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# **LOW VOLTAGE DETECTOR**

## **RN5VS SERIES**

### **APPLICATION MANUAL**

# **RICOH**

**ELECTRONIC DEVICES DIVISION**

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June 1995

# RN5VS SERIES

## APPLICATION MANUAL

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## LOW VOLTAGE DETECTOR

### RN5VS SERIES

#### OUTLINE

The RN5VS Series are voltage detector ICs with high detector threshold accuracy and ultra-low supply current by CMOS process, which can be operated at an extremely low voltage and is used, for instance, for system reset.

Each of these ICs consists of a voltage reference unit, a comparator, resistors for voltage detection, an output driver and a hysteresis circuit. The detector threshold is fixed with high accuracy.

The RN5VS Series are operable by a lower voltage than that for the R×5VL Series, and can be driven by a single battery.

Two output types, Nch open drain type and CMOS type, are available. Since the package for these ICs are SOT-23-5 (Mini-mold) package, high density mounting of the ICs on board is possible.

#### FEATURES

- Ultra-low Supply Current .....TYP. 0.8 $\mu$ A ( $V_{DD}$ =1.5V)
- Broad Operating Voltage Range ..... 0.7V to 10.0V ( $T_{opt}$  =25°C)
- Detector Threshold .....Stepwise setting with a step of 0.1V in the range of 0.9V to 6.0V  
is possible (refer to Selection Guide).
- High Accuracy Detector Threshold ..... $\pm 3.0\%$
- Low Temperature-Drift Coefficient of Detector Threshold .....TYP.  $\pm 100$ ppm/°C
- Two Output Types .....Nch Open Drain and CMOS
- Packages .....SOT-23-5 (Mini-mold)

#### APPLICATIONS

- CPU & Logic Circuit Reset
- Battery Checker
- Window Comparator
- Wave Shaping Circuit
- Battery Back-Up Circuit
- Power Failure Detector



Output Delay Time  $t_{PLH}$  is defined as follows:

1. In the case of Nch Open Drain Output:

When the time at which a pulse voltage which increases from 0.7V to  $+V_{DET}+2.0V$  is applied to  $V_{DD}$  is Time A, and the time at which the output voltage reaches 2.5V under the conditions that the output pin (OUT) is pulled up to 5V by a resistor of 470k $\Omega$  is Time B, the time period from Time A through Time B.

2. In the case of CMOS Output:

When the time at which a pulse voltage which increases from 0.7V to  $+V_{DET}+2.0V$  is applied to  $V_{DD}$  is Time A, and the time at which the output voltage reaches the voltage of  $(+V_{DET}+2.0V)/2$  is Time B, the time period from Time A through Time B.

## SELECTION GUIDE

The detector threshold, the output type, the packing type, and the taping type of RN5VS series can be designating at the user's request by specifying the part number as follows:

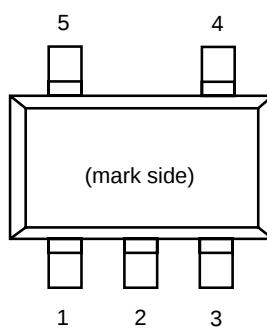
RN5VSXXXX- $\times$  → Part Number  
          ↑ ↑ ↑ ↑  
          a b c d

| Code | Contents                                                                                                                     |
|------|------------------------------------------------------------------------------------------------------------------------------|
| a    | Setting Detector Threshold ( $-V_{DET}$ ):<br>Stepwise setting with a step of 0.1V in the range of 0.9V to 6.0V is possible. |
| b    | Designation of Output Type:<br>A: Nch Open Drain<br>C: CMOS                                                                  |
| c    | Designation of Packing Type:<br>A: Taping<br>C: Antistatic bag for samples                                                   |
| d    | Designation of Taping Type:<br>Ex. TR, TL<br>(refer to Taping Specifications, the standard direction is TR.)                 |

For example, the product with Detector Threshold 3.5V, Output Type Nch Open Drain and Taping Type TR, is designated by Part Number RN5VS35AA-TR.

## PIN CONFIGURATION

### • SOT-23-5



## PIN DESCRIPTION

### • SOT-23-5

| Pin No. | Symbol          |
|---------|-----------------|
| 1       | OUT             |
| 2       | V <sub>DD</sub> |
| 3       | GND             |
| 4       | NC              |
| 5       | NC              |

**ABSOLUTE MAXIMUM RATINGS**T<sub>opt</sub>=25°C

| Symbol              | Item                         | Rating      |                                              | Unit |
|---------------------|------------------------------|-------------|----------------------------------------------|------|
| V <sub>DD</sub>     | Supply Voltage               | +12         |                                              | V    |
| V <sub>OUT</sub>    | Output Voltage               | CMOS        | V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3 | V    |
|                     |                              | Nch         | V <sub>SS</sub> -0.3 to +12                  |      |
| I <sub>OUT</sub>    | Output Current               | 70          |                                              | mA   |
| P <sub>D</sub>      | Power Dissipation            | 150         |                                              | mW   |
| T <sub>opt</sub>    | Operating Temperature Range  | -40 to +85  |                                              | °C   |
| T <sub>stg</sub>    | Storage Temperature Range    | -55 to +125 |                                              | °C   |
| T <sub>solder</sub> | Lead Temperature (Soldering) | 260°C, 10s  |                                              |      |

**ABSOLUTE MAXIMUM RATINGS**

Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

## ELECTRICAL CHARACTERISTICS

## • RN5VS09A/C

T<sub>opt</sub>=25°C

| Symbol                                  | Item                                       | Conditions                                            | MIN.  | TYP.  | MAX.  | Unit   | Note   |
|-----------------------------------------|--------------------------------------------|-------------------------------------------------------|-------|-------|-------|--------|--------|
| -V <sub>DET</sub>                       | Detector Threshold                         |                                                       | 0.873 | 0.900 | 0.927 | V      |        |
| V <sub>HYS</sub>                        | Detector Threshold Hysteresis              |                                                       | 0.018 | 0.045 | 0.072 | V      |        |
| I <sub>SS</sub>                         | Supply Current                             | V <sub>DD</sub> =0.80V                                |       | 0.8   | 2.4   | μA     |        |
|                                         |                                            | V <sub>DD</sub> =2.90V                                |       | 0.9   | 2.7   |        |        |
| V <sub>DDH</sub>                        | Maximum Operating Voltage                  |                                                       |       |       | 10    | V      |        |
| V <sub>DDL</sub>                        | Minimum Operating Voltage                  | T <sub>opt</sub> =25°C                                |       | 0.55  | 0.70  | V      | Note 1 |
|                                         |                                            | -40°C≤T <sub>opt</sub> ≤85°C                          |       | 0.65  | 0.80  |        |        |
| I <sub>OUT</sub>                        | Output Current                             | Nch<br>V <sub>DS</sub> =0.05V, V <sub>DD</sub> =0.70V | 0.01  | 0.05  |       | mA     |        |
|                                         |                                            | V <sub>DS</sub> =0.50V, V <sub>DD</sub> =0.85V        | 0.05  | 0.50  |       |        |        |
|                                         |                                            | Pch<br>V <sub>DS</sub> =-2.1V, V <sub>DD</sub> =4.5V  | 1.0   | 2.0   |       | mA     |        |
| t <sub>PLH</sub>                        | Output Delay Time                          |                                                       |       |       | 100   | μs     | Note 2 |
| $\frac{\Delta-V_{DET}}{\Delta T_{opt}}$ | Detector Threshold Temperature Coefficient | -40°C≤T <sub>opt</sub> ≤85°C                          |       | ±100  |       | ppm/°C |        |

## • RN5VS18A/C

T<sub>opt</sub>=25°C

| Symbol                                  | Item                                       | Conditions                                            | MIN.  | TYP.  | MAX.  | Unit   | Note   |
|-----------------------------------------|--------------------------------------------|-------------------------------------------------------|-------|-------|-------|--------|--------|
| -V <sub>DET</sub>                       | Detector Threshold                         |                                                       | 1.746 | 1.800 | 1.854 | V      |        |
| V <sub>HYS</sub>                        | Detector Threshold Hysteresis              |                                                       | 0.036 | 0.090 | 0.144 | V      |        |
| I <sub>SS</sub>                         | Supply Current                             | V <sub>DD</sub> =1.70V                                |       | 0.8   | 2.4   | μA     |        |
|                                         |                                            | V <sub>DD</sub> =3.80V                                |       | 1.0   | 3.0   |        |        |
| V <sub>DDH</sub>                        | Maximum Operating Voltage                  |                                                       |       |       | 10    | V      |        |
| V <sub>DDL</sub>                        | Minimum Operating Voltage                  | T <sub>opt</sub> =25°C                                |       | 0.55  | 0.70  | V      | Note 1 |
|                                         |                                            | -40°C≤T <sub>opt</sub> ≤85°C                          |       | 0.65  | 0.80  |        |        |
| I <sub>OUT</sub>                        | Output Current                             | Nch<br>V <sub>DS</sub> =0.05V, V <sub>DD</sub> =0.70V | 0.01  | 0.05  |       | mA     |        |
|                                         |                                            | V <sub>DS</sub> =0.50V, V <sub>DD</sub> =1.50V        | 1.00  | 2.00  |       |        |        |
|                                         |                                            | Pch<br>V <sub>DS</sub> =-2.1V, V <sub>DD</sub> =4.5V  | 1.0   | 2.0   |       | mA     |        |
| t <sub>PLH</sub>                        | Output Delay Time                          |                                                       |       |       | 100   | μs     | Note 2 |
| $\frac{\Delta-V_{DET}}{\Delta T_{opt}}$ | Detector Threshold Temperature Coefficient | -40°C≤T <sub>opt</sub> ≤85°C                          |       | ±100  |       | ppm/°C |        |

