

# High Sensitivity InGaAs APD Preamplifier Module with TEC



CMC Electronics' 264-339835 series use an InGaAs APD with a low k-factor of 0.2, featuring a built-in preamplifier and a thermoelectric cooler (TEC), tuned for remarkably high sensitivity in the most demanding sensing applications, thereby 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 a 50  $\Omega$  output impedance and 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 – 350  $\mu\text{m}$  InGaAs APD
- 0.5 – 3 MHz Preamplifier Module
- Spectral Response: 1050 – 1600 nm
- Low k-factor InGaAs APD
- Low Noise Equivalent Power (NEP)
- High Efficiency TEC
- High Sensitivity
- Hermetically Sealed TO-8 Package
- ITAR-Free
- ROHS compliant
- Optional: Fiber Receptacle

## Applications

- Differential Absorption LiDAR (DiAL)
- Remote Sensing
- Fluorescence
- Instrumentation

**Table 1. Electro-Optical Common Characteristics**Conditions:  $T_A = 25^\circ\text{C}$ ,  $V_{\text{POS}} = 5.0\text{ V}$ ,  $V_{\text{NEG}} = -5.0\text{ V}$ ,  $R_L = 50\ \Omega$ 

| Parameter                                                                    | Symbol                               | Min.      | Typ.      | Max.      | Units               |
|------------------------------------------------------------------------------|--------------------------------------|-----------|-----------|-----------|---------------------|
| Breakdown Voltage (Note 1)                                                   | $V_{\text{BR}}$                      | 45        |           | 80        | V                   |
| Operating point from Breakdown Voltage ( $V_{\text{BR}} - V_{\text{OP}}$ )   | $\Delta V$                           | 7         | 8         |           |                     |
| Temperature coefficient of $V_{\text{OP}}$                                   | $\Delta V/\Delta T$                  |           | 0.07      |           | V/ $^\circ\text{C}$ |
| Output impedance                                                             | $R_{\text{out}}$                     |           | 50        |           | $\Omega$            |
| Linear output voltage swing (Pulse)                                          |                                      | 1.5       | 2.5       | 4.0       | V                   |
| Output offset voltage                                                        | $V_{\text{oo}}$                      | -0.75     | -0.45     | 0         | V                   |
| Thermal sensor (Note 2)                                                      |                                      |           |           |           |                     |
| 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                 |                                      |           |           | 125       | mV                  |
| $V_{\text{out}} \rightarrow 1\ \mu\text{s}$ after pulse start                |                                      |           |           | 20        | mV                  |
| Hybrid Supply current                                                        | $V_{\text{pos}}$<br>$V_{\text{neg}}$ | 25<br>-20 |           | 40<br>-10 | mA<br>mA            |

**Notes:** 1. Each APD receiver will have its individual  $V_{\text{OP}}$  (provided on its production tests report).  
 2. Alternate thermal sensors (thermistance or diode) are available upon request.

**Table 2. Electro-Optical Characteristics**

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                                     | Symbol            | 80 $\mu\text{m}$<br>(VAR -003) |      |      | 200 $\mu\text{m}$<br>(VAR -002) |      |      | 350 $\mu\text{m}$<br>(VAR -001) |      |      | Units                  |
|-----------------------------------------------|-------------------|--------------------------------|------|------|---------------------------------|------|------|---------------------------------|------|------|------------------------|
|                                               |                   | Min.                           | Typ. | Max. | Min.                            | Typ. | Max. | Min.                            | Typ. | Max. |                        |
| Responsivity                                  | R                 |                                | 25   |      |                                 | 15   |      |                                 | 15   |      | MV/W                   |
| Noise equivalent power                        |                   |                                |      |      |                                 |      |      |                                 |      |      |                        |
| $T_{\text{case}} = 25^\circ\text{C}$          | NEP               |                                | 15   |      |                                 | 30   |      |                                 | 50   |      | fW/ $\sqrt{\text{Hz}}$ |
| $T_{\text{case}} = 85^\circ\text{C}$ (Note 1) |                   |                                | 45   |      |                                 | 90   |      |                                 | 125  |      | fW/ $\sqrt{\text{Hz}}$ |
| Bandwidth                                     | BW                |                                | 3    |      | 0.7                             | 1    |      |                                 | 0.5  |      | MHz                    |
| Rise time (10-90 %)                           | $t_{\text{rise}}$ |                                | 175  |      |                                 | 350  |      |                                 | 700  |      | ns                     |
| Fall time (90-10 %)                           | $t_{\text{fall}}$ |                                | 175  |      |                                 | 350  |      |                                 | 700  |      | ns                     |

