

R3113D SERIES

OUTLINE

The R3113 series are CMOS-based voltage detector ICs with high detector threshold accuracy and ultra-low supply current, which can be operated at an extremely low voltage and is used for system reset as an example.

Each of these ICs consists of a voltage reference unit, a comparator, resistors for detector threshold setting, an output driver and a hysteresis circuit. The detector threshold is fixed with high accuracy internally and does not require any adjustment.

Two output types, Nch open drain type and CMOS type are available.

Since the package is ultra-small SON1408-3 (MFPACK), high density mounting on board is possible .

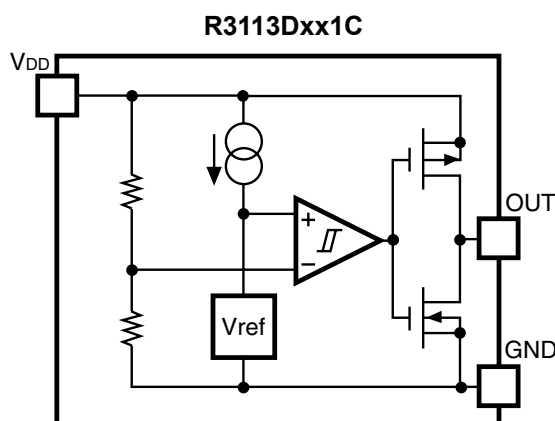
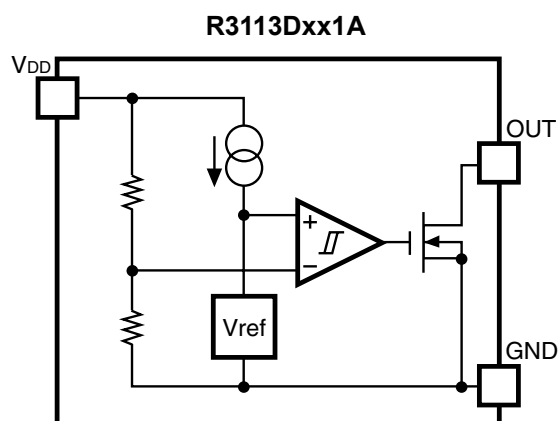
FEATURES

| | |
|---|--|
| Ultra-low Supply Current | Typ. 1.4 μ A ($V_{DET}>1.5V$: $V_{DD}=V_{DET}+1.0V$) |
| Wide Range of Operating Voltage | 0.6V to 6.0V ($V_{DET}=3.0V$, $T_{opt}=25^{\circ}C$) |
| Detector Threshold | Stepwise setting with a step of 0.1V in the range from 1.2V to 4.5V is possible. |
| High Accuracy Detector Threshold | $\pm 2.0\%$ |
| Low Temperature-Drift Coefficient of Detector Threshold | Typ. $\pm 100ppm/^{\circ}C$ |
| Two Output Types | Nch Open Drain and CMOS |
| Ultra-small Package | SON1408-3 |

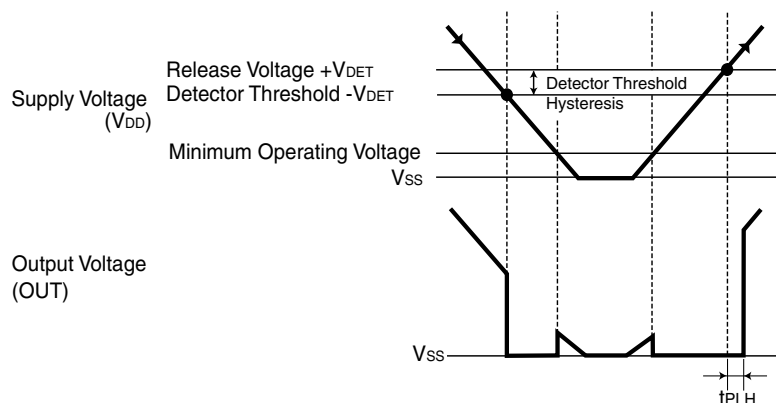
APPLICATIONS

CPU and Logic Circuit Reset
 Battery Checker
 Window Comparator
 Wave Shaping Circuit
 Battery Back-up Circuit
 Power Failure Detector

BLOCK DIAGRAMS



TIMING CHART



DEFINITION OF OUTPUT DELAY TIME

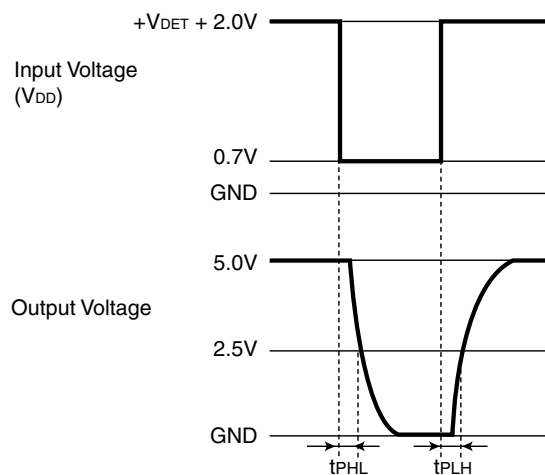
Output Delay Time t_{PLH} is defined as follows:

1. In the case of Nch Open Drain Output:

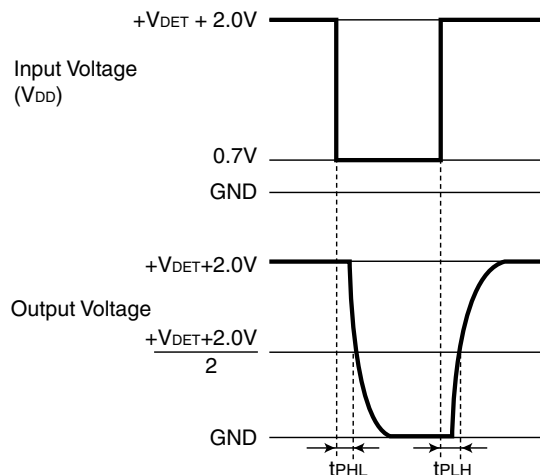
Under the condition of the output pin (OUT) is pulled up through a resistor of 470k Ω to 5V, the time interval between the rising edge of V_{DD} pulse from 0.7V to $(+V_{DET}) + 2.0V$ and becoming of the output voltage to 2.5V.

2. In the case of CMOS Output:

The time interval between the rising edge of V_{DD} pulse from 0.7V to $(+V_{DET}) + 2.0V$ and becoming of the output voltage to $(V_{DD}/2)$ V.