## RN5VS

### • RN5VS27A/C

T<sub>opt</sub>=25°C

| Symbol                                  | Item                                       | Conditions                                            | MIN.  | TYP.  | MAX.  | Unit   | Note   |
|-----------------------------------------|--------------------------------------------|-------------------------------------------------------|-------|-------|-------|--------|--------|
| -V <sub>DET</sub>                       | Detector Threshold                         |                                                       | 2.619 | 2.700 | 2.781 | V      |        |
| V <sub>HYS</sub>                        | Detector Threshold Hysteresis              |                                                       | 0.054 | 0.135 | 0.216 | V      |        |
| I <sub>SS</sub>                         | Supply Current                             | V <sub>DD</sub> =2.60V                                |       | 0.9   | 2.7   | μA     |        |
|                                         |                                            | V <sub>DD</sub> =4.70V                                |       | 1.1   | 3.3   |        |        |
| V <sub>DDH</sub>                        | Maximum Operating Voltage                  |                                                       |       |       | 10    | V      |        |
| V <sub>DDL</sub>                        | Minimum Operating Voltage                  | T <sub>opt</sub> =25°C                                |       | 0.55  | 0.70  | V      | Note 1 |
|                                         |                                            | -40°C≤T <sub>opt</sub> ≤85°C                          |       | 0.65  | 0.80  |        |        |
| I <sub>OUT</sub>                        | Output Current                             | Nch<br>V <sub>DS</sub> =0.05V, V <sub>DD</sub> =0.70V | 0.01  | 0.05  |       | mA     |        |
|                                         |                                            | V <sub>DS</sub> =0.50V, V <sub>DD</sub> =1.50V        | 1.00  | 2.00  |       |        |        |
|                                         |                                            | Pch<br>V <sub>DS</sub> =-2.1V, V <sub>DD</sub> =4.5V  | 1.0   | 2.0   |       | mA     |        |
| t <sub>PLH</sub>                        | Output Delay Time                          |                                                       |       |       | 100   | μs     | Note 2 |
| $\frac{\Delta-V_{DET}}{\Delta T_{opt}}$ | Detector Threshold Temperature Coefficient | -40°C≤T <sub>opt</sub> ≤85°C                          |       | ±100  |       | ppm/°C |        |

### • RN5VS36A/C

T<sub>opt</sub>=25°C

| Symbol                                  | Item                                       | Conditions                                            | MIN.  | TYP.  | MAX.  | Unit   | Note   |
|-----------------------------------------|--------------------------------------------|-------------------------------------------------------|-------|-------|-------|--------|--------|
| -V <sub>DET</sub>                       | Detector Threshold                         |                                                       | 3.492 | 3.600 | 3.708 | V      |        |
| V <sub>HYS</sub>                        | Detector Threshold Hysteresis              |                                                       | 0.072 | 0.180 | 0.288 | V      |        |
| I <sub>SS</sub>                         | Supply Current                             | V <sub>DD</sub> =3.47V                                |       | 1.0   | 3.0   | μA     |        |
|                                         |                                            | V <sub>DD</sub> =5.60V                                |       | 1.2   | 3.6   |        |        |
| V <sub>DDH</sub>                        | Maximum Operating Voltage                  |                                                       |       |       | 10    | V      |        |
| V <sub>DDL</sub>                        | Minimum Operating Voltage                  | T <sub>opt</sub> =25°C                                |       | 0.55  | 0.70  | V      | Note 1 |
|                                         |                                            | -40°C≤T <sub>opt</sub> ≤85°C                          |       | 0.65  | 0.80  |        |        |
| I <sub>OUT</sub>                        | Output Current                             | Nch<br>V <sub>DS</sub> =0.05V, V <sub>DD</sub> =0.70V | 0.01  | 0.05  |       | mA     |        |
|                                         |                                            | V <sub>DS</sub> =0.50V, V <sub>DD</sub> =1.50V        | 1.00  | 2.00  |       |        |        |
|                                         |                                            | Pch<br>V <sub>DS</sub> =-2.1V, V <sub>DD</sub> =4.5V  | 1.0   | 2.0   |       | mA     |        |
| t <sub>PLH</sub>                        | Output Delay Time                          |                                                       |       |       | 100   | μs     | Note 2 |
| $\frac{\Delta-V_{DET}}{\Delta T_{opt}}$ | Detector Threshold Temperature Coefficient | -40°C≤T <sub>opt</sub> ≤85°C                          |       | ±100  |       | ppm/°C |        |

## • RN5VS45A/C

Topt=25°C

| Symbol                               | Item                                       | Conditions                                         | MIN.  | TYP.  | MAX.  | Unit   | Note   |
|--------------------------------------|--------------------------------------------|----------------------------------------------------|-------|-------|-------|--------|--------|
| -V <sub>DET</sub>                    | Detector Threshold                         |                                                    | 4.365 | 4.500 | 4.635 | V      |        |
| V <sub>HYS</sub>                     | Detector Threshold Hysteresis              |                                                    | 0.090 | 0.225 | 0.360 | V      |        |
| I <sub>SS</sub>                      | Supply Current                             | V <sub>DD</sub> =4.34V                             |       | 1.1   | 3.3   | μA     |        |
|                                      |                                            | V <sub>DD</sub> =6.50V                             |       | 1.3   | 3.9   |        |        |
| V <sub>DDH</sub>                     | Maximum Operating Voltage                  |                                                    |       |       | 10    | V      |        |
| V <sub>DDL</sub>                     | Minimum Operating Voltage                  | Topt=25°C                                          |       | 0.55  | 0.70  | V      | Note 1 |
|                                      |                                            | -40°C≤Topt≤85°C                                    |       | 0.65  | 0.80  |        |        |
| I <sub>OUT</sub>                     | Output Current                             | Nch V <sub>DS</sub> =0.05V, V <sub>DD</sub> =0.70V | 0.01  | 0.05  |       | mA     |        |
|                                      |                                            | V <sub>DS</sub> =0.50V, V <sub>DD</sub> =1.50V     | 1.00  | 2.00  |       |        |        |
|                                      |                                            | Pch V <sub>DS</sub> =-2.1V, V <sub>DD</sub> =8.0V  | 1.5   | 3.0   |       | mA     |        |
| t <sub>PLH</sub>                     | Output Delay Time                          |                                                    |       |       | 100   | μs     | Note 2 |
| $\frac{\Delta-V_{DET}}{\Delta Topt}$ | Detector Threshold Temperature Coefficient | -40°C≤Topt≤85°C                                    |       | ±100  |       | ppm/°C |        |

## • RN5VS54A/C

Topt=25°C

| Symbol                               | Item                                       | Conditions                                         | MIN.  | TYP.  | MAX.  | Unit   | Note   |
|--------------------------------------|--------------------------------------------|----------------------------------------------------|-------|-------|-------|--------|--------|
| -V <sub>DET</sub>                    | Detector Threshold                         |                                                    | 5.238 | 5.400 | 5.562 | V      |        |
| V <sub>HYS</sub>                     | Detector Threshold Hysteresis              |                                                    | 0.108 | 0.270 | 0.432 | V      |        |
| I <sub>SS</sub>                      | Supply Current                             | V <sub>DD</sub> =5.20V                             |       | 1.2   | 3.6   | μA     |        |
|                                      |                                            | V <sub>DD</sub> =7.40V                             |       | 1.4   | 4.2   |        |        |
| V <sub>DDH</sub>                     | Maximum Operating Voltage                  |                                                    |       |       | 10    | V      |        |
| V <sub>DDL</sub>                     | Minimum Operating Voltage                  | Topt=25°C                                          |       | 0.55  | 0.70  | V      | Note 1 |
|                                      |                                            | -40°C≤Topt≤85°C                                    |       | 0.65  | 0.80  |        |        |
| I <sub>OUT</sub>                     | Output Current                             | Nch V <sub>DS</sub> =0.05V, V <sub>DD</sub> =0.70V | 0.01  | 0.05  |       | mA     |        |
|                                      |                                            | V <sub>DS</sub> =0.50V, V <sub>DD</sub> =1.50V     | 1.00  | 2.00  |       |        |        |
|                                      |                                            | Pch V <sub>DS</sub> =-2.1V, V <sub>DD</sub> =8.0V  | 1.5   | 3.0   |       | mA     |        |
| t <sub>PLH</sub>                     | Output Delay Time                          |                                                    |       |       | 100   | μs     | Note 2 |
| $\frac{\Delta-V_{DET}}{\Delta Topt}$ | Detector Threshold Temperature Coefficient | -40°C≤Topt≤85°C                                    |       | ±100  |       | ppm/°C |        |

(Note 1) Minimum Operating Voltage means the value of input voltage when output voltage maintains 0.1V or less, provided that in the case of Nch Open Drain Type Products, the pull-up resistance is set at 470kΩ, and the pull-up voltage is set at 5.0V.

(Note 2) Refer to the previously defined "Output Delay Time t<sub>PLH</sub>".

