

### 60 V Input Low Supply Current Voltage Detector for Industrial Applications

No. EY-402-170822

#### OVERVIEW

The R3160N is a 60 V-input voltage detector provided with high detector threshold accuracy and low supply current. This device offers a direct-monitoring of 24-/48-V battery and a detection of low-voltage battery state. This is a high-reliability semiconductor device for industrial applications (-Y) that has passed both the screening at high temperature and the reliability test with extended hours. This line of products operate in a wide temperature range from low temperature to high temperature to support harsh environment applications.

#### KEY BENEFITS

- Enables a direct-monitoring of battery voltage and can be used for an early warning of low-voltage battery state.
- Provides a wide-range detector threshold of 10 V to 48 V and a high-accuracy of  $\pm 1.5\%$  to  $\pm 1.75\%$ .
- Available in a small SOT-23-6 package.

#### KEY SPECIFICATIONS

- Operating Voltage Range (Maximum Rating): 2.7 V to 60.0 V (80.0 V)
- Operating Temperature Range:  $-50^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- Supply Current: Typ. 1.8  $\mu\text{A}$
- Voltage Detector Threshold Range: 10.0 V to 48.0 V
- Hysteresis Threshold: Typ. 4.3%
- Voltage Detector Threshold Accuracy:  $\pm 1.75\%$  (Detector Threshold 20 V or lower)  
 $\pm 1.5\%$  (Detector Threshold 20.5 V or higher)
- Release Delay Time (at Power-on): Typ. 18 ms ( $C_D = 0.01 \mu\text{F}$ )
- Output Type: Nch. Open-drain

#### SELECTION GUIDE

The detector threshold and the output logic are user selectable options.

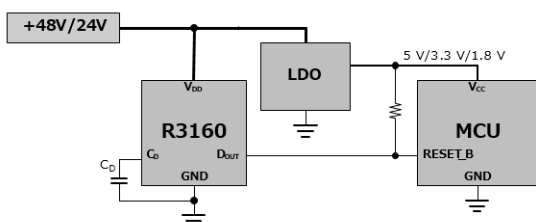
Product Name: R3160Nxxx\$

xxx: Detector Threshold ( $V_{\text{SET}}$ ) Ranges  
10.0 V (100) to 20.0 V (200) in 0.2 V step  
20.5 V (205) to 30.0 V (300) in 0.5 V step  
31.0 V (310) to 48.0 V (480) in 1.0 V step

\$: Output Logic

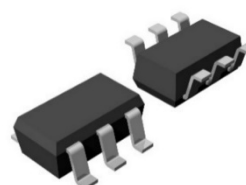
| \$ | DOUT Pin Output |         |
|----|-----------------|---------|
|    | Detection       | Release |
| A  | Low             | High    |
| B  | High            | Low     |

#### TYPICAL APPLICATION



$C_D$ : The capacitor according to the release delay time setting

#### PACKAGE



SOT-23-6  
Size = 2.9 mm x 2.8 mm, t = 1.3 mm (Max.)

#### APPLICATIONS

- Reset of microcomputers and logic circuits.
- Voltage supervisor for high-voltage batteries.

---

## R3160N

---

No. EY-402-170822

### SELECTION GUIDE

The detector threshold and the polarity of DOUT pin are user selectable options.

| Product Name      | Package  | Quantity per Reel | Pb Free | Halogen Free |
|-------------------|----------|-------------------|---------|--------------|
| R3160Nxxx\$-TR-YE | SOT-23-6 | 3,000 pcs         | Yes     | Yes          |

xxx : Detector Threshold ( $V_{SET}$ ) Ranges

10.0 V (100) to 20.0 V (200) in 0.2 V step

20.5 V (205) to 30.0 V (300) in 0.5 V step

31.0 V (310) to 48.0 V (480) in 1.0 V step

If a device with a voltage other than above is required, contact our sales representatives or our distributors.

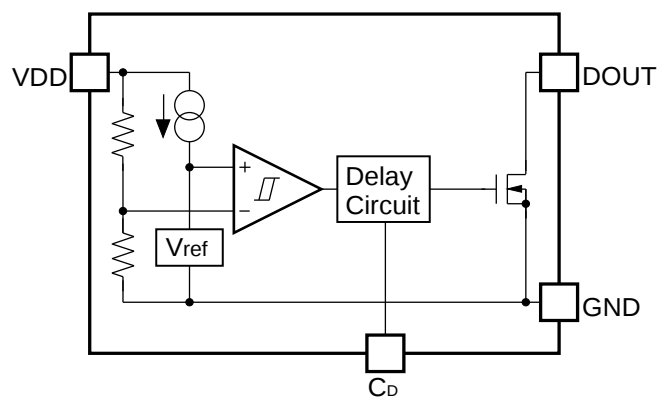
\$. Version

| Version                | DOUT Pin Output |         |
|------------------------|-----------------|---------|
|                        | Detection       | Release |
| <b>A</b>               | Low             | High    |
| <b>B<sup>(1)</sup></b> | High            | Low     |

---

<sup>(1)</sup> R3160NxxxB is the inverted output of R3160NxxxA.

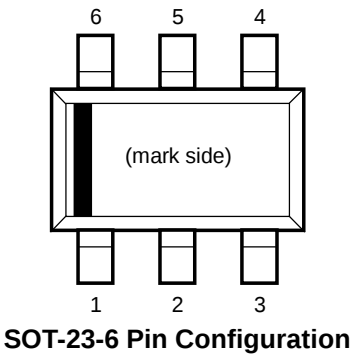
---

**BLOCK DIAGRAM****R3160Nxxx A/B Block Diagram**

**R3160N**

No. EY-402-170822

**PIN DESCRIPTIONS**

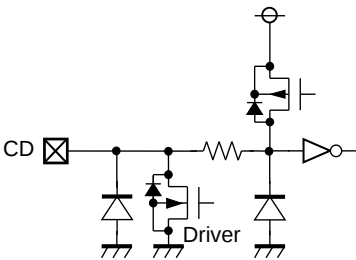


**Pin Description**

| Pin No. | Symbol | Description                                      |
|---------|--------|--------------------------------------------------|
| 1       | VDD    | Supply Voltage Pin                               |
| 2       | NC     | No Connection                                    |
| 3       | DOUT   | Driver Output Pin                                |
| 4       | CD     | Connection Pin with External Capacitor for Delay |
| 5       | TAB    | TAB Pin. GND short before use.                   |
| 6       | GND    | GND Pin                                          |

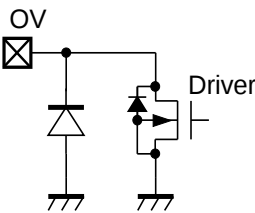
**Equivalent Circuits of Individual Pins**

**<CD Pin>**



**Equivalent Circuit for CD Pin**

**<DOUT Pin>**



**Equivalent Circuit for DOUT Pin**

## ABSOLUTE MAXIMUM RATINGS

| Symbol    | Item                                                               | Rating       | Unit |
|-----------|--------------------------------------------------------------------|--------------|------|
| $V_{DD}$  | Supply Voltage                                                     | -0.3 to 80.0 | V    |
|           | Peak Voltage <sup>(1)</sup>                                        | 90           |      |
| $V_{OUT}$ | DOUT Pin Output Voltage                                            | -0.3 to 7.0  | V    |
| $V_{CD}$  | CD Pin Output Voltage                                              | -0.3 to 7.0  | V    |
| $I_{OUT}$ | DOUT Pin Output Voltage                                            | 20           | mA   |
| $P_D$     | Power Dissipation <sup>(2)</sup> (SOT-23-6, Standard Land Pattern) | 525          | mW   |
| $T_j$     | Junction Temperature Range                                         | -50 to 150   | °C   |
| $T_{stg}$ | Storage Temperature Range                                          | -55 to 150   | °C   |

### ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings are not assured.

## RECOMMENDED OPERATING CONDITIONS

| Symbol   | Item                        | Rating      | Unit |
|----------|-----------------------------|-------------|------|
| $V_{DD}$ | Operating Voltage           | 2.7 to 60.0 | V    |
| $T_a$    | Operating Temperature Range | -50 to 125  | °C   |

### RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

<sup>(1)</sup> Applied Time: 200 ms or less

<sup>(2)</sup> Refer to *POWER DISSIPATION* for detailed information.

## R3160N

No. EY-402-170822

## ELECTRICAL CHARACTERISTICS

The specifications surrounded by   are guaranteed by design engineering at  $-50^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$ .