Nch Open Drain Output



CMOS Output

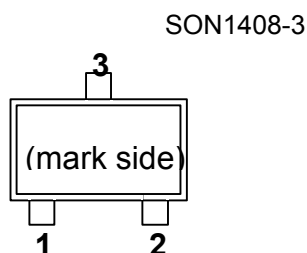
SELECTION GUIDE

The detector threshold, the output type and the taping type of R3113 Series can be designated at the users' request by specifying the part number as follows;

R3113xxxxx-xx ←Part Number
 ↑↑↑↑↑
 a b cd e

| Code | Descriptions |
|------|--|
| a | Designation of Package Type; D: SON1408-3 |
| b | Setting Detector Threshold ($-V_{DET}$); Stepwise setting with a step of 0.1V in the range of 1.2V to 4.5V is possible. |
| c | Designation of Package Type: 1 (Fixed) |
| d | Designation of Output Type; A: Nch Open Drain C: CMOS |
| e | Designation of Packing or Taping Type; Ex. TR prescribed as standard directions. (Refer to Taping Specifications.) Antistatic bag for samples: C |

PIN CONFIGURATION



PIN DESCRIPTION

- SON1408-3

| Pin No. | Symbol |
|---------|----------|
| 1 | OUT |
| 2 | V_{DD} |
| 3 | GND |

ABSOLUTE MAXIMUM RATINGS

| Symbol | Item | Rating | Unit |
|--------------|-------------------------------------|------------------------------|------|
| V_{DD} | Supply Voltage | 6.5 | V |
| V_{OUT1} | Output Voltage (CMOS) | $V_{SS}-0.3$ to $V_{DD}+0.3$ | V |
| V_{OUT2} | Output Voltage (Nch) | $V_{SS}-0.3$ to 6.5 | V |
| I_{OUT} | Output Current | 20 | mA |
| P_D | Power Dissipation ^{*Note1} | 250 | mW |
| T_{opt} | Operating Temperature Range | -40 to 85 | °C |
| T_{stg} | Storage Temperature Range | -55 to 125 | °C |
| T_{solder} | Lead temperature (Soldering) | 260°C, 10s | |

*Note 1: Applied to SON1408-3 at mounted on board

P_D depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

*Measurement Conditions

Environment: Mounted on board (Wind velocity 0m/s)

Board Material: FR-4 (2-layer)

Board dimensions: 40mm x 40mm x t1.6mm

Copper Area: 50%(Both Sides)

Tab pin (Pin 3) land pattern width is same as the lead, connected to the GND plane.

ELECTRICAL CHARACTERISTICS

• R3113D121A/C

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

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|---------------------------|---|---|------------|------------|------------|---------------|
| $-V_{DET}$ | Detector Threshold | | 1.176 | 1.200 | 1.224 | V |
| V_{HYS} | Detector Threshold Hysteresis | | 0.036 | 0.060 | 0.084 | V |
| I_{SS} | Supply Current | $V_{DD}=(-V_{DET})-0.1\text{V}$ $(-V_{DET})+1.0\text{V}$ | | 0.8 1.1 | 2.0 2.7 | μA |
| V_{DDH} | Maximum Operating Voltage | | | | 6 | V |
| V_{DDL} | Minimum Operating Voltage ^{*Note1} | $T_{opt}=25^{\circ}\text{C}$ | | 0.65 | 0.85 | V |
| | | $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$ | | | 0.95 | |
| I_{OUT} | Output Current (Driver Output Pin) | Nch $V_{DS}=0.05\text{V}$, $V_{DD}=0.85\text{V}$ $V_{DS}=0.50\text{V}$, $V_{DD}=1.10\text{V}$ | 0.2 1.0 | 0.3 2.2 | | mA |
| | | Pch $V_{DS}=-2.1\text{V}$, $V_{DD}=4.5\text{V}$ | 2.0 | 5.0 | | mA |
| t_{PLH} | Output Delay Time ^{*Note2} | | | | 100 | μs |
| $\Delta-V_{DET}/\Delta T$ | Detector Threshold Temperature Coefficient | $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$ | | ± 100 | | ppm/°C |

• R3113D181A/C

T_{opt}=25°C

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|------------------------|---|---|--------------|--------------|------------|--------|
| -V _{DET} | Detector Threshold | | 1.764 | 1.800 | 1.836 | V |
| V _{HYS} | Detector Threshold Hysteresis | | 0.054 | 0.090 | 0.126 | V |
| I _{SS} | Supply Current | V _{DD} = (-V _{DET})-0.1V (-V _{DET})+1.0V | | 1.3 1.4 | 3.3 3.6 | μA |
| V _{DDH} | Maximum Operating Voltage | | | | 6 | V |
| V _{DDL} | Minimum Operating Voltage ^{*Note1} | T _{opt} =25°C | | 0.45 | 0.70 | V |
| | | -40°C ≤ T _{opt} ≤ 85°C | | | 0.80 | |
| I _{OUT} | Output Current (Driver Output Pin) | Nch V _{DS} =0.05V, V _{DD} =0.70V V _{DS} =0.50V, V _{DD} =1.50V | 0.05 2.00 | 0.13 5.00 | | mA |
| | | Pch V _{DS} =-2.1V, V _{DD} =4.5V | 2.0 | 5.0 | | mA |
| t _{PLH} | Output Delay Time ^{*Note2} | | | | 100 | μs |
| Δ-V _{DET} /ΔT | Detector Threshold Temperature Coefficient | -40°C ≤ T _{opt} ≤ 85°C | | ±100 | | ppm/°C |

• R3113D271A/C

T_{opt}=25°C

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|------------------------|---|---|--------------|--------------|------------|--------|
| -V _{DET} | Detector Threshold | | 2.646 | 2.700 | 2.754 | V |
| V _{HYS} | Detector Threshold Hysteresis | | 0.081 | 0.135 | 0.189 | V |
| I _{SS} | Supply Current | V _{DD} = (-V _{DET})-0.1V (-V _{DET})+1.0V | | 1.3 1.4 | 3.3 3.6 | μA |
| V _{DDH} | Maximum Operating Voltage | | | | 6 | V |
| V _{DDL} | Minimum Operating Voltage ^{*Note1} | T _{opt} =25°C | | 0.45 | 0.70 | V |
| | | -40°C ≤ T _{opt} ≤ 85°C | | | 0.80 | |
| I _{OUT} | Output Current (Driver Output Pin) | Nch V _{DS} =0.05V, V _{DD} =0.70V V _{DS} =0.50V, V _{DD} =1.50V | 0.05 2.00 | 0.13 5.00 | | mA |
| | | Pch V _{DS} =-2.1V, V _{DD} =4.5V | 2.0 | 5.0 | | mA |
| t _{PLH} | Output Delay Time ^{*Note2} | | | | 100 | μs |
| Δ-V _{DET} /ΔT | Detector Threshold Temperature Coefficient | -40°C ≤ T _{opt} ≤ 85°C | | ±100 | | ppm/°C |

● R3113D361A/C

Topt=25°C

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------|---|---|--------------|--------------|------------|------------------|
| $-V_{DET}$ | Detector Threshold | | 3.528 | 3.600 | 3.672 | V |
| V_{HYS} | Detector Threshold Hysteresis | | 0.108 | 0.180 | 0.252 | V |
| I_{SS} | Supply Current | $V_{DD} = (-V_{DET}) - 0.1V$ $(-V_{DET}) + 1.0V$ | | 1.3 1.4 | 3.3 3.6 | μA |
| V_{DDH} | Maximum Operating Voltage | | | | 6 | V |
| V_{DDL} | Minimum Operating Voltage ^{*Note1} | Topt=25°C | | 0.45 | 0.70 | V |
| | | $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ | | | 0.70 | |
| I_{OUT} | Output Current (Driver Output Pin) | Nch $V_{DS}=0.05V, V_{DD}=0.70V$ $V_{DS}=0.50V, V_{DD}=1.50V$ | 0.05 2.00 | 0.13 5.00 | | mA |
| | | Pch $V_{DS}=-2.1V, V_{DD}=4.5V$ | 2.0 | 5.0 | | mA |
| t_{PLH} | Output Delay Time ^{*Note2} | | | | 100 | μs |
| $\Delta -V_{DET}/\Delta T$ | Detector Threshold Temperature Coefficient | $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ | | ± 100 | | ppm/ $^{\circ}C$ |