## ELECTRICAL CHARACTERISTICS BY DETECTOR THRESHOLD

• RN5VS09A/C to RN5VS39A/C

| Part Number | Detector Threshold |       |       | Detector Threshold Hysteresis |       |       | Supply Current 1                                    |      |      | Supply Current 2                                   |      |      |
|-------------|--------------------|-------|-------|-------------------------------|-------|-------|-----------------------------------------------------|------|------|----------------------------------------------------|------|------|
|             | -Vdet(V)           |       |       | Vhys(V)                       |       |       | Iss(μA)                                             |      |      | Iss(μA)                                            |      |      |
|             | MIN.               | TYP.  | MAX.  | MIN.                          | TYP.  | MAX.  | Conditions                                          | TYP. | MAX. | Conditions                                         | TYP. | MAX. |
| RN5VS09A/C  | 0.873              | 0.900 | 0.927 | 0.018                         | 0.045 | 0.072 | V <sub>DD</sub> =<br>(-V <sub>DET</sub> )<br>-0.10V | 0.8  | 2.4  | V <sub>DD</sub> =<br>(-V <sub>DET</sub> )<br>+2.0V | 0.9  | 2.7  |
| RN5VS10A/C  | 0.970              | 1.000 | 1.030 | 0.020                         | 0.050 | 0.080 |                                                     |      |      |                                                    | 1.0  | 3.0  |
| RN5VS11A/C  | 1.067              | 1.100 | 1.133 | 0.022                         | 0.055 | 0.088 |                                                     |      |      |                                                    |      |      |
| RN5VS12A/C  | 1.164              | 1.200 | 1.236 | 0.024                         | 0.060 | 0.096 |                                                     |      |      |                                                    |      |      |
| RN5VS13A/C  | 1.261              | 1.300 | 1.339 | 0.026                         | 0.065 | 0.104 |                                                     |      |      |                                                    |      |      |
| RN5VS14A/C  | 1.358              | 1.400 | 1.442 | 0.028                         | 0.070 | 0.112 |                                                     |      |      |                                                    |      |      |
| RN5VS15A/C  | 1.455              | 1.500 | 1.545 | 0.030                         | 0.075 | 0.120 |                                                     |      |      |                                                    |      |      |
| RN5VS16A/C  | 1.552              | 1.600 | 1.648 | 0.032                         | 0.080 | 0.128 |                                                     |      |      |                                                    |      |      |
| RN5VS17A/C  | 1.649              | 1.700 | 1.751 | 0.034                         | 0.085 | 0.136 |                                                     |      |      |                                                    |      |      |
| RN5VS18A/C  | 1.746              | 1.800 | 1.854 | 0.036                         | 0.090 | 0.144 |                                                     |      |      |                                                    |      |      |
| RN5VS19A/C  | 1.843              | 1.900 | 1.957 | 0.038                         | 0.095 | 0.152 |                                                     |      |      |                                                    |      |      |
| RN5VS20A/C  | 1.940              | 2.000 | 2.060 | 0.040                         | 0.100 | 0.160 |                                                     | 0.9  | 2.7  |                                                    | 1.1  | 3.3  |
| RN5VS21A/C  | 2.037              | 2.100 | 2.163 | 0.042                         | 0.105 | 0.168 |                                                     |      |      |                                                    |      |      |
| RN5VS22A/C  | 2.134              | 2.200 | 2.266 | 0.044                         | 0.110 | 0.176 |                                                     |      |      |                                                    |      |      |
| RN5VS23A/C  | 2.231              | 2.300 | 2.369 | 0.046                         | 0.115 | 0.184 |                                                     |      |      |                                                    |      |      |
| RN5VS24A/C  | 2.328              | 2.400 | 2.472 | 0.048                         | 0.120 | 0.192 |                                                     |      |      |                                                    |      |      |
| RN5VS25A/C  | 2.425              | 2.500 | 2.575 | 0.050                         | 0.125 | 0.200 |                                                     |      |      |                                                    |      |      |
| RN5VS26A/C  | 2.522              | 2.600 | 2.678 | 0.052                         | 0.130 | 0.208 |                                                     |      |      |                                                    |      |      |
| RN5VS27A/C  | 2.619              | 2.700 | 2.781 | 0.054                         | 0.135 | 0.216 |                                                     |      |      |                                                    |      |      |
| RN5VS28A/C  | 2.716              | 2.800 | 2.884 | 0.056                         | 0.140 | 0.224 |                                                     |      |      |                                                    |      |      |
| RN5VS29A/C  | 2.813              | 2.900 | 2.987 | 0.058                         | 0.145 | 0.232 |                                                     |      |      |                                                    |      |      |
| RN5VS30A/C  | 2.910              | 3.000 | 3.090 | 0.060                         | 0.150 | 0.240 | V <sub>DD</sub> =<br>(-V <sub>DET</sub> )<br>-0.13V | 1.0  | 3.0  |                                                    | 1.2  | 3.6  |
| RN5VS31A/C  | 3.007              | 3.100 | 3.193 | 0.062                         | 0.155 | 0.248 |                                                     |      |      |                                                    |      |      |
| RN5VS32A/C  | 3.104              | 3.200 | 3.296 | 0.064                         | 0.160 | 0.256 |                                                     |      |      |                                                    |      |      |
| RN5VS33A/C  | 3.201              | 3.300 | 3.399 | 0.066                         | 0.165 | 0.264 |                                                     |      |      |                                                    |      |      |
| RN5VS34A/C  | 3.298              | 3.400 | 3.502 | 0.068                         | 0.170 | 0.272 |                                                     |      |      |                                                    |      |      |
| RN5VS35A/C  | 3.395              | 3.500 | 3.605 | 0.070                         | 0.175 | 0.280 |                                                     |      |      |                                                    |      |      |
| RN5VS36A/C  | 3.492              | 3.600 | 3.708 | 0.072                         | 0.180 | 0.288 |                                                     |      |      |                                                    |      |      |
| RN5VS37A/C  | 3.589              | 3.700 | 3.811 | 0.074                         | 0.185 | 0.296 |                                                     |      |      |                                                    |      |      |
| RN5VS38A/C  | 3.686              | 3.800 | 3.914 | 0.076                         | 0.190 | 0.304 |                                                     |      |      |                                                    |      |      |
| RN5VS39A/C  | 3.783              | 3.900 | 4.017 | 0.078                         | 0.195 | 0.312 |                                                     |      |      |                                                    |      |      |

(Note 1) Refer to the previously defined "Output Delay Time t<sub>PLH</sub>".

(Note 2) Refer to the previously defined "Minimum Operating Voltage".

Condition 1 : T<sub>opt</sub> = 25°CCondition 2 : -40°C ≤ T<sub>opt</sub> ≤ 85°C

T<sub>opt</sub>=25°C

| Output Current 1 |      |      | Output Current 2 |           |      |           | Output Current 3 |      |      | Output Delay Time   | Minimum Operating Voltage |        | Detector Threshold Tempco. |      |
|------------------|------|------|------------------|-----------|------|-----------|------------------|------|------|---------------------|---------------------------|--------|----------------------------|------|
| Iout(mA)         |      |      | Iout(mA)         |           |      |           | Iout(mA)         |      |      | tph(μs)             | Vddl(V)                   |        | Δ-Vdet/ΔTopt (ppm/°C)      |      |
| Conditions       | MIN. | TYP. | Conditions       |           | MIN. | TYP.      | Conditions       | MIN. | TYP. | MAX.                | TYP.                      | MAX.   | Conditions                 | TYP. |
| Nch              | 0.01 | 0.05 | VDS=0.50V        | VDD=0.85V | 0.05 | 0.50      | Pch              | 1.0  | 2.0  | Note 1<br>100       | Note 2                    | Note 2 | -40°C≤<br>Topt<br>≤85°C    | ±100 |
|                  |      |      |                  | VDD=1.0V  | 0.2  | 1.0       |                  |      |      |                     |                           |        |                            |      |
|                  |      |      |                  | VDD=1.5V  | 1.0  | 2.0       |                  |      |      |                     |                           |        |                            |      |
| VDS=0.05V        |      |      |                  |           |      | VDS=-2.1V |                  |      |      | Condition 1<br>0.55 | Condition 1<br>0.70       |        |                            |      |
| VDD=0.7V         |      |      |                  |           |      | VDD=4.5V  |                  |      |      | Condition 2<br>0.65 | Condition 2<br>0.80       |        |                            |      |

