

# RA-Series SiPM Sensors

## Not Recommended for New Design Silicon Photomultipliers (SiPM), Red-Enhanced

The MicroRA sensors are a range of Silicon Photomultipliers (SiPM) providing increased sensitivity into the red and NIR region of the electromagnetic spectrum. MicroRA sensors are the first release from the R-Series family of red-enhanced SiPM sensors that feature high responsivity and fast signal response, all achieved at a low bias voltage. The sensor is packaged in a compact and robust MLP (molded lead frame) package that is suitable for reflow solder processes. Both the sensor and the package are designed for volume production with the product delivered on tape and reel.

SiPM sensors are an improvement over avalanche photodiodes (APD) and PIN diodes due to their high gain and single photon sensitivity. This enables the detection of low reflectivity targets at very long distance in LiDAR applications. Unlike the similarly-operated SPAD that can only detect single photons, the SiPM overcomes this limitation by incorporating a ‘microcell’ structure that allows for multi-photon detection with a high dynamic range.

It is strongly recommended that those new to SiPM sensors consult the [Introduction to Silicon Photomultipliers](#) application note. There is also a separate [Biasing and Readout](#) application note.

### RA-Series Key Features

- Enhanced Red Sensitivity SiPM
- Responsivity: > 100 kA/W @ 905 nm
- High Gain:  $\sim 1 \times 10^6$
- Compact MLP Package – Reflow Solder Compatible
- High Volume Product – Tape & Reel Delivery

**Table 1. GENERAL PARAMETERS**

Parameter (Note 1)	Cell Size	Minimum	Typical	Maximum	Unit
Breakdown Voltage (Vbr) (Notes 2, 3)	10 $\mu\text{m}$		38		V
	20 $\mu\text{m}$		32		
	35 $\mu\text{m}$		30		
Overvoltage (Vov) (Notes 2)	10 $\mu\text{m}$	5	16	25	V
	20 $\mu\text{m}$	5	12	20	
	35 $\mu\text{m}$	5	10	15	
Spectral Range (Note 4)		300		1050	nm
Temperature Coefficient			0.2		V/ $^{\circ}\text{C}$

1. All measurements made at 21 $^{\circ}\text{C}$  unless otherwise stated.

2. Operating bias (Vbias) = Vbr + Vov

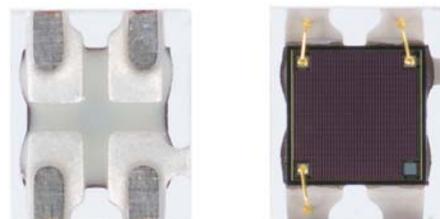
3. The breakdown voltage (Vbr) is defined as the value of the voltage intercept of a straight line fit to a plot of  $\sqrt{I}$  vs V, where I is the current and V is the bias voltage.

4. Range at which the maximum PDE is > 1%.



ON Semiconductor®

[www.onsemi.com](http://www.onsemi.com)



### ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

## RA-Series SiPM Sensors

**Table 2. PERFORMANCE PARAMETERS**

Parameter (Note 5)	10010	10020	10035	Unit
PDE @ 905 nm @ Maximum Overvoltage (Notes 6, 7)	3.7	5.3	6.3	%
PDE @ 905 nm @ Typical Overvoltage (Notes 5, 6)	2.5	3.5	4.5	%
Responsivity @ 905 nm @ Maximum Overvoltage (Note 7)	70	200	280	kA/W
Responsivity @ 905 nm @ Typical Overvoltage (Note 5)	24	38	80	kA/W
Gain – Cathode-anode Output (Note 5)	$0.4 \times 10^6$	$0.9 \times 10^6$	$1.6 \times 10^6$	
Dark Count Rate (Notes 5, 8)	1.2	1.3	1.4	MHz
Dark Current (Note 5)	200	350	780	nA
Microcell Recharge Time Constant (Notes 5, 9)	13	21	68	ns
Crosstalk (Note 5)	13	18	22	%
Afterpulsing (Note 5)	6	4	1	%
Excess Noise Factor (Note 5)	1.13	1.14	1.13	

5. All measurements made at 21°C and 'Typical' overvoltage (see page 1) unless otherwise specified.
6. PDE (Photon Detection Efficiency) is the product of the QE \* AIP \* FF, where QE is quantum efficiency, AIP is the avalanche initiation probability and FF is the fill factor of the microcells.
7. Measured at maximum overvoltage.
8. Each thermally generated 'noise' carrier in the active volume of the sensor will generate a signal equal to that of a single photon. The rate of these spurious counts is referred to as the dark count rate.
9. RC charging time constant of the microcell ( $\tau$ ).

