ ,  
 $\lambda = 1570\text{ nm} \pm 10\text{ nm}$ , Cooler OFF (Externally AC coupled through 4.7  $\mu\text{F}$ )

Parameter	Min.	Typ.	Max.	Units
Operating Voltage, $V_{\text{OP}}$ (Note 1)	40	54	85	V
Temperature coefficient of $V_{\text{OP}}$		0.07		$\text{V}/^\circ\text{C}$
Responsivity		1.4		$\text{MV}/\text{W}$
Noise equivalent power (Note 2)				
1570 nm [ $T_{\text{case}}=25^\circ\text{C}$ ]		70		$\text{fW}/\sqrt{\text{Hz}}$
1570 nm [ $T_{\text{case}}=85^\circ\text{C}$ ]		250		$\text{fW}/\sqrt{\text{Hz}}$
Output impedance, $R_{\text{out}}$		10		$\Omega$
Bandwidth	80	100		$\text{MHz}$
Rise time (10-90 %)		3.5		ns
Fall time (90-10 %)		3.5		ns
Linear output voltage swing (Pulse)	1.5	2.5	4.0	V
Output offset voltage	-0.75	-0.45	0	V
Thermal sensor (Note 3)				
Voltage output		1.5740		V
Accuracy (at $+30^\circ\text{C}$ )	$\pm 1.5$		$\pm 4$	$^\circ\text{C}$
Accuracy ( $-55^\circ\text{C}$ to $+130^\circ\text{C}$ )	$\pm 2.5$		$\pm 5$	$^\circ\text{C}$
Non-linearity		$\pm 0.4$		%
Overload recovery for optical power input signal of 1 mW, 20 ns pulse width:				
$V_{\text{out}} \rightarrow 200\text{ ns}$ after pulse start			250	$\text{mV}$
$V_{\text{out}} \rightarrow 1\ \mu\text{s}$ after pulse start			40	$\text{mV}$
Hybrid Supply current	$V_{\text{POS}}$ (pin 10)	25	40	$\text{mA}$
	$V_{\text{NEG}}$ (pin 11)	-20	-10	$\text{mA}$

**Notes:** 1. Each APD receiver will have its individual  $V_{\text{OP}}$  (provided on its production tests report).

2. NEP values for  $+85^\circ\text{C}$  are by design and are for reference only. No test values are provided on individual test reports. Integration of the noise calculation is based on minimum bandwidth.

3. Alternate thermal sensors (thermistance or diode) are available upon request.

**Table 2. Electro-Optical Characteristics for 80  $\mu\text{m}$  Active Area (-002)**

Unless otherwise specified:  $T_A = 25^\circ\text{C}$ ,  $V_{\text{POS}} = 5.0\text{ V}$ ,  $V_{\text{NEG}} = -5.0\text{ V}$ ,  $R_L = 50\ \Omega$ ,  
 $\lambda = 1570\text{ nm} \pm 10\text{ nm}$ , Cooler OFF (Externally AC coupled through 4.7  $\mu\text{F}$ )

Parameter	Min.	Typ.	Max.	Units
Operating Voltage, $V_{\text{OP}}$ (Note 1)	40	54	85	V
Temperature coefficient of $V_{\text{OP}}$		0.07		$\text{V}/^\circ\text{C}$
Responsivity		1.2		$\text{MV}/\text{W}$
Noise equivalent power (Note 2)				
1570 nm [ $T_{\text{case}}=25^\circ\text{C}$ ]		50		$\text{fW}/\sqrt{\text{Hz}}$
1570 nm [ $T_{\text{case}}=85^\circ\text{C}$ ]		80		$\text{fW}/\sqrt{\text{Hz}}$
Output impedance, $R_{\text{out}}$		50		$\Omega$
Bandwidth	180	200		$\text{MHz}$
Rise time (10-90 %)		1.75		ns
Fall time (90-10 %)		1.75		ns
Linear output voltage swing (Pulse)	0.75	1.25	2.0	V
Output offset voltage	-0.75	-0.45	0	V
Thermal sensor (Note 3)				
Voltage output		1.5740		V
Accuracy (at $+30^\circ\text{C}$ )	$\pm 1.5$		$\pm 4$	$^\circ\text{C}$
Accuracy ( $-55^\circ\text{C}$ to $+130^\circ\text{C}$ )	$\pm 2.5$		$\pm 5$	$^\circ\text{C}$
Non-linearity		$\pm 0.4$		%
Overload recovery for optical power input signal of 1 mW, 20 ns pulse width:				
$V_{\text{out}} \rightarrow 200\text{ ns}$ after pulse start			250	$\text{mV}$
$V_{\text{out}} \rightarrow 1\ \mu\text{s}$ after pulse start			40	$\text{mV}$
Hybrid Supply current	$V_{\text{POS}}$ (pin 10)	25	40	$\text{mA}$
	$V_{\text{NEG}}$ (pin 11)	-20	-10	$\text{mA}$