## RN5VS

### • RN5VS40A/C to RN5VS60A/C

| Part Number | Detector Threshold |       |       | Detector Threshold Hysteresis |       |       | Supply Current 1          |      |      | Supply Current 2         |      |      |
|-------------|--------------------|-------|-------|-------------------------------|-------|-------|---------------------------|------|------|--------------------------|------|------|
|             | -Vdet(V)           |       |       | Vhys(V)                       |       |       | Iss(μA)                   |      |      | Iss(μA)                  |      |      |
|             | MIN.               | TYP.  | MAX.  | MIN.                          | TYP.  | MAX.  | Conditions                | TYP. | MAX. | Conditions               | TYP. | MAX. |
| RN5VS40A/C  | 3.880              | 4.000 | 4.120 | 0.080                         | 0.200 | 0.320 | VDD=<br>(-VDET)<br>-0.16V | 1.1  | 3.3  | VDD=<br>(-VDET)<br>+2.0V | 1.3  | 3.9  |
| RN5VS41A/C  | 3.977              | 4.100 | 4.223 | 0.082                         | 0.205 | 0.328 |                           |      |      |                          |      |      |
| RN5VS42A/C  | 4.074              | 4.200 | 4.326 | 0.084                         | 0.210 | 0.336 |                           |      |      |                          |      |      |
| RN5VS43A/C  | 4.171              | 4.300 | 4.429 | 0.086                         | 0.215 | 0.344 |                           |      |      |                          |      |      |
| RN5VS44A/C  | 4.268              | 4.400 | 4.532 | 0.088                         | 0.220 | 0.352 |                           |      |      |                          |      |      |
| RN5VS45A/C  | 4.365              | 4.500 | 4.635 | 0.090                         | 0.225 | 0.360 |                           |      |      |                          |      |      |
| RN5VS46A/C  | 4.462              | 4.600 | 4.738 | 0.092                         | 0.230 | 0.368 |                           |      |      |                          |      |      |
| RN5VS47A/C  | 4.559              | 4.700 | 4.841 | 0.094                         | 0.235 | 0.376 |                           |      |      |                          |      |      |
| RN5VS48A/C  | 4.656              | 4.800 | 4.944 | 0.096                         | 0.240 | 0.384 |                           |      |      |                          |      |      |
| RN5VS49A/C  | 4.753              | 4.900 | 5.047 | 0.098                         | 0.245 | 0.392 | VDD=<br>(-VDET)<br>-0.20V | 1.2  | 3.6  | 1.4                      | 4.2  |      |
| RN5VS50A/C  | 4.850              | 5.000 | 5.150 | 0.100                         | 0.250 | 0.400 |                           |      |      |                          |      |      |
| RN5VS51A/C  | 4.947              | 5.100 | 5.253 | 0.102                         | 0.255 | 0.408 |                           |      |      |                          |      |      |
| RN5VS52A/C  | 5.044              | 5.200 | 5.356 | 0.104                         | 0.260 | 0.416 |                           |      |      |                          |      |      |
| RN5VS53A/C  | 5.141              | 5.300 | 5.459 | 0.106                         | 0.265 | 0.424 |                           |      |      |                          |      |      |
| RN5VS54A/C  | 5.238              | 5.400 | 5.562 | 0.108                         | 0.270 | 0.432 |                           |      |      |                          |      |      |
| RN5VS55A/C  | 5.335              | 5.500 | 5.665 | 0.110                         | 0.275 | 0.440 |                           |      |      |                          |      |      |
| RN5VS56A/C  | 5.432              | 5.600 | 5.768 | 0.112                         | 0.280 | 0.448 |                           |      |      |                          |      |      |
| RN5VS57A/C  | 5.529              | 5.700 | 5.871 | 0.114                         | 0.285 | 0.456 |                           |      |      |                          |      |      |
| RN5VS58A/C  | 5.626              | 5.800 | 5.974 | 0.116                         | 0.290 | 0.464 |                           |      |      |                          |      |      |
| RN5VS59A/C  | 5.723              | 5.900 | 6.077 | 0.118                         | 0.295 | 0.472 |                           |      |      |                          |      |      |
| RN5VS60A/C  | 5.820              | 6.000 | 6.180 | 0.120                         | 0.300 | 0.480 |                           |      |      |                          |      |      |

(Note 1) Refer to the previously defined "Output Delay Time  $t_{PLH}$ ".

(Note 2) Refer to the previously defined "Minimum Operating Voltage".

Condition 1 :  $T_{opt} = 25^{\circ}\text{C}$

Condition 2 :  $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$

T<sub>opt</sub>=25°C

| Output Current 1           |      |      | Output Current 2           |                           |      |      | Output Current 3           |      |      | Output Delay Time | Minimum Operating Voltage |                     | Detector Threshold Tempco.        |      |
|----------------------------|------|------|----------------------------|---------------------------|------|------|----------------------------|------|------|-------------------|---------------------------|---------------------|-----------------------------------|------|
| Iout(mA)                   |      |      | Iout(mA)                   |                           |      |      | Iout(mA)                   |      |      | tplh(μs)          | Vddl(V)                   |                     | Δ-Vdet/ΔT <sub>opt</sub> (ppm/°C) |      |
| Conditions                 | MIN. | TYP. | Conditions                 |                           | MIN. | TYP. | Conditions                 | MIN. | TYP. | MAX.              | TYP.                      | MAX.                | Conditions                        | TYP. |
| Nch                        |      |      |                            |                           |      |      | Pch                        |      |      |                   |                           |                     |                                   |      |
| V <sub>DS</sub> =<br>0.05V | 0.01 | 0.05 | V <sub>DS</sub> =<br>0.50V | V <sub>DD</sub> =<br>1.5V | 1.0  | 2.0  | V <sub>DS</sub> =<br>-2.1V | 1.5  | 3.0  | Note 1<br>100     | Condition 1<br>0.55       | Condition 1<br>0.70 | -40°C≤<br>T <sub>opt</sub> ≤85°C  | ±100 |
| V <sub>DD</sub> =<br>0.7V  |      |      |                            |                           |      |      | V <sub>DD</sub> =<br>8.0V  |      |      |                   | Condition 2<br>0.65       | Condition 2<br>0.80 |                                   |      |

OPERATION

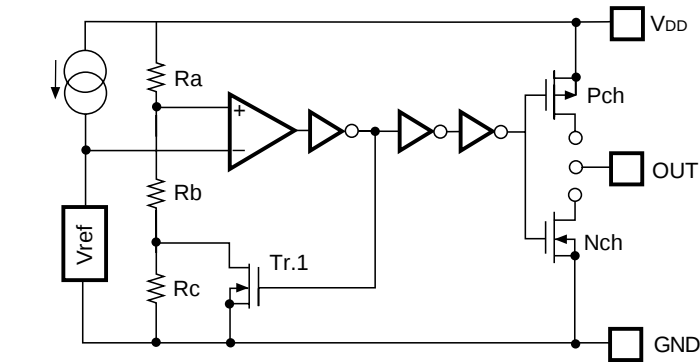


FIG. 1 Block Diagram

- In RN5VS××A, Nch Tr. drain is connected to OUT pin.
- In RN5VS××C, Nch Tr. drain and Pch Tr. drain are connected to OUT pin.

Operation Diagram

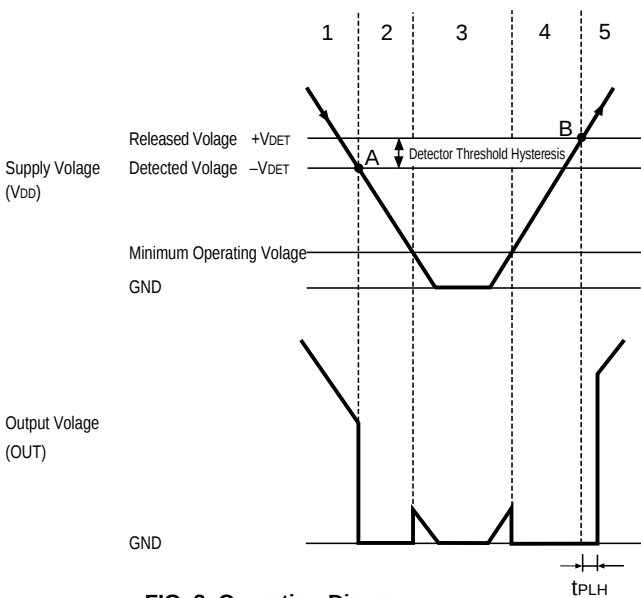


FIG. 2 Operation Diagram

| Step                            |     | Step 1 | Step 2 | Step 3     | Step 4 | Step 5 |
|---------------------------------|-----|--------|--------|------------|--------|--------|
| Comparator(+) Pin Input Voltage |     | I      | II     | II         | II     | I      |
| Comparator Output               |     | H      | L      | Indefinite | L      | H      |
| Tr. 1                           |     | OFF    | ON     | Indefinite | ON     | OFF    |
| Output Tr.                      | Pch | ON     | OFF    | Indefinite | OFF    | ON     |
|                                 | Nch | OFF    | ON     | Indefinite | ON     | OFF    |

I.  $\frac{R_b + R_c}{R_a + R_b + R_c} \cdot V_{DD}$

II.  $\frac{R_b}{R_a + R_b} \cdot V_{DD}$

- Step 1. Output Voltage is equal to Power Source Voltage ( $V_{DD}$ ).
- Step 2. When Input Voltage to Comparator reaches the state of  $V_{ref} \geq V_{DD} \cdot (R_b + R_c) / (R_a + R_b + R_c)$  at Point A (Detected Voltage  $-V_{DET}$ ), the output of Comparator is reserved, so that Output Voltage becomes GND.
- Step 3. In the case of CMOS Output, Output Voltage becomes unstable when Supply Voltage ( $V_{DD}$ ) is smaller than Minimum Operating Voltage. In the case of Nch Open Drain Output, a pulled-up voltage is output.
- Step 4. Output Voltage becomes equal to GND.
- Step 5. When Input Voltage to Comparator reaches the state of  $V_{ref} \leq V_{DD} \cdot (R_b) / (R_a + R_b)$  at Point B (Released Voltage  $+V_{DET}$ ), the output of Comparator is reversed, so that Output Voltage becomes equal to Supply Voltage ( $V_{DD}$ ).