**Table 3. PHYSICAL PARAMETERS**

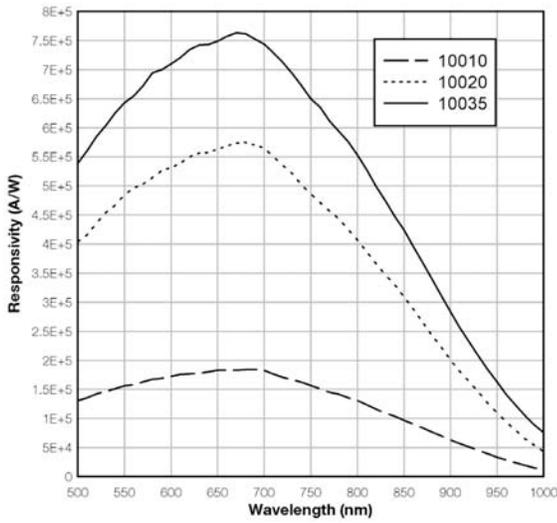
Parameter	10010	10020	10035
Active Area	1 mm × 1 mm		
No. of Microcells	4296	1590	620
Microcell Fill Factor	43%	63%	76%

**Table 4. PACKAGE PARAMETERS**

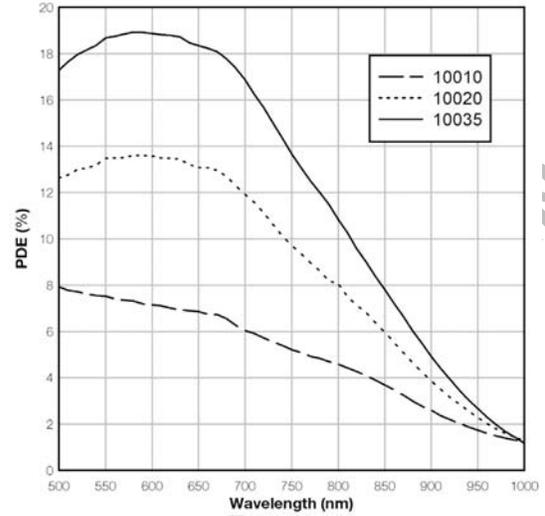
Parameter	10010	10020	10035
Package Dimensions	1.5 mm × 1.8 mm		
Recommended Operating Temperature Range	-40°C to +85°C		
Maximum Storage Temperature	+105°C		
Soldering Conditions	Lead-free, reflow soldering process compatible (MSL 3 for tape & reel quantities; MSL 4 for tape only qty.) See the <a href="#">MLP Handling</a> application note for more details.		
Encapsulant Type	Clear transfer molding compound		
Encapsulant Refractive Index	1.57 @ 589 nm		
Maximum Current	3 mA		