● R3113D451A/C

Topt=25°C

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------|---|---|--------------|--------------|------------|------------------|
| $-V_{DET}$ | Detector Threshold | | 4.410 | 4.500 | 4.590 | V |
| V_{HYS} | Detector Threshold Hysteresis | | 0.135 | 0.225 | 0.315 | V |
| I_{SS} | Supply Current | $V_{DD} = (-V_{DET}) - 0.1V$ $(-V_{DET}) + 1.0V$ | | 1.3 1.4 | 3.3 3.6 | μA |
| V_{DDH} | Maximum Operating Voltage | | | | 6 | V |
| V_{DDL} | Minimum Operating Voltage ^{*Note1} | Topt=25°C | | 0.45 | 0.70 | V |
| | | $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ | | | 0.80 | |
| I_{OUT} | Output Current (Driver Output Pin) | Nch $V_{DS}=0.05V, V_{DD}=0.70V$ $V_{DS}=0.50V, V_{DD}=1.50V$ | 0.05 2.00 | 0.13 5.00 | | mA |
| | | Pch $V_{DS}=-2.1V, V_{DD}=6.0V$ | 2.5 | 6.0 | | mA |
| t_{PLH} | Output Delay Time ^{*Note2} | | | | 100 | μs |
| $\Delta -V_{DET}/\Delta T$ | Detector Threshold Temperature Coefficient | $-40^{\circ}C \leq T_{opt} \leq 85^{\circ}C$ | | ± 100 | | ppm/ $^{\circ}C$ |

*Note1: The Minimum operating voltage means the value of input voltage when output voltage maintains 0.1V or less. (In the case of Nch Open Drain Output type, the output pin is pulled up with a resistance of 470k Ω to 5.0V.)

*Note2: In the case of CMOS Output type: The time interval between the rising edge of V_{DD} input pulse from 0.7V to $(+V_{DET}) + 2.0V$ and output voltage level becoming to $V_{DD}/2$.

ELECTRICAL CHARACTERISTICS BY DETECTOR THRESHOLD

• R3113D121x to R3113D451x

| Part Number | Detector Threshold | | | Detector Threshold Hysteresis | | | Supply Current 1 | | | Supply Current 2 | | |
|-------------|-----------------------|-------|-------|-------------------------------|-------|-------|---|------|------|-----------------------|------|------|
| | -V _{DET} [V] | | | V _{HYS} [V] | | | I _{SS1} [μA] | | | I _{SS2} [μA] | | |
| | Min | Typ. | Max. | Min. | Typ. | Max. | Condition | Typ. | Max. | Condition | Typ. | Max. |
| R3113D121x | 1.1 | 1.200 | 1.224 | 0.036 | 0.060 | 0.084 | V _{DD} = (-V _{DET}) -0.10V | 0.8 | 2.0 | | 1.1 | 2.7 |
| R3113D131x | 1.2 | 1.300 | 1.326 | 0.039 | 0.065 | 0.091 | | | | | | |
| R3113D141x | 1.3 | 1.400 | 1.428 | 0.042 | 0.070 | 0.098 | | | | | | |
| R3113D151x | 1.4 | 1.500 | 1.530 | 0.045 | 0.075 | 0.105 | | | | | | |
| R3113D161x | 1.5 | 1.600 | 1.632 | 0.048 | 0.080 | 0.112 | | | | | | |
| R3113D171x | 1.6 | 1.700 | 1.734 | 0.051 | 0.085 | 0.119 | | | | | | |
| R3113D181x | 1.7 | 1.800 | 1.836 | 0.054 | 0.090 | 0.126 | | | | | | |
| R3113D191x | 1.8 | 1.900 | 1.938 | 0.057 | 0.095 | 0.133 | | | | | | |
| R3113D201x | 1.9 | 2.000 | 2.040 | 0.060 | 0.100 | 0.140 | | | | | | |
| R3113D211x | 2.0 | 2.100 | 2.142 | 0.063 | 0.105 | 0.147 | | | | | | |
| R3113D221x | 2.1 | 2.200 | 2.244 | 0.066 | 0.110 | 0.154 | | | | | | |
| R3113D231x | 2.2 | 2.300 | 2.346 | 0.069 | 0.115 | 0.161 | | | | | | |
| R3113D241x | 2.3 | 2.400 | 2.448 | 0.072 | 0.120 | 0.168 | | | | | | |
| R3113D251x | 2.4 | 2.500 | 2.550 | 0.075 | 0.125 | 0.175 | | | | | | |
| R3113D261x | 2.5 | 2.600 | 2.652 | 0.078 | 0.130 | 0.182 | | | | | | |
| R3113D271x | 2.6 | 2.700 | 2.754 | 0.081 | 0.135 | 0.189 | | | | | | |
| R3113D281x | 2.7 | 2.800 | 2.856 | 0.084 | 0.140 | 0.196 | | | | | | |
| R3113D291x | 2.8 | 2.900 | 2.958 | 0.087 | 0.145 | 0.203 | | | | | | |
| R3113D301x | 2.9 | 3.000 | 3.060 | 0.090 | 0.150 | 0.210 | | | | | | |
| R3113D311x | 3.0 | 3.100 | 3.162 | 0.093 | 0.155 | 0.217 | | | | | | |
| R3113D321x | 3.1 | 3.200 | 3.264 | 0.096 | 0.160 | 0.224 | | | | | | |
| R3113D331x | 3.2 | 3.300 | 3.366 | 0.099 | 0.165 | 0.231 | | | | | | |
| R3113D341x | 3.3 | 3.400 | 3.468 | 0.102 | 0.170 | 0.238 | | | | | | |
| R3113D351x | 3.4 | 3.500 | 3.570 | 0.105 | 0.175 | 0.245 | | | | | | |
| R3113D361x | 3.5 | 3.600 | 3.672 | 0.108 | 0.180 | 0.252 | | | | | | |
| R3113D371x | 3.6 | 3.700 | 3.774 | 0.111 | 0.185 | 0.259 | | | | | | |
| R3113D381x | 3.7 | 3.800 | 3.876 | 0.114 | 0.190 | 0.266 | | | | | | |
| R3113D391x | 3.8 | 3.900 | 3.978 | 0.117 | 0.195 | 0.273 | | | | | | |
| R3113D401x | 3.9 | 4.000 | 4.080 | 0.120 | 0.200 | 0.280 | | | | | | |
| R3113D411x | 4.0 | 4.100 | 4.182 | 0.123 | 0.205 | 0.287 | | | | | | |
| R3113D421x | 4.1 | 4.200 | 4.284 | 0.126 | 0.210 | 0.294 | | | | | | |
| R3113D431x | 4.2 | 4.300 | 4.386 | 0.129 | 0.215 | 0.301 | | | | | | |
| R3113D441x | 4.3 | 4.400 | 4.488 | 0.132 | 0.220 | 0.308 | | | | | | |
| R3113D451x | 4.4 | 4.500 | 4.590 | 0.135 | 0.225 | 0.315 | | | | | | |

| Output Current 1 | | | Output Current 2 | | | Output Delay Time | Minimum Operating Voltage | | Detector Threshold Temperature Coefficient | | |
|---|------|------|----------------------------------|---------------------------|------|-----------------------|---------------------------|--|--|------------------------------------|------|
| I _{OUT1} [mA] | | | I _{OUT2} [mA] | | | t _{PLH} [μs] | V _{DDL} [V] | | Δ−V _{DET} /ΔT[ppm/°C] | | |
| Condition | Min. | Typ. | Condition | | Min. | Typ. | Max. | Typ. | Max. | Condition | Typ. |
| Nch V _{DS} =0.05V V _{DD} =0.85V | 0.2 | 0.3 | | V _{DD} = 1.1V | 1.0 | 2.2 | | Note 2 Condition 1 0.65 Condition 2 | Condition 1 0.85 Condition 2 0.95 | | |
| | | | | | | | | | | | |
| Nch V _{DS} =0.05V V _{DD} =0.7V | 0.05 | 0.13 | Nch V _{DS} = 0.5V | V _{DD} = 1.5V | 2.0 | 5.0 | Note 1 100 | Note 2 Condition 1 0.45 Condition 2 | Note 2 Condition 1 0.70 Condition 2 0.80 | −40°C ≤ T _{opt} ≤ 85°C | ±100 |