**Notes:** 1. Each APD receiver will have its individual  $V_{\text{OP}}$  (provided on its production tests report).

2. NEP values for  $+85^\circ\text{C}$  are by design and are for reference only. No test values are provided on individual test reports. Integration of the noise calculation is based on minimum bandwidth.

3. Alternate thermal sensors (thermistance or diode) are available upon request.

**Table 3. Absolute-Maximum Ratings, Limiting Values**

Parameter	Min.	Max.	Units
APD breakdown, Maximum voltage [ HV_POSITIVE (pin7) ] (Note 1)		90	V
Recommended overcurrent limit		100	µA
Input Voltage Positive Supply [ V_POS (+5V) (pin10) ]	+4.8	+6.0	V
Input Voltage Negative Supply [ V_NEG (-5V) (pin11) ]	-4.8	-6.0	V
Maximum Optical Power, CW		10	µW
Peak value, 20ns pulses <100Hz		100	kW/cm <sup>2</sup>
TEC Current	-0.9	0.9	A
Temperature sensor (LM20)			
Sensor bias voltage (pin 4)	2.5	5.0	V
Sensor drive current	1	10	mA
Sensor output (pin 5)	0.2	2.5	V
Operating Temperature	-40	85	°C
Storage Temperature	-55	125	°C
Soldering Temperature (5 s, leads only)		250	°C

**Note:** 1. Absolute maximum over the product Temperature Operating Range (-40<sup>0</sup>C to +85<sup>0</sup>C).

To obtain the expected voltage from a specific temperature:

$$V_o = (-3.88 \times 10^{-6} \times T^2) + (-1.15 \times 10^{-2} \times T) + 1.8639$$

And to convert in Celsius the voltage measured at the sensor output:

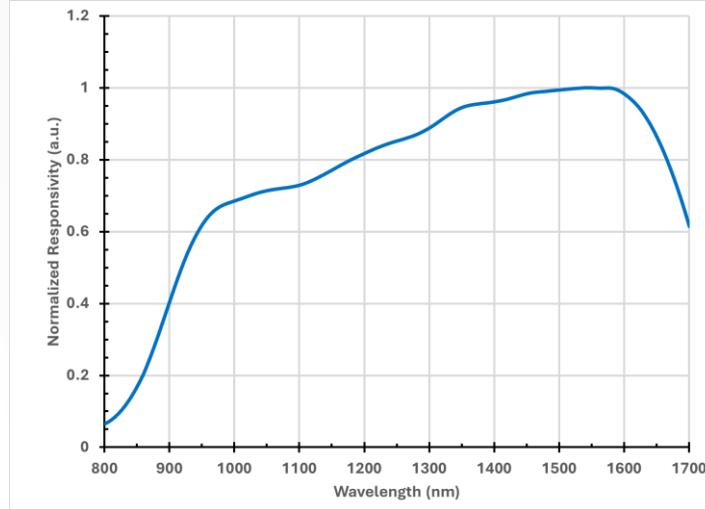
$$T = -1481.96 + \sqrt{2.1962 \times 10^6 + \frac{1.8639 - V_o}{3.88 \times 10^{-6}}}$$

In the above formulas:

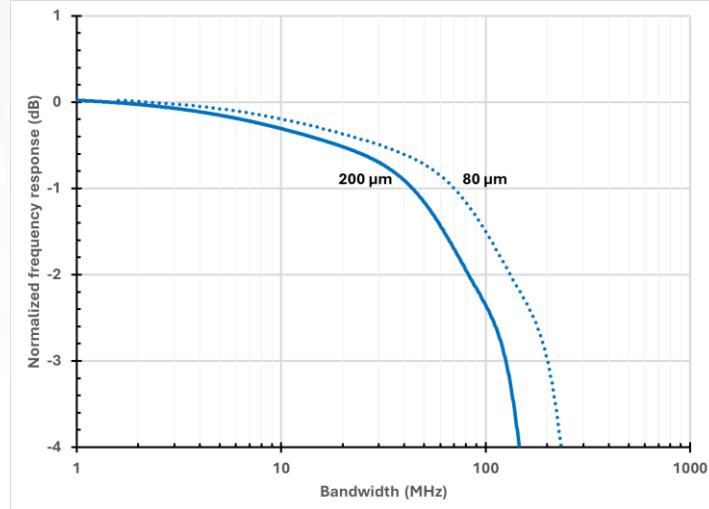
$V_o$  is the voltage level of the temperature sensor (receiver PIN 5 -  $T_{\text{sensor}}$   $V_{\text{out}}$ )

T is the temperature expressed in Celsius.