# RA-Series SiPM Sensors

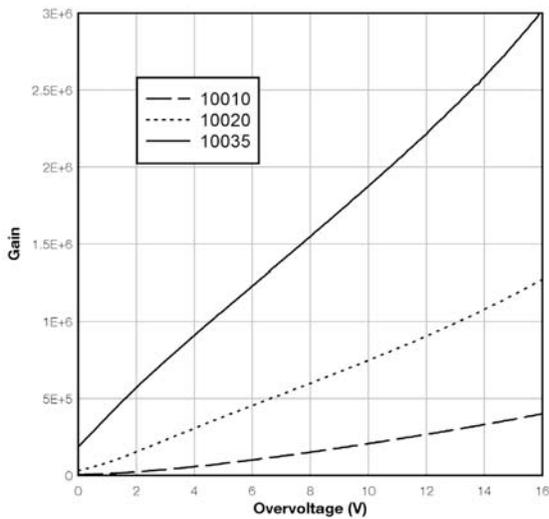
## PERFORMANCE PLOTS



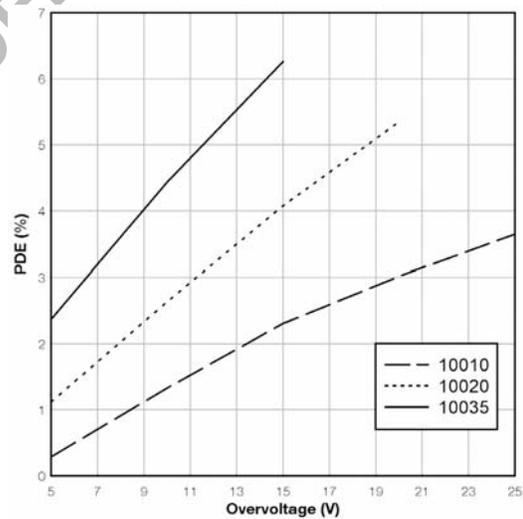
**Figure 1. Responsivity vs. Wavelength**  
(MicroRA-10010, MicroRA-10020, MicroRA-10035  
@ Maximum Overvoltage)



**Figure 2. PDE vs. Wavelength**  
(MicroRA-10010, MicroRA-10020, MicroRA-10035  
@ Typical Overvoltage)



**Figure 3. Gain vs. Overvoltage**  
(MicroRA-10010, MicroRA-10020, MicroRA-10035)



**Figure 4. PDE vs. Overvoltage**  
(MicroRA-10010, MicroRA-10020, MicroRA-10035 @ 905 nm)

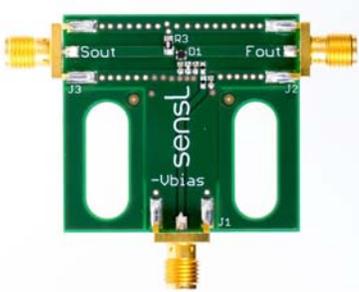
# RA-Series SiPM Sensors

## EVALUATION BOARDS

### SMA BIASING BOARD (MicroRA-SMA-100XX)

The MicroRA-SMA is a printed circuit board (PCB) that can facilitate the evaluation of the MicroRA MLP sensors. The board has three female SMA connectors for connecting the bias voltage, the standard output from the cathode and the fast output signal. The output signals can be connected directly to a 50 Ω-terminated oscilloscope for viewing. The biasing and output signal tracks are laid out in such a way as to preserve the fast timing characteristics of the sensor.

The MicroRA-SMA is recommended for users who require a plug-and-play set-up to quickly evaluate MicroRA sensors with optimum timing performance. The board also allows the signal from the cathode-anode readout to be observed at the same time as the fast output. The outputs can be connected directly to the oscilloscope or measurement device, but external preamplification may be required to boost the signal. The table below lists the SMA board connections. The SMA board electrical schematics are available to download in the [Board Reference Design](#) document.



MicroRA-SMA-100XX	
Output	Function
Vbias	Negative bias input (anode)
Fout	Fast output
Sout	Standard output (cathode)

### PIN ADAPTER BOARD (MicroRA-SMTPA-100XX)

The Pin Adapter board (SMTPA) is a small PCB board that houses the SiPM sensor and has through-hole pins to allow its use with standard sockets or probe clips. This product is useful for those needing a quick way to evaluate the MLP-packaged sensor without the need for specialist surface-mount soldering. While this is a 'quick fix' suitable for many evaluations, it should be noted that the timing performance from this board will not be optimized and if the

best possible timing performance is required, the MicroRA-SMA-100XX is recommended.

The SMTPA circuit schematic is shown below in Figure 6. The SMTPA board electrical schematics are available to download in the [Board Reference Design](#) document. The [Biasing and Readout](#) application note provides further information.