OPERATION

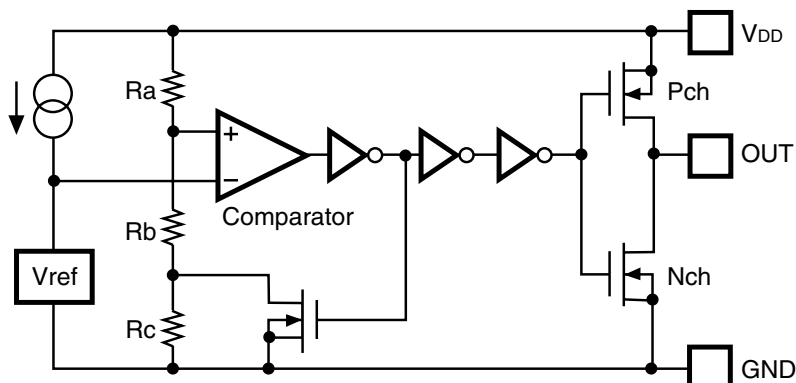


Figure 1. Block Diagram

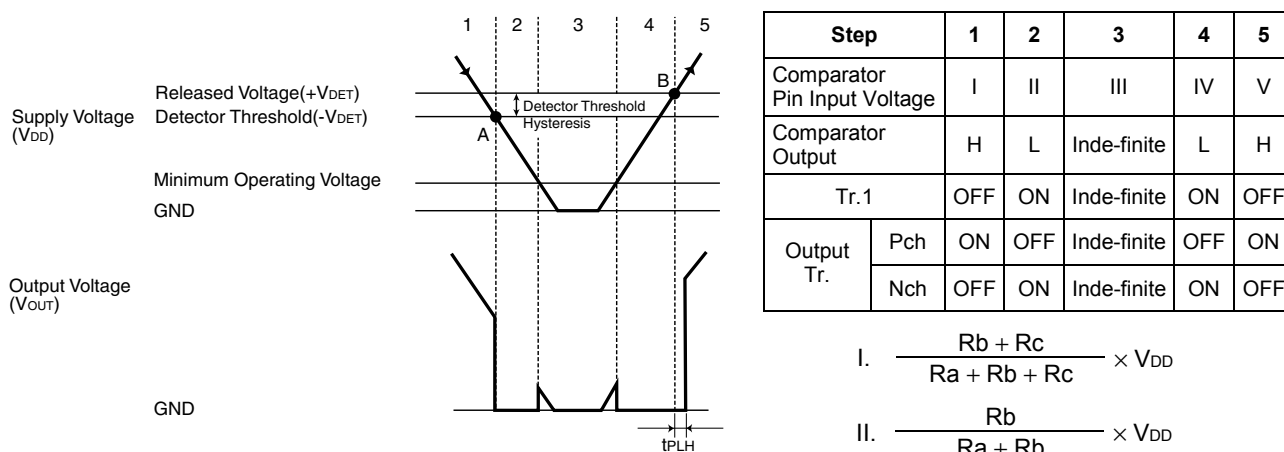


Figure 2. Operation Diagram

Step 1. The output voltage is equal to the supply voltage (V_{DD}).

Step 2. At Point "A", $V_{ref} \geq V_{DD} \times (R_b + R_c) / (R_a + R_b + R_c)$ is true, as a result, the output of comparator is reverse, and output voltage becomes to GND level. The voltage level of Point A means detector threshold voltage, or ($-V_{DET}$).

Step 3. When the supply voltage is less than minimum operating voltage, the operation of output transistor becomes indefinite, and in the case that output is pulled up to V_{DD} , the output voltage equals to V_{DD} voltage.

Step 4. The output voltage equals to GND level.

Step 5. At Point "B", $V_{ref} \geq V_{DD} \times R_b / (R_a + R_b)$ is true, Output of the comparator is reverse, and output voltage is equal to the supply voltage, or (V_{DD}). The voltage level of Point B means released voltage, or ($+V_{DET}$).

* The difference between released voltage and detector threshold voltage is the detector threshold hysteresis.

TEST CIRCUITS

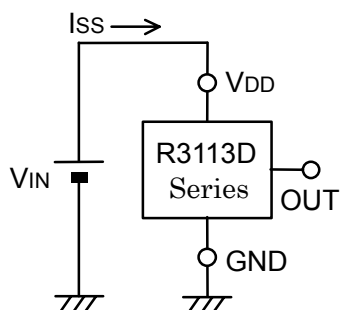
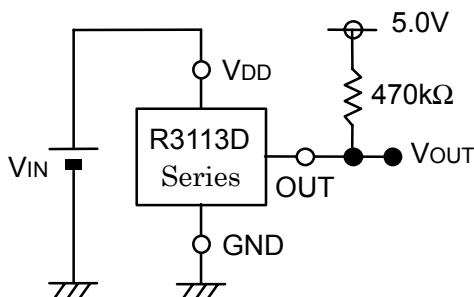


Figure 3. Supply Current Test Circuit



Pull-up circuit is not necessary for CMOS Output type, or R3113xxxxC.

Figure 4. Detector Threshold Test Circuit

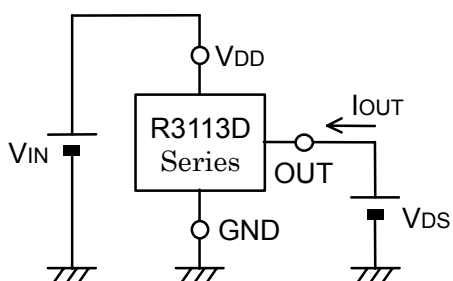
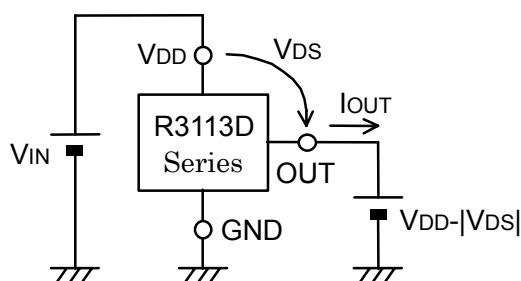