### R3160Nxxx\$ (-YE) Electrical Characteristics

( $T_a = 25^{\circ}\text{C}$ )

| Symbol             | Item                                                   | Conditions                                                                                           |                                                                                      | Min.                                                                     | Typ. | Max.                                                                     | Unit          |
|--------------------|--------------------------------------------------------|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------|------|--------------------------------------------------------------------------|---------------|
| $-V_{\text{DET}}$  | Detector Threshold                                     | $T_a = 25^{\circ}\text{C}$                                                                           |                                                                                      | $\times 0.99$                                                            |      | $\times 1.01$                                                            | V             |
|                    |                                                        | $-50^{\circ}\text{C} \leq T_a$                                                                       | $-V_{\text{DET}} \leq 20 \text{ V}$                                                  | <span style="border: 1px solid black;"><math>\times 0.9825</math></span> |      | <span style="border: 1px solid black;"><math>\times 1.0175</math></span> |               |
|                    |                                                        | $\leq 125^{\circ}\text{C}$                                                                           | $-V_{\text{DET}} \geq 20.5 \text{ V}$                                                | <span style="border: 1px solid black;"><math>\times 0.985</math></span>  |      | <span style="border: 1px solid black;"><math>\times 1.015</math></span>  |               |
| $V_{\text{HYS}}$   | Hysteresis Threshold                                   |                                                                                                      |                                                                                      | <span style="border: 1px solid black;">3.4</span>                        | 4.3  | <span style="border: 1px solid black;">5.2</span>                        | %             |
| $I_{\text{SS}}$    | Supply Current                                         | $V_{\text{DD}} = -V_{\text{DET}} - 0.1 \text{ V}$                                                    |                                                                                      |                                                                          | 1.8  | <span style="border: 1px solid black;">5.0</span>                        | $\mu\text{A}$ |
|                    |                                                        | $V_{\text{DD}} = -V_{\text{DET}} + 0.1 \text{ V}$                                                    |                                                                                      |                                                                          | 1.8  | <span style="border: 1px solid black;">5.0</span>                        |               |
| $V_{\text{DDH}}$   | Maximum Operating Voltage                              |                                                                                                      |                                                                                      |                                                                          |      | 60                                                                       | V             |
| $V_{\text{DDL}}$   | Minimum Operating Voltage                              |                                                                                                      |                                                                                      |                                                                          |      | 2.7                                                                      | V             |
| $V_{\text{DDL V}}$ | Driver Output Minimum Operating Voltage <sup>(1)</sup> |                                                                                                      |                                                                                      |                                                                          |      | 1.5                                                                      | V             |
| $I_{\text{OUT}}$   | Output Current (Driver Output Current)                 | R3160NxxxA                                                                                           | $V_{\text{DD}} = 3.0 \text{ V}, V_{\text{DS}} = 0.05 \text{ V}$                      | <span style="border: 1px solid black;">360</span>                        |      |                                                                          | $\mu\text{A}$ |
|                    |                                                        | R3160NxxxA                                                                                           | $V_{\text{DD}} = -V_{\text{DET}} - 0.1 \text{ V}$<br>$V_{\text{DS}} = 0.5 \text{ V}$ | 3.3                                                                      |      |                                                                          | mA            |
|                    |                                                        | R3160NxxxB                                                                                           | $V_{\text{DD}} = +V_{\text{DET}} + 0.1 \text{ V}$<br>$V_{\text{DS}} = 0.5 \text{ V}$ |                                                                          |      |                                                                          |               |
| $I_{\text{LEAK}}$  | Nch. Driver Leakage Current                            | R3160NxxxA                                                                                           | $V_{\text{DD}} = 60 \text{ V}, V_{\text{DS}} = 6.0 \text{ V}$                        |                                                                          |      | <span style="border: 1px solid black;">1.0</span>                        | $\mu\text{A}$ |
|                    |                                                        | R3160NxxxB                                                                                           | $V_{\text{DD}} = -V_{\text{DET}} - 0.1 \text{ V}$<br>$V_{\text{DS}} = 6.0 \text{ V}$ |                                                                          |      |                                                                          |               |
| $t_{\text{DELAY}}$ | Release Delay Time                                     | $-V_{\text{DET}} \times 0.9 \rightarrow V_{\text{DET}} \times 1.1$<br>$C_{\text{D}} = 10 \text{ nF}$ |                                                                                      | <span style="border: 1px solid black;">9</span>                          | 18   | <span style="border: 1px solid black;">27</span>                         | ms            |

All test items listed under Electrical Characteristics are done under the pulse load condition ( $T_j \approx T_a = 25^{\circ}\text{C}$ ).

<sup>(1)</sup> The Minimum value of power supply voltage when an output voltage becomes 50 mV or less at a detection (pulled-up resistance: 100 k $\Omega$ , pulled-up voltage: 5 V).

The specifications surrounded by   are guaranteed by design engineering at  $-50^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$ .