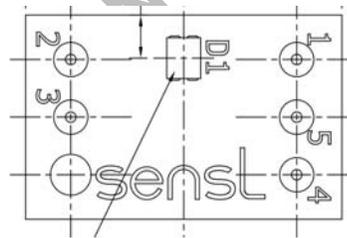
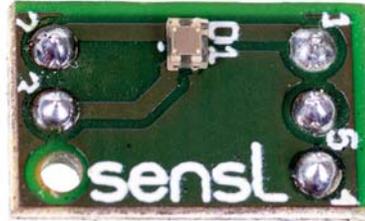


Figure 5. Top View of the SMTPA Board Showing the Pin Numbering

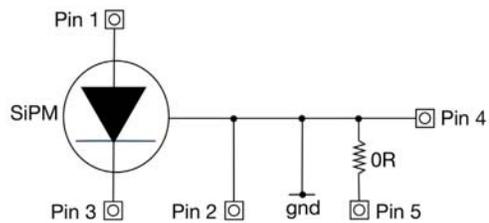


Figure 6. SMTPA Circuit Schematic

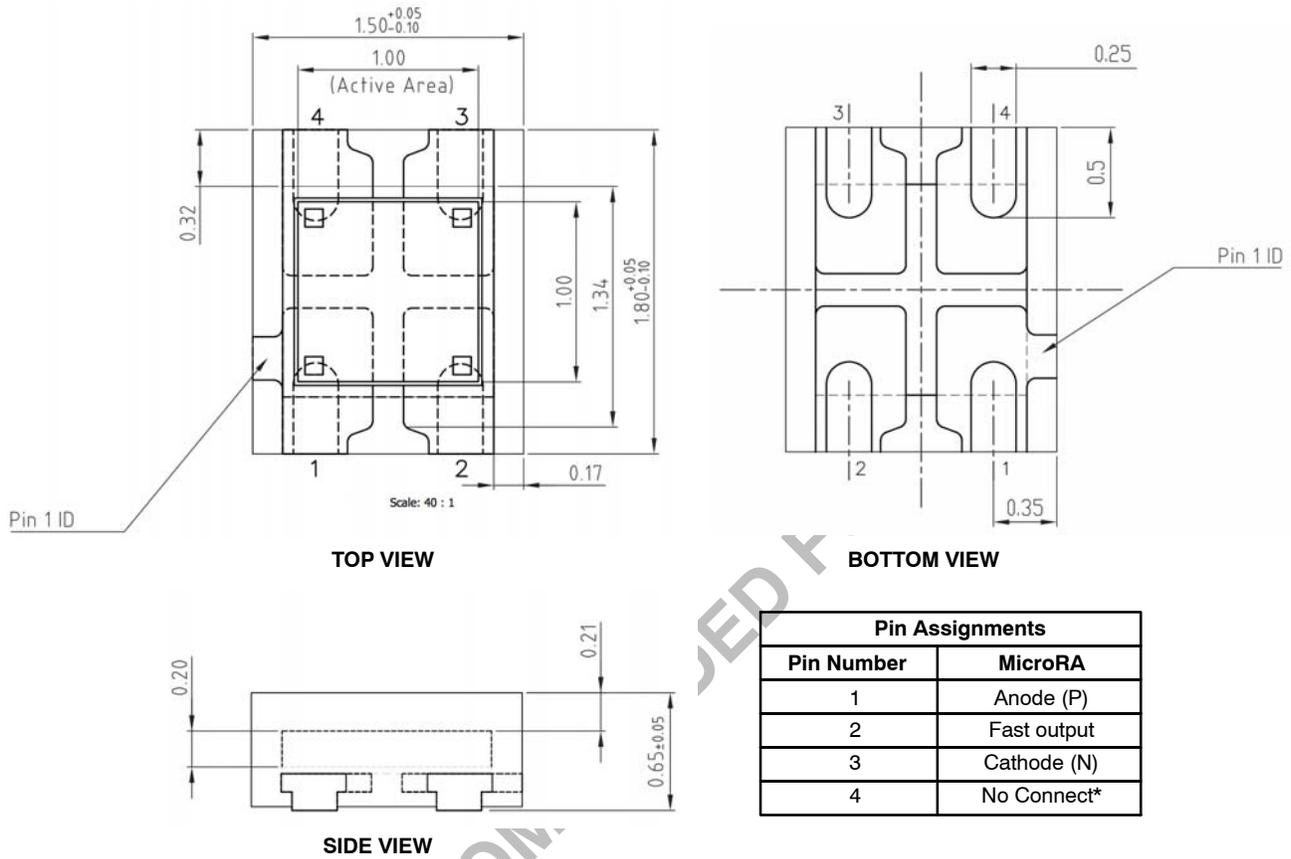
MicroRA-SMTPA-100XX	
Pin No.	Connection
1	Anode
2	Fast output
3	Cathode
4	Ground
5	No connect