Figure 5. Nch Driver Output Current Test Circuit



*Apply to CMOS Output type only

Figure 6. Pch Driver Output Current Test Circuit

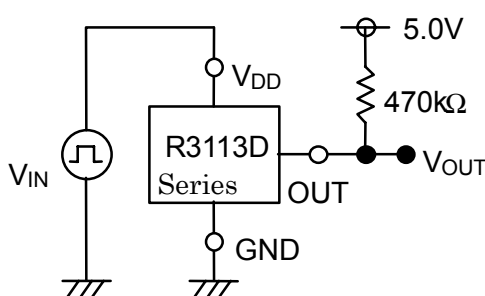
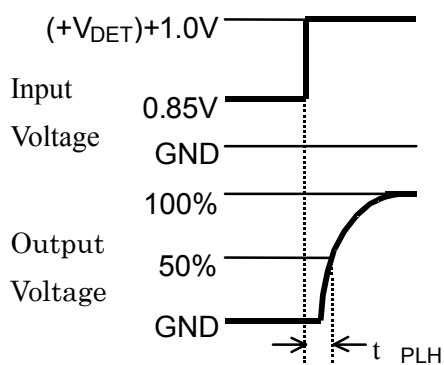
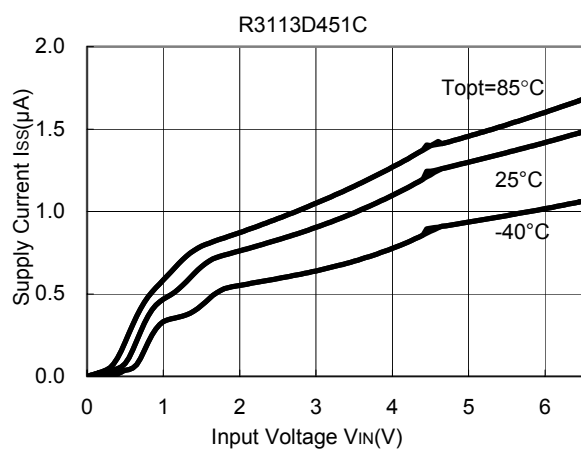
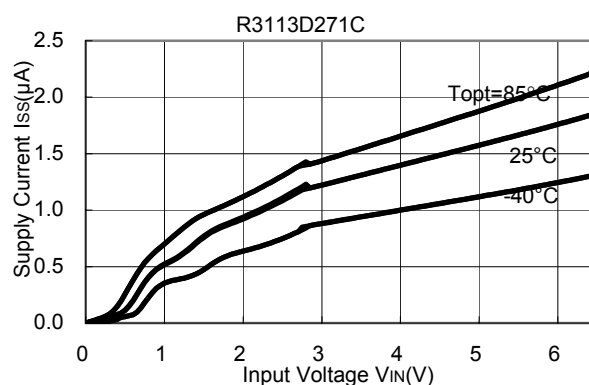
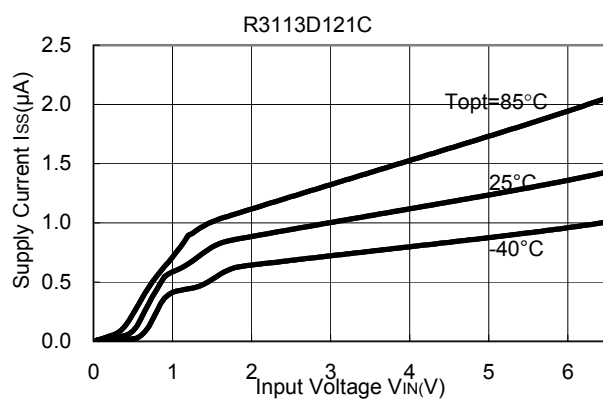


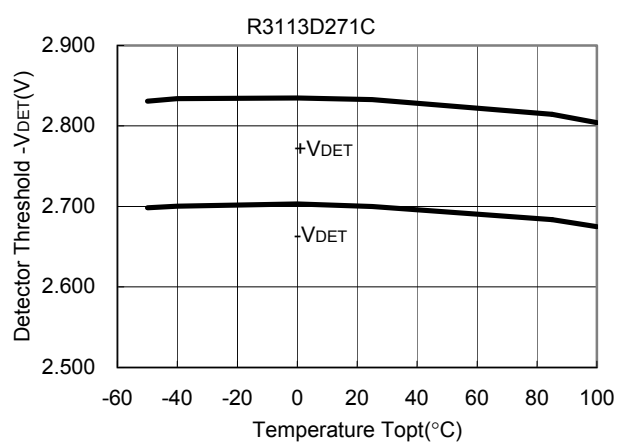
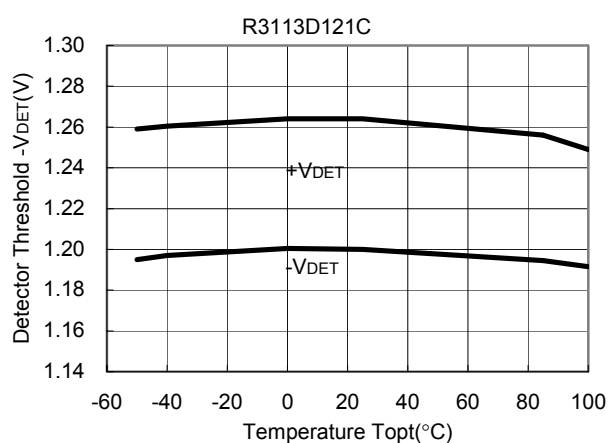
Figure 7. Output Delay Time Test Circuit (1) Figure 8. Output Delay Time Test Circuit (2)