**R3160Nxxx\$ (-YE) Product-specific Electrical Characteristics**

| Product Name | $-V_{\text{DET}}$ [V]      |      |        |                                                         |      |                                                       |
|--------------|----------------------------|------|--------|---------------------------------------------------------|------|-------------------------------------------------------|
|              | $T_a = 25^{\circ}\text{C}$ |      |        | $-50^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$ |      |                                                       |
|              | Min.                       | Typ. | Max.   | Min.                                                    | Typ. | Max.                                                  |
| R3160N100x   | 9.900                      | 10.0 | 10.100 | <span style="border: 1px solid black;">9.8250</span>    | 10.0 | <span style="border: 1px solid black;">10.1750</span> |
| R3160N102x   | 10.098                     | 10.2 | 10.302 | <span style="border: 1px solid black;">10.0215</span>   | 10.2 | <span style="border: 1px solid black;">10.3785</span> |
| R3160N104x   | 10.296                     | 10.4 | 10.504 | <span style="border: 1px solid black;">10.2180</span>   | 10.4 | <span style="border: 1px solid black;">10.5820</span> |
| R3160N106x   | 10.494                     | 10.6 | 10.706 | <span style="border: 1px solid black;">10.4145</span>   | 10.6 | <span style="border: 1px solid black;">10.7855</span> |
| R3160N108x   | 10.692                     | 10.8 | 10.908 | <span style="border: 1px solid black;">10.6110</span>   | 10.8 | <span style="border: 1px solid black;">10.9890</span> |
| R3160N110x   | 10.890                     | 11.0 | 11.110 | <span style="border: 1px solid black;">10.8075</span>   | 11.0 | <span style="border: 1px solid black;">11.1925</span> |
| R3160N112x   | 11.088                     | 11.2 | 11.312 | <span style="border: 1px solid black;">11.0040</span>   | 11.2 | <span style="border: 1px solid black;">11.3960</span> |
| R3160N114x   | 11.286                     | 11.4 | 11.514 | <span style="border: 1px solid black;">11.2005</span>   | 11.4 | <span style="border: 1px solid black;">11.5995</span> |
| R3160N116x   | 11.484                     | 11.6 | 11.716 | <span style="border: 1px solid black;">11.3970</span>   | 11.6 | <span style="border: 1px solid black;">11.8030</span> |
| R3160N118x   | 11.682                     | 11.8 | 11.918 | <span style="border: 1px solid black;">11.5935</span>   | 11.8 | <span style="border: 1px solid black;">12.0065</span> |
| R3160N120x   | 11.880                     | 12.0 | 12.120 | <span style="border: 1px solid black;">11.7900</span>   | 12.0 | <span style="border: 1px solid black;">12.2100</span> |
| R3160N122x   | 12.078                     | 12.2 | 12.322 | <span style="border: 1px solid black;">11.9865</span>   | 12.2 | <span style="border: 1px solid black;">12.4135</span> |
| R3160N124x   | 12.276                     | 12.4 | 12.524 | <span style="border: 1px solid black;">12.1830</span>   | 12.4 | <span style="border: 1px solid black;">12.6170</span> |
| R3160N126x   | 12.474                     | 12.6 | 12.726 | <span style="border: 1px solid black;">12.3795</span>   | 12.6 | <span style="border: 1px solid black;">12.8205</span> |
| R3160N128x   | 12.672                     | 12.8 | 12.928 | <span style="border: 1px solid black;">12.5760</span>   | 12.8 | <span style="border: 1px solid black;">13.0240</span> |
| R3160N130x   | 12.870                     | 13.0 | 13.130 | <span style="border: 1px solid black;">12.7725</span>   | 13.0 | <span style="border: 1px solid black;">13.2275</span> |
| R3160N132x   | 13.068                     | 13.2 | 13.332 | <span style="border: 1px solid black;">12.9690</span>   | 13.2 | <span style="border: 1px solid black;">13.4310</span> |
| R3160N134x   | 13.266                     | 13.4 | 13.534 | <span style="border: 1px solid black;">13.1655</span>   | 13.4 | <span style="border: 1px solid black;">13.6345</span> |
| R3160N136x   | 13.464                     | 13.6 | 13.736 | <span style="border: 1px solid black;">13.3620</span>   | 13.6 | <span style="border: 1px solid black;">13.8380</span> |
| R3160N138x   | 13.662                     | 13.8 | 13.938 | <span style="border: 1px solid black;">13.5585</span>   | 13.8 | <span style="border: 1px solid black;">14.0415</span> |
| R3160N140x   | 13.860                     | 14.0 | 14.140 | <span style="border: 1px solid black;">13.7550</span>   | 14.0 | <span style="border: 1px solid black;">14.2450</span> |
| R3160N142x   | 14.058                     | 14.2 | 14.342 | <span style="border: 1px solid black;">13.9515</span>   | 14.2 | <span style="border: 1px solid black;">14.4485</span> |
| R3160N144x   | 14.256                     | 14.4 | 14.544 | <span style="border: 1px solid black;">14.1480</span>   | 14.4 | <span style="border: 1px solid black;">14.6520</span> |
| R3160N146x   | 14.454                     | 14.6 | 14.746 | <span style="border: 1px solid black;">14.3445</span>   | 14.6 | <span style="border: 1px solid black;">14.8555</span> |
| R3160N148x   | 14.652                     | 14.8 | 14.948 | <span style="border: 1px solid black;">14.5410</span>   | 14.8 | <span style="border: 1px solid black;">15.0590</span> |
| R3160N150x   | 14.850                     | 15.0 | 15.150 | <span style="border: 1px solid black;">14.7375</span>   | 15.0 | <span style="border: 1px solid black;">15.2625</span> |
| R3160N152x   | 15.048                     | 15.2 | 15.352 | <span style="border: 1px solid black;">14.9340</span>   | 15.2 | <span style="border: 1px solid black;">15.4660</span> |
| R3160N154x   | 15.246                     | 15.4 | 15.554 | <span style="border: 1px solid black;">15.1305</span>   | 15.4 | <span style="border: 1px solid black;">15.6695</span> |
| R3160N156x   | 15.444                     | 15.6 | 15.756 | <span style="border: 1px solid black;">15.3270</span>   | 15.6 | <span style="border: 1px solid black;">15.8730</span> |
| R3160N158x   | 15.642                     | 15.8 | 15.958 | <span style="border: 1px solid black;">15.5235</span>   | 15.8 | <span style="border: 1px solid black;">16.0765</span> |
| R3160N160x   | 15.840                     | 16.0 | 16.160 | <span style="border: 1px solid black;">15.7200</span>   | 16.0 | <span style="border: 1px solid black;">16.2800</span> |
| R3160N162x   | 16.038                     | 16.2 | 16.362 | <span style="border: 1px solid black;">15.9165</span>   | 16.2 | <span style="border: 1px solid black;">16.4835</span> |
| R3160N164x   | 16.236                     | 16.4 | 16.564 | <span style="border: 1px solid black;">16.1130</span>   | 16.4 | <span style="border: 1px solid black;">16.6870</span> |
| R3160N166x   | 16.434                     | 16.6 | 16.766 | <span style="border: 1px solid black;">16.3095</span>   | 16.6 | <span style="border: 1px solid black;">16.8905</span> |
| R3160N168x   | 16.632                     | 16.8 | 16.968 | <span style="border: 1px solid black;">16.5060</span>   | 16.8 | <span style="border: 1px solid black;">17.0940</span> |
| R3160N170x   | 16.830                     | 17.0 | 17.170 | <span style="border: 1px solid black;">16.7025</span>   | 17.0 | <span style="border: 1px solid black;">17.2975</span> |
| R3160N172x   | 17.028                     | 17.2 | 17.372 | <span style="border: 1px solid black;">16.8990</span>   | 17.2 | <span style="border: 1px solid black;">17.5010</span> |
| R3160N174x   | 17.226                     | 17.4 | 17.574 | <span style="border: 1px solid black;">17.0955</span>   | 17.4 | <span style="border: 1px solid black;">17.7045</span> |
| R3160N176x   | 17.424                     | 17.6 | 17.776 | <span style="border: 1px solid black;">17.2920</span>   | 17.6 | <span style="border: 1px solid black;">17.9080</span> |
| R3160N178x   | 17.622                     | 17.8 | 17.978 | <span style="border: 1px solid black;">17.4885</span>   | 17.8 | <span style="border: 1px solid black;">18.1115</span> |
| R3160N180x   | 17.820                     | 18.0 | 18.180 | <span style="border: 1px solid black;">17.6850</span>   | 18.0 | <span style="border: 1px solid black;">18.3150</span> |
| R3160N182x   | 18.018                     | 18.2 | 18.382 | <span style="border: 1px solid black;">17.8815</span>   | 18.2 | <span style="border: 1px solid black;">18.5185</span> |
| R3160N184x   | 18.216                     | 18.4 | 18.584 | <span style="border: 1px solid black;">18.0780</span>   | 18.4 | <span style="border: 1px solid black;">18.7220</span> |
| R3160N186x   | 18.414                     | 18.6 | 18.786 | <span style="border: 1px solid black;">18.2745</span>   | 18.6 | <span style="border: 1px solid black;">18.9255</span> |
| R3160N188x   | 18.612                     | 18.8 | 18.988 | <span style="border: 1px solid black;">18.4710</span>   | 18.8 | <span style="border: 1px solid black;">19.1290</span> |

## R3160N

No. EY-402-170822

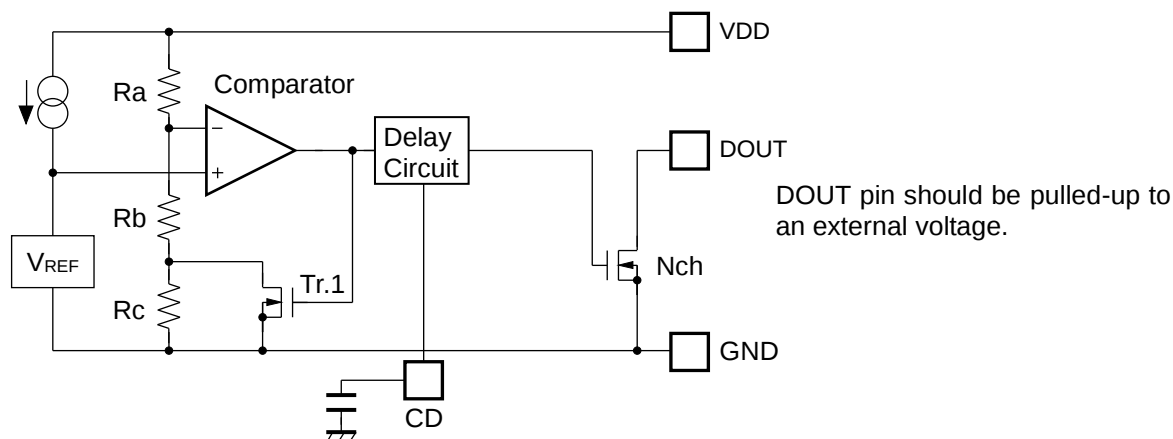
The specifications surrounded by   are guaranteed by design engineering at  $-50^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$ .