# RA-Series SiPM Sensors

## PACKAGE DIMENSIONS

(All Dimensions in mm)

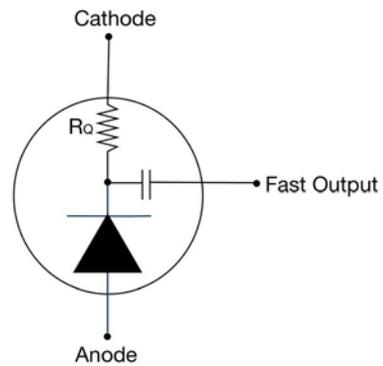
### MicroRA-100XX-MLP



\*The 'No Connect' pins are electrically isolated and should be soldered to a ground (or bias) plane to help with heat dissipation.

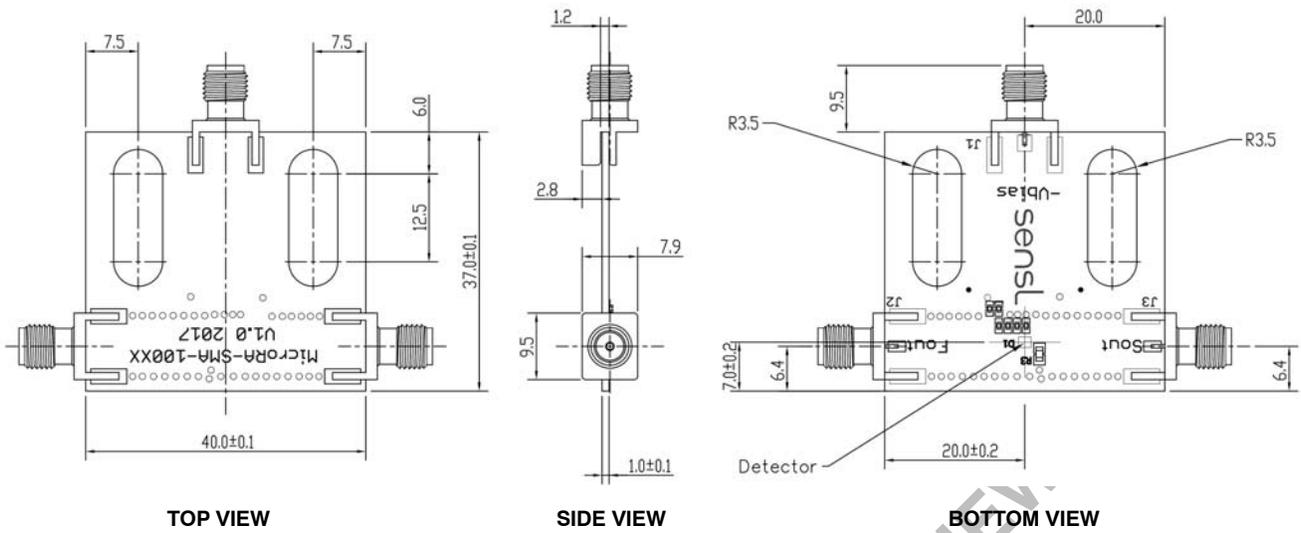
The CAD file for the MicroRA-100XX-MLP package and tape and reel, and the solder footprint is available to download [here](#).

NOTE: MicroRA sensors use an N-on-P diode and therefore have a different fast pulse polarity compared to ON Semiconductor P-on-N sensors i.e. C-Series, although the pin-out is the same.