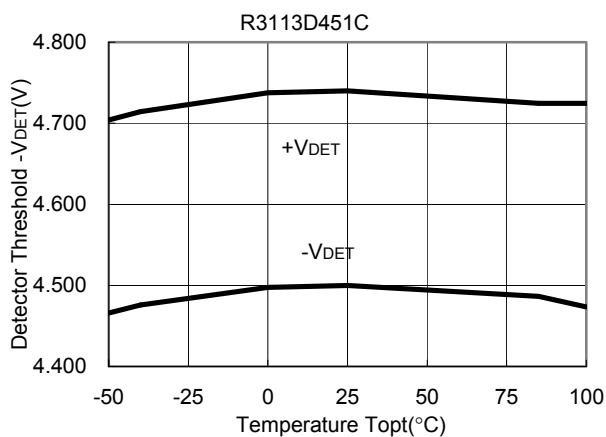
TYPICAL CHARACTERISTICS

1) Supply Current vs. Input Voltage

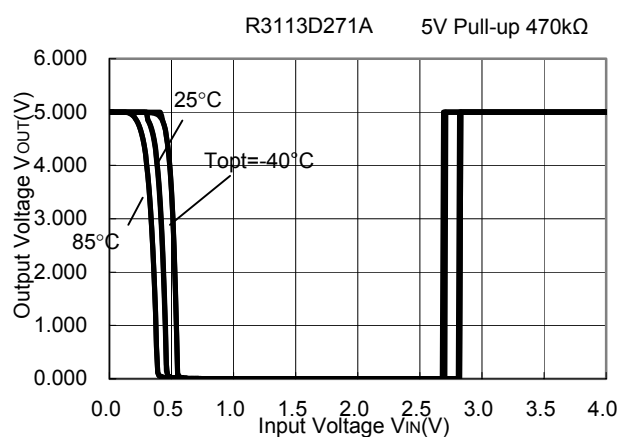
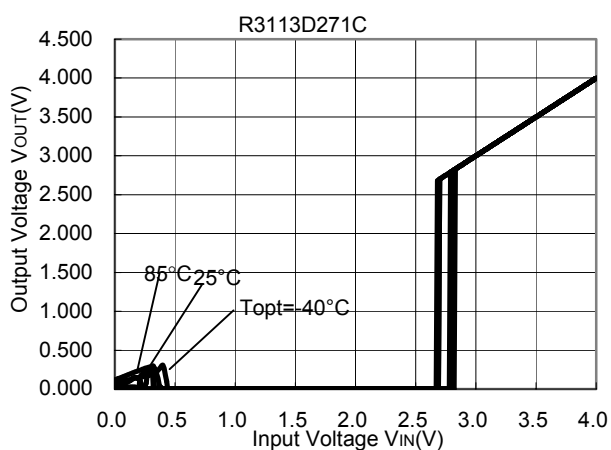
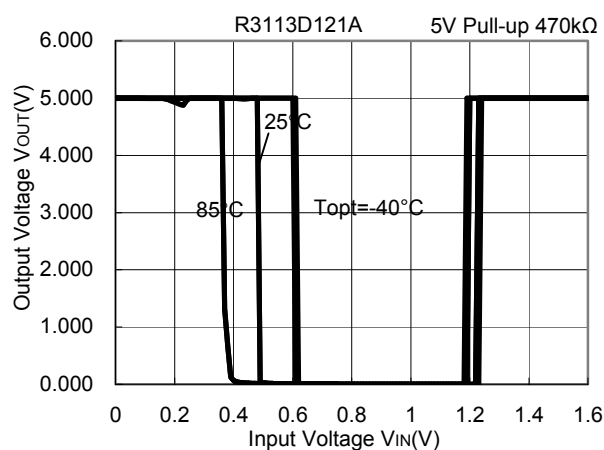
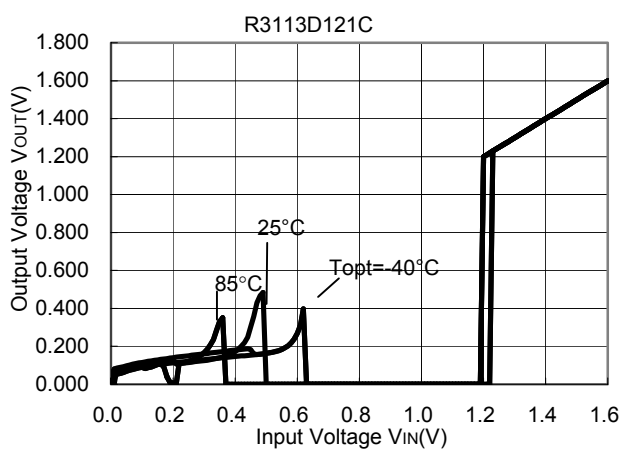


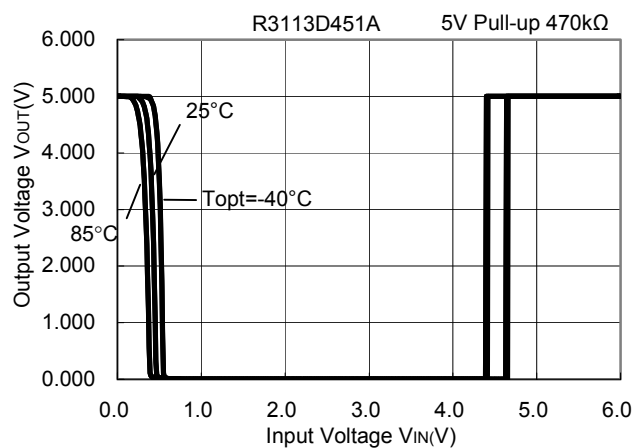
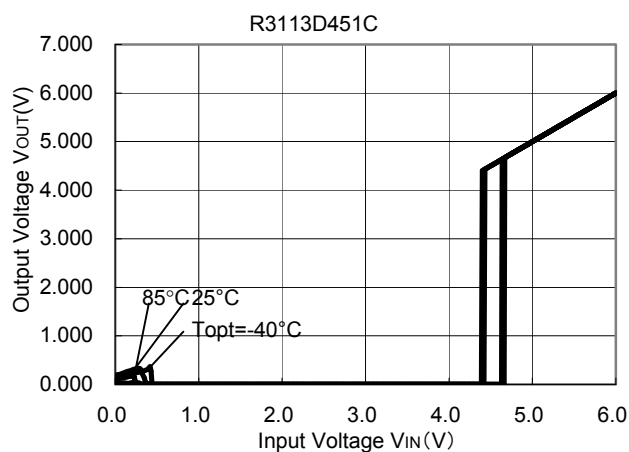
2) Detector Threshold Hysteresis vs. Temperature



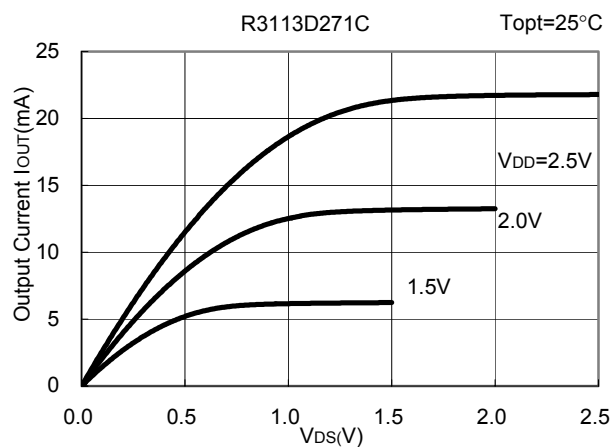
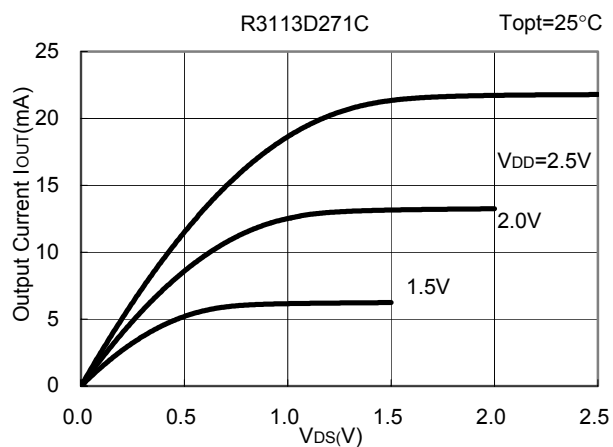
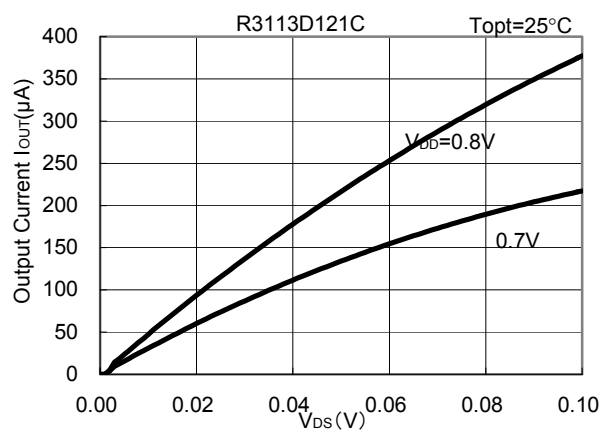
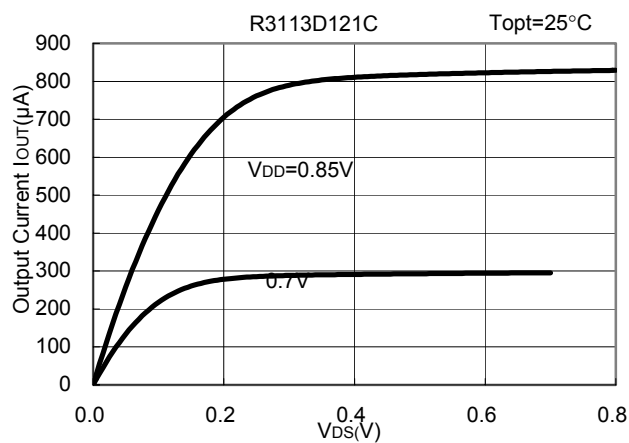