### R3160Nxxx\$ (-YE) Product-specific Electrical Characteristics

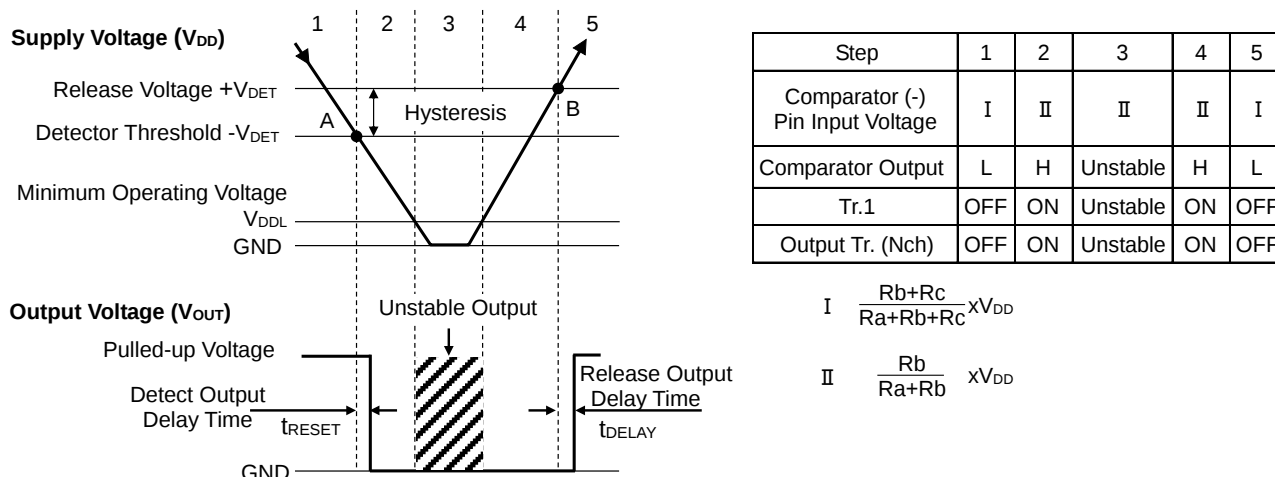
| Product Name | -V <sub>DET</sub> [V] |      |        |                                                       |      |                                                       |
|--------------|-----------------------|------|--------|-------------------------------------------------------|------|-------------------------------------------------------|
|              | Ta = 25°C             |      |        | -50°C ≤ Ta ≤ 125°C                                    |      |                                                       |
|              | Min.                  | Typ. | Max.   | Min.                                                  | Typ. | Max.                                                  |
| R3160N190x   | 18.810                | 19.0 | 19.190 | <span style="border: 1px solid black;">18.6675</span> | 19.0 | <span style="border: 1px solid black;">19.3325</span> |
| R3160N192x   | 19.008                | 19.2 | 19.392 | <span style="border: 1px solid black;">18.8640</span> | 19.2 | <span style="border: 1px solid black;">19.5360</span> |
| R3160N194x   | 19.206                | 19.4 | 19.594 | <span style="border: 1px solid black;">19.0605</span> | 19.4 | <span style="border: 1px solid black;">19.7395</span> |
| R3160N196x   | 19.404                | 19.6 | 19.796 | <span style="border: 1px solid black;">19.2570</span> | 19.6 | <span style="border: 1px solid black;">19.9430</span> |
| R3160N198x   | 19.602                | 19.8 | 19.998 | <span style="border: 1px solid black;">19.4535</span> | 19.8 | <span style="border: 1px solid black;">20.1465</span> |
| R3160N200x   | 19.800                | 20.0 | 20.200 | <span style="border: 1px solid black;">19.6500</span> | 20.0 | <span style="border: 1px solid black;">20.3500</span> |
| R3160N205x   | 20.295                | 20.5 | 20.705 | <span style="border: 1px solid black;">20.1925</span> | 20.5 | <span style="border: 1px solid black;">20.8075</span> |
| R3160N210x   | 20.790                | 21.0 | 21.210 | <span style="border: 1px solid black;">20.6850</span> | 21.0 | <span style="border: 1px solid black;">21.3150</span> |
| R3160N215x   | 21.285                | 21.5 | 21.715 | <span style="border: 1px solid black;">21.1775</span> | 21.5 | <span style="border: 1px solid black;">21.8225</span> |
| R3160N220x   | 21.780                | 22.0 | 22.220 | <span style="border: 1px solid black;">21.6700</span> | 22.0 | <span style="border: 1px solid black;">22.3300</span> |
| R3160N225x   | 22.275                | 22.5 | 22.725 | <span style="border: 1px solid black;">22.1625</span> | 22.5 | <span style="border: 1px solid black;">22.8375</span> |
| R3160N230x   | 22.770                | 23.0 | 23.230 | <span style="border: 1px solid black;">22.6550</span> | 23.0 | <span style="border: 1px solid black;">23.3450</span> |
| R3160N235x   | 23.265                | 23.5 | 23.735 | <span style="border: 1px solid black;">23.1475</span> | 23.5 | <span style="border: 1px solid black;">23.8525</span> |
| R3160N240x   | 23.760                | 24.0 | 24.240 | <span style="border: 1px solid black;">23.6400</span> | 24.0 | <span style="border: 1px solid black;">24.3600</span> |
| R3160N245x   | 24.255                | 24.5 | 24.745 | <span style="border: 1px solid black;">24.1325</span> | 24.5 | <span style="border: 1px solid black;">24.8675</span> |
| R3160N250x   | 24.750                | 25.0 | 25.250 | <span style="border: 1px solid black;">24.6250</span> | 25.0 | <span style="border: 1px solid black;">25.3750</span> |
| R3160N255x   | 25.245                | 25.5 | 25.755 | <span style="border: 1px solid black;">25.1175</span> | 25.5 | <span style="border: 1px solid black;">25.8825</span> |
| R3160N260x   | 25.740                | 26.0 | 26.260 | <span style="border: 1px solid black;">25.6100</span> | 26.0 | <span style="border: 1px solid black;">26.3900</span> |
| R3160N265x   | 26.235                | 26.5 | 26.765 | <span style="border: 1px solid black;">26.1025</span> | 26.5 | <span style="border: 1px solid black;">26.8975</span> |
| R3160N270x   | 26.730                | 27.0 | 27.270 | <span style="border: 1px solid black;">26.5950</span> | 27.0 | <span style="border: 1px solid black;">27.4050</span> |
| R3160N275x   | 27.225                | 27.5 | 27.775 | <span style="border: 1px solid black;">27.0875</span> | 27.5 | <span style="border: 1px solid black;">27.9125</span> |
| R3160N280x   | 27.720                | 28.0 | 28.280 | <span style="border: 1px solid black;">27.5800</span> | 28.0 | <span style="border: 1px solid black;">28.4200</span> |
| R3160N285x   | 28.215                | 28.5 | 28.785 | <span style="border: 1px solid black;">28.0725</span> | 28.5 | <span style="border: 1px solid black;">28.9275</span> |
| R3160N290x   | 28.710                | 29.0 | 29.290 | <span style="border: 1px solid black;">28.5650</span> | 29.0 | <span style="border: 1px solid black;">29.4350</span> |
| R3160N295x   | 29.205                | 29.5 | 29.795 | <span style="border: 1px solid black;">29.0575</span> | 29.5 | <span style="border: 1px solid black;">29.9425</span> |
| R3160N300x   | 29.700                | 30.0 | 30.300 | <span style="border: 1px solid black;">29.5500</span> | 30.0 | <span style="border: 1px solid black;">30.4500</span> |
| R3160N310x   | 30.690                | 31.0 | 31.310 | <span style="border: 1px solid black;">30.5350</span> | 31.0 | <span style="border: 1px solid black;">31.4650</span> |
| R3160N320x   | 31.680                | 32.0 | 32.320 | <span style="border: 1px solid black;">31.5200</span> | 32.0 | <span style="border: 1px solid black;">32.4800</span> |
| R3160N330x   | 32.670                | 33.0 | 33.330 | <span style="border: 1px solid black;">32.5050</span> | 33.0 | <span style="border: 1px solid black;">33.4950</span> |
| R3160N340x   | 33.660                | 34.0 | 34.340 | <span style="border: 1px solid black;">33.4900</span> | 34.0 | <span style="border: 1px solid black;">34.5100</span> |
| R3160N350x   | 34.650                | 35.0 | 35.350 | <span style="border: 1px solid black;">34.4750</span> | 35.0 | <span style="border: 1px solid black;">35.5250</span> |
| R3160N360x   | 35.640                | 36.0 | 36.360 | <span style="border: 1px solid black;">35.4600</span> | 36.0 | <span style="border: 1px solid black;">36.5400</span> |
| R3160N370x   | 36.630                | 37.0 | 37.370 | <span style="border: 1px solid black;">36.4450</span> | 37.0 | <span style="border: 1px solid black;">37.5550</span> |
| R3160N380x   | 37.620                | 38.0 | 38.380 | <span style="border: 1px solid black;">37.4300</span> | 38.0 | <span style="border: 1px solid black;">38.5700</span> |
| R3160N390x   | 38.610                | 39.0 | 39.390 | <span style="border: 1px solid black;">38.4150</span> | 39.0 | <span style="border: 1px solid black;">39.5850</span> |
| R3160N400x   | 39.600                | 40.0 | 40.400 | <span style="border: 1px solid black;">39.4000</span> | 40.0 | <span style="border: 1px solid black;">40.6000</span> |
| R3160N410x   | 40.590                | 41.0 | 41.410 | <span style="border: 1px solid black;">40.3850</span> | 41.0 | <span style="border: 1px solid black;">41.6150</span> |
| R3160N420x   | 41.580                | 42.0 | 42.420 | <span style="border: 1px solid black;">41.3700</span> | 42.0 | <span style="border: 1px solid black;">42.6300</span> |
| R3160N430x   | 42.570                | 43.0 | 43.430 | <span style="border: 1px solid black;">42.3550</span> | 43.0 | <span style="border: 1px solid black;">43.6450</span> |
| R3160N440x   | 43.560                | 44.0 | 44.440 | <span style="border: 1px solid black;">43.3400</span> | 44.0 | <span style="border: 1px solid black;">44.6600</span> |
| R3160N450x   | 44.550                | 45.0 | 45.450 | <span style="border: 1px solid black;">44.3250</span> | 45.0 | <span style="border: 1px solid black;">45.6750</span> |
| R3160N460x   | 45.540                | 46.0 | 46.460 | <span style="border: 1px solid black;">45.3100</span> | 46.0 | <span style="border: 1px solid black;">46.6900</span> |
| R3160N470x   | 46.530                | 47.0 | 47.470 | <span style="border: 1px solid black;">46.2950</span> | 47.0 | <span style="border: 1px solid black;">47.7050</span> |
| R3160N480x   | 47.520                | 48.0 | 48.480 | <span style="border: 1px solid black;">47.2800</span> | 48.0 | <span style="border: 1px solid black;">48.7200</span> |