**Note:** 1. NEP values for  $+85^\circ\text{C}$  are by design and are for reference only. No test values are provided on individual test reports.

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

| Parameter                               | Symbol                 | Min. | Max. | Units              |
|-----------------------------------------|------------------------|------|------|--------------------|
| APD breakdown, Maximum voltage (Note 1) | HV <sub>positive</sub> |      | 90   | V                  |
| Recommended overcurrent limit           |                        |      | 100  | μA                 |
| Input Voltage Positive Supply           | V <sub>pos</sub>       | +4.8 | +6.0 | V                  |
| Input Voltage Negative Supply           | V <sub>neg</sub>       | -4.8 | -6.0 | V                  |
| Maximum Optical Power, CW               |                        |      | 10   | μW                 |
| Peak value, 20ns pulses <100Hz          |                        |      | 100  | kW/cm <sup>2</sup> |
| TEC Current                             | i <sub>TEC</sub>       | -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                   | T <sub>oper</sub>      | -40  | 85   | °C                 |
| Storage Temperature                     | T <sub>store</sub>     | -55  | 125  | °C                 |
| Soldering Temperature (5 s, leads only) |                        |      | 250  | °C                 |

**Note:** 1. Absolute maximum over the product Temperature Operating Range (-40°C to +85°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<sub>o</sub> is the voltage level of the temperature sensor (receiver PIN 5 - T<sub>sensor</sub> V<sub>out</sub>)

T is the temperature expressed in Celsius.

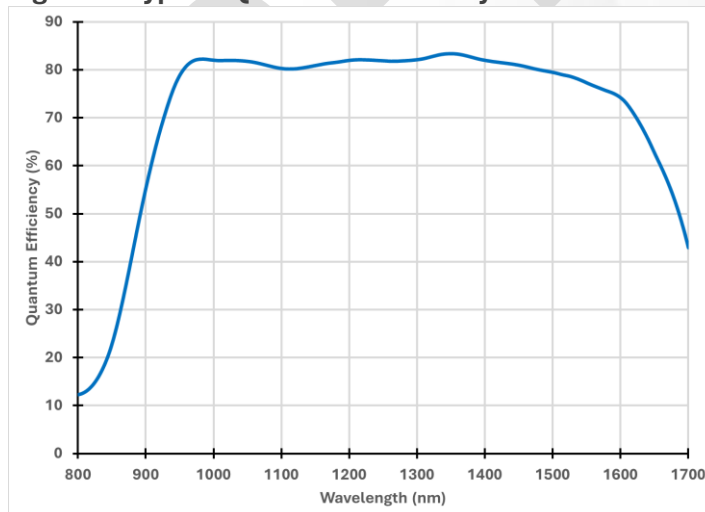
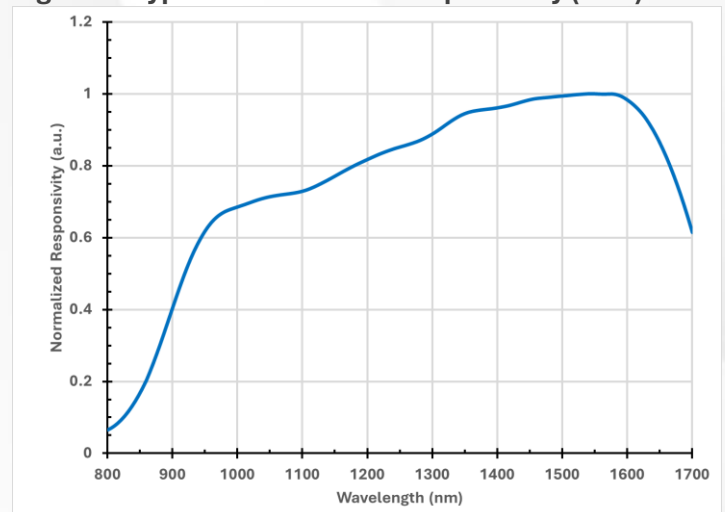
**Figure 1. Typical Quantum Efficiency****Figure 2. Typical Normalized Responsivity (M=1)**

