

# ON Semiconductor

## Is Now

# onsemi™

To learn more about onsemi™, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

---

**onsemi** and **onsemi** and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi** product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** 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 **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** 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. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** 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 **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** 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 **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.



ON Semiconductor®

<http://onsemi.com>

## Powering-Up and Resetting the 16-Bit PCA I<sup>2</sup>C-Bus I/O Expanders

### Introduction

ON Semiconductor's new PCA family of 16-Bit I<sup>2</sup>C-Bus General Purpose I/O expanders are available with various combinations of I/O types. The PCA9535E device has push-pull I/Os. The PCA9535EC device has open-drain I/Os. The PCA9655E device also has push-pull I/Os with each I/O being pulled up to V<sub>DD</sub> by an internal 100 kΩ resistor.

For these devices to operate properly, the internal I<sup>2</sup>C/SMBus control block, and the internal registers and I/Os have to be reset and initialized properly during power-on or during a power-reset cycle.

### Powering-On

When power is applied to V<sub>DD</sub>, an internal Power-On Reset (POR) holds the device in a reset condition. When V<sub>DD</sub> has reached the power-on-reset voltage, V<sub>POR</sub>, the reset condition is released. Upon release of the reset condition, the POR will then initialize the internal registers and I<sup>2</sup>C control block to their default states. The reset and initialization of the internal circuit blocks requires a certain amount of time to complete. The device should operate normally afterwards.

## APPLICATION NOTE

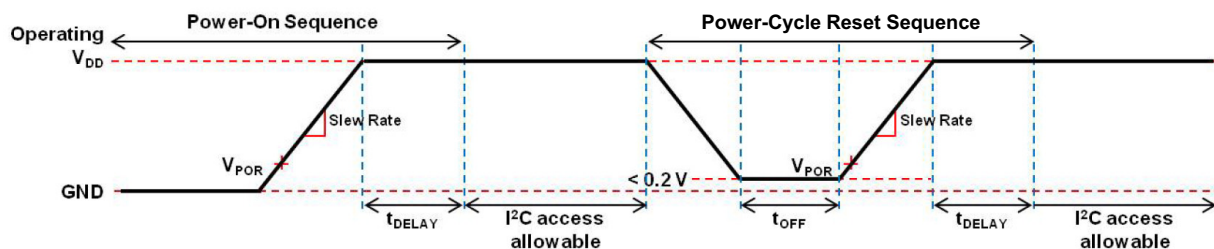
### Power-Cycling Reset

In the event of a lockout or when the application requires it, the master may reset the device to have the device operate normally again.

Without the benefit of an external reset pin, the recommended method is to power-cycle reset the device. The power-cycle reset method works by pulling down the V<sub>DD</sub> line lower than 0.2 V for a certain amount of time, and then powering-up the device to operating V<sub>DD</sub> voltage level.

### Recommended Power-Up and Power-Cycle Reset Profile

Proper reset and initialization of the devices is key to normal operation of the devices. Figure 1 shows the recommended power-up and power-cycle reset profile. Table 1 defines the recommended values for the slew rate, t<sub>DELAY</sub> and t<sub>OFF</sub> defined in Figure 1.



- V<sub>POR</sub> : Power-On-Reset Voltage, voltage level when initialization of I<sup>2</sup>C block and registers starts
- Slew Rate : Rate at which the V<sub>DD</sub> line rises up to operating level
- t<sub>DELAY</sub> : Wait time before starting I<sup>2</sup>C port access
- t<sub>OFF</sub> : Time for maintaining V<sub>DD</sub> below 0.2 V during a power-cycle reset

Figure 1. Recommended Power-Up and Power-Cycle Reset Profile

## AND9169/D

**Table 1. RECOMMENDED VALUES FOR SLEW RATE** ( $t_{\text{DELAY}}$  and  $t_{\text{OFF}}$  at  $T_A = 25^\circ\text{C}$ )

Operating $V_{\text{DD}}$ (V)	Slew Rate ( $\mu\text{s}/\text{V}$ )	$t_{\text{DELAY}}$ (ms)	$t_{\text{OFF}}$ (ms)
1.65 to 1.95	120 to 1500	> 7000	> 100
2.3 to 2.7	120 to 1500	> 1400	> 50
3.0 to 3.6	120 to 1500	> 300	> 40
4.5 to 5.5	120 to 1500	> 100	> 30

NOTE: The values indicated in Table 1 are recommendations only. The values may need to be tuned for actual applications and for actual application conditions.

**Table 2. ORDERING INFORMATION FOR FEATURED DEVICES**

Device	I/O Type	Package	Shipping <sup>†</sup>
PCA9535EDWR2G	Push-Pull	SOIC-24 (Pb-Free)	1000 / Tape & Reel
PCA9535EDTR2G, NLVPCA9535EDTR2G*	Push-Pull	TSSOP-24 (Pb-Free)	2500 / Tape & Reel
PCA9535EMTTXG	Push-Pull	WQFN24 (Pb-Free)	3000 / Tape & Reel
PCA9535ECDWR2G	Open Drain	SOIC-24 (Pb-Free)	1000 / Tape & Reel
PCA9535ECDTR2G	Open Drain	TSSOP-24 (Pb-Free)	2500 / Tape & Reel
PCA9535ECMTTXG	Open Drain	WQFN24 (Pb-Free)	3000 / Tape & Reel
PCA9655EDWR2G	Push-Pull with Pullup	SOIC-24 (Pb-Free)	1000 / Tape & Reel
PCA9655EDTR2G	Push-Pull with Pullup	TSSOP-24 (Pb-Free)	2500 / Tape & Reel
PCA9655EMTTXG	Push-Pull with Pullup	WQFN24 (Pb-Free)	3000 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.


\*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

### Additional Information

For additional information, please visit [www.onsemi.com](http://www.onsemi.com).

# AND9169/D

## NOTES

**ON Semiconductor** and  are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC'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). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC 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. "Typical" parameters which may be provided in SCILLC 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. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC 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 SCILLC was negligent regarding the design or manufacture of the part. SCILLC 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  
P.O. Box 5163, Denver, Colorado 80217 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  
**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**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