## THEORY OF OPERATION

### Operating Conditions (R3160NxxxA)



Block Diagram with External Capacitor



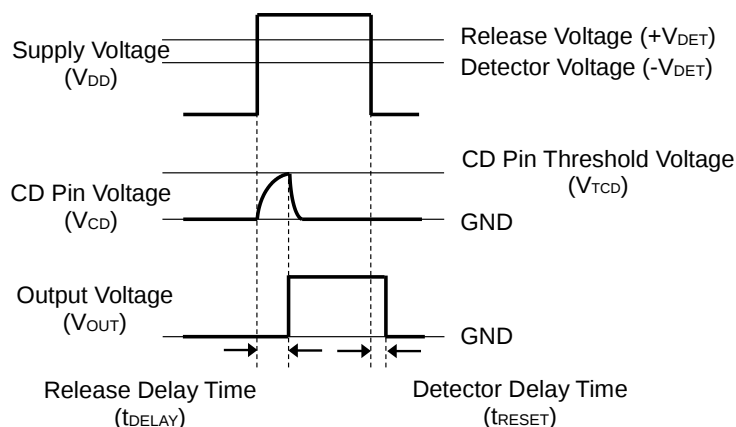
Operation Diagram

### Operating Conditions <sup>(1)</sup>

1.  $V_{OUT}$  is equalized to the pulled-up voltage.
2. When  $V_{DD}$  drops to  $-V_{DET}$  (A point) which means  $V_{ref} \geq V_{DD} \times (R_b+R_c) / (R_a+R_b+R_c)$ , the comparator output shifts from "Low" to "High" voltage and  $V_{OUT}$  becomes equal to GND.
3. If  $V_{DD}$  is lower than  $V_{DDL}$ ,  $V_{OUT}$  becomes unstable.
4.  $V_{OUT}$  becomes equal to GND.
5. When  $V_{DD}$  becomes higher than  $+V_{DET}$  (B point) which means  $V_{REF} \leq V_{DD} \times R_b / (R_a+R_b)$ , the comparator output shifts from "High" to "Low" voltage and  $V_{OUT}$  becomes equal to the pulled-up voltage.

<sup>(1)</sup> For R3160NxxxB, the output voltage logic is inverted except 3. The R3160NxxxB becomes pulled-up voltage in 3.

### Delay in Operation and Release Delay Time ( $t_{\text{DELAY}}$ )



**Release Delay Timing Diagram**

When supplying  $V_{\text{DD}}$  higher than  $+V_{\text{DET}}$  to the VDD pin, charging to an external capacitor starts and  $V_{\text{CD}}$  increases.  $V_{\text{OUT}}$  maintains “Low” until  $V_{\text{CD}}$  reaches  $V_{\text{TCD}}$ .  $V_{\text{OUT}}$  inverts from “Low” to “High” when  $V_{\text{CD}}$  exceeds  $V_{\text{TCD}}$ . The release delay time ( $t_{\text{DELAY}}$ ) is the period from supplying  $V_{\text{DD}}$  to  $V_{\text{OUT}}$  inverted.

$V_{\text{OUT}}$  inverted from “Low” to “High” starts discharging the load charged to the external capacitor. Therefore, the detector delay time ( $t_{\text{RESET}}$ ) until  $V_{\text{OUT}}$  is inverted from “High” to “Low” remains constant independent of the external capacitor, when  $V_{\text{DD}}$  lower than the  $-V_{\text{DET}}$  is supplied to the VDD pin.

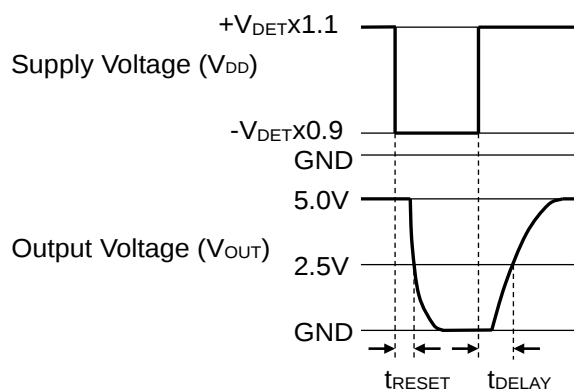
For R3160NxxxB, the above output voltage logic is inverted.

### Calculation of Release Delay Time ( $t_{\text{DELAY}}$ )

The following equation can calculate a typical value of the release delay time ( $t_{\text{DELAY}}$ ) with using the external capacitor ( $C_{\text{D}}$ ).

$$t_{\text{DELAY}} (\text{s}) = 1.8 \times 10^6 \times C_{\text{D}} (\text{F})$$

$t_{\text{DELAY}}$  is the period from supplying a pulse voltage of  $-V_{\text{DET}} \times 0.9$  to  $V_{\text{DET}} \times 1.1$  to the VDD pin to  $V_{\text{OUT}}$  reached 2.5 V after the COUT pin is pulled up to 5 V with a resistor of 100 k $\Omega$ .

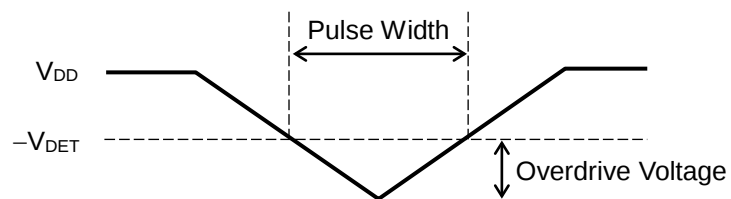


**R3160NxxxA**

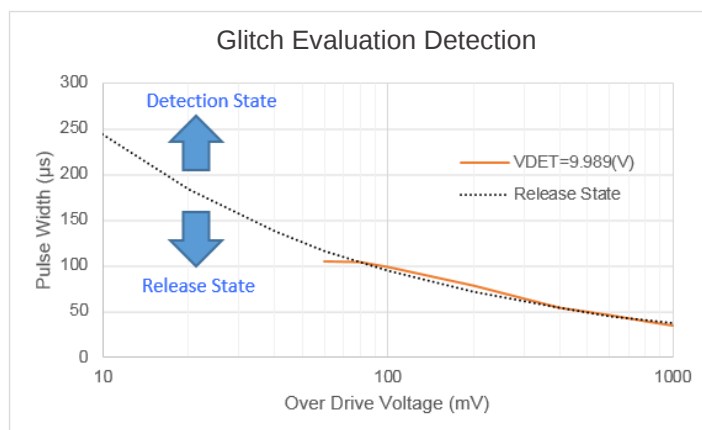
### Detection by the glitch of $V_{DD}$

The following graph shows a pulse amplitude and a pulse width, which maintain the release state when the detector voltage ( $-V_{DET}$ ) or lower pulse is input to  $V_{DD}$  at the release state.

The graph shows the maximum pulse condition that enables to maintain the release state. Note that a reset signal may be output when a pulse with larger amplitude/width than the pulse on the graph is input to  $V_{DD}$ .