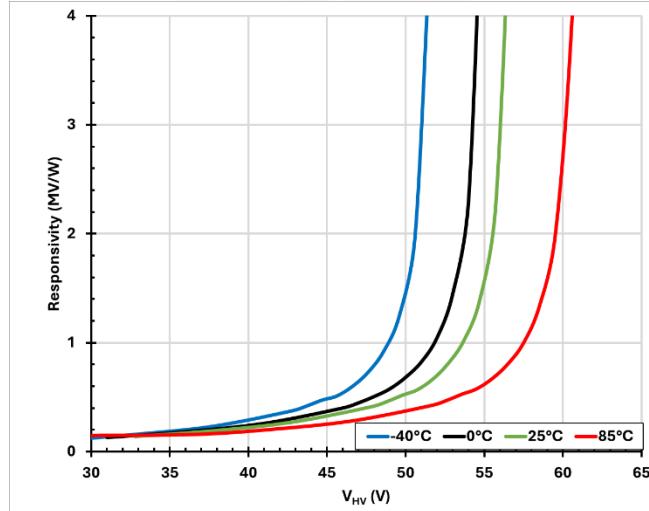
**Figure 1. Typical Normalized Responsivity (M=1)**



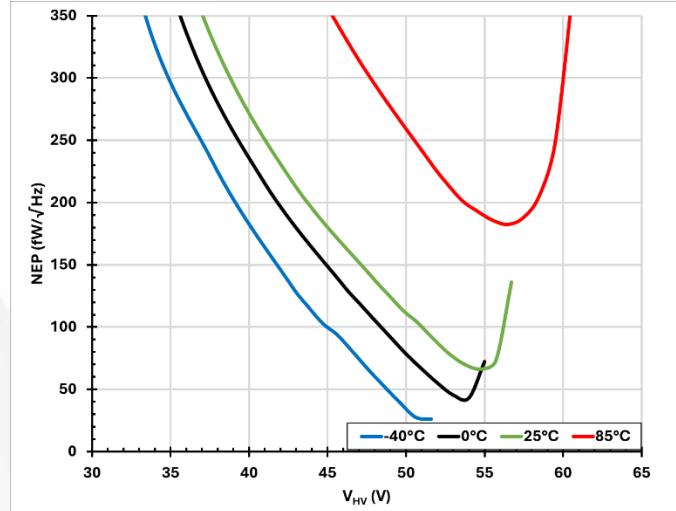
**Figure 2. Typical Normalized Frequency Response**



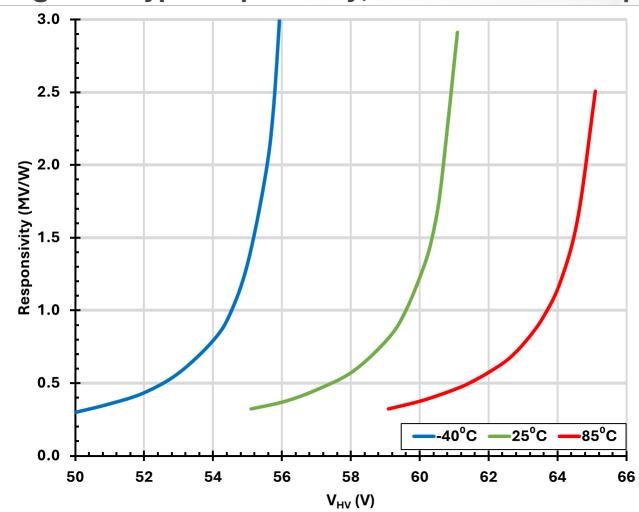
**Figure 3. Typ. Responsivity,  $R_L = 100 \Omega$  Area = 200 μm**