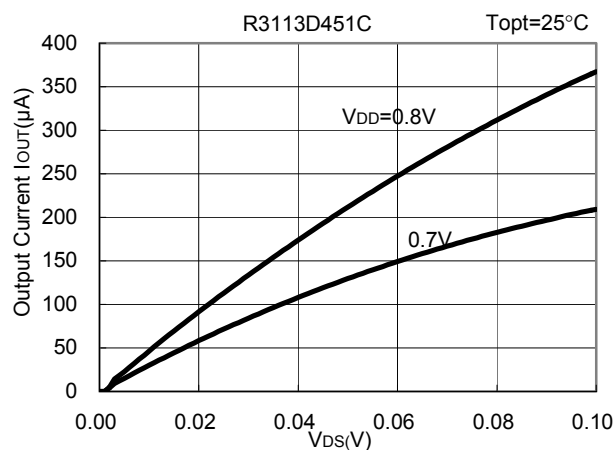
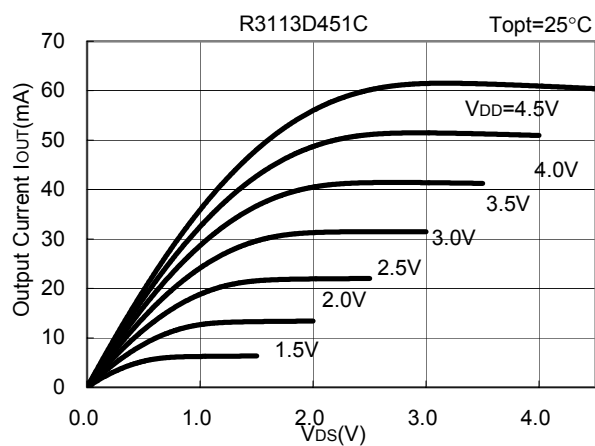
3) Output Voltage vs. Input Voltage



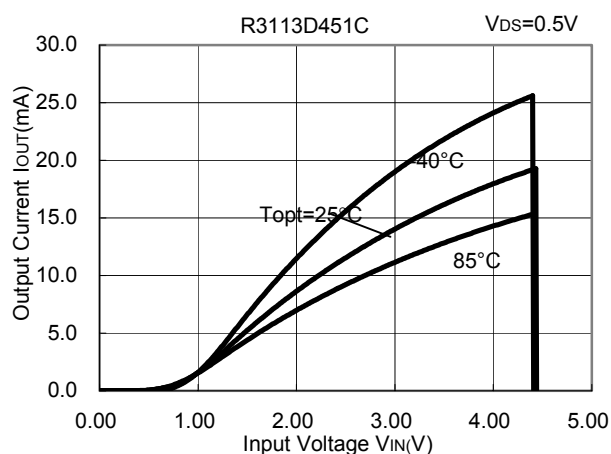
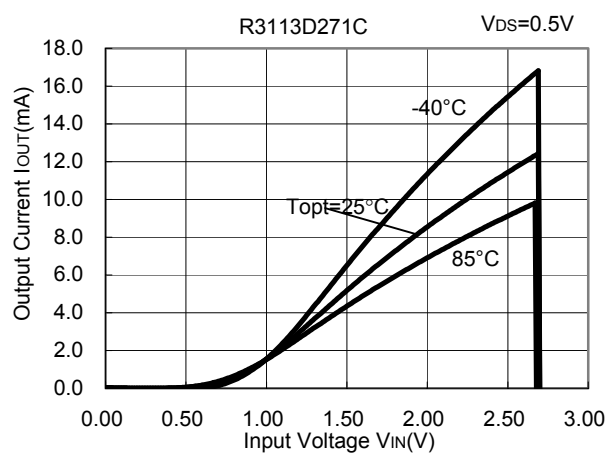
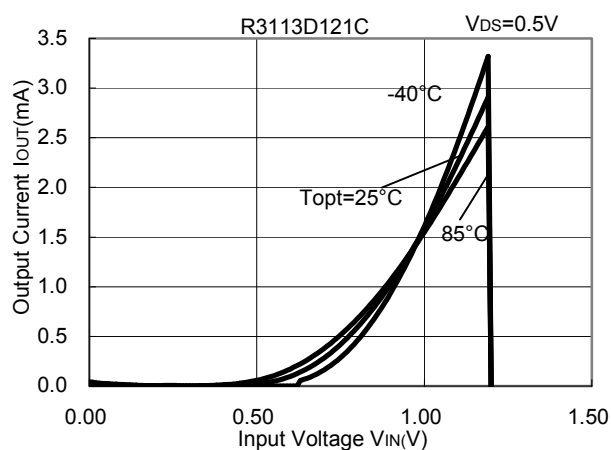


4) Nch Driver Output Current vs. V_{DS}

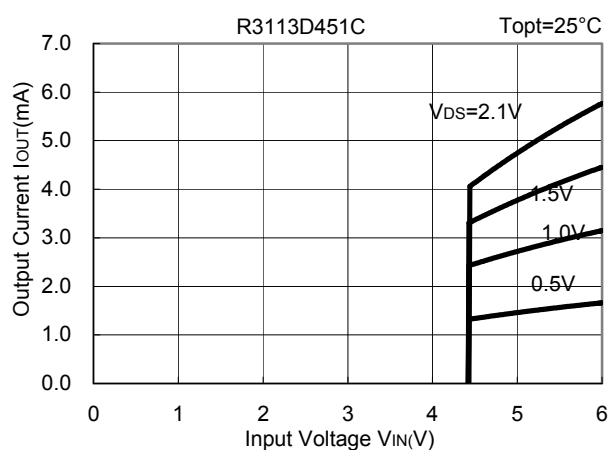
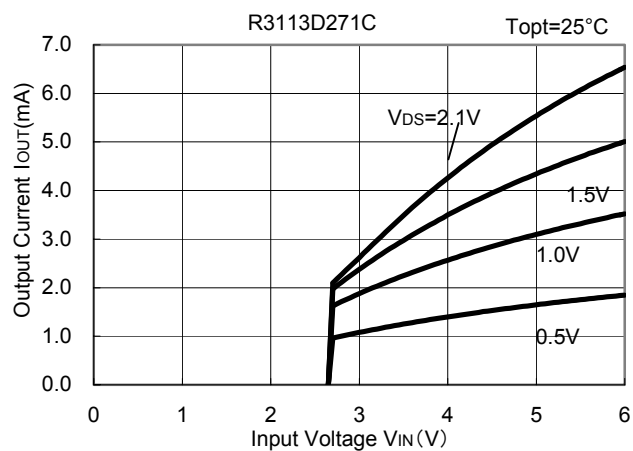
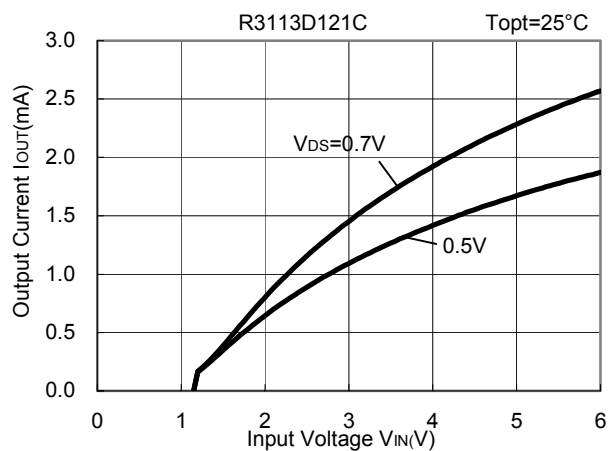