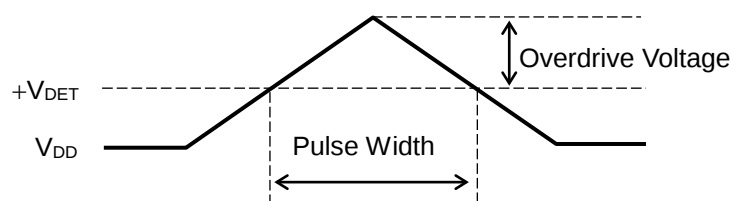
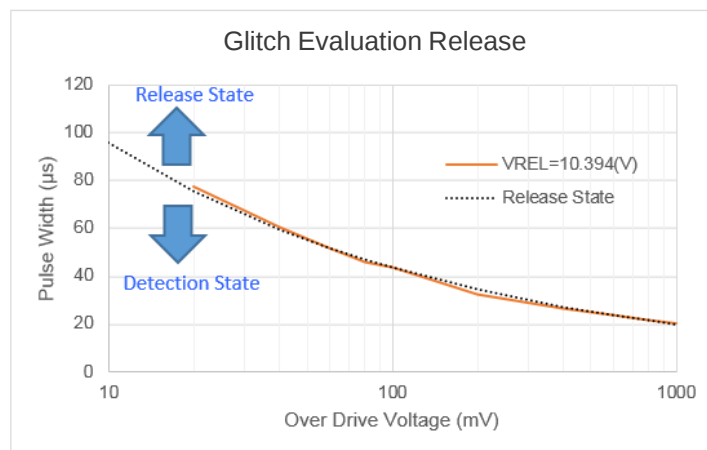
**$V_{DD}$  Input Waveform**



**Release by the glitch of  $V_{DD}$** 

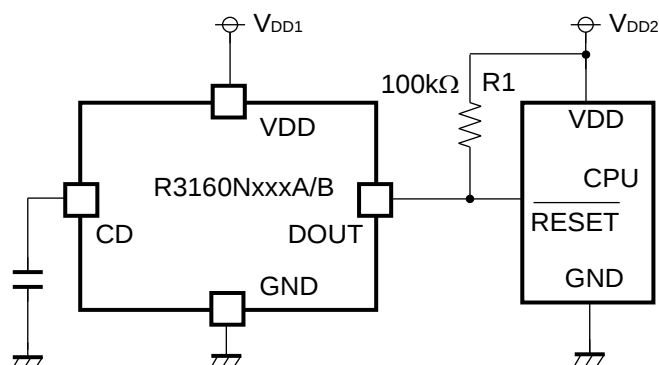
The following graph shows a pulse amplitude and a pulse width, which maintain the detection state when the release voltage ( $+V_{DET}$ ) or higher pulse is input to  $V_{DD}$  at the detection state.

The graph shows the maximum pulse condition that enables to maintain the detection state. Note that a release signal may be output when a pulse with larger amplitude/width than the pulse on the graph is input to  $V_{DD}$ .

 **$V_{DD}$  Input Waveform**

## APPLICATION INFORMATION

### Typical Application Circuit



R3160Nxxx A/B Typical Application Circuit

### Recommended External Components

| Symbol         | Description                                                                                                                                                                                                                                                      |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C <sub>D</sub> | A capacitor corresponding to the release delay time setting is required. Refer to <i>Delay in Operation and Release Delay Time (t<sub>DELAY</sub>)</i> in <i>THEORY OF OPERATION</i> for details.                                                                |
| R1             | A resistor is required to set with consideration of the output current at Nch. driver's ON and the leakage current at Nch. driver's OFF. Refer to <i>ELECTRICAL CHARACTERISTICS</i> for details – the evaluation result provided with a resistor of 100 kΩ used. |

## TECHNICAL NOTES

### When connecting resistors to the device's input pin

When connecting a resistor (R1) to an input of this device, the input voltage decreases by [Device's Consumption Current] x [Resistance Value] only. And, the cross conduction current, which occurs when changing from the detecting state to the release state, is decreased the input voltage by [Cross Conduction Current] x [Resistance Value] only. And then, this device will enter the re-detecting state if the input voltage reduction is larger than the difference between the detector voltage and the released voltage.

When the input resistance value is large and the VDD is gone up at mildly in the vicinity of the released voltage, repeating the above operation may result in the occurrence of output.

As shown in Figure A/B, set R1 to become 100 kΩ or less as a guide, and connect C<sub>IN</sub><sup>(1)</sup> of 0.1 μF and more to between the input pin and GND. Besides, make evaluations including temperature properties under the actual usage condition, with using the evaluation board like this way. As result, make sure that the cross conduction current has no problem.

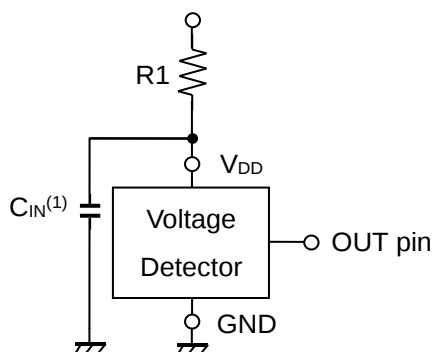


Figure A

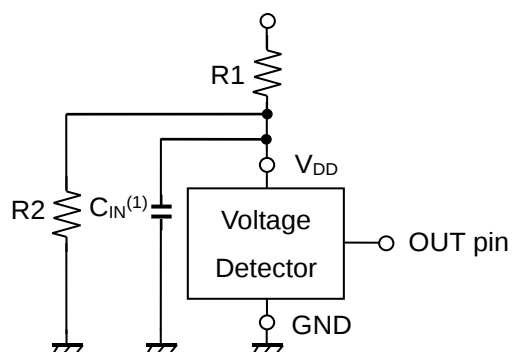


Figure B

---

<sup>(1)</sup> Note the bias dependence of capacitors.

---

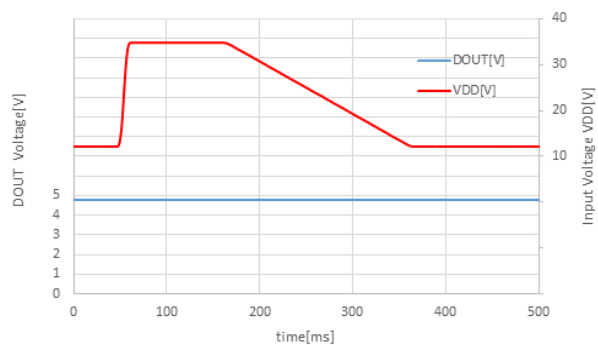
## TYPICAL CHARACTERISTICS

Typical Characteristics are intended to be used as reference data, they are not guaranteed.

### 1) Load Dump ( $T_a = 25^\circ\text{C}$ )

VDD = 12 V  $\rightarrow$  35 V ( $T_r = 1$  ms)  $\rightarrow$  12 V ( $T_f = 170$  ms)

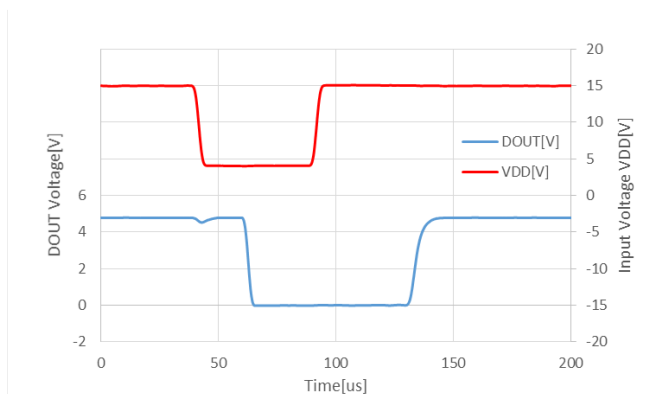
R3160N100A



### 2) Cranking ( $T_a = 25^\circ\text{C}$ )

VDD = 15 V  $\rightarrow$  4 V  $\rightarrow$  15 V ( $T_r = T_f = 1$   $\mu\text{s}$ )