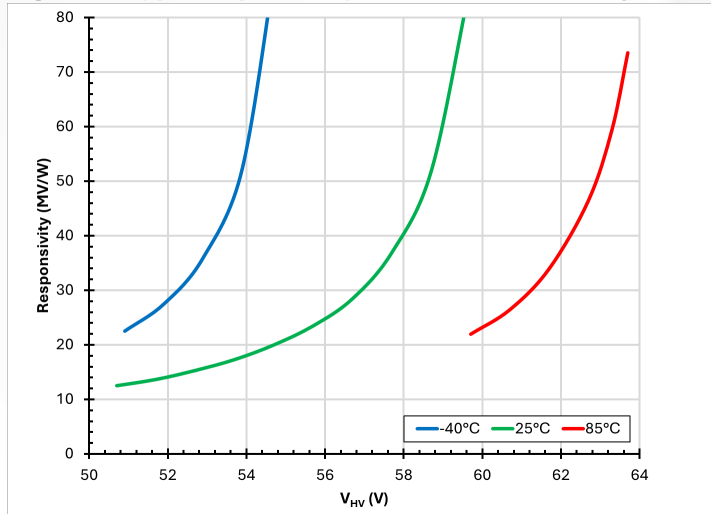
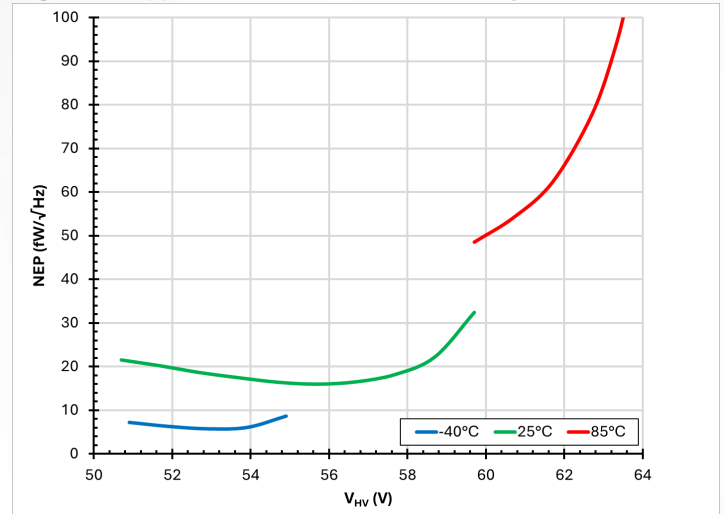
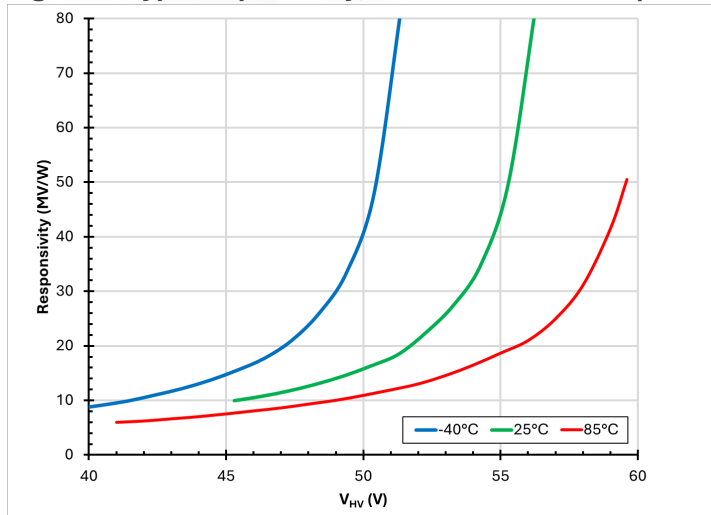
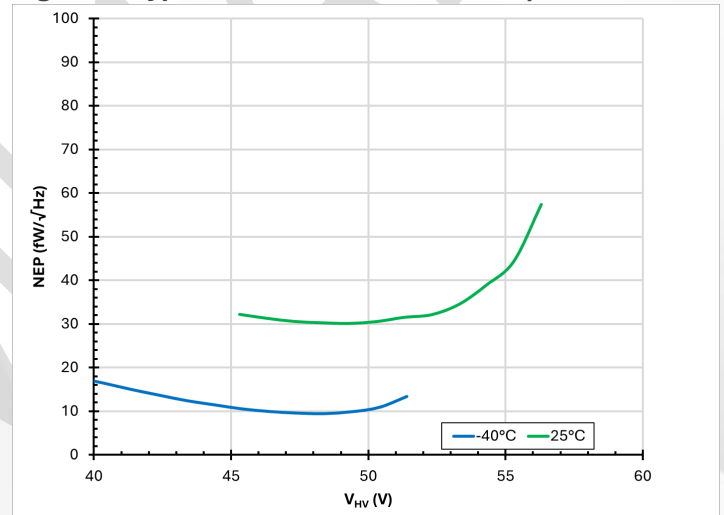
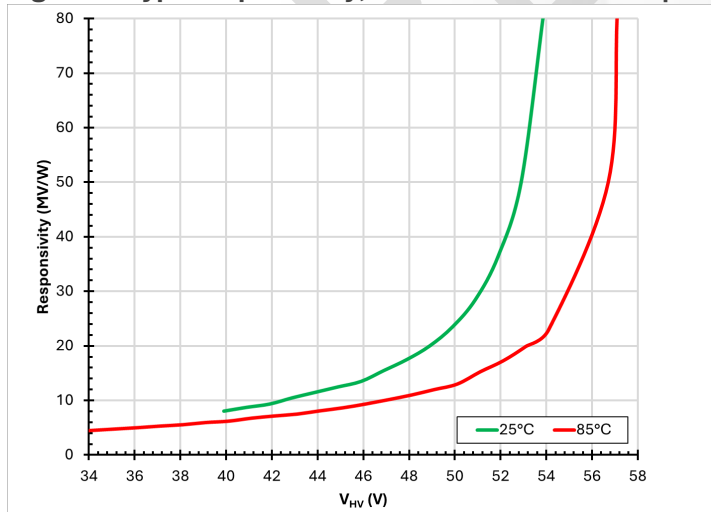
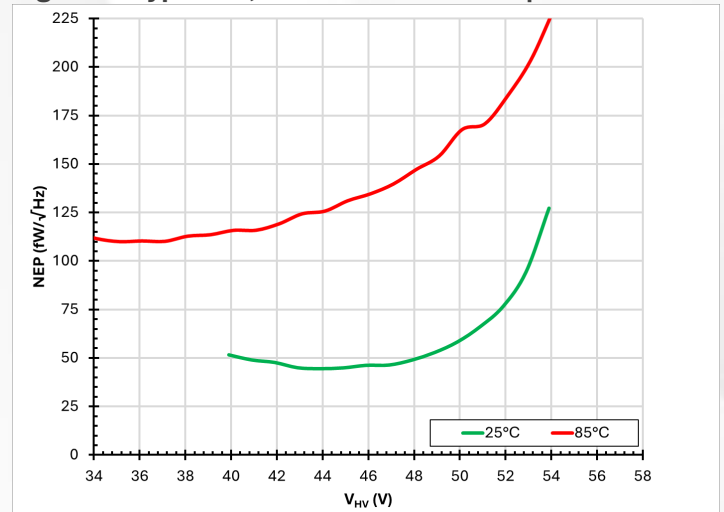
Figure 3. Typ. Responsivity,  $R_L = 50\ \Omega$  Area =  $80\ \mu\text{m}$ Figure 4. Typ. NEP,  $R_L = 50\ \Omega$  Area =  $80\ \mu\text{m}$ Figure 5. Typ. Responsivity,  $R_L = 50\ \Omega$  Area =  $200\ \mu\text{m}$ Figure 6. Typ. NEP,  $R_L = 50\ \Omega$  Area =  $200\ \mu\text{m}$ Figure 7. Typ. Responsivity,  $R_L = 50\ \Omega$  & Area =  $350\ \mu\text{m}$ Figure 8. Typ. NEP,  $R_L = 50\ \Omega$  Area =  $350\ \mu\text{m}$ 