## TEST CIRCUITS

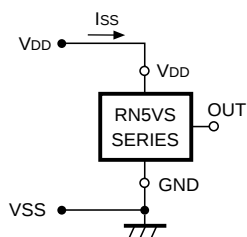


FIG. 3 Supply Current Test Circuit

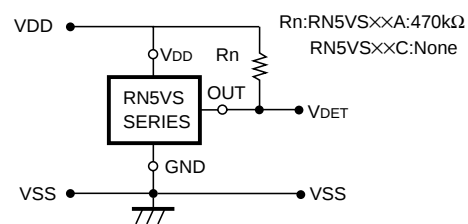


FIG. 4 Detector Threshold Test Circuit

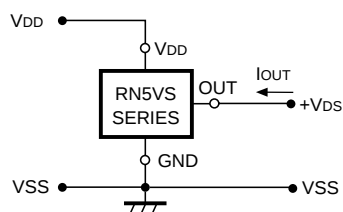


FIG. 5 Nch Driver Output Current Test Circuit

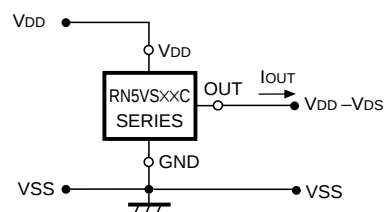


FIG. 6 Pch Driver Output Current Test Circuit

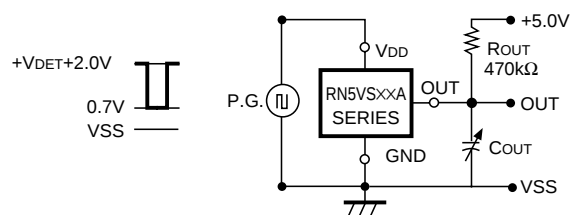


FIG. 7 Output Delay Time Test Circuit (1)

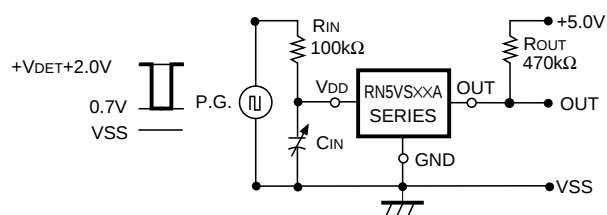
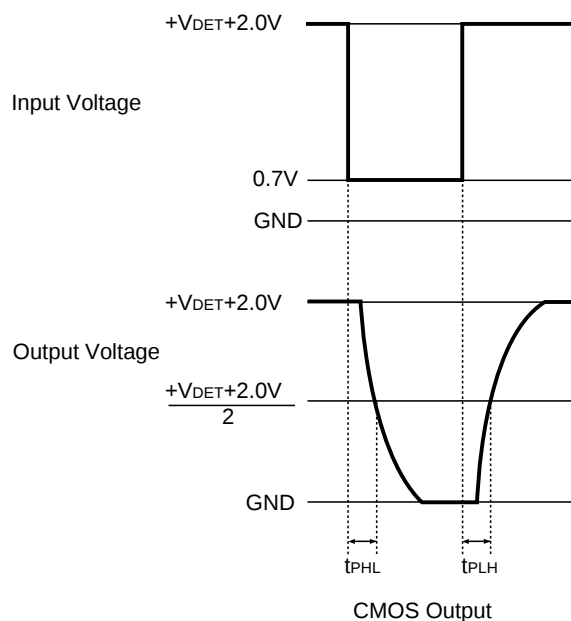
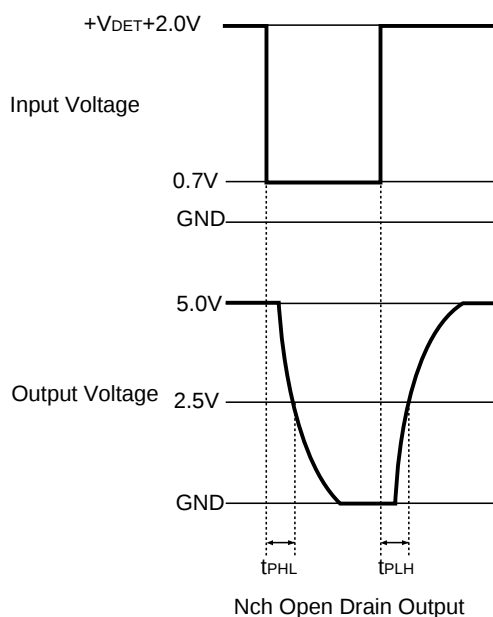


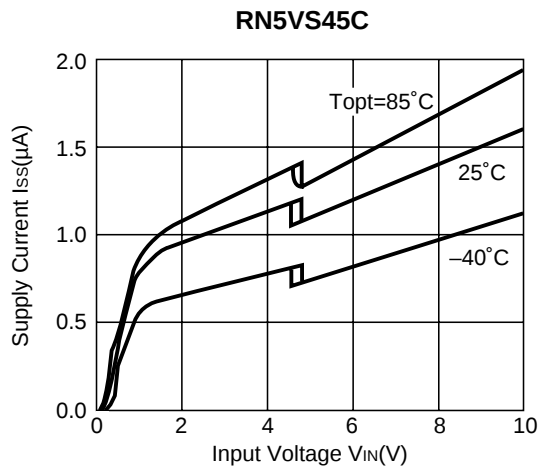
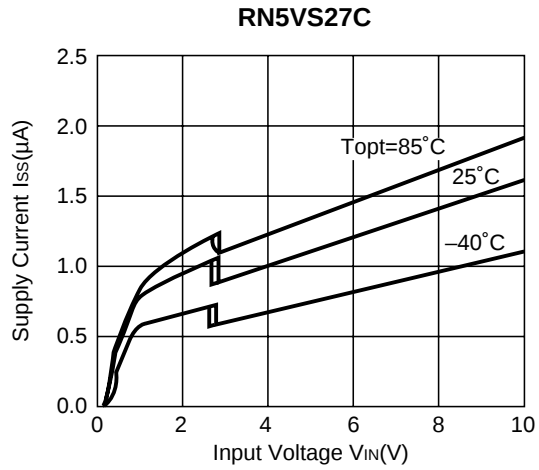
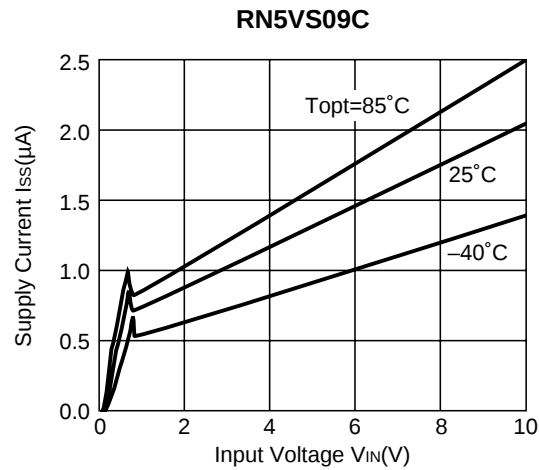
FIG. 8 Output Delay Time Test Circuit (2)

In Output Delay Time Test Circuits (1) and (2) in FIG. 7 and FIG. 8, their respective Output Voltage Fall Times ( $t_{PHL}$ ) and Rise Times ( $t_{PLH}$ ) are defined as shown below.

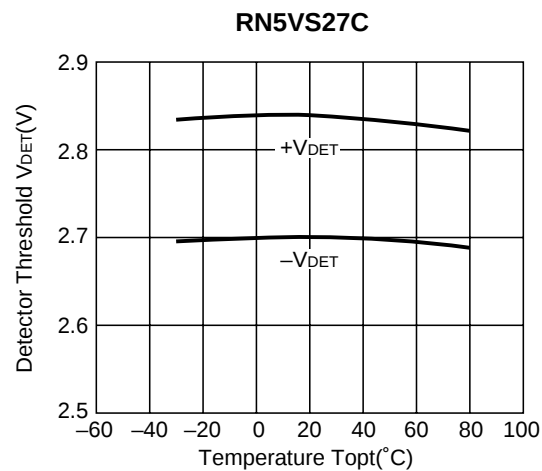
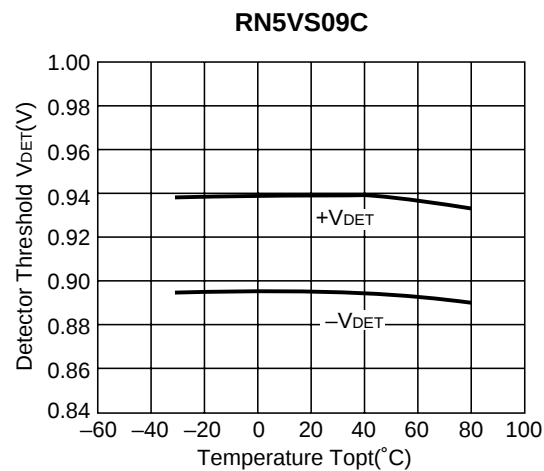