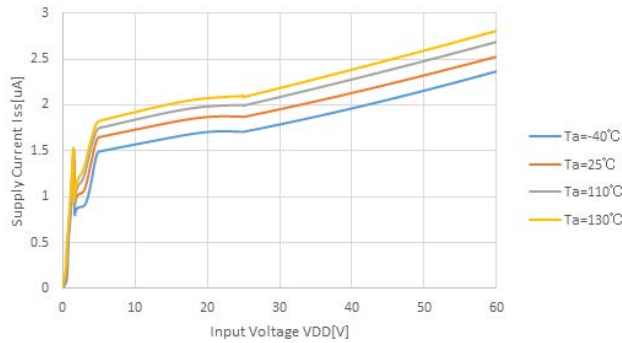
R3160N100A, CD = none



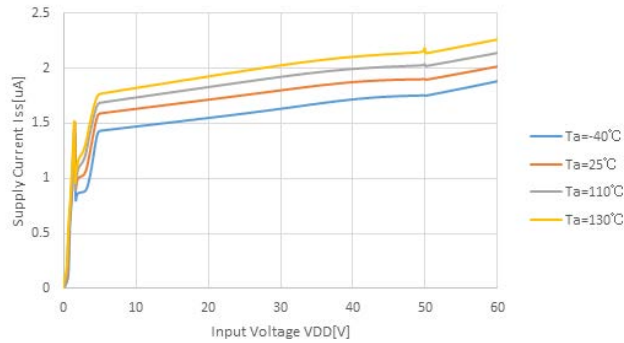
# R3160N

No. EY-402-170822

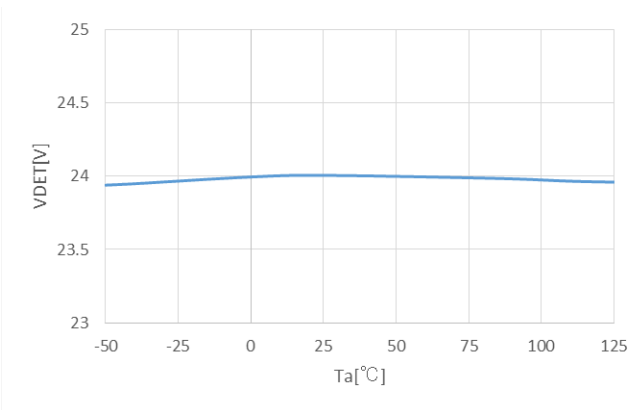
## 3) Supply Current vs. $V_{DD}$ R3160N240A



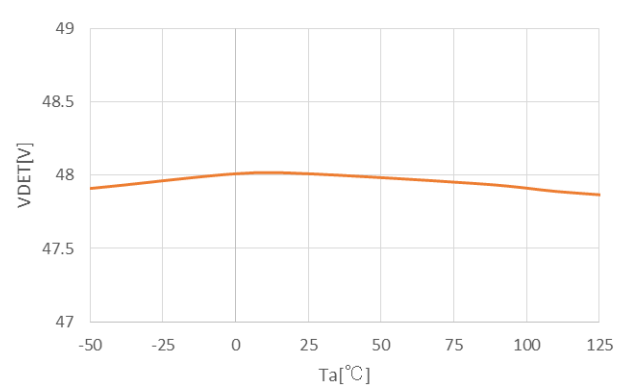
## R3160N480A



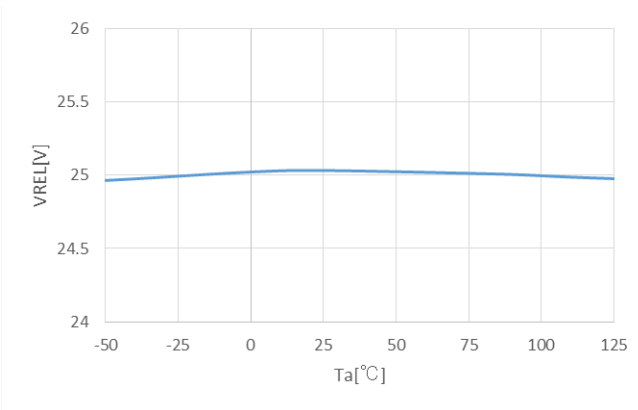
## 4) Detector Voltage vs. Ambient Temperature R3160N240A



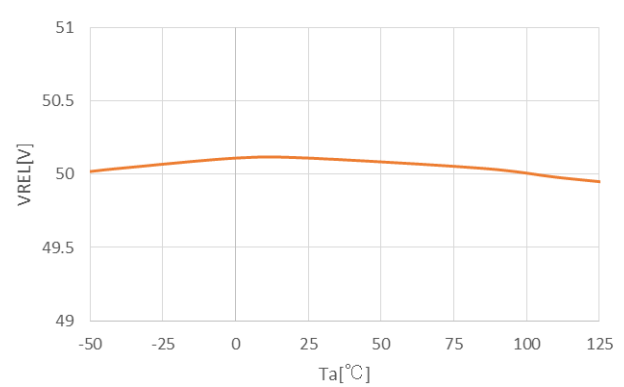
## R3160N480A



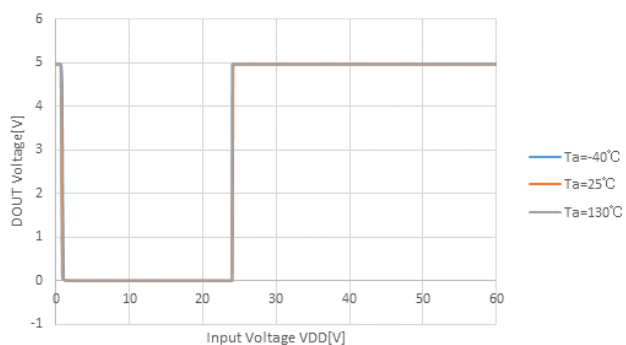
## 5) Release Voltage vs. Ambient Temperature R3160N240A



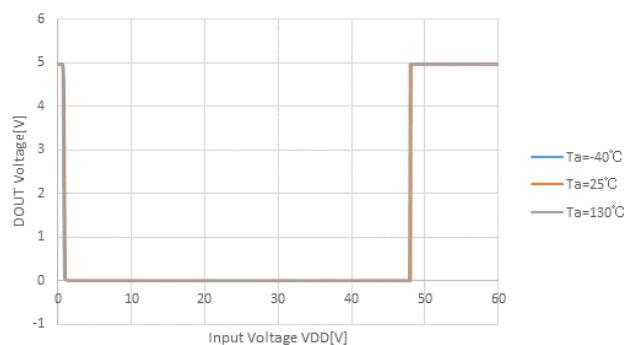
## R3160N480A



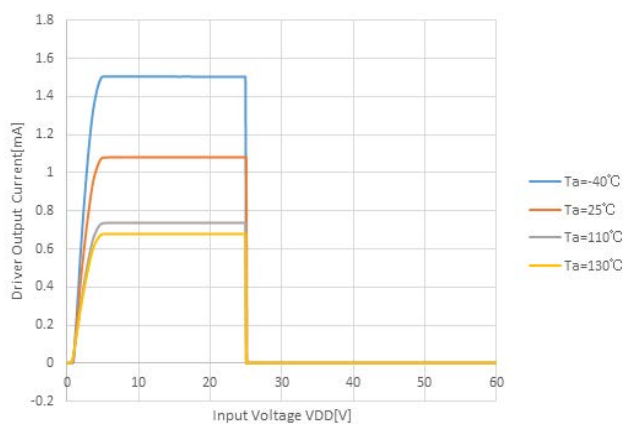
6) DOUT Voltage vs. Input Voltage  
 DOUT: 5 V pulled up with 100 kohm  
 R3160N240A



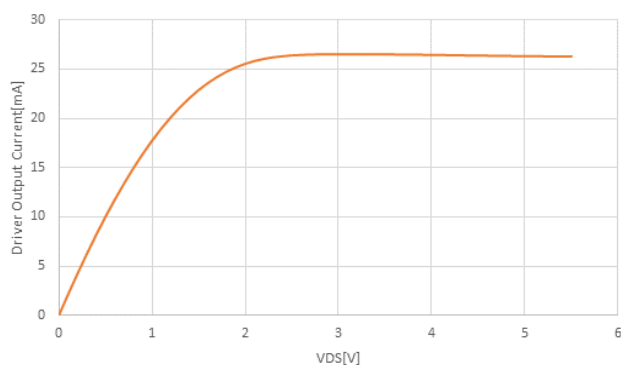
R3160N480A



7) Driver Output Current vs. Input Voltage  
 DOUT = 0.05 V  
 R3160N240A



8) Driver Output Current vs. VDS (Ta = 25°C)  
 VDD = VDET - 0.1 V, DOUT = 0 V → 5.5 V  
 R3160N240A