Figure 9. CMC 264-339835 Series block diagram

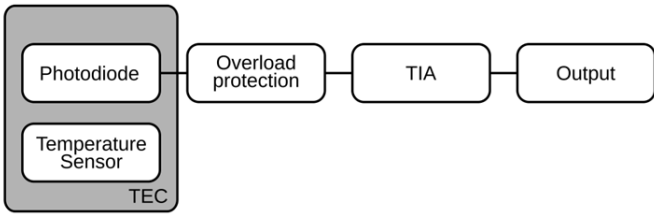
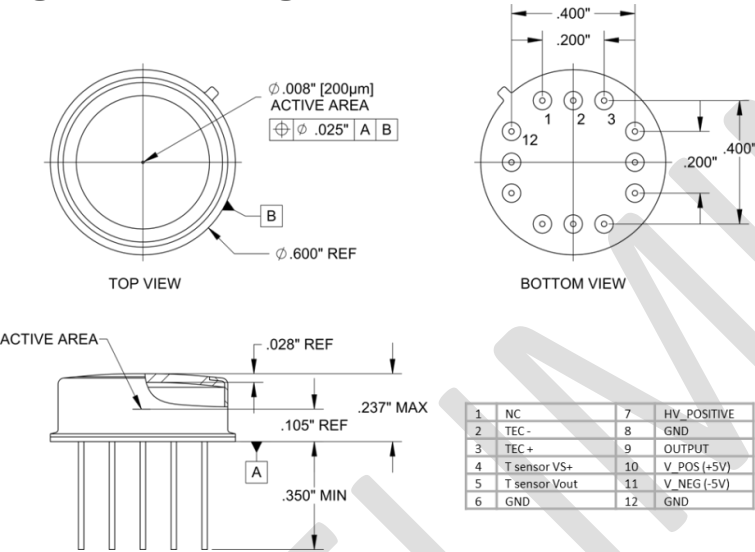
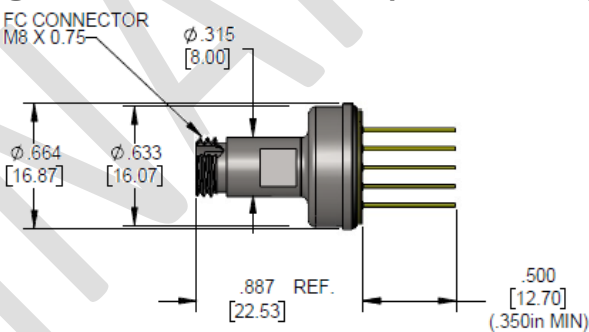


Figure 10. Package Dimension and Pinout



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

Figure 11. FC connector (617-339835)



VAR Options

| VAR  | 264-339835-VAR                           |
|------|------------------------------------------|
| -001 | InGaAs APD 350 µm, 0.5 MHz TIA, with TEC |
| -002 | InGaAs APD 200 µm, 1 MHz TIA, with TEC   |
| -003 | InGaAs APD 80 µm, 3 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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