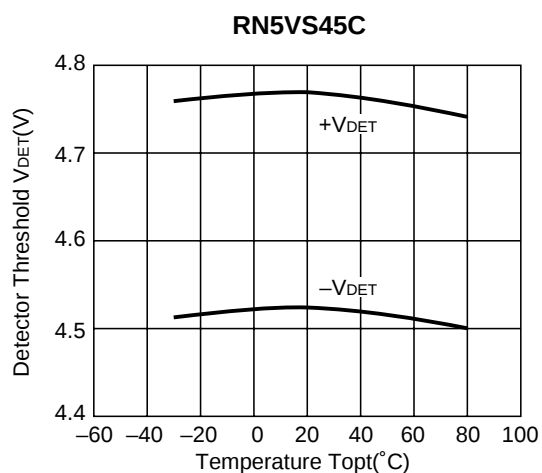
TYPICAL CHARACTERISTICS

1) Supply Current vs. Input Voltage

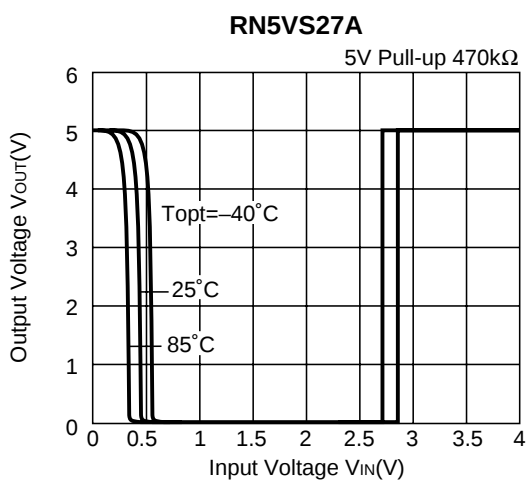
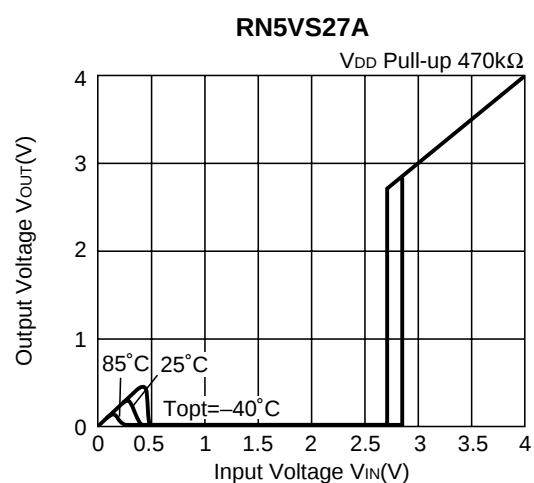
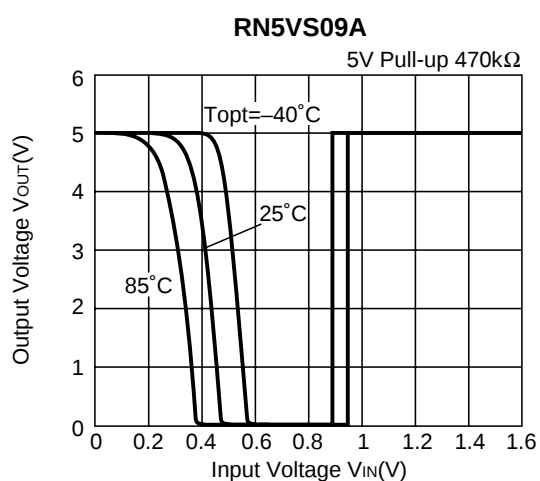
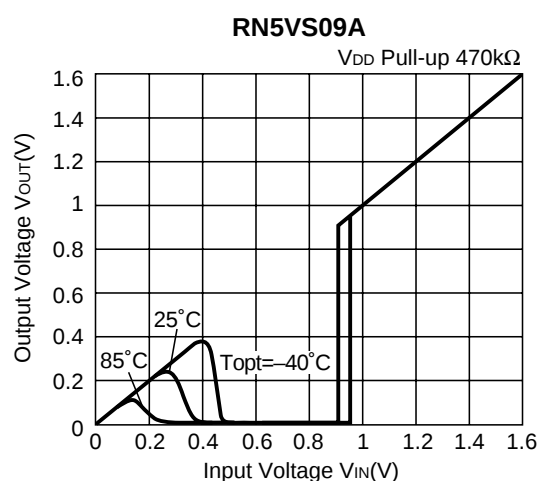


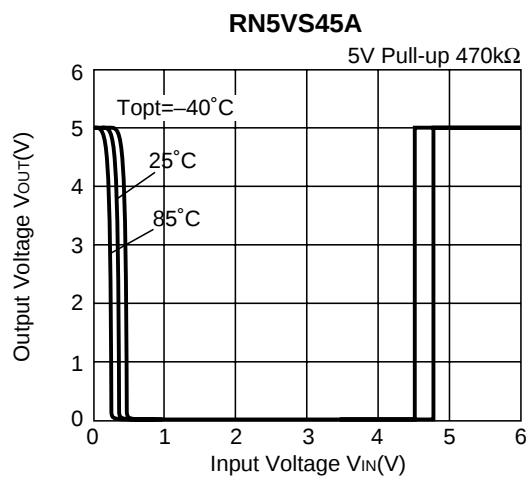
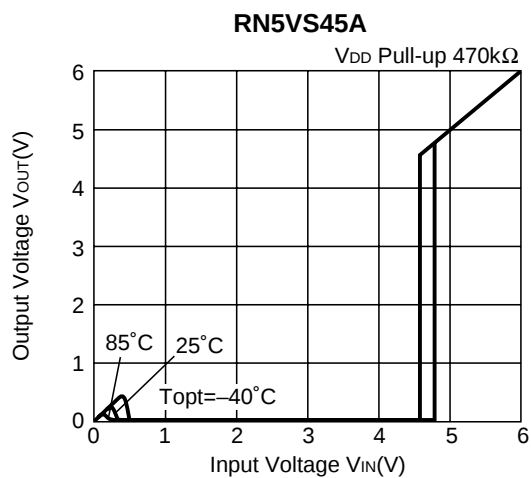
2) Detector Threshold vs. Temperature



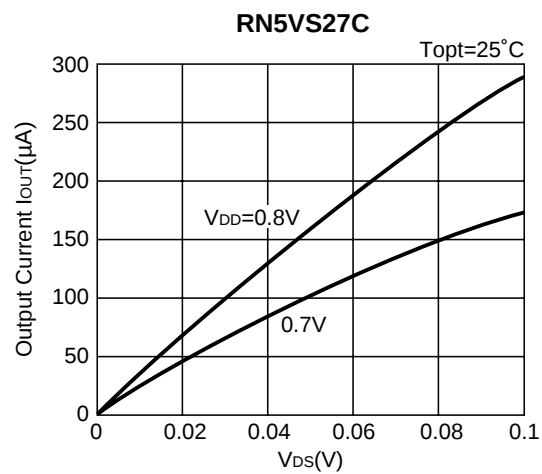
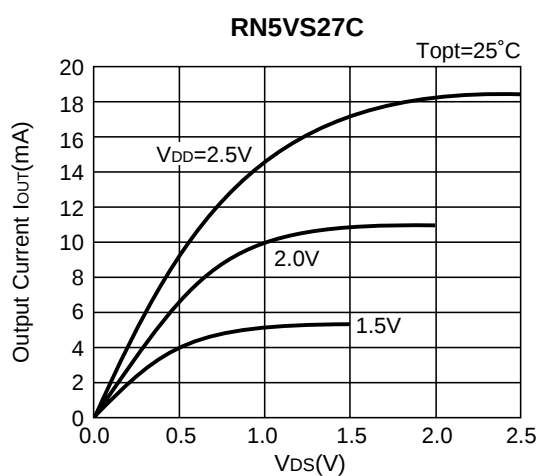
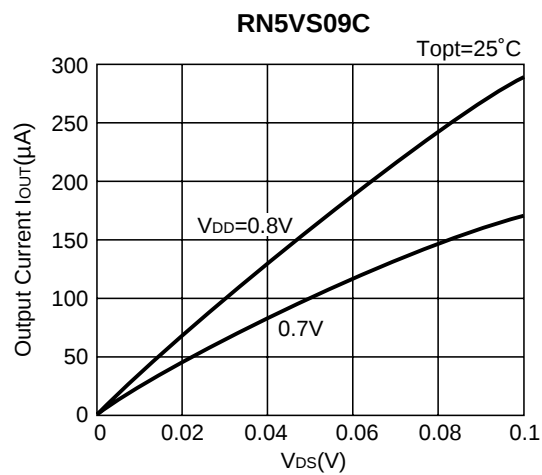
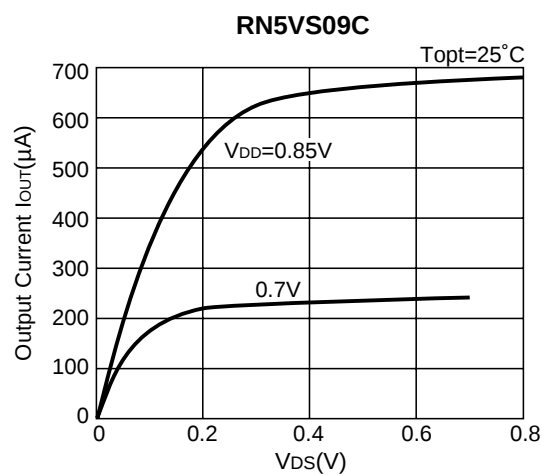


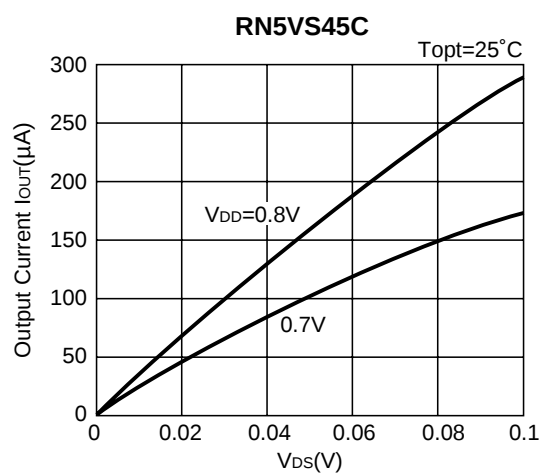
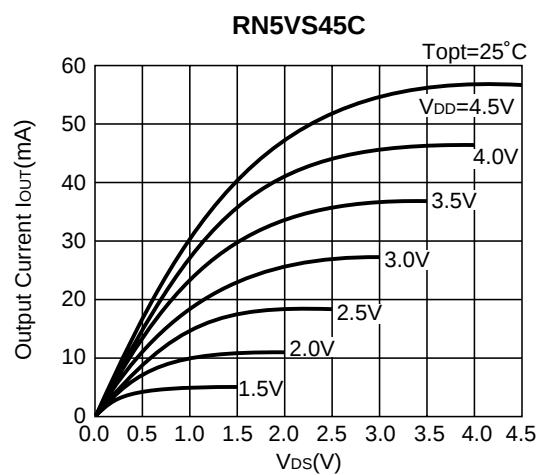
### 3) Output Voltage vs. Input Voltage