---

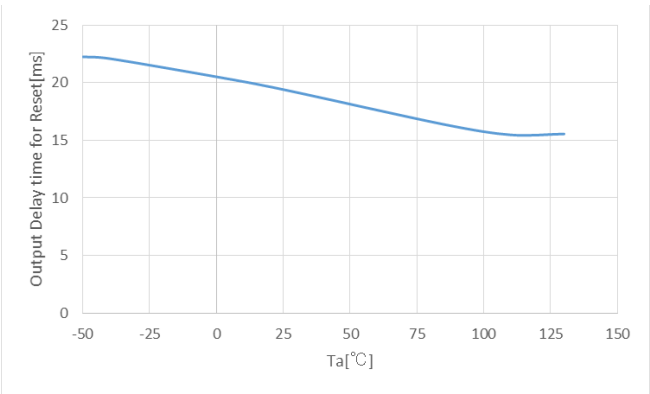
# R3160N

---

No. EY-402-170822

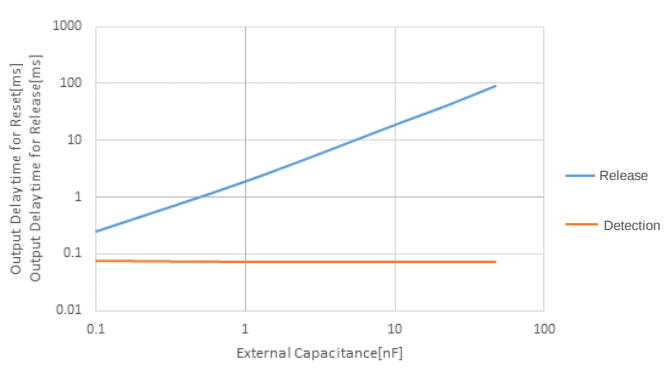
9) Release Delay Time vs. Ambient Temperature

R3160N240A  
CD = 10 nF



10) Detector/Release Delay Time vs. External Capacitor for CD Pin (Ta = 25°C)

R3160N240A  
CD = 100 pF to 47 nF



The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

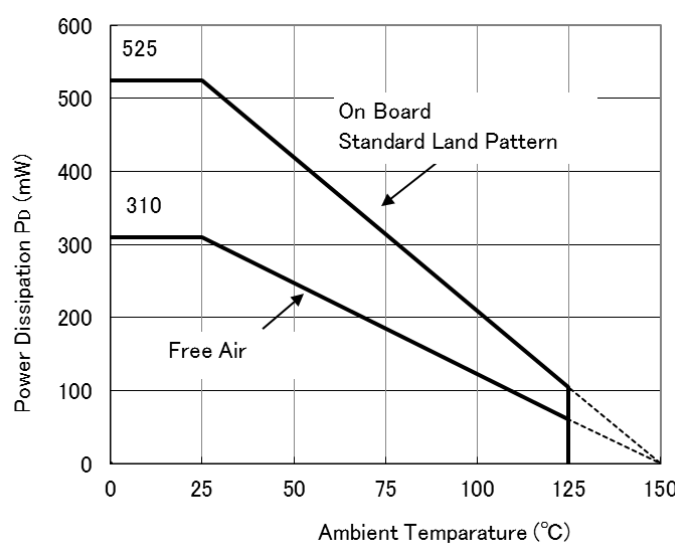
Measurement Conditions

|                  | Standard Test Land Pattern                        |
|------------------|---------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)         |
| Board Material   | Glass Cloth Epoxy Plastic (Double-Sided Board)    |
| Board Dimensions | 40 mm × 40 mm × 1.6 mm                            |
| Copper Ratio     | Top Side: Approx. 50%<br>Bottom Side: Approx. 50% |
| Through-holes    | φ 0.5 mm × 44 pcs                                 |

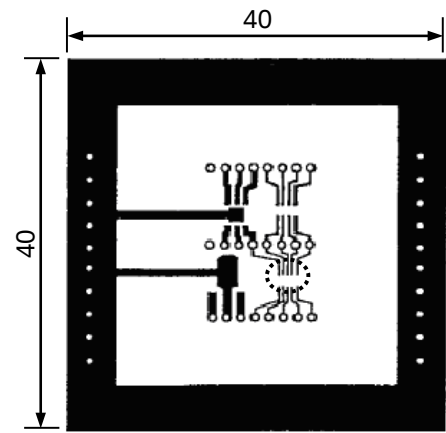
Measurement Result

(Ta = 25°C, Tjmax = 150°C)

|                    | Standard Test Land Pattern                                                           | Free Air  |
|--------------------|--------------------------------------------------------------------------------------|-----------|
| Power Dissipation  | 525 mW                                                                               | 310 mW    |
| Thermal Resistance | $\theta_{ja} = (150 - 25^{\circ}\text{C}) / 0.525 \text{ W} = 238^{\circ}\text{C/W}$ | 400°C / W |

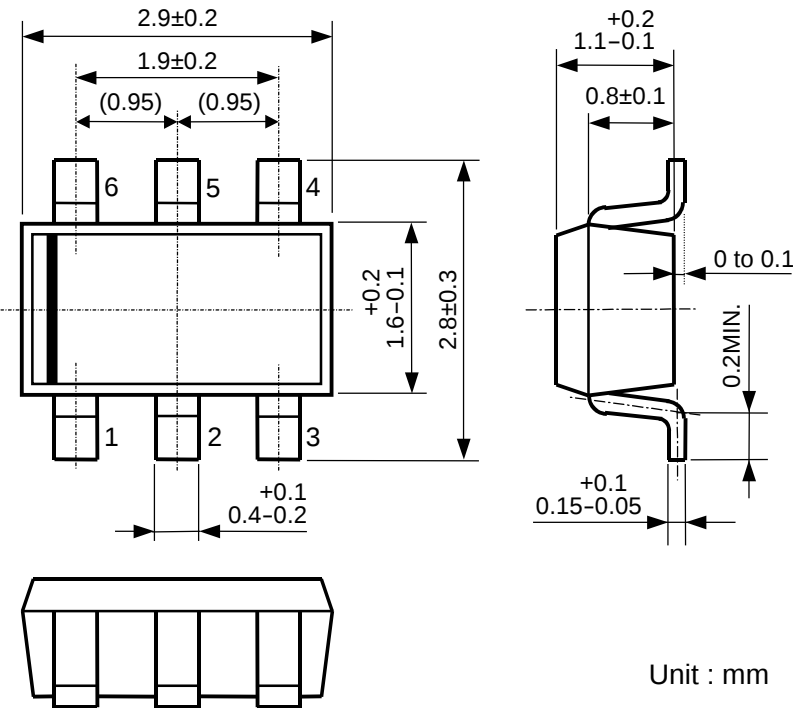


Power Dissipation vs. Ambient Temperature



○ IC Mount Area (mm)

Measurement Board Pattern



SOT-23-6 Package Dimensions



1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh's or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. Anti-radiation design is not implemented in the products described in this document.
8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.
11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.



**Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment.**

Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

**RICOH** RICOH ELECTRONIC DEVICES CO., LTD.

<https://www.e-devices.ricoh.co.jp/en/>

#### Sales & Support Offices

##### **Ricoh Electronic Devices Co., Ltd.**

##### **Shin-Yokohama Office (International Sales)**

2-3, Shin-Yokohama 3-chome, Kohoku-ku, Yokohama-shi, Kanagawa, 222-8530, Japan  
Phone: +81-50-3814-7687 Fax: +81-45-474-0074

##### **Ricoh Americas Holdings, Inc.**

675 Campbell Technology Parkway, Suite 200 Campbell, CA 95008, U.S.A.  
Phone: +1-408-610-3105

##### **Ricoh Europe (Netherlands) B.V.**

##### **Semiconductor Support Centre**

Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands  
Phone: +31-20-5474-309

##### **Ricoh International B.V. - German Branch**

##### **Semiconductor Sales and Support Centre**

Oberrather Strasse 6, 40472 Düsseldorf, Germany  
Phone: +49-211-6546-0

##### **Ricoh Electronic Devices Korea Co., Ltd.**

3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea  
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

##### **Ricoh Electronic Devices Shanghai Co., Ltd.**

Room 403, No.2 Building, No.690 Bibo Road, Pu Dong New District, Shanghai 201203,  
People's Republic of China  
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

##### **Ricoh Electronic Devices Shanghai Co., Ltd.**

##### **Shenzhen Branch**

1205, Block D(Jinlong Building), Kingkey 100, Hongbao Road, Luohu District,  
Shenzhen, China  
Phone: +86-755-8348-7600 Ext 225

##### **Ricoh Electronic Devices Co., Ltd.**

##### **Taipei office**

Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)  
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Ricoch Electronics:](#)

[R3160N160A-TR-YE](#) [R3160N160B-TR-YE](#) [R3160N250A-TR-YE](#) [R3160N290A-TR-YE](#) [R3160N350A-TR-YE](#)  
[R3160N370A-TR-YE](#)