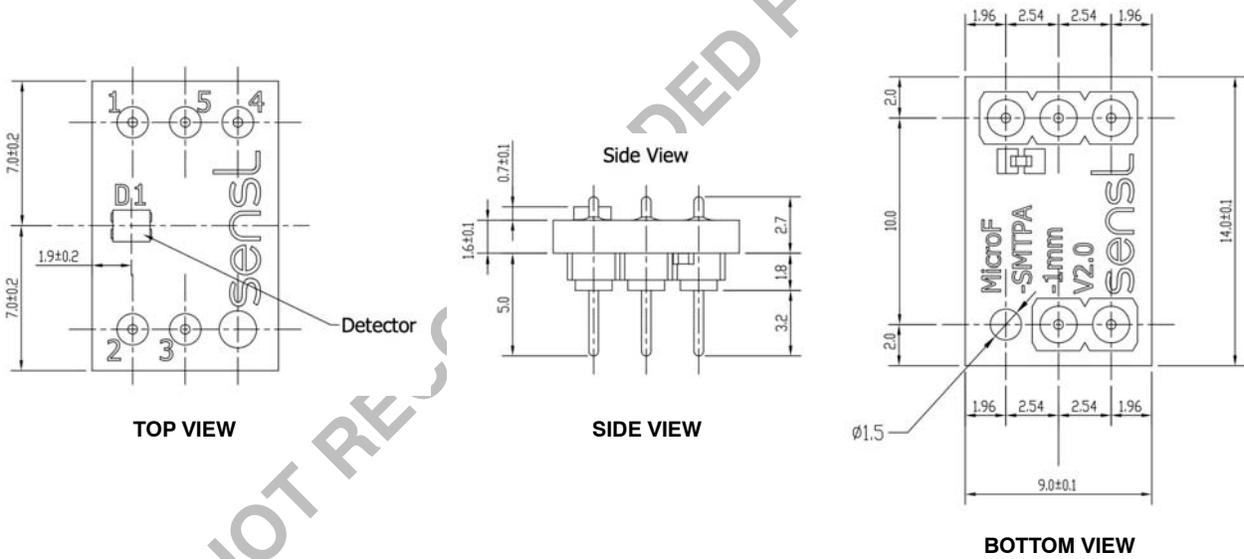
# RA-Series SiPM Sensors

## MicroRA-SMA-100XX



The complete MicroRA-SMA-100XX CAD file is available to download [here](#).

## MicroRA-SMTPA-100XX



The complete MicroRA-SMTPA-100XX CAD file is available to download [here](#).

# RA-Series SiPM Sensors

## ORDERING INFORMATION

**Table 5. ORDERING INFORMATION**

Product Code	Microcell Size	Sensor Active Area	Package Description	Delivery Option (Note 10)
MicroRA-10010-MLP	10 $\mu\text{m}$	1 $\times$ 1 mm <sup>2</sup>	4-side tileable, surface mount, molded leadframe package (MLP)	TR1, TR
MicroRA-SMA-10010			MLP sensor mounted onto a PCB with SMA connectors for bias and output	PK
MicroRA-SMTPA-10010			MLP packaged sensor mounted onto a pin adapter board	PK
MicroRA-10020-MLP	20 $\mu\text{m}$		4-side tileable, surface mount, molded leadframe package (MLP)	TR1, TR
MicroRA-SMA-10020			MLP sensor mounted onto a PCB with SMA connectors for bias and output	PK
MicroRA-SMTPA-10020			MLP packaged sensor mounted onto a pin adapter board	PK
MicroRA-10035-MLP	35 $\mu\text{m}$		4-side tileable, surface mount, molded leadframe package (MLP)	TR1, TR
MicroRA-SMA-10035			MLP sensor mounted onto a PCB with SMA connectors for bias and output	PK
MicroRA-SMTPA-10035			MLP packaged sensor mounted onto a pin adapter board	PK

10. The two-letter delivery option code should be appended to the order number, e.g.) to receive a MicroRA-10035-MLP on cut tape, use MicroRA-10035-MLP-TR1. The codes are as follows:

PK = ESD Package  
TR1 = Tape  
TR = Tape and Reel

There is a minimum order quantity (MOQ) of 3000 for the tape and reel (TR) option. The TR option is only available in multiples of the MOQ.

For information on the availability of automotive qualified versions of these parts, please contact ON Semiconductor Sales.

SensL is a registered trademark of of Semiconductor Components Industries, LLC (SCILLC) or its subsidiaries in the United States and/or other countries.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

### PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT:**  
Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>

For additional information, please contact your local Sales Representative