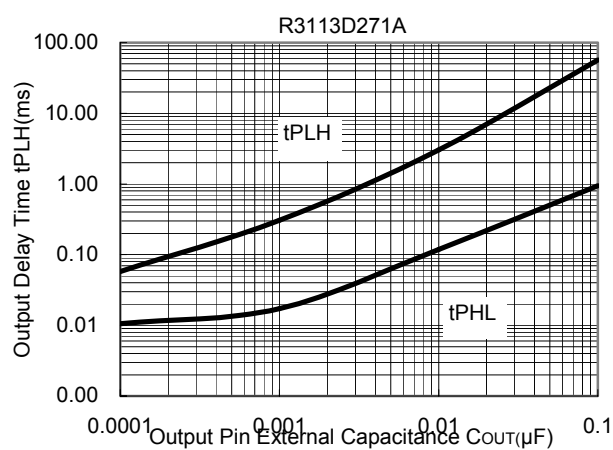
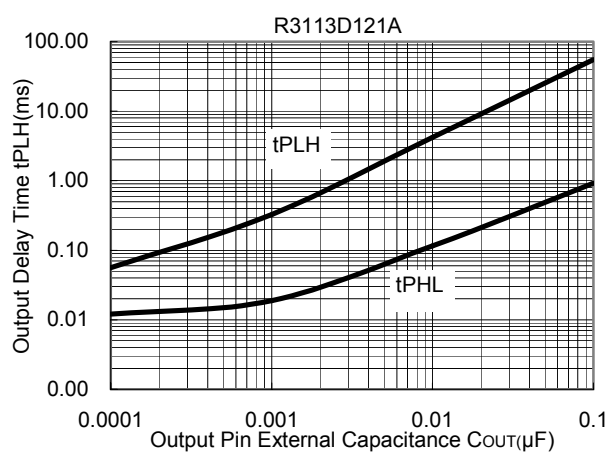
5) Nch Driver Output Current vs. Input Voltage

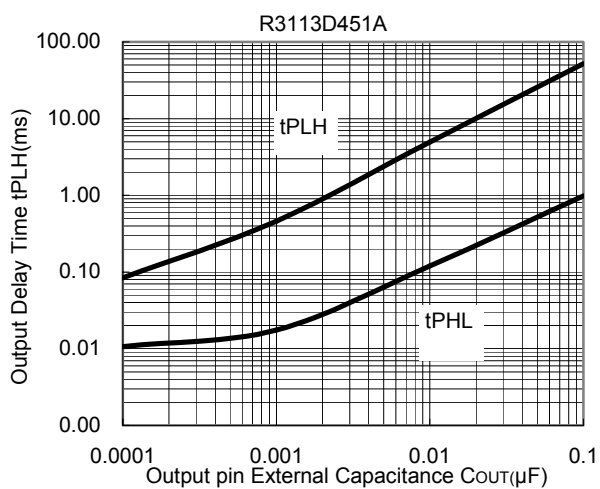


6) Pch Driver Output Current vs. Input Voltage

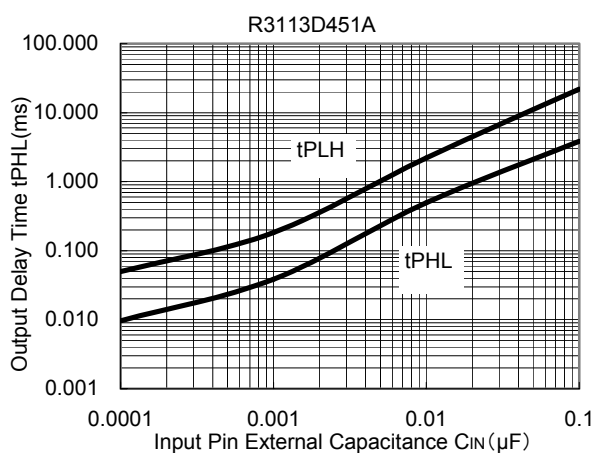
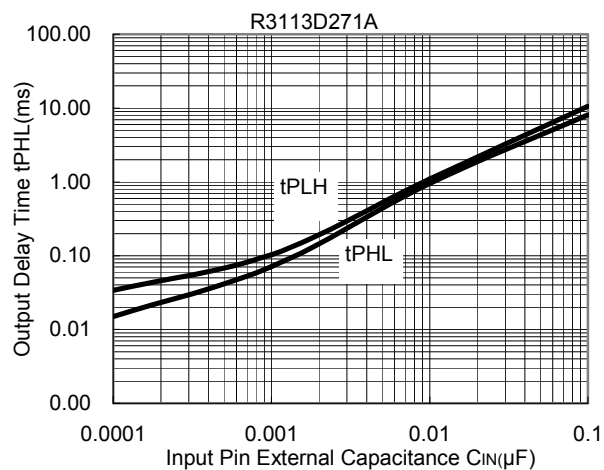
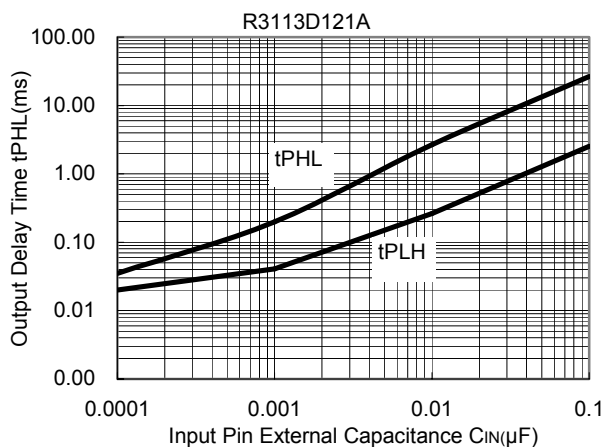


7) Output Delay Time vs. Load Capacitance





8) Output Delay Time vs. Input Pin Capacitance



TECHNICAL NOTES

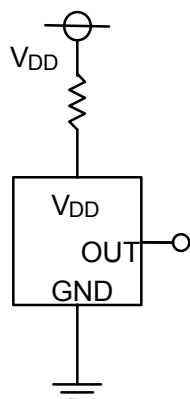


Figure 9

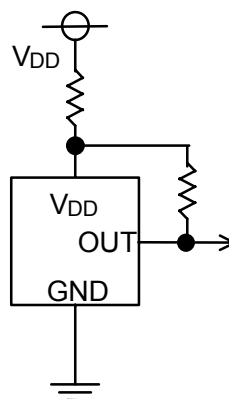


Figure 10

1. In Figure 9, When R3113Dxx1C is used, and if an impedance is connected between Voltage Supplier and the V_{DD} Pin of R3113Dxx1C Series, the operation might be unstable by cross conduction current at detection.

When R3113Dxx1A is used in Figure 9, if the value of R is set excessively large, voltage drop may occur caused by supply current of IC itself and Detector threshold may vary.

2. Wiring as shown in Figure 10 may cause the oscillation in both output types of R3113 Series.