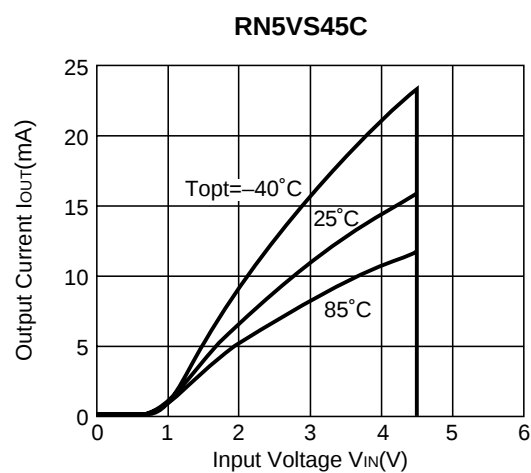
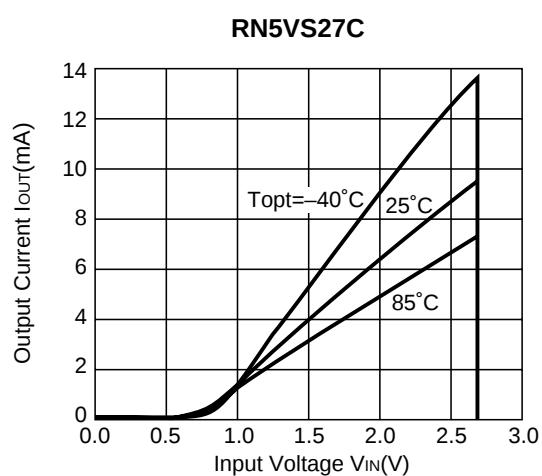
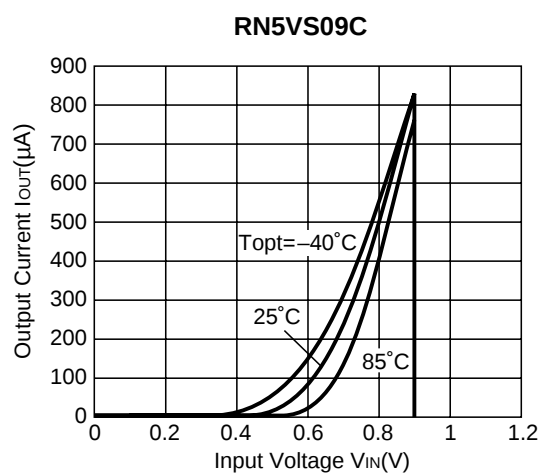


#### 4) Nch Driver Output Current vs. $V_{DS}$

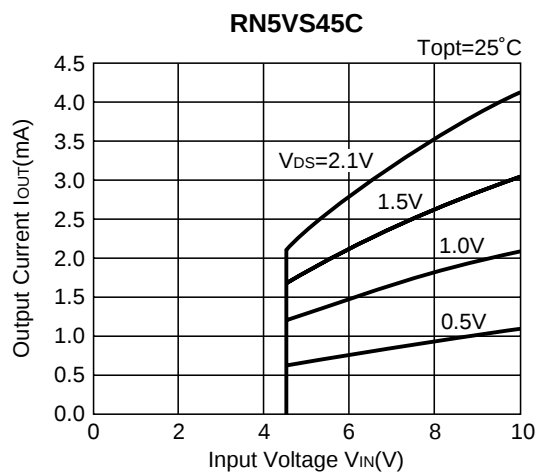
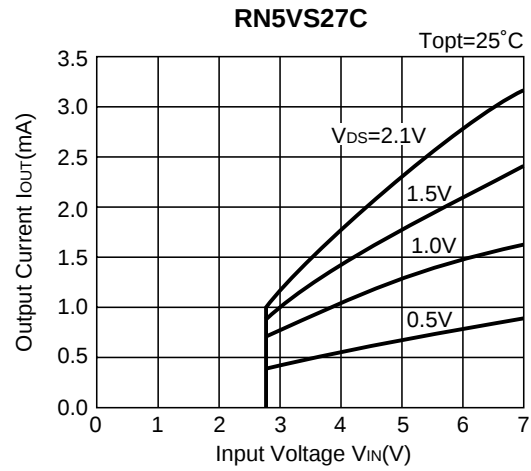
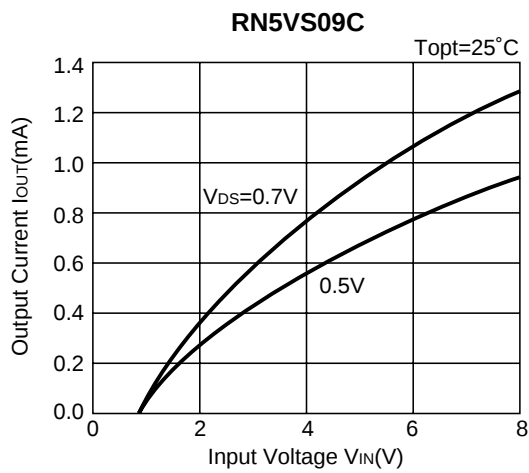




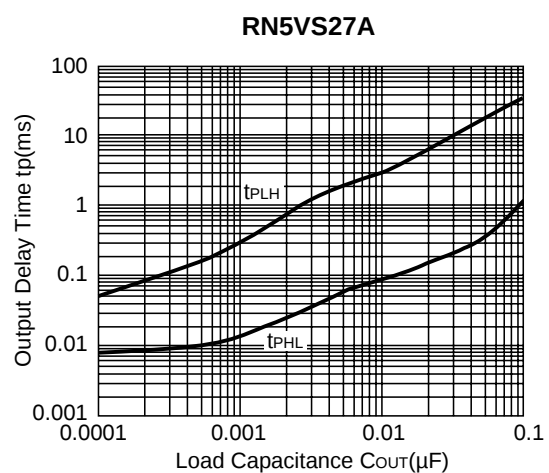
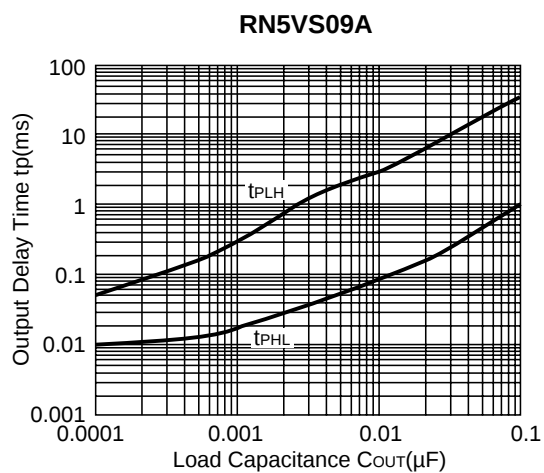
### 5) Nch Driver Output Current vs. Input Voltage

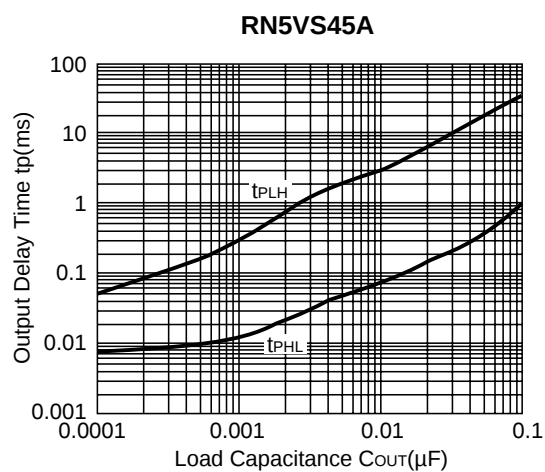


## 6) Pch Driver Output Current vs. Input Voltage

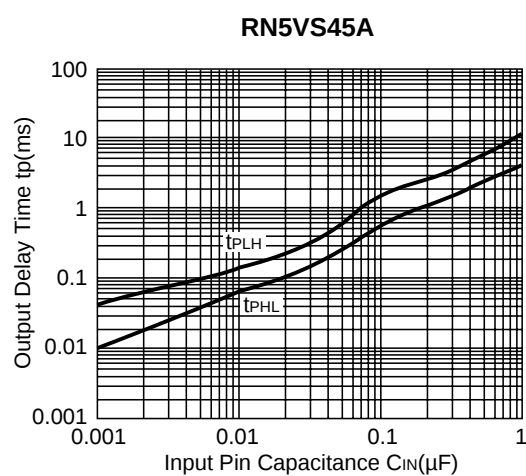
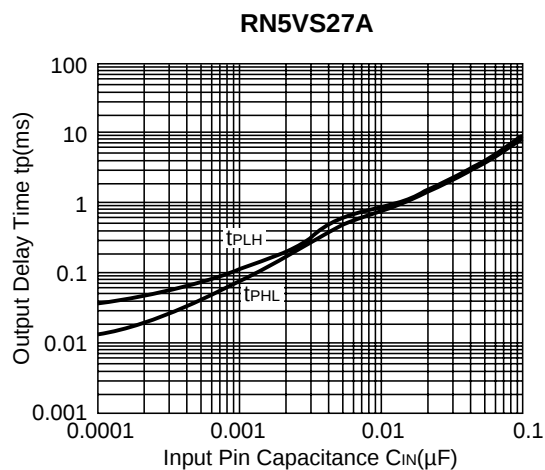
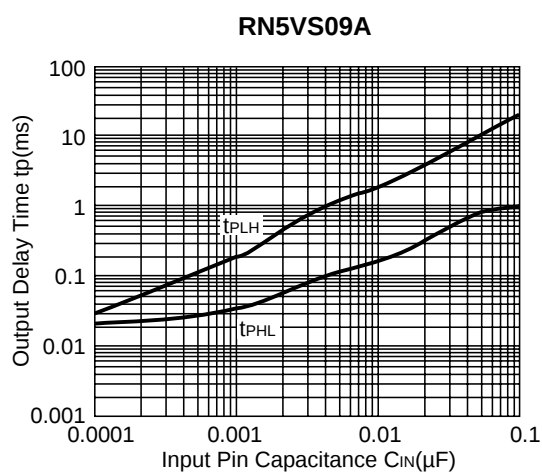


## 7) Output Delay Time vs. Load Capacitance





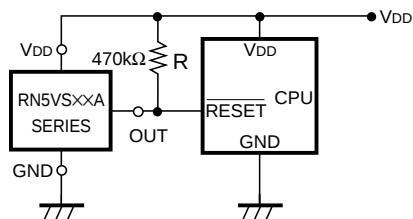
#### 8) Output Delay Time vs. Input Pin Capacitance



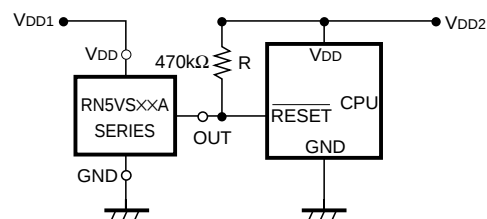
## TYPICAL APPLICATIONS

### • RN5VS××A CPU Reset Circuit (Nch Open Drain Output)

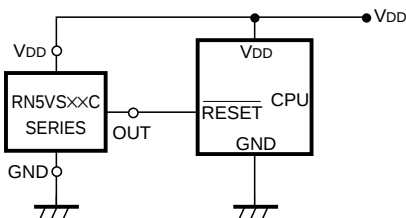
(1) Input Voltage to RN5VS××A is the same as the input voltage to CPU.