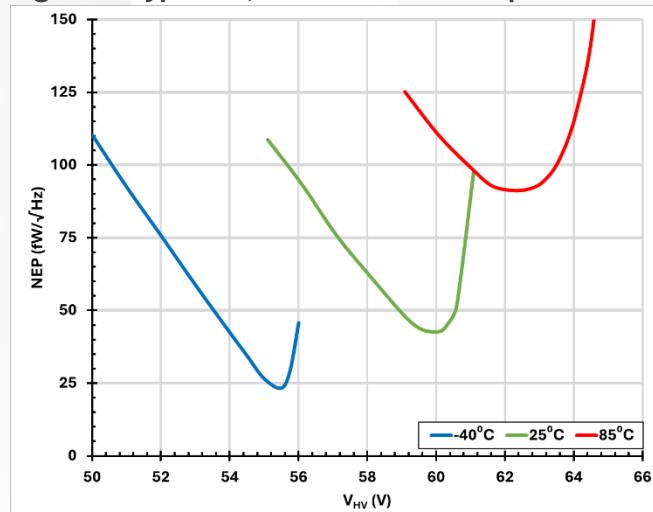
**Figure 4. Typ. NEP,  $R_L = 100 \Omega$  Area = 200 μm**

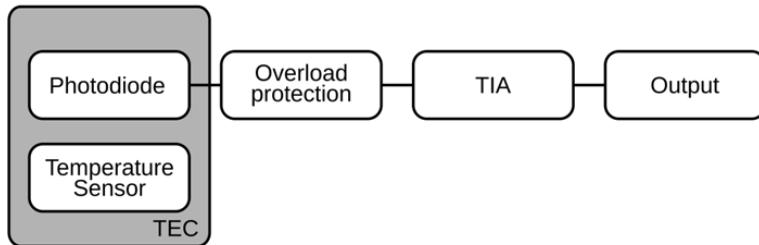
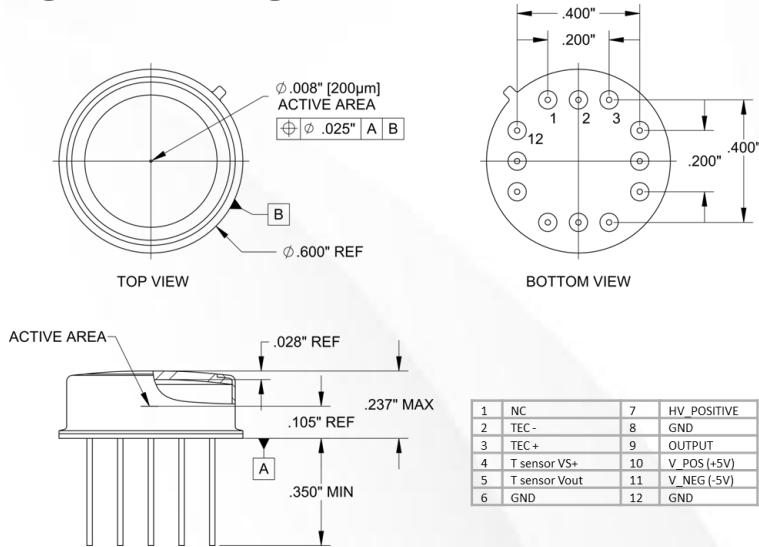
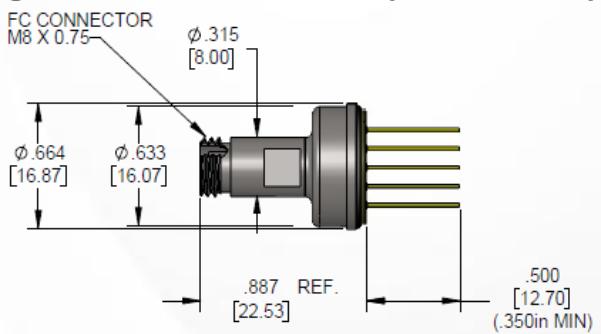


**Figure 5. Typ. Responsivity,  $R_L = 50 \Omega$  Area = 80 μm**



**Figure 6. Typ. NEP,  $R_L = 50 \Omega$  Area = 80 μm**



**Figure 5. CMC 264-339814 Series block diagram****Figure 6. Package Dimension and Pinout****Figure 11. FC connector (617-339814)**

Unless otherwise specified, dimensions are in inches (mm) and are for reference only.

## VAR Options

### VAR 264-339814-VAR

- 001 InGaAs APD 200 µm, 100 MHz TIA, with TEC
- 002 InGaAs APD 80 µm, 200 MHz TIA, with TEC



For more information, visit [www.cmcelectronics.ca/optoelectronics](http://www.cmcelectronics.ca/optoelectronics) or email us at [opto@cmcelectronics.ca](mailto:opto@cmcelectronics.ca)

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