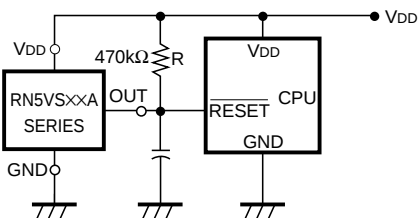
(2) Input Voltage to RN5VS××A is different from the input voltage to CPU.



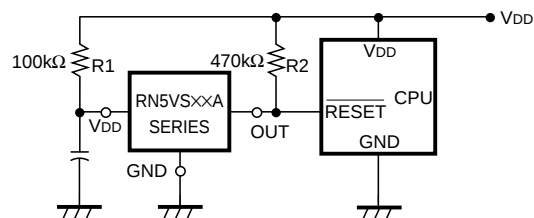
### • RN5VS××C CPU Reset Circuit (CMOS Output)



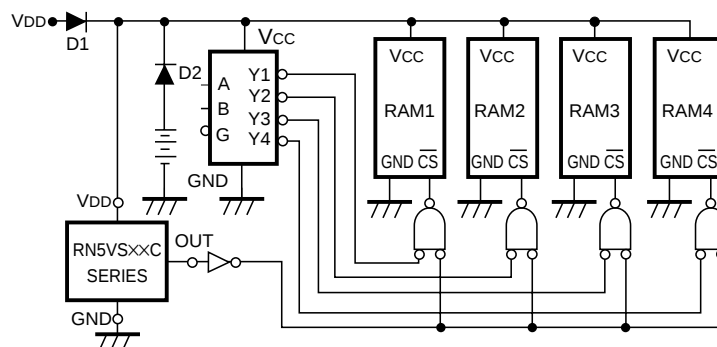
### • RN5VS××A Output delay Time Circuit 1



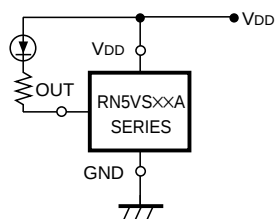
### • RN5VS××A Output delay Time Circuit 2



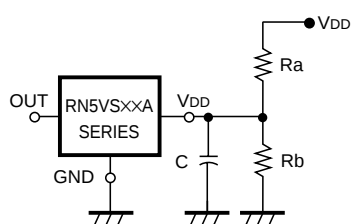
### • Memory Back-up Circuit



- **Voltage Level Indicator Circuit (lighted when the power runs out)**  
(Nch Open Drain Output)



- **Detector Threshold Changing Circuit**  
(Nch Open Drain Output)

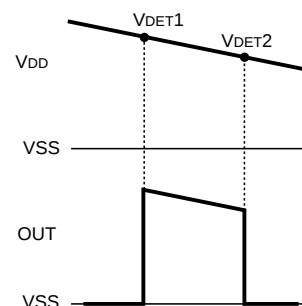
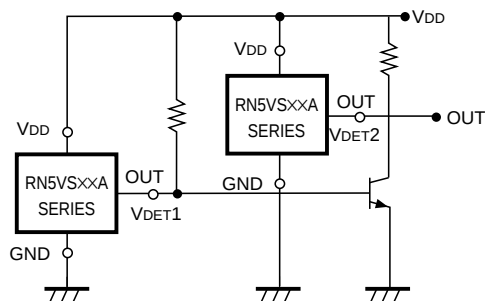


$$\text{Changed Detector Threshold} = \frac{R_a + R_b}{R_b} \cdot (-V_{\text{DET}})$$

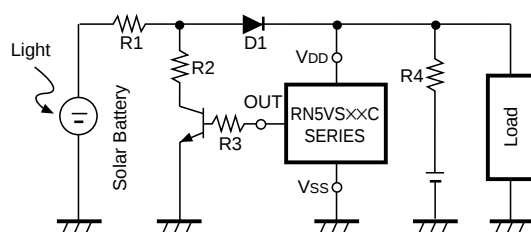
$$\text{Hysteresis Voltage} = \frac{R_a + R_b}{R_b} \cdot V_{\text{HYS}}$$

(Note) Please note that when the value of  $R_a$  becomes excessively large, the detector threshold detected may differ from the value calculated by use of the above formula.

- **Window Comparator Circuit**  
(Nch Open Drain Output)



- **Excessive Charge Preventing Circuit**



APPLICATION HINTS

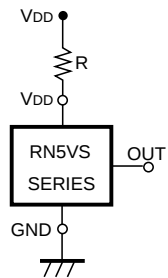


FIG.9

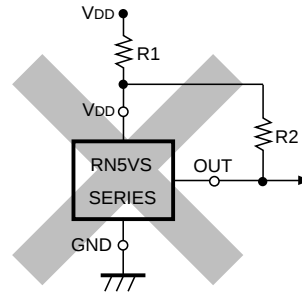
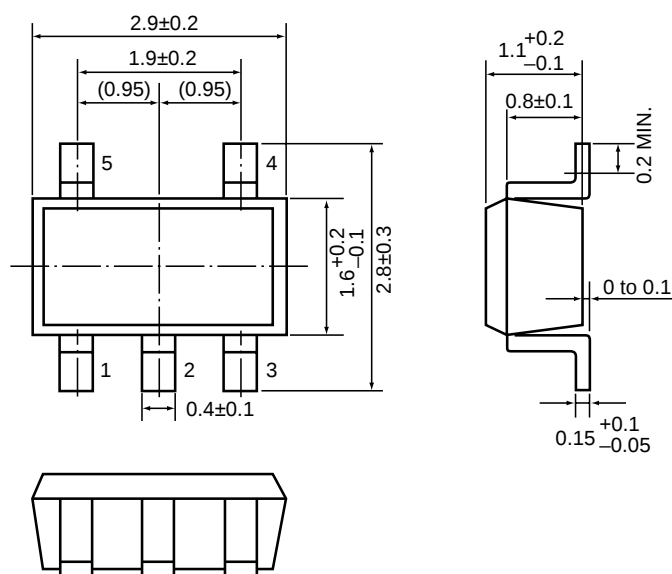


FIG.10

1. When RN5VS××C (CMOS Output) is used in FIG. 9, this IC may oscillate by the through-type current at the detection when impedance is connected between Power Source VDD and RN5VS VDD Pin. When RN5VS××A (Nch Open Drain Output) is used in FIG. 9, and R becomes excessively large, Detector Threshold may be varied because of the voltage drop of the supply current in the IC itself.
2. The connection as shown in FIG. 10 may cause the oscillation in both RN5VS××C (CMOS Output) and RN5VS××A (Nch Open Drain Output).

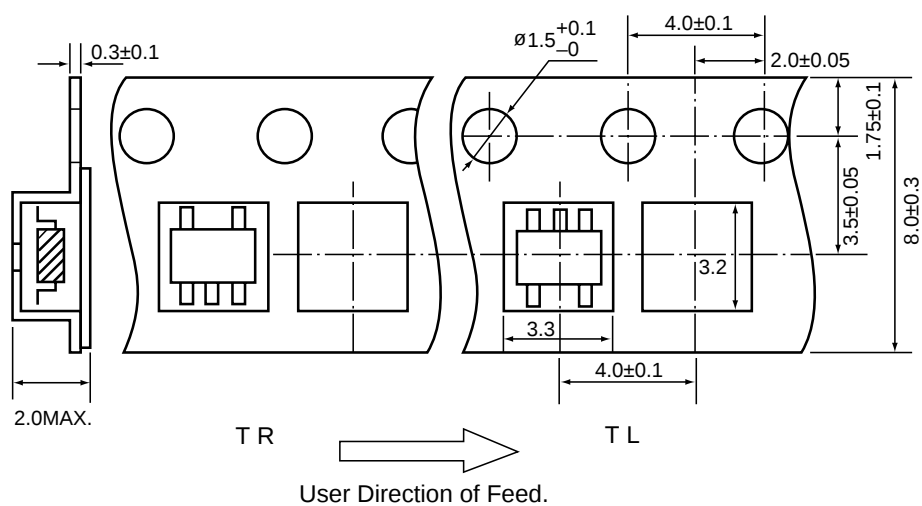
# PACKAGE DIMENSIONS (Unit: mm)

## • SOT-23-5



# TAPING SPECIFICATIONS (Unit: mm)

## • SOT-23-5





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